Development, Assessment and Implementation of Program Educational Objectives and Program Outcomes of BSEE Program

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Abstract

Systematic development of program educational objectives and program outcomes and their assessment for continuous improvement in program effectiveness requires relevant consideration of constituent needs or requirements and program mission. The assessment criteria should reflect program aspirations and should be reflected in assessment tools. This paper describes successful development of program educational objectives and program outcomes that reflect university and college missions and skill sets desired by prospective employers. Qualitative and quantitative assessment tools are used to identify areas of improvement for continuous enhancement of program effectiveness.

Introduction

Systems engineering approach is used to address the need for highly qualified workforce to address the technological needs of our society. The goals and objectives of the department are developed through a top-down approach to reflect the needs of the society and are consistent with the mission of the University and the College. The goal of the Department of Electrical and Computer Engineering at Tennessee State University is to offer a high quality, broad-based program in electrical engineering, complemented by basic and applied research and public service, to prepare its graduates for starting positions in industry, government and/or pursue graduate study in related fields.

Development of Program Educational Objectives and Program Outcomes

ABET EC 2000 criteria has two new criteria (Program Educational Objectives and Program Outcomes and Assessment) in addition to the six criteria for program assessment in the old ABET criteria[1,2]. The B.S. in Electrical Engineering program offered by Tennessee State University developed its Program Educational Objectives (PEO), as shown in Table 1, that are consistent with the mission of the University, and its College of Engineering, Technology and Computer Science, address the requirements of its constituents, and its aspirations. Its constituents include matriculating students, faculty, alumni, industry and industrial cluster members and the departmental industrial cluster committee. The constituents are selected based upon their interest and involvement in our program and its graduates. The inputs from industry, technical and professional societies, ABET, governmental agencies, etc, regarding skills desired of engineering graduates are mapped in Table 2.

The Program Educational Objectives (PEO) of the Electrical Engineering (EE) program are:

1 To provide the student with the knowledge of natural sciences, mathematics, engineering and computer science so that the student has the ability to systematically delineate and solve electrical and related engineering problems.

2 To provide the student with a broad-based background in electrical engineering with experiences in the design, development and analysis of electrical and computer systems, subsystems and components.

3 To provide the students with an engineering education to function as educated members of a global society, with awareness of contemporary issues, professional responsibility, ethics, impact of technology on society, and the need for life-long learning.

4 To provide the students with skills to function as members of multidisciplinary teams, and to communicate effectively using modern tools.

These Program Educational Objectives (PEO) describe the characteristics and capabilities that the alumni of our Electrical Engineering program are expected to exhibit a few years after graduation. The fulfillment of these PEOs provides quality education in Electrical Engineering at Tennessee State University.

Development of Program Outcomes

After reviewing, revising and updating the PEOs, the departmental faculty began the process of developing a statement of Program Educational Outcomes. After several departmental and College meetings on this topic, the College's Administrative Council decided to adopt the ABET EC 2000 Educational Outcomes (a through k of Criterion 3) as the foundation for all engineering programs [2] . The departmental faculty decided to add one more outcome 'l' to address program specific requirement and the remaining three outcomes 'm', 'n', and 'o' were added with input from the Industrial Cluster and College Administrative Council. With input from matriculating students, review and approval by the Departmental Cluster Committee and College Administrative Council, the following 'a' through 'o' Program Outcomes were selected and were published in the current Undergraduate Catalog and on the departmental website.

Table 3 and Figure 1 reflect the process of continuous review, analysis, evaluation and updating of the program Educational Objectives and Program Outcomes and the involvement of various constituents.

Table 1

University Statement of Mission Mapped To Electrical Engineering PEO [3]

	TENNESSEE STATE UNIVERSITY STATEMENT OF MISSION					
PROGRAM EDUCATIONAL OBJECTIVES	**1. Provide quality instruction**	**2. Provide for pure and applied research**	**3. Provide constituents an array of programs and services**	**4. Commitment to overall student developments**	**5. Projects to students to "Think, Work, Serve"**	**6. Committed to the education of multiracial, multi-ethnic, multi- cultural student body**
1 To provide the student with the knowledge of natural science, mathematics, engineering and computer science so that the student has the ability to systematically delineate and solve electrical and related engineering problems.	●					
2 To provide the student with a broad-based background in electrical engineering with experiences in the design, development and analysis of electrical and computer systems, subsystems and components.	●	●	●			
3 To provide the students with an engineering education to function as educated members of a global society, with awareness of the contemporary issues, professional responsibility, ethics, impact of technology on society, and the need for life-long learning.				●	●	
4 To provide the students with skills to function as members of multi-disciplinary teams, and to communicate effectively using modern tools.		●		●		●

Table 2
Mapping of Attributes of an Attractive Engineering Graduate

PROGRAM EDUCATIONAL OBJECTIVES / ATTRIBUTES OF AN ATTRACTIVE ENGINEERING GRADUATE BY INDUSTRY	1. To provide the student with the knowledge of natural science, mathematics, engineering and computer science so that the student has the ability to systematically delineate and solve electrical and related engineering problems.	2. To provide the student with a broad-based background in electrical engineering with experiences in the design, development and analysis of electrical and computer systems, subsystems and components.	3. To provide the students with an engineering education to function as educated members of a global society, with awareness of the contemporary issues, professional responsibility, ethics, impact of technology on society, and the need for life-long learning.	4. To provide the students with skills to function as members of multi-disciplinary teams, and to communicate effectively using modern tools.
BOEING CORPORATION AND NSF				
1. A good grasp of engineering science fundamentals: Mathematics, including statistics, Physical and life sciences, Information technology	●			
2. A good understanding of the design process and manufacturing		●		
3. A basic understanding of the context in which engineering is practiced: economics, history, ethics and the environment, and customer and societal needs			●	
4. Good communication skills (written, verbal, graphic, listening) **NSF**				●
5. Ability to think both critically and creatively; independently and cooperatively			●	
6. Flexibility: ability and self-confidence to adapt to rapid/major change			●	
7. Curiosity and a desire to learn—for life			●	
8. Profound understanding of the importance of teamwork				●
GENERAL MOTORS MANUFACT.				
. 1. Problem solving skills	●	●		
2. Communication skills .written & oral **NSF**				●
3. Quality & continuous improvement focus			●	
4. Leadership ability				
5. Technical knowledge		●		
6. Team focus				●
7. Project management - **NSF**		●		
8. Global thinker - **NSF**				●
FORD MOTOR COMPANY & NSF				
1. Business sense and understand the economics		●		
2. Team work and leadership skills **NSF**				●
3. Eager to learn			●	
4. People and communication skills **NSF**				●

Table 3.

Constituent Input and their Involvement in Evaluation of PEO and PO

INPUTS FROM CONSTITUENTS	Faculty	Graduating seniors	Matriculating students	Student leadership Con.	Pre-engr. Students, Parent	College	University	Industrial Cluster	Alumni Association	EE Alumni	Employer	Accreditation Agencies	Prof. & Tech. Societies
REVIEW OF PROGRAM EDUCATIONAL OBJECTIVES AND PROGRAM OUT COMES													
1. Review of college and departmental educational goals and objectives	●				●				●				
2. Major contributors in the establishment and evaluation of Program Educational Objectives & Outcomes	●			●		●	●	●	●		●		
3. Constituents who periodically assess Program Educational Objectives, Program Outcomes, and student performance	●	●	●					●		●	●		
4. Major impact on the development and minor impact on the assessment of Program Educational Objectives												●	●
EVALUATION OF EDUCATIONAL OBJECTIVES AND PROGRAM OUTCOMES													
1. Faculty evaluation of student performance in EE courses which ensure the achievement of the course objectives and Overall Program Educational Objectives and Outcomes **Instrument:** Faculty Course Outcomes Assessment Report and Departmental Accreditation Committee Assessment Report	●												
2. Graduating seniors self assessment of their ability to achieve Program Educational Objectives and POs, and matriculating Student Course Assessment Survey of Course Objectives and Outcomes **Instrument:** Senior Exit Survey, Student Course Assessment Survey		●	●	●									
3. EE Alumni self assessment of ability to perform job related tasks using skills, gained from courses which ensure achievement of course and overall PEOs and POs **Instrument:** Alumni self Assessment of Performance in the Work-Place										●			
4. Employer assessment of alumni performance in completing tasks using skills which should have been acquired in those courses identified as ensuring achievement of Program Eos and POs. **Instrument:** EE Industrial Cluster Comm.- App Employer Survey of Alumni											●		

Table 4

Course Coverage of EE Program Outcomes [3]

Course Outcomes	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
MATH 1060 Calculus I	x														
ENGL 1010, 1020 Fresh. English I, II							x								
ENGR 100L Intro. To Engr. I	x			x	x	x	x	x	x	x	x		x		
CHEM 151 Gen. Chem. Eng	x														
CHEM 151L Gen. Chem. Lab	x	x		x			x								
ENGR 115L Engr. Graphic Des				x	x		x				x		x		
MATH 1070 Calculus II	x														
ENGR 101L Intro to Engr. II	x	x	x	x	x	x	x	x	x	x	x	x	x		
PHYS 2030 Gen. Physics I	x														
PHYS 2031 Gen. Physic I Lab	x	x		x			x				x				
HIST 2010 American History I							x	x		x					
MATH 263 Calculus III	x														
PHYS 2040 Gen. Physics II	x														
PHYS 2041 Gen. Phys. II Lab.	x	x		x			x				x				
MATH 264 Calculus IV	x														
ENGR 223L Computer C++ Prog. Lab	x				x		x				x				
PHY 223 Physics III	x														
ENGR 213 Statics	x		x		x								x		
ENGL 2010 Literature I							x								
MATH 303 Applied Math.	x														
ENGR 200 Circuits I	x				x				x		x				
ENGR 200L Circuits I Lab.	x	x		x			x		x		x	x	x		
ENGR 212 Dynamics	x		x	x	x		x		x		x				
ENGR 225 Transport Phenom.	x		x		x	x	x		x	x	x		x		
ENGR 320 Intro. To Design	x		x	x	x	x	x	x	x	x	x	x	x	x	
EE 212 Circuits II	x		x		x						x		x		
EE 306L Adv. Programming	x						x		x		x				
EE 310 Digital Logic Design	x		x	x	x		x	x			x		x	x	
EE 310L Digital Logic Lab		x	x	x			x				x		x		
ENGR 330 Intro. Material Science	x	x	x	x	x		x	x	x		x		x		
ENGL 2020 Literature II							x								
ENGR 340 Numerical Analysis	x	x			x						x	x			
EE 320 Linear Systems	x				x				x		x				
EE 321 E. M. Theory	x				x				x	x	x				
EE 330 Electronics	x		x		x	x	x		x		x				
EE 330L Electronics Lab	x	x	x	x	x	x	x				x		x		
CS 320 Discrete Math	x														
EE 341 Energy Conversion	x		x		x				x						
EE 350 Communication Sys.	x		x	x	x		x			x	x	x	x		
EE 400 Control Systems I	x		x		x	x	x		x		x				
EE 400L Control System Lab		x	x	x	x		x				x				
EE 410L Elect. System Lab.	x	x	x	x	x	x	x	x	x	x	x		x	x	
ENGR 420L FE Review	x				x				x			x		x	
ENGR 450 Capstone Design I	x		x		x	x	x	x			x				
EE 431 Software Engineering	x		x	x	x	x	x	x	x		x				
Hum Elec. & Soc. Science Elect.								x		x					
EE 342 Power Systems	x		x		x	x	x	x	x	x	x	x	x		
EE 430 Digital Comp. Struct.	x		x		x	x	x		x		x				
ENGR 451 Capstone Design II	x		x		x		x	x	x	x	x			x	x
EE 480 Intro. to Microprocessor.	x		x		x	x	x	x	x	x	x				
ENGR 490 Prof. Dev. Seminar						x	x	x	x	x				x	x
Tech. Electives (2)	x		x		x				x	x	x		x	x	

X - means covered outcome. a score of 3.0 or more out of 4.0 is considered acceptable outcome

All graduates of the Electrical Engineering program are expected to have[3]:

a. an ability to systematically apply knowledge of mathematics, science and engineering sciences to solve problems
b. an ability to plan, design, and conduct engineering experiments as well as to analyze and interpret data and report results
c. an ability to systematically identify, formulate, design and demonstrate electrical engineering systems, subsystems, components and/or processes that meet desired performance, cost, time and safety requirements
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate and solve engineering and electrical engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate technical information through professional quality reports, oral presentations and interaction with audience
h. the broad education necessary to understand the impact of electrical 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 modern techniques, skills and tools including computer based tools for analysis and design
l. knowledge of probability and statistics, numerical analysis and their applications.
m. familiarity with appropriate Codes and Standards
n. awareness of business environment in which engineering systems are designed and developed.
o. a sense of security and capability to integrate it into electrical system design

Assessment Process and Criteria to Measure Success

Learning is described as a four step process of (1) Information, (2) Comprehension, (3) Synthesis and (4) Application. A top-down (preliminary design) approach is used to allocate these program Educational Objectives and Program Outcomes to individual course objectives and course outcomes. Our B.S.E.E. four year curriculum is a reflection of the learning process and leads to the achievement of the Program Education Objectives and Program Outcomes through systematic and progressive learning[1,3]. The contribution of each course in the curriculum to the accomplishment of the program outcomes is mapped in Table 4. The contribution of each individual course to different Program Outcomes is assessed through: (1) the Student Course Assessment Survey, and (2) the Faculty Course Outcomes Assessment ("Closing the Loop") Report. These two assessment tools together with assessment from the Senior Exit Survey, and the contribution of the Capstone Design Project II report constitute the Internal Assessment of the Program Outcomes. Four other tools, the Employer Survey, the Alumni Survey, Departmental Industrial Cluster Input and the Capstone Design Oral Presentation constitute the External Assessment. The overall assessment process to measure achievement of these outcomes involves analysis of input from these eight different tools as listed in Table 6. The Program Outcomes map the PEOs and assure achievement of PEOs[3]. The Program Educational Objectives are assessed through

internal and external input and quantitative and qualitative tools as shown in Table 5. The quantitative tools are specifically designed to assess PEOs.

Metric Goals for Assessment of PO and PEOs

The metric for assessing overall success in achievement of an outcome is that six out of eight measurement tools, described above and listed in Table 5, will either have a score of 3.0 or more out of 4.0 or satisfactory assessment. Any average score that is less than 3.0 in any of the tools will trigger a detailed review of that tool and data to identify areas for improvement.

Each course will be assessed, for its contribution to the various outcomes by using the Student Course Assessment Survey forms. The cumulative average of the contributions of all courses, shown in Table 4, to an outcome is shown as the Student Course Assessment Survey (quantitative) contribution in Table 6. The criteria for successful achievement of an outcome, in this tool, will be a score of 3.0 or better out of 4.0 in the cumulative average.

The Faculty Course Outcomes Assessment (qualitative) Report is an overall evaluation, by the course faculty, of the course's contribution to its individual outcomes and course objectives. Faculty considers the evaluation of specific modules of home work assignments, tests and examinations, any computer assignments, special reports, and/or design reports required for the course. Faculty also uses the results of Student Course Assessment Survey and Student Evaluation of Instruction results in developing the Faculty Course Outcomes Assessment Report for each course.

All of the Faculty Course Outcomes Assessment Reports are then further analyzed by the Departmental Accreditation Committee to identify the level of overall success in achieving Program Educational Objectives and Program Outcomes from the combination of individual course reports. The assessments of each PEO and PO are shown under the column Departmental Accreditation Committee Assessment in Tables 5 and 6 respectively.

The fourth item of internal assessment includes input from Capstone Design Project II written report which contributes to a few of the specific outcomes and this is a qualitative input. The results of external quantitative inputs from Employer Survey, and Alumni Survey, and qualitative input from Cluster Committee Review, the Capstone Design Written Reports and Oral Presentations are tabulated in Tables 5 and 6 for PEO and PO respectively.

Evaluation, Assessment and Demonstration of Achievement of PEO

1. The Electrical Engineering Program Educational Objectives are mapped to the skill sets required by the various industries listed in Tables 2. This table shows agreement between Electrical Engineering Program Educational Objectives and the industry requirements for hiring of Electrical Engineering graduates. This indicates

that the Electrical Engineering Program Educational Objectives are in agreement with industrial skill set requirements.

2. The Program Educational Objectives are mapped to University Educational Objectives and the College Mission. These mappings show excellent agreement between Electrical Engineering Educational Objectives and the University Educational Objectives and College mission.

3. The Electrical Engineering Program Educational Objectives are also mapped to the Program Outcomes, which are in agreement with ABET Criteria. The Electrical Engineering Program Educational Objectives are also mapped to the IEEE Program Criteria. Both show excellent agreement.

4. The Electrical Engineering Program Educational Objectives are mapped to the Employer and Alumni surveys. Their results indicate satisfactory performance of the Electrical Engineering graduates in the work place. Results of Employer and Alumni Surveys are shown in Table 5[3].

5. The Electrical Engineering Program Educational Objectives are mapped to the Senior Exit Survey which indicates that they have met the objectives in the courses which ensure achievement of the Program Educational Objectives as shown in Table 5.

6. The Faculty Course Outcomes Assessment Report assesses achievement of individual course objectives for each course taught by the faculty. The Departmental Accreditation Committee's assessment of cumulative Faculty Outcomes Assessment Reports assesses the achievement of the overall Electrical Engineering Program Educational Objectives and is shown in Table 5.

The system of ongoing evaluation process described earlier uses input from eight different sources: (1) Faculty - Departmental Accreditation Committee, (2) Senior Exit Survey, (3) Alumni Survey, (4) Employer Survey, (5) Departmental Industrial Cluster Input (6) Department Head, (7) College Accreditation Steering Committee, (8) College Administrative Council. The last three basically review the recommendations and provide feedback and approval.

The cumulative results from the first five sources are listed in Table 6 and were used in overall recommendations.

As shown in Table 5, at least four tools indicated that all the Electrical Engineering Program Educational Objectives have been achieved according to our chosen criteria.

Electrical Engineering Faculty is involved in the final decisions on recommendations from the Departmental Accreditation Committee, the Departmental Curriculum Committee, and feedback from College, University Administration, and Supporting Programs.

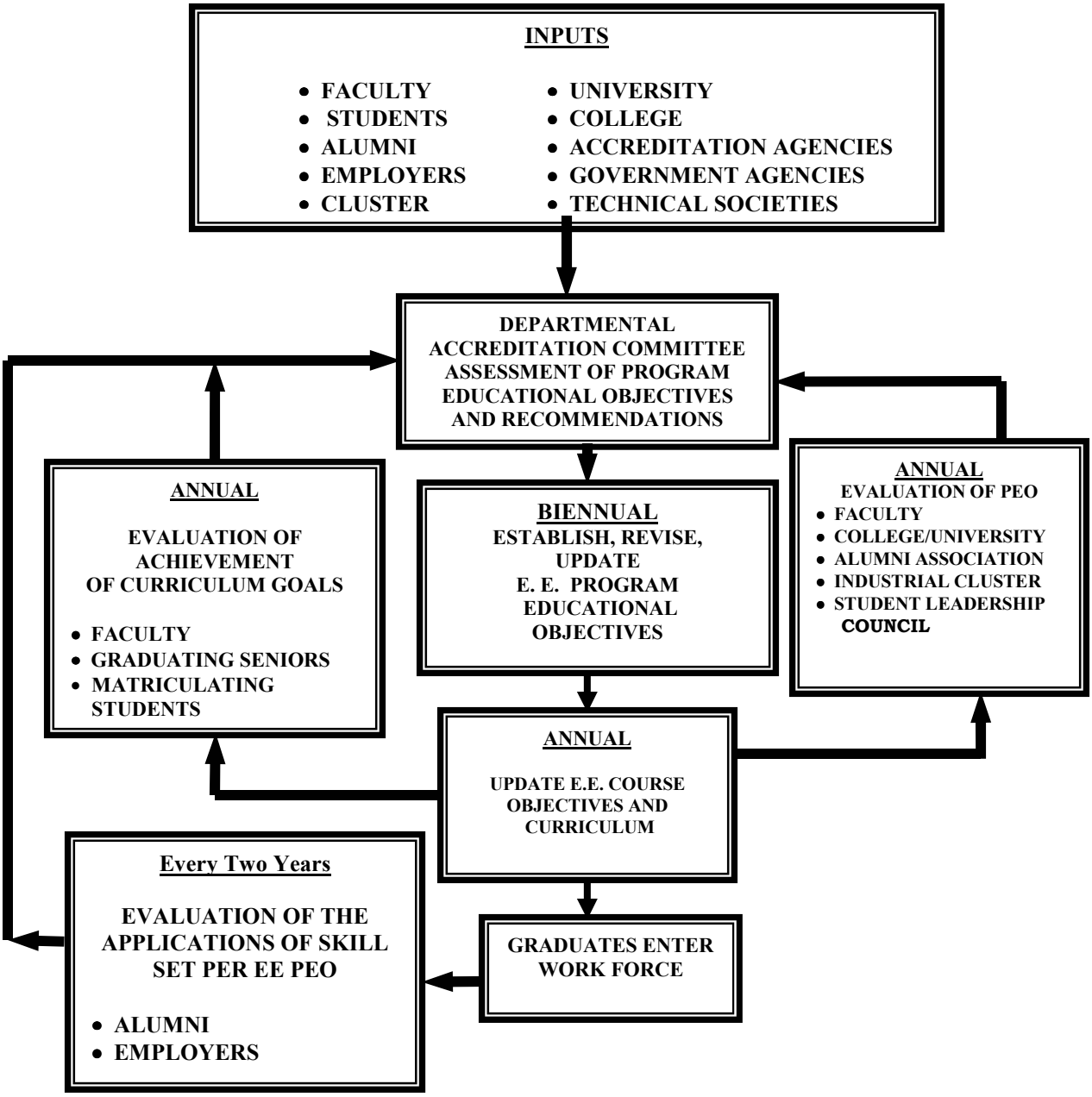

Figure 1. Process for Development, Assessment, Evaluation and Approval of PEO and Program Outcomes [3]

Evaluation, Analysis and Demonstration of Achievement of POs

The various tools that were used for assessment of Program Outcomes and their results are shown in Table 6. The criteria for defining success in achieving the desired level of competency is a cumulative average of 3.0 or more out of 4.0 (or 75%) in quantitative tools and satisfactory or better performance in qualitative tools [3,4].

These tools are used to identify areas needing improvement. Once these areas are identified, steps for improvement are developed.

Eight of the tools listed below are used for internal and external assessment of the electrical engineering Program Outcomes. The internal and external assessments include both quantitative and qualitative assessments. The internal assessment tools include: (1) Senior Exit Survey, (2) Summary of Student Course Assessment Survey, (3) Departmental Accreditation Committee's assessment of the Faculty Course Outcomes Assessment Reports, (4) Capstone Design Project II Report. The external assessment tools include: (5) Employer Survey, (6) Alumni Survey, (7) Departmental Industrial Cluster Committee input and (8) Evaluation of Capstone Oral Presentation by Cluster. Additional assessment tools that may be used to further identify any areas needing improvement are explained in reference 3.

Assessment Tools

The various tools that were used for assessment of Program Outcomes are explained here in detail.

Senior Exit Survey (Quantitative)

A graduating student's assessment of the level of accomplishment of the Program Outcomes is carried out through the Senior Exit Survey. One part of this survey is designed to evaluate the level of achievement of the Program Outcomes. This survey document is prepared by the Departmental Accreditation Committee in consultation with the department head and is approved by the ECE faculty and the College. This survey is conducted and collected every semester by the departmental secretary during the final week of the student's graduation semester. The survey is summarized and analyzed by the Departmental Accreditation Committee. It is also reviewed by the department head. The survey data is filed and maintained by the departmental secretary but the summary results are maintained by the department head.

Student Course Assessment Survey (Quantitative)

This survey is unique for each course and is used to seek student input in determining the level of achievement of each of the individual Program Outcomes covered by the given course. Table 4 is used to determine the survey questions. Each course survey form is prepared by the Departmental Accreditation Committee in consultation with the course instructor and approved by the ECE faculty and the Department Head. This survey is conducted and collected, during the last two weeks of the semester, every time the course is offered, by the departmental secretary. The survey is summarized and analyzed by the Departmental Accreditation Committee and reviewed by the department head. The survey data is filed and maintained by the departmental secretary but the summary results are maintained by the department head and a copy is given to the instructor of the course.

Departmental Accreditation Committee Assessment of Faculty Course Outcomes Assessment Reports (Qualitative)

The Departmental Accreditation Committee provides a qualitative assessment of the achievement of Program Outcomes based upon cumulative analysis of Faculty Course Outcomes Assessment Reports.

The faculty input is the most important of all assessments because it uses all the elements used for course assessment and includes the results from Student Course Assessment Survey and student evaluation of course instruction and the instructor. Faculty Course Outcomes Assessment Report for each course includes faculty assessment of course contributions to achievement of Program Educational Objectives and Program Outcomes, based upon contributions from applicable sample homework, tests, projects, presentations, computer assignments, and/or design project reports. It also includes recommendations for improvement and revised course outlines for continuous improvement. These reports are due within two weeks from the end of the semester the courses are offered. Faculty are also involved in the decisions on final recommendations from the Departmental Accreditation Committee, the Departmental Curriculum Committee and feedback from College, University Administration, and Supporting Programs wherever applicable.

Capstone Design Project II Report (Qualitative)

The ENGR 450 and 451 - Capstone Design Project I and II courses provide a culminating design experience for each graduating student. These include project issues reports on ethics, aesthetics, codes and standards, etc, engineering design and development, establishment of milestones, meeting established deadlines, and written technical report. These reports cover the Program Outcomes 'a, c, e, f, h, i, j, k, n and o'. The assessment tool is a completed Capstone Design Project II Check List prepared by the course project advisor and the course instructor. This tool was approved by the College Administrative Council and is maintained by the course instructor.

Employer Survey (Quantitative)

The Employer Survey is prepared and updated by the Departmental Accreditation Committee and approved by the ECE Faculty and the College Administrative Council. It is designed to seek employer input on the level of achievement of Program Educational Objectives (PEO) and Program Outcomes based upon their experience with employees who are graduates of the program. It also seeks input regarding the level of satisfaction with the services offered by the university for employers of our graduates. Every two years, the employers are surveyed using the Employer Survey form. This survey is conducted, collected, filed and maintained by the departmental secretary. It is analyzed, documented and reported by the Departmental Accreditation Committee, and the recommendations and results are sent to the department head for record keeping and for use to assess accomplishments.

Alumni Survey (Quantitative)

This survey document is prepared by the Departmental Accreditation Committee and approved by the ECE faculty, the Department Head, and the College Administrative Council. The Alumni Survey of the graduates of the past five years is conducted, every two years, by the departmental secretary. The Alumni Survey assesses the level of the accomplishment of the Program Educational Objectives, the Program Outcomes and other educational experiences. The Alumni Survey is mailed, collected, filed and maintained by the departmental secretary. It is reviewed, summarized and analyzed by the Departmental Accreditation Committee and the results are submitted to the department head for record keeping.

Departmental Industrial Cluster Input (Qualitative)

Twice a year, Industrial Cluster members visit the campus to review our students' ENGR 451- Capstone Design Project II presentations. During the second day of their visit, selected members of Cluster review individual program offerings and provide valuable input toward accomplishments of program educational objectives and other curriculum matters. This input is in the form of verbal and written recommendations to the department head and an overall input by the Cluster to the Dean and the College Administrative Council. This information is collected and reviewed regularly and is used in assessment as external input. The same criteria are used for this assessment also.

Evaluation of Capstone Oral Presentation by Cluster (Qualitative)

Every year in April and November, Industrial Cluster members and engineers from local industry are invited to review our senior students' ENGR 451 - Capstone Design Project II Oral Presentations. The summaries of the fall 2002 and spring 2003 "Evaluation of Capstone Design Oral Presentation by Cluster" show continuous improvement in oral presentations. The program outcomes covered by the Oral Presentation evaluation include 'a', 'c', 'e', 'g' and 'h'.

Additional tools are used only to identify areas that need improvement if any evaluation of an outcome is not satisfactory. These additional tools for each of the Program Outcomes are discussed in reference [3].

Demonstration of Achievement of Program Educational Objectives

Based upon the criteria defined earlier for successful achievement of the Program Educational Objectives (PEO), Table 5 shows that all four Program Educational Objectives have been achieved.

Analysis of these surveys also provided valuable information about our program. The fact that about 30% pursue graduate study of whom 5% pursue Ph.D. degrees, and that our graduates have moved up the corporate and governmental ladder to higher and more responsible positions is an indication that our program is effective in achievement of its Program Educational Objectives.

Table 5

Internal and External Tools for Program Educational Objectives Assessment [3]

Electrical Engineering Program Education Objectives	Senior Exit Survey	Departmental Accreditation Committee Assessment of Faculty Course Outcomes Assessment	Alumni Survey	Employer Survey	Industrial Cluster Input
1. To provide the Student with the knowledge of natural science, mathematics, engineering and computer science so that the student has the ability to systematically delineate and solve electrical and related engineering problems.	3.1	No change	3.57	3.58	Satisfactory
2. To provide the student with a broad-based background in electrical engineering with experiences in the design, development and analysis of electrical and computer systems, subsystems and components.	3.1	No change	3.75	3.66	Satisfactory
3. To provide the students with an engineering education to function as educated members of a global society, with awareness of the contemporary issues, professional responsibility, ethics, impact of technology on society, and the need for life-long learning.	3.0	No change	3.61	3.69	Contemporary issues
4. To provide the students with skills to function as members of multi-disciplinary teams, and to communicate effectively using modern tools.	3.3	No change	3.63	3.5	Satisfactory

Program Improvement

Over the past years, the electrical and computer engineering department has been assessing its programs and has developed new curriculum, new courses, revised course sequencing and prerequisite requirements within the program to improve its effectiveness. No formal official record of these assessments was kept other than what can be seen from the course and curricular changes in TSU catalogs of recent past.

Table 6
Program Outcomes Assessment Results [3]

Program Outcomes \ Assessment Survey	Internal assessment				External Assessment			
	Senior Exit Survey S03	Student Course Assessment	Faculty Course Outcomes	Capstone Design Proj.	Employer Survey	Alumni Survey F2002	Employ/ Industry Cluster	Capstone Design Oral Presentation
a. an ability to systematically apply knowledge of mathematics, science and engineering to problems	3.2	3.21	80% (3.2)	82.3% (3.3)	3.46	3.36	3.67	3.62
b. an ability to plan, design, and conduct engineering experiments as well as to analyze and interpret data and report results	3.1	3.42	100%		3.54	3.73	3.33	
c. an ability to systematically identify, formulate, design and demonstrate electrical engineering systems, subsystems, components and/or processes that meet desired performance, cost, time and safety requirements	3.0	3.17	87.5% (3.5)	82.3% (3.3)	3.54	3.79	3.67	3.62
d. an ability to function on multidisciplinary teams	3.2	3.3	66.7% (2.67)		3.81	3.71	2.67	
e. an ability to systematically apply knowledge of mathematics, science and engineering to the analysis of electrical engineering problems	3.2	3.21	77.5% (3.3	82.3% (3.3)	3.45	3.78	3.0	3.62
f. an understanding of professional and ethical responsibility	3.0	3.44	60% (2.4)		3.72	3.67	3.33	
g. an ability to communicate technical information through professional quality reports, oral presentations and interaction with audience	3.2	3.31	80% (3.2)		3.5	3.78	3.67	3.47
h. the broad education necessary to understand the impact of electrical engineering solutions in a global and societal context	2.9	3.35	100%		3.54	3.50	2.50	3.62
i. a recognition of the need for, and an ability to engage in lifelong learning	3.22	3.39	100%		3.54	3.47	3.0	
j. knowledge of contemporary issues	2.9	3.32	100%		3.60	3.20	3.0	
k. an ability to use modern techniques, skills and tools including computer based tools for analysis and design	3.1	3.17	80% (3.2)	85.5% (3.4)	3.57	3.67	3.5	
l.. knowledge of probability and statistics, numerical analysis and their applications	2.7	3.55			3.36	3.06	2.0	
m. familiarity with appropriate Codes and Standards	2.3	3.40		82.4% (3.3)	3.54	3.47	2.67	
n. Awareness of business environment in which engineering systems are designed and developed	2.3	3.43		80.4% (3.2)	3.54	3.67	3.0	
o. a sense of security and capability to integrate it into electrical system design.	n/a	3.74			n/a	n/a	n/a	

For the past two years, the department has undertaken a formal process of assessment including the recording of data and its analysis leading to changes in courses and the curriculum. Table 6 provides the results from the eight assessment tools that were used to

determine overall success in accomplishment of program outcomes, during the 2002-2003 academic year.

Table 7 shows the status of improvement in six outcomes, at the course level, that were identified for improvement after spring 2002 and later compared with their outcomes in spring 2003. In almost all cases improvements did occur and in some cases these will be continued so that the established criterion of 3.0 or more out of 4.0 is met. This indicates that some positive actions were taken by faculty to address those outcomes and that the process is effective in continuous improvement of the Program Outcomes.

Table 7

Results of Continuous Improvement [3]

Course	Outcome	Spring 2002	Spring 2003	Comments
EE 321	a, e	2.72	2.96	Continue improvement
E. M. Theory	j	2.42	3.07	Weakness addressed
EE 330L -	b	2.63	3.48	Weakness addressed
Electronics Lab	c	2.8	3.37	Weakness addressed
EE 410 -Digital Signal Processing	e	2.47	3.33	Weakness addressed
	c	2.81	3.05	Weakness addressed
EE 430 – Digital	c	2.75	2.91	Continue improvement
Comp. Structures	k	2.79	3.03	Weakness addressed

Action Items for Improvement

An overall analysis of the information in Table 6 indicates that all outcomes meet the established criteria. However, a further review of Table 6 indicates that following outcomes need to be strengthened and are listed in order of priority; (1) Impact of engineering decisions on society (Outcome h), (2) Enhanced coverage of Probability and Statistics (Outcome l), (3) Knowledge of Standards and Codes (Outcome m), (4) Contemporary Issues (Outcome j), (5) Awareness of business sense (Outcome n), (6) Professional and Ethical Responsibility (Outcome f), and (7) Implementation and sense of security in engineering design (Outcome o).

Most of these outcomes will be strengthened through; integration at all levels and especially in design courses; adherence to specific formats; setting of milestones in courses with design content; and requiring Issues Reports in the culminating design

courses such as EE 410L - Electrical Systems Design Laboratory course and the ENGR 450 and 451 – Capstone Design Project I and II.

The Departmental Accreditation Committee identified a number of areas that need to be addressed and made specific recommendations for the instructors and the department. These have been discussed among faculty and they are being implemented.

Specific Plans for Continuous Improvement

1. Update Assessment Tools: The Departmental Accreditation Committee worked with faculty to update all survey instruments to accurately assess Program Outcomes and Objectives. These survey instruments were used for fall 2003 evaluations.
2. Develop modules consisting of homework, tests, reports and design projects to be used for assessment of specific outcomes in each course.
3. Faculty will require discussion of impact of engineering design on society, considerations of applicable codes and standards and discussion of Professional Responsibility and Ethics in all design content courses. This has started with ENGR 100L – Intro to Engineering and culminating in EE 410L – Electrical Systems Design Lab, and the ENGR 450, 451 – Capstone Design Project I and II courses.
4. Department will update formats for design project, computer program assignment, and laboratory reports and make them available to students. Faculty will expect professional and ethical responsibility in preparation, timely submission and evaluation of these assignments.
5. Special seminars or lectures will be arranged to review vector calculus, Probability and Statistics and their application to engineering problems, and issues related to security and business sense. These will be integrated in ENGR 101L, ENGR 200L, EE 320 and EE 350 – Communication Systems and EE 343 – Power Distribution System (TE), and ENGR 490 - Professional Development Seminar courses

The same evaluation criteria will be used to measure success and the results should show improvement in scores for these outcomes in the Student Course Assessment Survey and the Faculty Course Outcomes Assessment Reports.

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