

# Turning a Weakness into a Strength: Addressing ABET Requirements for Outcomes Assessment

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**Abstract** – The University of South Alabama Electrical and Computer Engineering (ECE) Department underwent a comprehensive review of undergraduate programs in Electrical Engineering and Computer Engineering by ABET’s Engineering Accreditation Commission (EAC) in October of 2005. The Department’s two programs were determined to have weaknesses in Criterion 3 that related to the measurement of student outcomes achievement. Constituent surveys were revised and an end-of-semester course report was revised to provide documentation that individual classroom assignments directly address ABET program outcomes. The system was implemented in Fall semester of 2005 and the data was provided to ABET in June of 2006. Based on the information provided, ABET rescinded the program weaknesses and awarded full six-year accreditation to both programs. This paper reviews the outcomes assessment requirements and how they were met without significantly increasing faculty workloads.

*Keywords:* ABET, Criterion 3, outcomes assessment, assessment tools

## INTRODUCTION

All engineering programs at the University of South Alabama (USA) were reviewed for re-accreditation during the general review conducted by ABET in October 2005. In the Electrical and Computer Engineering (ECE) Department, academic programs in computer engineering and in electrical engineering were evaluated and were both found to have weaknesses associated with Outcomes Assessment (Criterion 3). One problem identified by the reviewers was the reliance on subjective assessment tools, particularly the personal opinions of faculty members on the degree to which Criterion 3 was met for a particular course. Another problem identified was the lack of a clearly-defined procedure for addressing Criterion 3 deficiencies, including action thresholds and specific corrective actions.

At the time of the general review, USA was using thirteen outcome assessment tools [Thomas,2] for Criterion 3. End-of-semester surveys were used in every undergraduate course, which required students to rate the instructional material and the course instructor’s performance for compliance with course outcomes. In addition, the instructor would rate the class as a whole for compliance with course outcomes using a survey form. There was no formal rubric for the rating process: the instructor relied on teaching experience and perception of class performance. The ABET reviewers had some problems with this strategy. In their draft statement, the ABET team noted that program outcomes for each course were identified and were mapped into Criterion 3 a-k required outcomes. There was, however, a shortcoming in that the assessment tools should be better tied to specific outcomes and should better indicate the degree to which the outcomes are achieved by the students at the time of graduation. A specific comment in the draft statement was that the only evidence of student achievement is the “Faculty Assessment of Class” form.

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In response to the findings in the draft report, a number of refinements and changes were made to the assessment tools. The new tools were used to collect data during the Fall 2005 and Spring 2006 semesters, and the results were summarized in a response to the ABET draft statement [USA, 5]. Based on this input, ABET rescinded the weaknesses in the electrical and the computer engineering programs and granted a full six-year accreditation, with the next scheduled review in 2012.

## METHODOLOGY

During the self-study year prior to the 2005 ABET visit, the Department of Electrical and Computer Engineering used a total of thirteen assessment tools to document program compliance with Criterion 3. Based on the feedback from the site visitors and the ABET draft report, the assessment tools were extensively revised and streamlined. The revised tools were approved at the February 2006 faculty retreat, attended by representatives of constituents of the electrical engineering and computer engineering programs. The representatives included the ECE department faculty, ECE students, ECE alumni, and members of the ECE industrial advisory board. Based on discussions and input from constituents, a total of five assessment tools were adopted.

### Outcomes Assessment Tools

End of Course Evaluations – For each undergraduate course, the instructor is required to submit a course report at the end of the semester that includes a syllabus, copies of all tests and quizzes, copies of homework, copies of handouts, and an instructor survey that documents student compliance with outcomes a-k.

The instructor survey is a rubric that maps student scores into specific course outcomes (Figure 1). When the instructor makes up a test or a quiz, individual questions are targeted to the individual outcomes associated with the course. Although ABET discourages the use of course final grades for evidence of compliance with outcomes, the reviewers whole-heartedly approved using student grades on specific assignments targeted to specific outcomes. Since the instructor for each course is aware of the outcomes supported by that particular course, it is a minimal inconvenience to the instructor to link specific assignments to specific outcomes. The main inconvenience to instructors is the necessity for recording scores for individual problems on a particular test. In large classes, graduate teaching assistants help in the recording of the data. Once an instructor organizes the course grade sheet, class averages for each outcome supported by a particular course are calculated.

The advantage of using this method is that the opinion of the instructor is no longer the basis for outcome compliance. Actual data from student assignments is used to take a snapshot of each course in each semester. Trends in student performance can be quantized and appropriate action can be taken.

Graduating Student Survey – All graduating seniors complete an exit questionnaire, which includes a section on program outcomes. The questionnaire has been modified to rate the student's perception of the importance of each outcome to their development as an engineer and how well their education at USA prepared them to exercise their skills and abilities. This procedure enables the construction of a graph in which the importance of each outcome is plotted against the preparation for achievement of each outcome. Desirable performance is that the data points all lie in the first quadrant of the graph. Significant deviation results in corrective action.

The Fundamentals of Engineering (FE) exam – USA requires all graduating seniors to take the FE exam. Although the students are not required to pass the exam to graduate, every effort is made to impress upon the students the advantages of professional registration and the importance of adequate preparation for the exam. For example, in each semester, free college-wide review sessions are conducted for the subject material in the general exam and subject-specific reviews are conducted by each department. When the exam results become available, each department receives a breakdown of student scores by subject area. Comparison of these scores with prior exam results for USA and with national averages indicate potential problem areas.

### Mapping of Student Performance to Program Outcomes

**Course** EE 441 - Computer Networks  
**Semester** Fall 2006  
**Instructor** Tom Thomas

#### OUTCOMES

Question/Quiz/Lab/Project	1	2	3	4	5	6	7	8	9	10	11	12
Test 1												
Part 1	8.7		8.7		8.7			8.7		8.7		
Problem 1	6.9				6.9			6.9		6.9		
Part 2	8.4				8.4			8.4		8.4		
Presentation				10.0				10.0		10.0		
Final Exam												
Part 1	8.7				8.7			8.7		8.7		
Part 2	7.9				7.9			7.9		7.9		
Part 3	8.4		8.4		8.4			8.4		8.4		
<b>AVERAGE</b>	<b>8.2</b>	<b>####</b>	<b>8.6</b>	<b>10.0</b>	<b>8.2</b>	<b>####</b>	<b>####</b>	<b>8.4</b>	<b>####</b>	<b>8.4</b>	<b>####</b>	<b>####</b>

#### Index of Electrical Engineering Program Outcomes

1. A practical working knowledge of mathematical, scientific, and engineering principles in the field of electrical engineering. [Criterion 3(a)]
2. The ability to plan and conduct experiments in electrical engineering science and design, as well as to analyze and interpret data. [Criterion 3(b)]
3. Design skills sufficient for specification and implementation of electrical systems, processes and components. [Criterion 3(c)]
4. An ability to effectively participate in a multi-disciplinary team environment. [Criterion 3(d)]
5. A capacity for problem identification, formulation, solution generation, and decision making. [Criterion 3(e)]
6. An ability to make ethical decisions in professional life and to cultivate personal integrity. [Criterion 3(f)]
7. A capacity for effective written, graphical and oral communication. [Criterion 3(g)]
8. A broad education to understand the role and impact of the electrical engineering profession in a global and societal context. [Criterion 3(h)]
9. Recognition of the need for and an ability to continue life-long learning. [Criterion 3(i)]
10. Knowledge of the changing technological environment and its impact on contemporary issues. [Criterion 3(j)]
11. An ability to use modern engineering techniques, instrumentation, and software tools to practice the electrical engineering profession. [Criterion 3(k)]
12. An appreciation of the unique concerns regarding safety required when designing and working with electrical systems.

Figure 1 – Map of student performance to program outcomes.

Employer Survey – Once each year a survey is sent to employers of USA ECE Department graduates in the Gulf Coast area. The survey includes a section on program outcomes that is organized identically to the outcomes section in the Graduating Student Survey. The data collected from the survey is plotted on an importance vs. preparation graph. Again, desirable performance is that data points lie in the first quadrant of the graph. Significant deviation results in corrective action.

Alumni Survey – Once each year, a polling group conducts a survey of USA ECE Department alumni. The survey includes a section on program outcomes organized as described above. The data collected from the survey is plotted on an importance vs. preparation graph, subject to the same interpretation as described in the Graduating Student Survey and Employer Survey.

#### Action Thresholds

For each assessment tool, an action threshold was established. For the graduating student, alumni, and employer surveys, any point not falling in the first quadrant of the corresponding graph is cause for concern. The ratings on the survey forms are based on responses from 1 to 4, with 4 being the most favorable rating. The importance threshold and the preparation threshold were both set at 2.5, which places the first quadrant of the associated graph

in the region above 2.5 for importance and to the right of 2.5 for preparation. If a point falls outside the region, the survey result becomes an agenda item for the ECE department undergraduate affairs committee. Depending on the particular outcome that falls below the threshold, action is recommended by the committee.

The threshold for the FE exam was set at 10% below the national average for a peer group of students. If the overall student scores for the USA ECE graduates in any particular subject area falls more than 10% below the national average for ECE graduates, the test result becomes an agenda item for the ECE department undergraduate affairs committee. Again, depending on the particular subject area, action is recommended by the committee.

For the end of course evaluations, thresholds were set at 3.5 out of a maximum of 5.0 for compliance with outcomes. If a particular course outcome is below 3.5, the data is reviewed by the ECE chairman and is discussed with the individual faculty member responsible for teaching the course. Based on the results of the discussion, the data is either forwarded to the undergraduate affairs committee as an agenda item, or changes to the assessment materials are made. One advantage of tying the individual graded assignments to outcomes in the course is that modifications to the materials or the presentation can be rapidly made without waiting for the end of the semester. Thus, problems can be identified early and can be corrected.

## RESULTS AND DISCUSSION

End of course evaluations – Figure 2 shows a graphical summary of all electrical engineering outcomes for Fall semester 2005. The summary shows that all outcomes were at a level of 3.5 or higher, the lowest being Criterion F, “an ability to make ethical decisions in professional life...”, with all results well above the level where any curriculum or course action is suggested

Graduating student survey – The data for Fall semester 2005, shown in Figure 3, indicates that all of the program outcomes fall well within the desired quadrant with level of importance and level of preparation above 2.5.

FE exam results – The subject results of the Fall 2005 FE exam indicated that USA students met the criteria of being within 10% of the national average in every area with the exception of numerical methods. This issue was discussed in an undergraduate affairs meeting and the decision was made to incorporate numerical method topics in several courses. The FE exam results will be monitored in the next cycle to see if the situation improves. This issue was also discussed with ECE constituents at the annual retreat in February of 2006.

Employer survey – The results of the employer surveys for Fall semester 2005 show that the assessment of outcomes by employers are clustered in the desired quadrant, indicating high importance and high preparation (Figure 4). An exception is criterion H, “A broad education to understand the role of electrical engineering in a global societal context.” The employers rated preparation above the threshold (2.90) and importance below the threshold (2.4). This issue was discussed at the annual retreat and it was determined that some employers question the requirement for students to take six courses in humanities and social sciences. In their opinion, the academic time would be better spent in technical classes. The results of the discussion were that the humanities and social science requirements are the minimum allowed under Alabama state articulation requirements, and that there is currently nothing that can be done to change the situation.

Alumni survey – The survey of electrical engineering shows that for all the program outcomes associated with Criterion 3, alumni were well prepared and found the associated skill to be important (Figure 5).

Based on input from ABET in their final report, USA believes that the assessment procedures are sound and are workable in their present form. The data from the latest review cycle indicates that the outcomes of the electrical engineering program are currently being met to the satisfaction of all program constituents. Procedures are now in place to address problems as they occur. Developing and implementing review procedures to insure that the data is actually used for program improvement will be an on-going effort. At USA, maintaining a close relationship with constituents is crucial for the process to be effective.

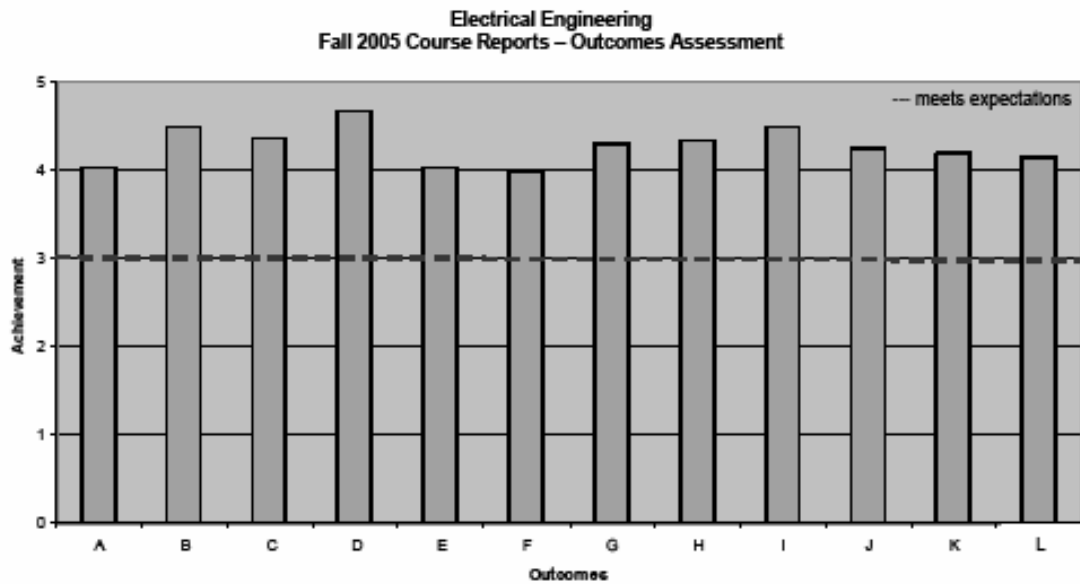
## CONCLUSION

The most recent accreditation cycle is the second evaluation of USA electrical and computer engineering programs under the EC 2000 criteria [Thomas, 2],[Thomas, 3]. In August 2000, the ABET Engineering Accreditation Commission identified weaknesses in both programs, requiring an Interim Report (IR) after a two-year period [USA,4]. The weaknesses were successfully addressed and both programs were fully accredited following a Next General Review (NGR) action in August of 2002. Significant lessons were learned in the process of correcting the weaknesses, resulting in constructive program changes. The most recent cycle also identified weaknesses, which were successfully addressed by changes to assessment tools and procedures. It is anticipated that the current assessment procedures and program evaluation procedures will address all ABET concerns about outcomes assessment and that future accreditation will be greatly facilitated.

One issue became clear in the latest accreditation cycle. It is vitally important that the constituent input is actually being used to improve the educational programs that serve constituent needs, and that a continual improvement process is in place. The first line of implementation is the faculty. Without faculty participation, the entire process can and will break down. It is, therefore, important that the ECE faculty be a willing partner in the process and that the faculty not view the outcomes assessment process as being an inconvenience or a waste of time. At USA, faculty course loads are high compared to other institutions, so outcomes assessment procedures must have a minimal impact on faculty workloads. After all, the best available assessment tools and procedures are useless if they aren't taken seriously.

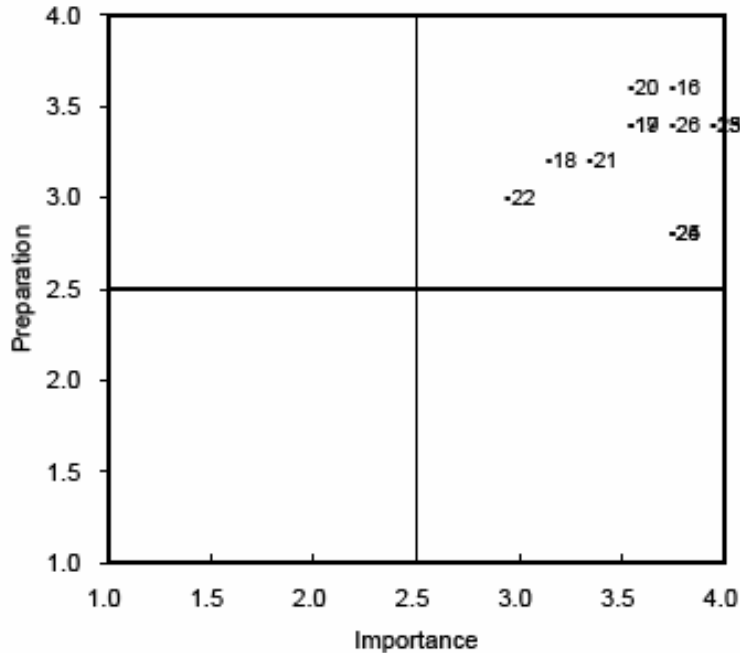
The challenge in the current accreditation period will be to maintain the procedures and not become complacent. The worst thing that can happen is that the faculty, or other program constituents, will say to themselves; "Well, now that's over – we can get back to work and forget about this accreditation nonsense until the next self-study year." The aim of ABET accreditation is continual program improvement with legitimate input from the people who have the most to gain from good educational programs[EAC,1].

Figure 2 – Fall 2005 course report results.



Criterion	Outcome	Avg.
A	A practical working knowledge of mathematical, scientific, and engineering principles in the field of electrical engineering. [ABET Criterion 3(a)]	4.03
B	The ability to plan and conduct experiments in electrical engineering science and design, as well as to analyze and interpret data. [ABET Criterion 3(b)]	4.49
C	Design skills sufficient for specification and implementation of electrical systems, processes and components. [ABET Criterion 3(c)]	4.37
D	An ability to effectively participate in a multi-disciplinary team environment. [ABET Criterion 3(d)]	4.67
E	A capacity for problem identification, formulation, solution generation, and decision making. [ABET Criterion 3(e)]	4.03
F	An ability to make ethical decisions in professional life and to cultivate personal integrity. [ABET Criterion 3(f)]	4.00
G	A capacity for effective written, graphical and oral communication. [ABET Criterion 3(g)]	4.31
H	A broad education to understand the role and impact of the electrical engineering profession in a global and societal context. [ABET Criterion 3(h)]	4.34
I	Recognition of the need for and an ability to continue life-long learning. [ABET Criterion 3(i)]	4.50
J	Knowledge of the changing technological environment and its impact on contemporary issues. [ABET Criterion 3(j)]	4.25
K	An ability to use modern engineering techniques, instrumentation, and software tools to practice the electrical engineering profession. [ABET Criterion 3(k)]	4.18
L	An appreciation of the unique concerns regarding safety required when designing and working with electrical systems.	4.14

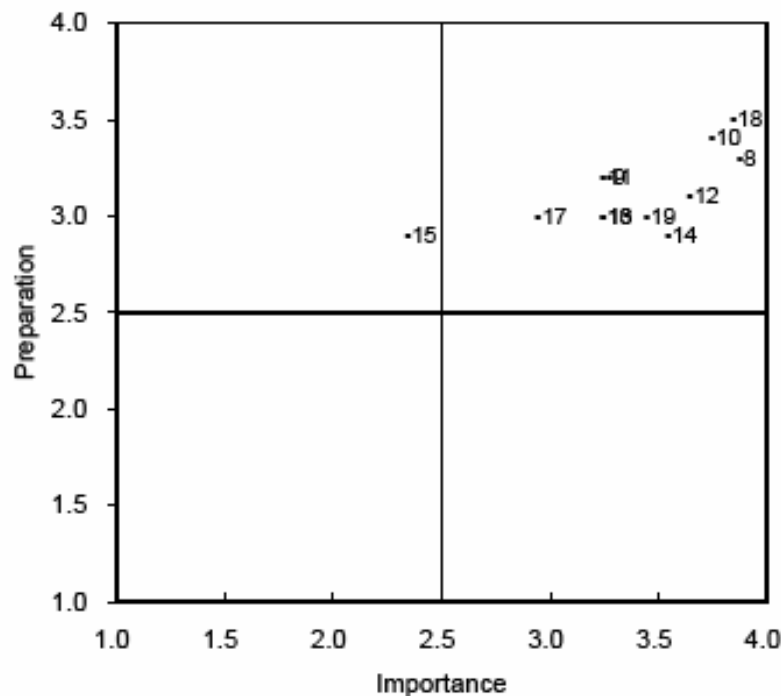
Exit Questionnaire (Survey of Graduating Students)  
 Electrical Engineering Program Outcomes  
 BSEE Majors  
 Fall 2005



Criterion	Question	Survey Question #	Imp.	Prep.
A	A practical working knowledge of mathematical, scientific, and engineering principles in the field of electrical engineering. [ABET Criterion 3(a)]	15	4.0	3.4
B	The ability to plan and conduct experiments in electrical engineering science and design, as well as to analyze and interpret data. [ABET Criterion 3(b)]	16	3.8	3.6
C	Design skills sufficient for specification and implementation of electrical systems, processes and components. [ABET Criterion 3(c)]	17	3.6	3.4
D	An ability to effectively participate in a multi-disciplinary team environment. [ABET Criterion 3(d)]	18	3.2	3.2
E	A capacity for problem identification, formulation, solution generation, and decision making. [ABET Criterion 3(e)]	19	3.6	3.4
F	An ability to make ethical decisions in professional life and to cultivate personal integrity. [ABET Criterion 3(f)]	20	3.6	3.6
G	A capacity for effective written, graphical and oral communication. [ABET Criterion 3(g)]	21	3.4	3.2
H	A broad education to understand the role and impact of the electrical engineering profession in a global and societal context. [ABET Criterion 3(h)]	22	3.0	3.0
I	Recognition of the need for and an ability to continue life-long learning. [ABET Criterion 3(i)]	23	4.0	3.4
J	Knowledge of the changing technological environment and its impact on contemporary issues. [ABET Criterion 3(j)]	24	3.8	2.8
K	An ability to use modern engineering techniques, instrumentation, and software tools to practice the electrical engineering profession. [ABET Criterion 3(k)]	25	3.8	2.8
L	An appreciation of the unique concerns regarding safety required when designing and working with electrical systems.	26	3.8	3.4

Figure 3 – Fall 2005 survey of graduating students.

**Employer Survey of Electrical Engineering Program Outcomes  
BSEE Majors  
Fall 2005**

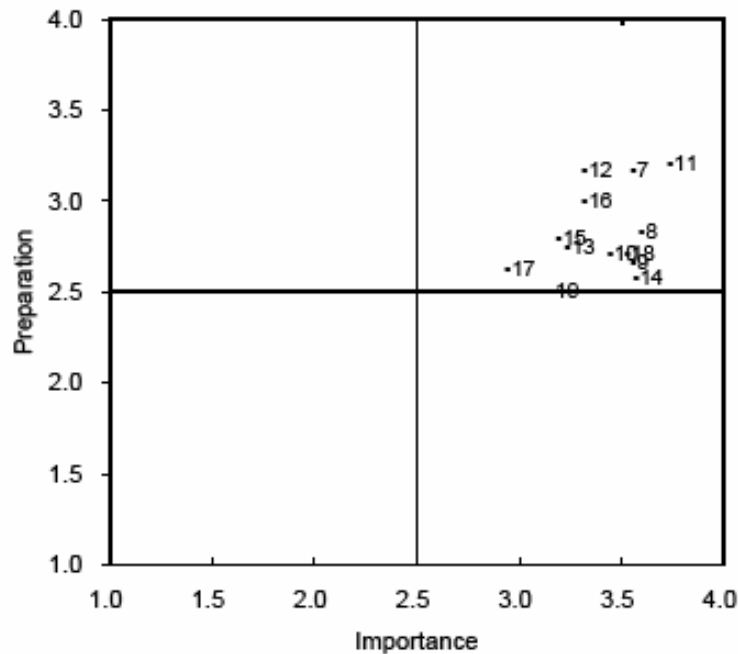


Criterion	Question	Survey Question #	Imp.	Prep.
A	A practical working knowledge of mathematical, scientific, and engineering principles in the field of electrical engineering. [ABET Criterion 3(a)]	8	3.9	3.3
B	The ability to plan and conduct experiments in electrical engineering science and design, as well as to analyze and interpret data. [ABET Criterion 3(b)]	9	3.3	3.2
C	Design skills sufficient for specification and implementation of electrical systems, processes and components. [ABET Criterion 3(c)]	10	3.8	3.4
D	An ability to effectively participate in a multi-disciplinary team environment. [ABET Criterion 3(d)]	11	3.3	3.2
E	A capacity for problem identification, formulation, solution generation, and decision making. [ABET Criterion 3(e)]	12	3.7	3.1
F	An ability to make ethical decisions in professional life and to cultivate personal integrity. [ABET Criterion 3(f)]	13	3.3	3.0
G	A capacity for effective written, graphical and oral communication. [ABET Criterion 3(g)]	14	3.6	2.9
H	A broad education to understand the role and impact of the electrical engineering profession in a global and societal context. [ABET Criterion 3(h)]	15	2.4	2.9
I	Recognition of the need for and an ability to continue life-long learning. [ABET Criterion 3(i)]	16	3.3	3.0
J	Knowledge of the changing technological environment and its impact on contemporary issues. [ABET Criterion 3(j)]	17	3.0	3.0
K	An ability to use modern engineering techniques, instrumentation, and software tools to practice the electrical engineering profession. [ABET Criterion 3(k)]	18	3.9	3.5
L	An appreciation of the unique concerns regarding safety required when designing and working with electrical systems.	19	3.5	3.0

Figure 4 – Fall 2005 employer survey.



**Alumni Survey of Electrical Engineering Program Outcomes  
BSEE Majors  
Fall 2005**



Criterion	Question	Survey Question #	Imp.	Prep.
A	An understanding and ability to apply knowledge of mathematics and science to electrical engineering problems [ABET Criterion 3(a)]	7	3.6	3.2
B	An ability to design and conduct electrical experiments as well as to analyze and interpret data [ABET Criterion 3(b)]	8	3.6	2.8
C	An ability to design a electrical system, component or process to meet desired needs [ABET Criterion 3(c)]	9	3.6	2.7
D	An ability to function on multidisciplinary teams [ABET Criterion 3(d)]	10	3.5	2.7
E	An ability to identify, formulate and solve electrical engineering problems [ABET Criterion 3(e)]	11	3.8	3.2
F	An understanding of professional and ethical responsibility [ABET Criterion 3(f)]	12	3.4	3.2
G1	An ability to communicate effectively by writing [ABET Criterion 3(g)]	13	3.3	2.8
G2	An ability to communicate effectively orally [ABET Criterion 3(g)]	14	3.6	2.8
H	The broad education necessary to understand the impact of electrical engineering solutions in a global and societal context [ABET Criterion 3(h)]	15	3.3	2.8
I	A recognition of the need for life-long learning and the ability to learn independently [ABET Criterion 3(i)]	16	3.4	3.0
J	A knowledge of contemporary issues affecting engineering [ABET Criterion 3(j)]	17	3.0	2.8
K	An ability to use the techniques, skills, and modern engineering tools necessary for electrical engineering practice [ABET Criterion 3(k)]	18	3.6	2.7
L	An appreciation of the unique concerns regarding safety required when designing and working with electrical systems.	19	3.2	2.5

Figure 5 – Fall 2005 alumni survey.

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