Assessment Processes in the Electrical and Computer Engineering Department

Utah State University

Spring 2006

1 Introduction

The assessment process in the Electrical and Computer Engineering (ECE) Department at Utah State University is designed to provide information about how the courses work together to achieve local educational objectives as well as ensure that the objectives of the ABET accreditation body are achieved. The process is designed to be a minimal burden on the faculty while leaving flexibility to adjust courses and curriculum to changing needs.

The assessment effort in the ECE department serves multiple purposes. One purpose is to ensure that the overall curricular needs of the department are met: that the courses taught cover the outcomes, that there are no holes in the curriculum, and that courses flow together well. Another purpose is the ensure that the ABET outcomes (a)–(k) of ABET Criterion 3 are attained by each student. Another purpose is to work to ensure that the department program objectives are being attained by graduates. Because of these multiple purposes, a variety of input data are used in the assessment cycle. These include:

- Faculty course assessments (section 5.1)
- Alumni survey (section 5.2)
- Industrial advisory committee (section 5.3)
- Senior exit interviews (section 5.4)
- Senior project jury form (section 5.5)
- Individual measurements of (a)–(k) outcomes (section 7).

The overall process is summarized in section 8.

These assessment processes are under the supervision of the department head, who delegates operational responsibility to the chair of the Assessment Committee. Standing committee structures involved in the assessment process are described in section 2.

An important part of the assessment process is that every course has a set of outcomes associated with it. How these outcomes are established, modified, and used is described in section 4. These outcomes are driven by curricular needs, research needs, and the program objectives. The program objectives and how they are modified are described in section 3.

The assessment process is viewed as a dynamic, changing, even experimental, process, which is modified as we understand better what our goals are and how to measure progress. The processes of incorporating change is described in this document, which processes are themselves constantly undergoing modification.

2 Department Governance Structure

The ECE department has three standing committees, each with its own chair. These committees are the assessment committee, the curriculum committee, and the graduate committee. The assessment committee is charged with establishing assessment tools, gathering the information from the various assessment tools, evaluating the information, and reporting back to the committees and faculty to close the loop. The curriculum committee is charged with ensuring that course offerings support timely completion of degree requirements and ensuring that courses having the necessary content are taught. The graduate committee is responsible for graduate student admission, oversight of graduate student research, and compliance with graduate student requirements. (See figure 1.)

The three chairs of these three committees together with the department head, constitute the executive committee of the department. The executive committee deals with curricular issues, graduate issues, and department strategic planning.

Because of the close relationship between assessment and curriculum, the chair of the curriculum committee is a member of the assessment committee, and the chair of the assessment committee is a member of the curriculum

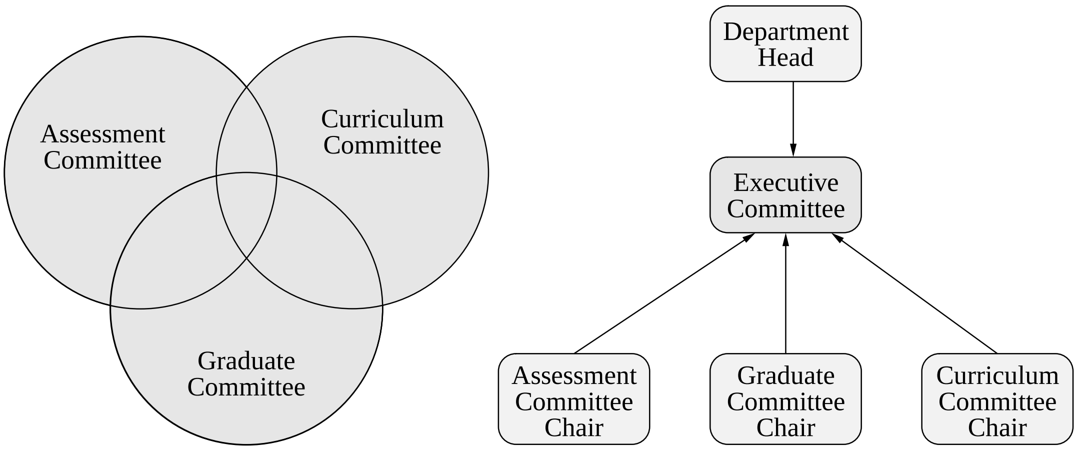

Figure 1: Department governance committees

committee. A great deal of coordination and information interchange takes place directly between the assessment and curriculum committees via the two chairs, making the process more agile while eliminating committee work.

This governance structure makes issues discovered by assessment immediately accessible to the department head and chairs of other committees.

3 Program Objectives

The program objectives are "broad statements that describe career and professional accomplishments that the program is preparing graduates to achieve." ("Criteria for Accrediting Engineering Programs," ABET, 2004). As these are broad statements and goals, and not particular technical skills, it was determined in Fall 2005 that both the electrical engineering program and the computer engineering program should share the same objectives. (Prior to that time, there were differences between the stated electrical engineering and the computer engineering objectives, in an attempt to distinguish the two programs.)

Program objectives were initially formulated by the faculty. When changes to the objectives are contemplated, such changes are presented to the IAC for discussion. Their input is used to shape the objectives, which are then submitted for final approval to the IAC and the faculty. The process is diagrammed in figure 2. Such a process took place, for example, in Fall 2005–Spring 2006, when modified objectives were established. These objectives are compared against, and mapped from, the (a)–(k) outcomes, as shown in table 2. Assessment of the achievement of the objectives is primarily through an annual alumni survey, as described in section 5.2.

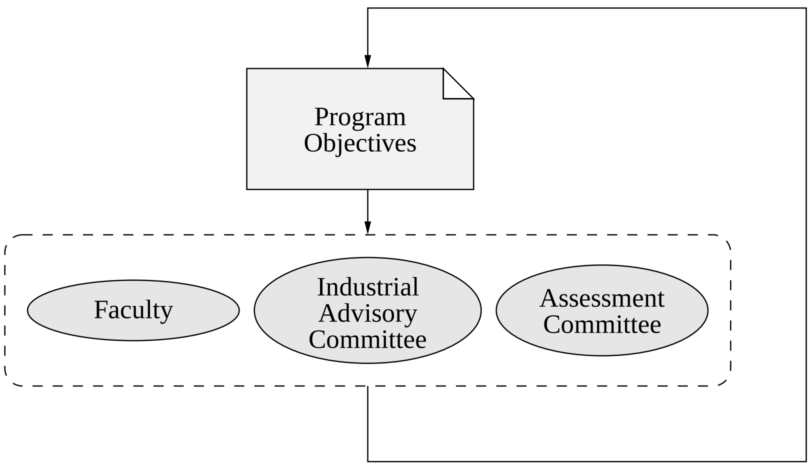

Figure 2: Establishment and Modification of Program Objectives

	Education in the fundamental sciences and mathematics that underline engineering with a general breadth and depth in engineering analysis and design	Awareness of current technology and the fundamental background to be able to stay informed and adept at new technologies	The ability to put ideas into practice through effective analysis, problem solving, requirements development, design, and implementation	A broad awareness of the world around them through general education so they are prepared to achieve their potential and make contributions in their professional and personal lives	The foundation of communications and teamwork skills and professional attitudes and ethics
(a) An ability to apply knowledge of mathematics, science, and engineering	2	2	2		
(b) An ability to design and conduct experiments, as well as to analyze and interpret data	2	2	1		
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, health and safety, manufacturability, and sustainability		2	2	2	
(d) An ability to function on multidisciplinary teams			1	1	2
(e) An ability to identify, formulate, and solve engineering problems	2	2	2		
(f) An understanding of professional and ethical responisibility				2	2
(g) An ability to communicate effectively			1	1	2
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, and societal context	2	1	1	2	2
(i) A recognition of the need for, and an ability to engage in, life-long learning		2		1	
(j) A knowledge of contemporary issues		1		2	1
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	2	1	2		

Table 2: Mapping of outcomes to program objectives

The objectives are available at

`http://www.engineering.usu.edu/ece/assessment/ece_objectives.php`

which states:

> **The educational objectives of the Electrical Engineering and Computer Engineering Programs at Utah State University are as follows.**
>
> **To provide graduates with:**
>
> 1. **Education in the fundamental sciences and mathematics that underlie engineering with a general breadth and depth in engineering analysis and design;**
> 2. **Awareness of current technology and the fundamental background to be able to stay informed and adept at new technologies;**
> 3. **The ability to put ideas into practice through effective analysis, problem solving, requirements development, design, and implementation;**
> 4. **A broad awareness of the world around them through general education so they are prepared to achieve their potential and make contributions in their professional and personal lives;**
> 5. **The foundation of communications and teamwork skills and professional attitudes and ethics.**

4 Course Outcomes and their Modification Process

The course outcomes form an important part of the coordination and assessment effort in the department. The outcomes provide a set of "minimal" expectations for the courses, outlining what the course is supposed to cover. This is used for articulation between classes (to ensure that there is more or less seamless transition among courses) and to ensure coverage of the material.

Every course in the department has a set of course outcomes. These are posted at

`http://www.engineering.usu.edu/ece/academics/courses.php?show_objs=1`

Course outcomes are generally established by the individual faculty for the courses that they teach, and reflect curricular needs, research needs, and teaching interests of the faculty. This is particularly true in areas of specialization and graduate level courses. For such courses, if a teacher wants to change the outcomes, a new list of candidate outcomes is presented to the curriculum committee for approval. (The approval is almost universal and *pro forma* for these courses.)

There are, however, a few courses which are regarded as the core curriculum, which provide foundation material, key prerequisite material, or must dovetail with other courses. For these courses, changes in the outcomes are generally subjected to a closer scrutiny. These courses are ECE 2270 (electrical circuits), ECE 2700 (digital circuits), ECE 3410 (microelectronics I), ECE 3620 (circuits and signals), ECE 3640 (signals and systems), and ECE 3710 (microcomputer hardware and software).

New or temporary classes frequently arise. For example, a person might want to teach a course in a new or developing area. To obtain approval for such a course to be taught for credit, one of the key steps is filling out a set of course outcomes for the course. This helps guide the formulation of the class, and provides information for students to use in deciding whether to take the class.

In all cases, faculty are encouraged to consult with their colleagues that teach courses that are related or might be affected by this. Our experience to this point has been that the process of establishing and changing course outcomes works well. The process is outlined in figure 3

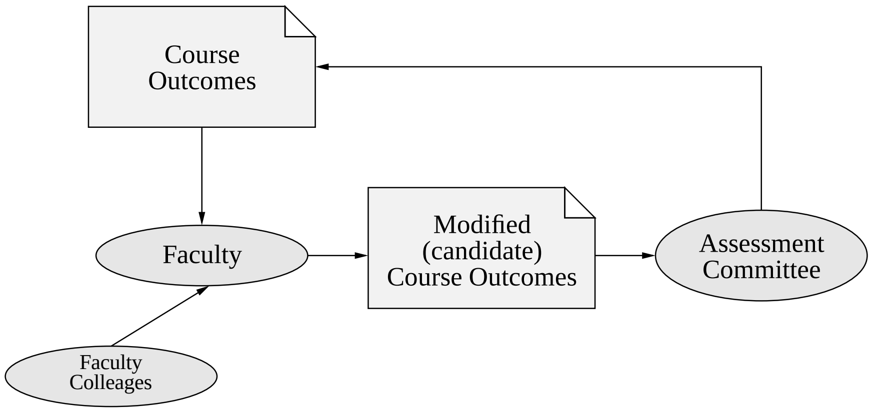

Figure 3: Modification of Course Outcomes

5 Sources of Data

Several sources of data are used to acquire information for the assessments. These sources are used for different purposes by the different assessment mechanisms. This section identifies some of the major data sources.

5.1 Faculty Course Assessments

Every semester, every faculty member provides a *faculty course assessment* of each course he or she has just taught, using the forms at

`http://www.engineering.usu.edu/ece/assessment/semesterindex.php`

A boilerplate form is shown in appendix A. Each faculty course assessment has four parts.

1. The first part is called the **Outcomes Assessment**, the faculty determines an assessment for each outcome in the stated class outcomes. For each outcome, the faculty member rates the course on a scale of 0 to 2:

   0 Outcome not met

   1 Outcome adequately met

   2 Outcome strongly met

   For each outcome, the faculty identify the basis upon which the outcome is assessed, such as homework, labs, projects, etc. There is considerable latitude in how the faculty employ these bases.

2. The second part addresses the question **How well were students prepared for the course?** This question invites a free response, and is intended to address articulation between classes. If an instructor feels that students were consistently less prepared than expected, this flags the need to re-examine pre-requisite courses, to ensure that the outcomes are adequate, that the material is taught to achieve the outcomes, and that the teaching is effective.

3. The third part addresses **Significant issues from student evaluations.** This is an opportunity to bring significant issues from the students' perspective into the the individual course assessment process.

4. The fourth part is free-form **Discussion**. Among other possibilities, responses are sought to questions such as "What scores were low, and why? What could be done better next time around? What went well?

The faculty course assessment is also a forum for the faculty to make notes, either for themselves next time they teach, or for the next person who teaches the course. It thus provides some memory from class to class and leads to course improvement over time. The process is shown in figure 4.

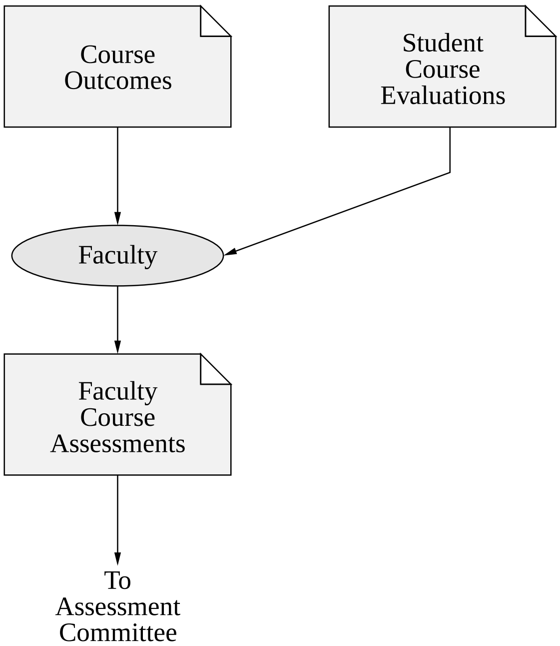

Figure 4: Faculty Course Assessment

Faculty course assessments are collected each semester by a department secretary. Faculty are encouraged to fill out most of the assessments as soon as possible after semester, while the performance and class issues are still fresh in mind. However, completion of the portion from the student evaluations requires some delay, since it takes many weeks before student evaluation forms are returned. (This is one of the major difficulties of the process, since it is easy to postpone filling out the form until the student evaluations are available, by which point the semester is so far back that memories and motivations fade.) Faculty participation in this process is quite high. However, since these assessments are used for local purposes only, we do not (and cannot) insist on 100% compliance.

5.2 Alumni Survey

Each fall we send out a survey to students who have graduated three years prior. The intent is the determine progress toward attaining the objectives of the department. To encourage completion of the survey, a T-shirt is offered to all respondents.

The survey changes somewhat from year to year, depending on the particular information we desire to gather. The form for 2005 is shown in appendix C

5.3 Industrial Advisory Committee

The Industrial Advisory Committee (IAC) meets twice each year with the department head. At many of these meetings, assessment issues are discussed. For example, in Fall 2005 changes to the department objectives were discussed. In Spring 2006, a draft of the changes was presented, and further discussion was held, leading to the objectives adopted in 2006.

The IAC has also been provided with a survey to determine their input on what we should be teaching. An example survey is shown in appendix D.

5.4 Senior Exit Interview

Every spring the graduating seniors are interviewed. Issues regarding courses, professors, and employment are discussed. Prior to 2006 this interview was done by the department head. Starting in 2006 the interview was done by the associate department head. To encourage participation in this, seniors involved in the interviews are provided with lunch by the department (pizza).

Appendix E shows the questions that were asked for the 2006 senior exit interview.

5.5 Senior Project Jury

The senior project is a very important culminating experience for the students, both from the point of view of what the students learn, and the opportunities that this learning experience provides for assessing what they have learned. The sequence of design classes leading to the senior project is set up to introduce several concepts important to the ABET outcomes.

Several of the (a)–(k) outcomes are assessed in the senior project. Because of its importance, a special assessment form has been devised which is reviewed by a jury panel consisting of members of the IAC, other engineers from the community, and some faculty members. The assessment form was put together with input from the IAC as well. The assessment form is shown in appendix F.

5.6 Results from Outcomes/Objective Assessments

For each of the ABET (a)–(k) outcomes, specific measurement tools have been devised. These are outlined fully in the section 7.

6 Mapping courses to (a)–(k) outcomes

In the original curricular assessment process, all undergraduate courses were mapped to the (a)–(k) outcomes. This mapping was used in conjunction with the faculty course assessment and the curricular assessment described above as a partial means of performing assessment of the (a)–(k) outcomes. This provides at best an indirect measurement of these outcomes, but was deemed initially to be sufficient. The new assessment tools, put into place starting in Fall 2006, significantly strengthen this assessment. Nevertheless, the course mapping is still an important part of ensuring that the outcomes are covered in our classes.

Mappings are expressed for two different kinds of classes. The first are the core classes that all students from both degree programs in the professional program must take. These are important for assessment purposes, because all students must be evaluated on all courses. The other classes are all those not in the core, which students might elsewhere take before transferring to USU, or as technical electives in our program. From an assessment point of view, these provide a sense of depth of coverage.

Table 4 shows the mapping for the core courses. As this mapping shows, each ABET outcome is covered in at least one course, with some of the outcomes having more thorough coverage. Since these are core courses, either taken by all students at USU or from transfer institutions whose corresponding courses are carefully examined, we assert that students are taught or exposed to aspects relating to all of the (a)–(k) criteria.

To gain a greater appreciation for the depth of coverage of the (a)–(k) criteria, table 6 shows the mapping for all undergraduate courses in the ECE department.

7 Outcomes/Objective Assessment

The mapping from courses to (a)–(k) outcomes provides, by means of the faculty course assessments, some degree of assessment of these outcomes. However, this assessment is as best an indirect of the (a)–(k) outcomes. While

Mapping from Courses to ABET Criteria
The courses shown here are in the core courses taken by both electrical and computer engineers.
(Rated on a scale 0 through 2,
where 2 represents a strong contribution to outcome, and
0 (or empty) represents little or no contribution.

			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
1010	Intro. to ECE		1	1			1	1			1		
2410	Elec. circuits		2	1	1		1						1
2530	Digital circuits		1		2		2		1				2
3410	Microelectronics I		2	2	2		2						2
3620	Circuits and Signals		2	1	1		1						1
3640	Signals and Systems		2	1	1		1						1
3710	Micro.Comp.Hard.&Soft.		1	1	2		2		2				2
3820	Design I		1	2	2	2	1	2	2	1	1	1	
4840	Design II		1	1	2	2	2	2	2	1	1	1	
4850	Design III		1	1	2	2	2	2	2	1	1	1	
5530	Digital Systems Design		1		2	2	2		1				2

Table 4: Mappings from Courses to (a)–(k) criteria for core courses

			a	b	c	d	e	f	g	h	i	j	k
1010	Intro. to ECE		1	1			1	1			1		
2410	Elec. circuits		2	1	1		1						1
2530	Digital circuits		1		2		2		1				2
3410	Microelectronics I		2	2	2		2						2
3620	Circuits and Signals		2	1	1		1						1
3640	Signals and Systems		2	1	1		1						1
3710	Micro.Comp.Hard.&Soft.		1	1	2		2		2				2
3720	Micro.Comp.System Prog.		1		2		2		1		1		2
3820	Design I		1	2	2	2	1	2	2	1	1	1	
4650	Optics I		1	1	1		1						1
4680	Optics II		1	1			1						1
4740	Comp. and Data Commun.		1	1	2		2						2
4840	Design II		1	1	2	2	2	2	2	1	1	1	
4850	Design III		1	1	2	2	2	2	2	1	1	1	
5230	Spacecraft Syst. Engr.		2	1	2	1	1	1	1		1		2
5240	Spacecraft Syst. Design		2	1	2	2	1	1	1		1		1
5310	Control Systems		2	2	2	1	2						2
5320	Mechatronics		2	2	2	1	2						2
5340	Mobile Robots		1	1	2	1	2						1
5420	Microelectronics II		2	2	2		2						1
5430	Applied CMOS Electr.		2	2	2		2						2
5460	Digital VLSI Syst. Design I		2	2	2		2						2
5470	Digital VLSI Syst. Design II		2	2	2		2						2
5480	Electromagnetic Compatibility		2	2	2		2	1	1				2
5530	Digital Systems Design		1		2	2	2		1				2
5630	Intro. to Dig. Sig. Proc		2	1	2		2						2
5640	Real-time processors		2	1	2	1	2		1				2
5660	Communication Syst. I		2	1	2		2		1		1		1
5740	Concurrent programming		1	1	2		2						2
5750	High Performance Mic. Arch		1	1	2		2						2
5770	Microcomp. Interfacing		1	2	2		2						2
5780	Real-time systems		1	2	2		2						2
5800	Electromagnetics II		2		1		1						1
5810	Microwaves I		2	1	1		2						1
5820	Electromagnetics Lab.		1	2	2		2						2
5850	Antennas I		2	1	2		2						1
5870	Wireless Comm. Lab		1	2	2	1	2						1
5820	Electromagnetics Lab.		1	2	1	1	2						1

Table 6: Mappings from Course to (a)–(k) criteria for all ECE courses for majors

this assessment mechanism has been deemed sufficiently effective in the past, it has been decided to strengthen the assessment by providing measures of each of the outcomes. In keeping with the philosophy to not have an overly burdensome assessment process, it has been decided to measure these outcomes at only a small number of points. Rather than collect all possible measurements on each outcome, only a few specific points of measurement are used. Satisfactory achievement on these points of measurement is deemed sufficient. Of course, if additional information is needed, then information can be drawn from the courses that contribute to these outcomes.

In forming our (a)–(k) assessment tools, we have been guided by the principle that *every* student should be evaluated on each outcome. As a result, all criteria must be evaluated in core classes, not technical electives. We have chosen to do evaluations in core courses that are common to both the electrical and computer engineering degrees. For the most part, we are interested in courses in the professional program (since the earlier courses may be taken at other institutions). These courses are:

- ECE 3410: Microelectronics I.
- ECE 3620: Circuits and Signals.
- ECE 3640: Signals and Systems.
- ECE 3710: Microprocessor Architecture.
- ECE 3820: Design I.
- ECE 4840: Design II.
- ECE 4850: Design III.

While some of these criteria are treated in several classes, we have in each case assigned the evaluations to specific courses. It should not be construed that, because we have chosen to assess the outcomes in the specific classes and manners described below, these are the only classes or exercises in which the criteria are exposed. Additional coverage is revealed by the course-to-outcome mapping that is part of our assessment documentation. For each of the ABET criteria, a specific assignment or lab exercise has been selected. Such assignments should not be changed without coordination of the assessment committee! We recognize that this is an imposition on the freedom and flexibility of the instructor of the class. However, it is possible to change the assignment (but not the outcome), with proper coordination.

For each of the designated assignments, an evaluation form will be provided, scored on the basis of 0 through 2:

- **0**: outcome not satisfied.
- **1**: outcome satisfied
- **2**: outcome strongly satisfied.

The student's outcome scores are reported to the responsible department secretary, who keeps track of the criteria passed by all students, and ensures that all students have met all criteria by graduation.

Outcome A

"An ability to apply knowledge of mathematics, science, and engineering."

Two classes have been chosen for specific evaluation.

Class: ECE 3620

Assignment: Programming Assignment # 1. The assignment requires numerical solution of differential equations. It also includes the problem of determining the differential equation for a circuit and comparing the analytical and numerical solutions.

Means of Assessment: Special assessment form (see appendix B.1) to be filled out by grader.

This assignment requires numerical solution of differential equations using Euler integration. This combines elements of computer science, differential equations, numerical analysis. It also involves circuit analysis, translating a physical problem into a mathematical description, then into a numerical solution.

Outcome B

"An ability to design and conduct experiments, as well as to analyze and interpret data."

We have chosen to interpret an "experiment" as a means to discover information previously unknown to the student; to perform scientific discovery. This distinguishes it from a laboratory design exercise, or a lab experiment which demonstrates some concept. We think this is consistent with the ABET philosophy (while being, perhaps, somewhat different from what most of our labs are about since they are design labs).

Two classes have been chosen.

Class : ECE 3640

Assignment : Adaptive filtering assignment.

Means of Assessment: Special assessment form, filled out by instructor or grader (see appendix B.2).

This assignment requires implementation of an adaptive filter. There is a parameter μ which governs the rate of adaptation. Students are asked to determine experimentally the largest μ, then compare this with theoretical results.

Class: ECE 3710

Assignment : Output characteristics on a digital IC.

Means of Assessment: Special assessment form, filled out by instructor or grader (see appendix B.2).

This assignment requires determining the effect of exceeding stated drive capabilities for digital IC.

Criterion C

"An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, social, political, ethical, health and safety, manufacturability, and sustainability."

The natural location for evaluating this criterion is in junior and senior design. Questions are provided on the Senior Project Jury Evaluation Form that address this criterion.

Class: ECE 4850, Design III

Assignment: Senior Project

Means of Assessment: Senior project report, evaluated by course instructor (appendix F). Senior project jury form, filled out by senior project jury.

Criterion D

"An ability to function on multi-disciplinary teams."

Class: ECE 3820 Design I (Junior Design)

Means of Assessment: Team Evaluation Form, filled out be each member of each team.

Criterion E

"An ability to identify, formulate, and solve engineering problems."

This criterion is addressed with in every one of our classes. We have chosen to address this in ECE 2410 and ECE 2530, and Senior Design. (Even though a significant portion of our students might take these classes at other institutions, any articulated program should address this criterion.) This is evaluated also in the senior design sequence.

Class: Circuits 1 and Digital Design 1, and Senior Design.

Means of Assessment: Senior Design Jury Form (appendix F).

Criterion F

"An understanding of professional and ethical responsibility."

Means of Assessment: The university's Computer Information Literacy (CIL) examination has a portion discussing computer ethics, piracy and copyright considerations. Students are required to pass this exam as a graduation requirement.

A web-based ethics examination has also been established. Passing this examination is required for graduation, which is checked by the department secretary. Several courses also require passing this exam (to ensure that it is done prior to graduation), including ECE 3710.

Criterion G

"An ability to communicate effectively."

Class: ECE 4850 Design III (Senior Design)

Means of Assessment: Students' work is evaluated by graduate students in the technical writing program. After writing a draft, the work is critiqued and returned for modification. Following this process, the reviewers fill out a form (appendix F).

Criterion H

"The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context."

While the classes for this criterion are provided by the required general education courses, this does not provide the necessary assessment.

Means of Assessment The senior project documentation report form has a question on it addressing impact in a bigger context. This is evaluated by the reviewers.

Criterion I

"A recognition of the need for, and an ability to engage in, life-long learning."

It is difficult to assess the recognition of a need. However, we can assess something of an *ability* to do life-long search, whose lack would certainly make life-long learning more difficult. In discussing this option, we have observed that ability to engage in life-long learning includes an ability to do effective computer-based searches. This ability is examined, in part, by the university's standard Computer Information Literation (CIL) exam.

Means of Assessment: University's CIL exam. Students must past the examination to graduate, which includes aspects of network information searches.

The need for life-long learning is also assessed by questions in the senior exit interview (appendix E).

Criterion J

"A knowledge of contemporary issues."

Means of Assessment: During ECE 3820 (Design I), students read articles linked from a website to journals such as *EE Times*, then write a short summary article. These summaries are read by department secretary for content and appropriate writing.

Criterion K

"An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice."

Classes: ECE 3410 uses Spice and ECE 5530 covers design using Verilog; both of these are modern engineering tools.

Means of Assessment: A lab assignment is to be selected from each of these classes that make use of these tools. This will be evaluated with a specific form. [**Note to self:** need forms for these!]

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8 Assessment Summary

For the annual assessment, the following sources of information are used:

- Input from the industrial advisory committee
- Interview summaries from the senior exit interviews
- Alumni surveys
- Input from the curriculum committee
- Input from (a)–(k) forms and devices (starting in 2006)
- Other *ad hoc* sources of information

Once the faculty course assessments are collected, they are reviewed by the department assessment committee, along with alumni surveys, student exit interview summaries, input from the IAC, input from other employers, input from department meetings and the executive meetings. From this review, the chair of the assessment committee writes an **annual assessment report**. This report includes information such as the following:

- Results and changes made during the year are summarized
- Curricular and assessment goals for the upcoming year
- Issues needing discussion in faculty meeting affecting the curriculum as a whole
- Issues from particular classes determined from the faculty course assessments that rise to the level of departmental concern

This report is reviewed by the assessment committee. It is then circulated among the faculty and discussed at the annual Fall departmental retreat. The faculty, then, take input from the annual assessment report to incorporate into their teaching. Other issues (for example, lab hardware concerns) are treated at the executive committee level. The process is outlined in figure 5.

The overall result of this is that the curriculum is fairly cohesive and flows well. There are, in reality, some issues still to be worked out (transients still ringing from the switch from quarters to semesters). But the assessment process has brought attention to these issues, and motivates the need to resolve these concerns. The inclusion of ABET (a)–(k) outcome measurements keeps focus on points that must be covered well and ensures that all students receive the coverage they need on all aspects.

9 History of the Assessment Process in the ECE Department

Starting in Fall 1997, USU switched from a quarter-based system to a semester-based system. The ECE department also started its computer engineering degree in 1997. In preparation for these changes and for the ABET 2000, the faculty decided to implement the assessment method that is the forerunner of our curricular assessment method. This method very adequately met the assessment needs of the department. It was the method in place for the 2002 accreditation visit, where it was deemed adequate by the program reviewers.

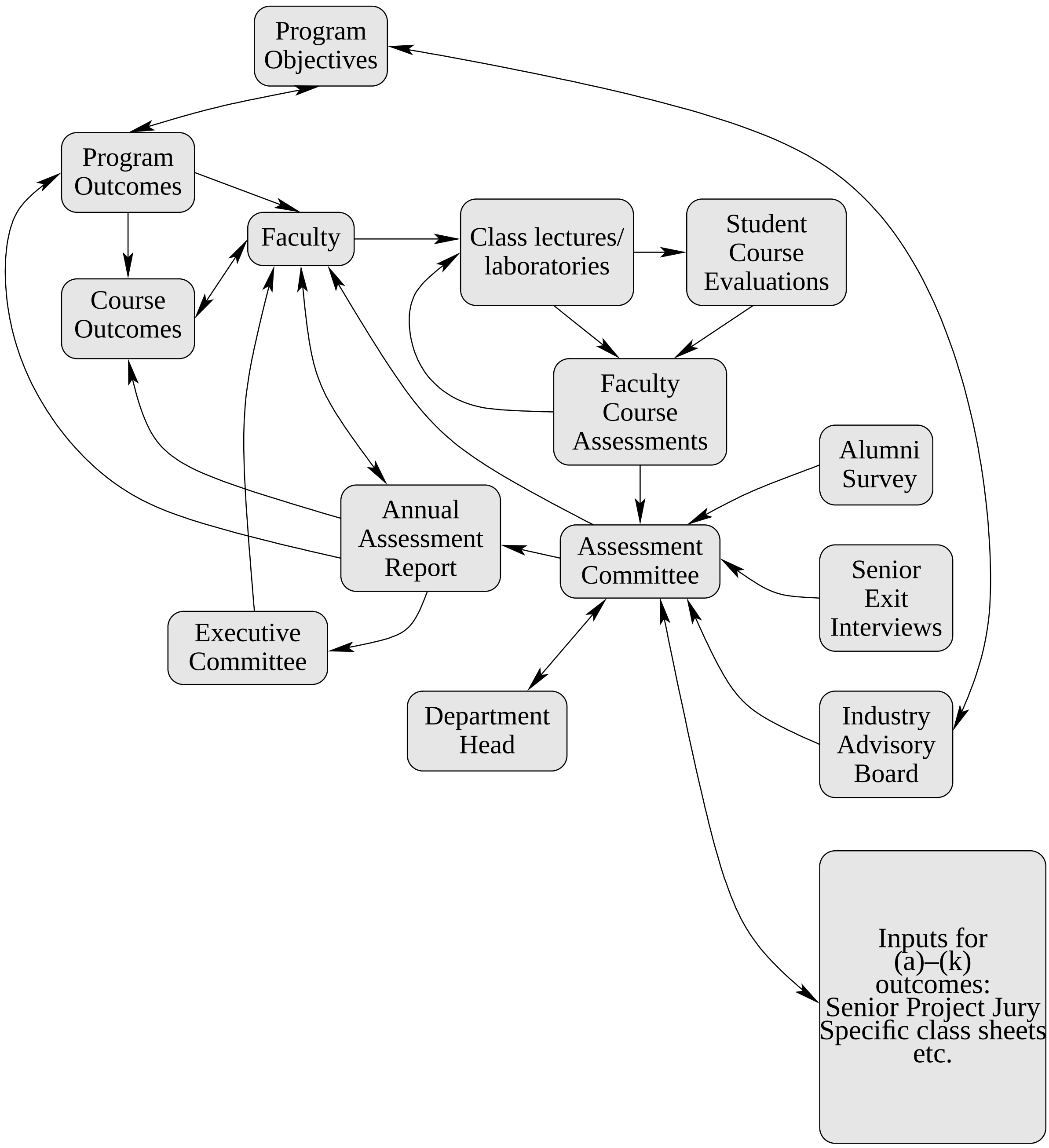

Figure 5: ECE Annual Assessment Process

However, under the curricular assessment, the (a)–(k) outcome assessment was at best indirect, accomplished via the course to outcome mapping. In Fall 2005, it was decided to strengthen the assessment mechanism to provide more explicit, and usually more direct, measures of the (a)–(k) outcomes, while still retaining the curricular assessment. In particular, in a meeting between the department head (Tamal Bose) and the curriculum committee head (Paul Wheeler) and the assessment committee head (Todd Moon) held on Dec. 18, 2005, a set of specific check points was discussed as candidates for measurements. Rather than phase out the old mechanism, it was decided to retain it, since it provides useful information for the operation of the department.

A Appendix: Boilerplate Faculty Course Assessment Form

Electrical and Computer Engineering **XXXX**
Course Name
Semester Taught

Instructor: Instructor name, Instructor phone, `Instructor email`

A. Outcomes Assessment (Possible brief description)

Outcome	**Measurement device**	**Score (0-2)**
1. Fill in the first outcome here.	Briefly describe the activities you will use to assess (e.g., homework, labs, quizzes, midterms, oral evaluation)	
2.		
3.		
4.		
5.		
6.		

B. How well were students prepared for the course?

The purpose of this question is to assess how well the courses are articulating with each other. Describe issues relating to pre-requisite classes if you perceive a need for a change.

C. Significant issues from student evaluations

Describe issues that may affect how the course is taught next time around.

D. Discussion

What scores were low, and why. What can be done to improve this for the next time around ...

Next time, I would modify ....

The following went well ...

We need to change ....

Facilities that would help this ...

B Appendix: Forms for assessing (a)–(k) outcomes

B.1 Forms for Outcome A

ABET Outcome A
Assessment Form
ECE 3620
Numerical Solution of Differential Equations

Name: ____

Students must demonstrate "An ability to apply knowledge of mathematics, science, and engineering."

The assignment requires application of computer science (programming) and math (differential equations) to solve a problem of engineering interest: the response of a linear time-invariant system in general, particularly the zero-input response of a circuit.

Scores are based on the scale of 0 — 2: 0 meaning "not adequate skill," 1 meaning "adequate," and 2 meaning "strong skill."

- Student correctly moves from physical system (circuit) to mathematical descriptions as a differential equation and differential equations in state variable form. ________

- Student correctly translates mathematical problem into appropriate computer language. ________

- Student compares theoretical results with simulated results and accounts for any discrepancy. ________

- Provided evidence of understanding and application in discussion: ________

- **Average:** ________

B.2 Forms for Outcome B

ABET Outcome B
Assessment Form
ECE 3640
Determining maximum μ for an adaptive filter.

Name: ________________________________

Students must demonstrate "an ability to design and conduct experiments, as well as to anaylze and interpret data."

Scores are based on the scale of 0 — 2: 0 meaning "not adequate skill," 1 meaning "adequate," and 2 meaning "strong skill."

Students must obtain at least a **1** in each item to pass the class.

- Student develops an effective procedure for experimentally determining the largest value of μ that you can use. ________
- Student effectively presents the data from the experiments and interprets the results. ________
- Student makes effective comparisons between experimental results and theoretical predictions and accounts for discrepancies. ________
- **Average:** ________

ABET Outcome B
Assessment Form

ECE 3710

Output characteristics on a digital IC

Name: ____

Students must demonstrate “an ability to design and conduct experiments, as well as to anaylze and interpret data.”

Scores are based on the scale of 0 — 2: 0 meaning “not adequate skill,” 1 meaning “adequate,” and 2 meaning “strong skill.”

Students must obtain at least a **1** in each item to pass the class.

- Student develops an effective procedure for experimentally determining the effect of exceeding voltage/current limits on a digital IC. ________
- Student effectively presents the data from the experiments and interprets the results. ________
- Student interprets and applies results in terms of design limitations. ________
- **Average:** ________

C Appendix: Alumni Survey 2005

Utah State University
Electrical and Computer Engineering Department
Alumni Survey 2005

Whether you buy a toaster or a video camera, it seems that everyone wants to know how you like the product and the service that came with it. Ideally, this information is used to improve the product in the future.

Well, you paid a lot of time and money for an education from Utah State University, and we want to know how it went for you. We are not merely casually interested. We are charged by our accreditation board (ABET) to produce students who meet certain objectives — objectives which are defined *years after* graduation! We need to hear from you to see how well what we provided to you while you were a student here has served you in achieving our objectives that we hoped for you.

Here are the objectives — the long-term goals — that are established for the Electrical Engineering Major.

- Contribute to engineering practice, advance engineering knowledge, and contribute to the good of society.
- Are advancing their education in engineering or other professions.
- Take a leadership role in engineering and society.

And here are the objectives for the Computer Engineering Major.

- Apply fundamental principles, to solve practical engineering problems.
- Are continually engaged in professional, personal, and community development.
- Are implementing well-planned, top-down designs of complex systems.
- Function well as team members and interact well with other professionals and non-engineers.

Please provide a thoughtful response to the following questions and return it to us in the envelope provided.

1. What size T-shirt would you like? (**M, L, XL, XXL None**)
   (To say thanks for helping us out with this survey, we will send a T-shirt back to you if you send in this survey. We'll try to send the size you indicate.)
2. If you want a T-shirt, we will need your address to send it back to. (This means that your comments won't be anonymous.) Your address:

   ____

   ____

   ____

In the following questions, please circle responses as appropriate. Also, please feel free to add additional written feedback on the lines provided.

3. Were you an Electrical Engineering Major or a Computer Engineering Major?

   Electrical Engineer   Computer Engineer

4. Are you employed as an engineer or in an engineering-related position?   Yes   No

5. If the answer to the previous question is "no," have you found that your engineering education at USU has helped you arrive at your current position?   Yes   No

   ____

6. Have the technical courses at USU equipped you with fundamentals in math, science, and engineering appropriate for your current position

   $1 =$ not at all 2 3 4 $5 =$ very much

   ____

7. Are there ways in which your education at USU could have been modified which would have improved your abilities to make professional and societal contributions? Circle all that apply

   OK as is   more physics   more math   more electronics   more English

   more digital   more programming   more EM   more business   more biology

   Other (please specify): ______________   ______________

   ____

8. Compared to your professional peers with similar education levels from other institutions, how do you feel the technical aspects of your engineering education compares to theirs?

   very poorly (1)   weakly (2)   about equal (3)   stronger in some areas (4)   generally stronger (5)

   ____

9. Identify professional development/educational activities have you done since graduating with your B.S.

   graduate school   in-house training   technical conferences   technical reading

   professional collaborations   Other (please specify): ______________

   ____

10. To what extent do you consider yourself a leader in your field and/or your community?

    $1 =$ not a leader 2 3 4 $5 =$ strong leader

    ____

11. To what extent has your education at USU prepared you with design skills and tools necessary to contribute to your profession?

    $1 =$ poorly 2 3 4 $5 =$ strong

    ____

12. To what extent has your education at USU prepared you to function as a contributing team member?

    $1 =$ poorly 2 3 4 $5 =$ strong

    ____

13. To what extent has your education at USU prepared you for interaction with other people in your professional life?

$1 =$ poorly 2 3 4 $5 =$ strong

---

14. To what extent has your education at USU provided you with appropriate written and verbal communication skills? How could the program be modified to further strengthen these skills?

$1 =$ poorly 2 3 4 $5 =$ strong

---

15. What is the extent to which your engineering education at Utah State University has helped you make contributions to your profession and to society.

not much	a little	some	quite a bit	a great deal
1	2	3	4	5

---

16. To what extent are you involved (or have been involved) in community or professional service activities?

$1 =$ not much 2 3 4 $5 =$ very involved

---

17. What did you like best about our ECE program?

____

____

18. If you could change one thing in the program, what would it be?

____

____

Thanks for your input!

D Appendix: IAC Questionnaire

Curriculum Survey for Industrial Advisory Committee

Feb. 22, 2003

In an effort to strengthen our educational process, we are undergoing a review of our undergraduate curriculum. We hope to achieve a balance between the particular needs of your company in particular (as an important part of our employer constituency) and the needs of engineers in general (that is, those that are hired by other firms). As you answer the following questions, please keep in mind two perspectives: what applies to the engineers that your company hires, and also what should apply to all engineers.

1. Our undergraduates have useful strengths in the following areas (circle all that apply that you have experience to judge):

   (a) Basic circuits
   (b) Digital design
   (c) Electronics
   (d) Solid state
   (e) Microprocessors
   (f) Programming
   (g) Computer operation/operating systems
   (h) Signals
   (i) Systems
   (j) Communications
   (k) Electromagnetics
   (l) Mathematics/tools
   (m) Physics/fundamentals
   (n) Controls
   (o) Writing/presentation
   (p) Work habits
   (q) Lab skills (specify) ______________________________
   (r) Other (specify) ______________________________

2. From your perspective, you would like to see the following areas of undergraduate education strengthened (circle all that apply):

   (a) Basic circuits
   (b) Digital design
   (c) Electronics
   (d) Solid state
   (e) Microprocessors
   (f) Programming
   (g) Computer operation/operating systems
   (h) Signals
   (i) Systems
   (j) Communications
   (k) Electromagnetics

(l) Mathematics/tools
(m) Physics/fundamentals
(n) Controls
(o) Writing/presentation
(p) Work habits
(q) Lab skills (specify) ______________________________
(r) Other (specify) ______________________________
(s) Other (specify) ______________________________
(t) Other (specify) ______________________________

3. Our undergraduate curriculum is full (some say to overflowing). If there are areas to be strengthened, there are other areas which must be cut back. Which of the following areas would you recommend that we cut back on, in order to strengthen the areas you indicated in the last question:

(a) Basic circuits
(b) Digital design
(c) Electronics
(d) Solid state
(e) Microprocessors
(f) Programming
(g) Computer operation/operating systems
(h) Signals
(i) Systems
(j) Communications
(k) Electromagnetics
(l) Mathematics/tools
(m) Physics/fundamentals
(n) Controls
(o) Writing/presentation
(p) Work habits
(q) Lab skills (specify) ______________________________
(r) Other (specify) ______________________________
(s) Other (specify) ______________________________
(t) Other (specify) ______________________________

4. There is frequently a perceived tradeoff between focusing on fundamental knowledge (including foundation lab skills), leading to a graduate with a solid foundation but who needs training on the job to come up to speed on the most recent tools *vs* focusing on particular on-the-job skills (e.g., operating particular design packages), leading to a graduate who is ready to go "right out of the box" in that area, but may lack fundamental knowledge and basic lab experience.

   (Fundamental knowledge includes such areas as physics, mathematics, electromagnetics, solid state physics, or systems theory; fundamental lab skills include, for example, digital and analog design and construction.)

   Regarding this tradeoff, compared to how we are currently preparing students, you would prefer (circle one):

   (a) A student with more knowledge of fundamentals, but with less experience on current design tools.

   (b) A student with approximately our current mix of fundamentals and particular tools.

   (c) A student with more knowledge and experience with current design tools, but with less fundamental knowledge.

5. One point of immediate discussion revolves around electronics and programming. Given the needs of your industry and the long-term career needs of our graduates, which of the following tradeoffs would you prefer for electrical engineer graduates[1]:

   (a) Increasing the amount of programming for the electrical engineers, possibly at the expense of cutting back on the amount of electronics.

   (b) Keeping the electronics where it is, or strengthening it, without increasing the amount of computer programming for electrical engineers.

[1] The question does not necessarily apply to computer engineer graduates, since they already receive more computer programming and less electronics than the electrical engineers.

E Appendix: Questions for Senior Exit Survey

ECE Senior/Exit Luncheon Summary
2005–2006
April 2006

- Number of students present?
- Companies that gave offers?
- Number of students going to graduate school?
- List your favorite ECE courses. Why?
- List your least favorite ECE courses. Why?
- Do you think the senior project experience is worthwhile? Why?
- List your favorite science/computer science courses. Why?
- List your least favorite science/computer science courses. Why?
- List your favorite math courses. Why?
- List your least favorite math courses. Why?
- List your favorite gen. ed. courses. Why?
- List your least favorite gen. ed. courses. Why?
- Are you a transfer student. If no: How well did our pre-professional program prepare you for the profession program?

  If yes: Where did you transfer from? How well did their pre-professional program prepare you for our professional program?
- List three things you enjoy about ECE and USU.
- List three things you would suggest the faculty or the department could do to change or improve.
- Issues related to content of curriculum.
- Issues related to faculty.
- Issues related to facilities.
- Issues related to atmosphere.
- Give your ECE education at USU a grade for giving you:
  - An ability to apply knowledge of mathematics, science, and engineering.
  - An ability to design and conduct experiments, as well as to analyze and interpret data.
  - An ability to design a system, component, or process to meet desired needs.
  - An ability to function on multidisciplinary teams.
  - An ability to identify, formulate, and solve engineering problems.
  - An understanding of professional and etheical responsibility.
  - An ability to communicate effectively.
  - The broad education necessary to understand the impact of engineering solutions in a global and societal context.
  - A recognition of the need for, and an ability to engage in, life-long learning.
  - A knowledge of contemporary issues.
  - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

F Appendix: Senior Project Jury and Senior Project Documentation Form

ELEMENTS of DESIGN PERTAINING TO SENIOR PROJECT EVALUATION
2006

In the items below, “project” is understood to be the physical item, the documentation associated with it, or both. Information needed to assign a score may be obtained from the student’s oral presentation and by his/her answers to the jury’s questions. Please assign each item a score of 0, 1 or 2, according to the following scale:

0 Missing or significantly deficient

1 Present and adequately executed; however, there is room for improvement.

2 Present and fully executed.

PROJECT TITLE ______________________________ STUDENT ______________________________

1. Identifying the Need ____________
   How did the student identify the need that prompted the project?
   Was that need clearly stated at the outset?
2. Defining the problem ____________
   Goal(s): Did the student adequately state the goal (i.e., how this project will satisfy the need)?
   Objectives: Were the project’s objectives identified, such as
      Quantifiable performance expectations?
      Operating conditions under which the design must perform?
   Constraints: Were limitations, technical or other, identified and included in the requirements?
      Examples: manufacturability, sustainability, economic, regulatory, safety, environmental.
3. Planning the project ____________
   Was a project plan formulated showing result-oriented tasks, with stand and completion dates?
   Did the plan include enough tasks to allow project progress to be realistically monitored?
   Were labor and material costs estimated for the tasks? Were records kept of the actuals?
4. Gathering information ____________
   Did the student initially lack required knowledge and obtain it “on-the-fly”
   Was any experimentation required or used to fill information gaps?
5. Conceptualizing Alternative Design Approaches (creativity and Synthesis) ____________
   Were various design solutions envisioned at this stage, allowing a wide range of options?
   If so, were these possible solutions discussed with other people for their feedback?
6. Evaluating the Alternatives (analysis) and Selecting the Optimum (tradeoff assessment) ____________
   Were analysis made of the various design options to find out which best met the specs?
   Were tradeoffs identified and weighed in order to select the best design?
   Did the original design objectives stay firm, or were changes necessary?
7. Project Documentation and Internal Communication ____________
   Does the student’s lab book have entries and sketches showing the design’s evolution?
   If a team project, was it a coordinated effort? If solo, did the student seek and find help as needed?
8. Implementation of the Design ____________
   Does the final product perform satisfactorily relative to the initial (or modified) objectives?
9. Presentation of the Result; Consideration of the Constraints ____________
   Do the poster and oral presentation show professionalism, and state the objective, design, and result?
   Does the student discuss constraints that do or might apply?

Judge: ______________________________ Date _______________ Total Score ____________

The Senior Project Jury form appearing on the previous page was used for the first time in 2006. For purposes of addressing particular (a)–(k) outcomes, we make the following mapping:

Outcome c (design a system, component, or process): Overall score, since these questions all address the question of design.

Outcome e (an ability to identify, formulate, and solve engineering problems): Overall score, since these questions all address questions of identifying and solving problems.

While this jury form is well suited to the question of evaluating the design process, and has pedagogical value for that purpose, it seems less suitable for determining performance on specific ABET outcomes. Accordingly, the following forms are proposed for use in future years. The preceding form is suggested for use of students for self-evaluation and education. The first form is filled out by the reviewers from the English department. The second (still to be accepted) form is filled out by the jury.

ABET Outcomes (g) and (h)
Senior Project Documentation Report Form

Student Name: ____

Student Project Name: ____

Please score on the basis of 0 to 2:

0 Missing or significantly deficient
1 Present and adequately executed. However, there is room improvement.
2 Present and fully executed.

1. The project documentation is complete ________
2. The project documentation is well organized ________
3. The project documentation is free of grammatical, punctuation, and other errors of writing. ________
4. The documentation is clear and well-written ________
5. The student has included in the project documentation a *meaningful* discussion of the project's potential impact in an economic, environmental, or societal context. ________

Evaluator Name: ____ Date: ____________ Total: ________

Senior Project Jury Evaluation Form

Student Name(s): ______________________ ______________________ ______________________

Project Number: _______________

Student Project Name: ____

Students are to be evaluated *as a team.*
For ABET requirements, students must demonstrate:

- (c) "An ability to design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability."
- (e) "An ability to identify, formulate, and solve engineering problems."
- (g) "An ability to communicate effectively."
- (h) "The broad understanding necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context."

Please score on the basis of 0 to 2:

0 Missing or significantly deficient
1 "Meets expectations": Present, and adequately executed. However, there is room improvement.
2 "Exceeds expectations": Present and fully executed.

The "project" in the items below includes either the physical item, or the documentation associated with it. Answers may also be obtained to questions asked by the jury.

1. The design states and meets desired needs (ABET C, E) ________
2. The design solution exhibits consideration of constraints, and meets the needs within reasonable constraints, such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability. (ABET C, E) ________
3. The student/team is able to demonstrate that design steps were followed, such as: ________
   - Clearly defining the problem
   - Gathering information
   - Considering alternative designs and trading off aspects of the designs
   - Clearly documenting progress

   (ABET C, E)
4. The implementation follows proper procedures appropriate for the design (ABET C, E) ________
5. Student/team has appropriately identified engineering problems and solved them. (ABET E) ________
6. Student/team orally describes impact of project on economic, environmental, or societal systems. (ABET H) ________
7. Student/team communicates orally in a clear and effective manner (ABET G) ________

Evaluator Name: ____ Date: ____________ ________

G Appendix: Multidisciplinary Team Evaluation Form

ABET Outcome D
Assessment Form
ECE 3820
Multidisciplinary Team Evaluation Form

This form is to be filled out be each member of each team.

Students must demonstrate "An ability to function on multi-disciplinary teams."

Scores are based on the scale of 0 — 2: 0 meaning "not adequate skill," 1 meaning "adequate," and 2 meaning "strong skill."

Student Being Evaluated: ______________________________

Student Doing Evaluation: ______________________________

Please score on the basis of 0 to 2:

0 Missing or significantly deficient

1 Present, and adequately executed. However, there is room improvement.

2 Present and fully executed.

---

1. Student was present at most or all team meetings: ________

2. Student carried out designated responsibilities: ________

3. Student shared *constructive* criticism: ________

4. Student avoided negative attitudes: ________

5. Student carried fair share of load: ________

6. Student was committed to good of team, and not just self-interest: ________

Average Score: ________