Electrical Engineering
2012–2013 Assessment Report

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Contents

1 Introduction

1.1 Program Goals and Design

Electrical Engineering at Oregon Institute of Technology (Oregon Tech) aims to impart a thorough grounding in the theory, concepts, and practices of electrical and electronics engineering. Emphasis is on practical applications of engineering knowledge. The hands-on student projects undertaken by all program graduates include real-world applications like electric, hybrid, and fuel-cell cars, a three-term multidisciplinary senior project (design, implementation, and test—not just simulation) and NASA's High-Altitude Balloon and Rocket Projects. The goal of this program design is to graduate engineers who require minimal on-the-job training while providing sufficient theoretical background to enable graduates to attend and succeed in graduate education in engineering.

1.2 Program History, Enrollment & Graduates

In 2007, Oregon Tech began offering its new Bachelor of Science in Electrical Engineering (BSEE) program at its main campus in Klamath Falls, Oregon (KF). The BSEE degree is a traditional EE degree that has replaced the BSEET program that was previously in Klamath Falls, and it was created to prepare graduates for careers in various fields associated with Electrical Engineering. These include, but are not limited to, analog integrated circuits and systems, digital integrated circuits and microcontroller systems, signal processing, communication systems, control systems, semiconductors, optoelectronics, renewable energy, and biomedical fields as stated in the Oregon Tech catalogs for 2007 through 2013.

The program's first graduating class was in June 2010 with a class size of five. Total enrollment has increased to 65 (headcount, including one dual-majoring student and one post-baccalaureate) as of Fall 2012, week 4. Enrollment for 2007 through 2012 is shown in Table 1.

Table 1: Enrollment (student headcount), Fall 2007 through Fall 2012

2007	2008	2009	2010	2011	2012
36*	38	53	48	55	68

We anticipate that all BSEE graduates will enter careers in electrical engineering as design engineers, test engineers, characterization engineers, applications engineers, field engineers, hardware engineers, process engineers, control engineers, power engineers, semiconductor-processing engineers, controls and signal-processing engineers, energy system-integration engineers, analog-systems engineers, digital-systems engineers, embedded-hardware engineers, and other electrical engineers. Graduates of the program will be able to pursue a wide range of career opportunities, not only within the more traditional areas of Electrical Engineering, but within the emerging fields of Renewable Energy Engineering and smart-grid engineering as well.

Twenty-seven BSEE students have graduated as of Spring 2012. The BSEE program will have a graduating class at the end of every spring term. The status of Oregon Tech EE graduates in terms of employment and graduate studies is summarized in the Table 2 for graduates of 2010, 2011, and 2012.

In 2010, three out of six graduates went on to graduate programs, two at the University of Oregon Applied Physics industrial-internship program that Oregon Tech is a partner in, and one in ocean engineering at Florida Atlantic. The remaining three graduates went onto engineering jobs.

In 2011, two out of fifteen graduates continued onto graduate school, one in computer science and one in power engineering, with eleven of the remaining thirteen graduates getting engineering jobs. Two graduates in 2011 got other employment, namely one as a technician and one as a manager.

In 2012, Oregon Tech's EE program had six graduates, with one continuing onto graduate studies and five finding jobs as engineers. These results are summarized in Table 2.

Table 2: BSEE Program Graduates

Identifier, Grad Year	**Company (or Graduate School)**	**Job Title**	**Industry (or Major)**
1, 2010	Micron	Industrial Production Engineer	Semiconductor Memory
2, 2010	Weyerhaeuser	Industrial Production Engineer	Paper, and Building Products
3, 2010	JELD~WEN	QC Engineer	Building Products
4, 2010	University of Oregon	Graduate Student	Materials Science
5, 2010	University of Oregon	Graduate Student	Materials Science
6, 2010	Florida Atlantic Univ.	Graduate Student	Ocean Engineering
1, 2011	Advanced Technology & Research Corp.	Junior Engineer	Military & Automation
2, 2011	Leviton Manufacturing	Electrical Engineer	Networking, Energy & Renewable Energy
3, 2011	JELD~WEN	Manufacturing Project Manager	Building Products
4, 2011	Alyrica Networks	Technician	Clean-Energy Networking
5, 2011	Novellus	Product Engineer	Manufacturing Equipment for Semiconductor Industry
6, 2011	Novellus	Product Engineer	Manufacturing Equipment for

			Semiconductor Industry
7, 2011	Novellus	Product Engineer	Manufacturing Equipment for Semiconductor Industry
8, 2011	Biotronix	Test Engineer	Biomedical
9, 2011	Schweitzer Eng.	Design Engineer	Automation, Telecommunications & Power
10, 2011	US Air Guard	Comm. Engineer	Military
11, 2011	PCM Sierra	Design Engineer	Networking & Telecommunications
12, 2011	Black & Veatch	Power Engineer	Construction
13, 2011	SEL	Process Engineer	Power Systems
14, 2011	University of Idaho	Graduate Student	Computer Science
15, 2011	Colorado School of Mines	Graduate Student	Power Engineering
1, 2012	POWER Testing and Energization	Field Test Engineer	Power Engineering
2, 2012	Black & Veatch	Electrical Engineer 1	Construction
3, 2012	Black & Veatch	Electrical Engineer	Construction
4, 2012	POWER Testing and Energization	Field Engineer	Power Engineering
5, 2012	Novellus Systems	Field-Service Engineer	Manufacturing Equipment for Semiconductor Industry
6, 2012	University of California, Santa Barbara	Graduate Student	Computer Engineering

1.3 Improvements to Program Equipment

In the academic year of 2012–13, ten equipment-purchase or equipment-update proposals by the EERE department (which houses the EE program) were fully or partial funded. The total amount awarded by Oregon Tech to nine proposals directly affecting the department was $70,125.36, which, with external funding, comes to a total of $129,108.06 in lab upgrades.

In addition, the Wilsonville campus was awarded $16,200.00 for the purchase of equipment to be able to offer the CHE201/204 and CHE202/205 in Wilsonville. This proposal directly affects programs in the EERE department, since these were the only two courses remaining that are necessary for offering all EERE degrees in their entirety at the Wilsonville campus.

Descriptions of the funded proposals follow.

1. Update of General-Purpose Electronic Lab Equipment for PV 237 and 241 Labs

This allowed the acquisition of replacement lab test equipment (20 DMMs, 20 power supplies, and 20 oscilloscopes) for EERE labs in Klamath Falls Purvine 237 and Purvine 241. Current equipment is out of date and raised a concern at the last ABET visit. A 50% discount from Tektronix Charitable Donation Grant allows to upgrade equipment for two labs for the price of one.

2.Replacement of General Lab Test Equipment in Purvine 248 and Purvine 251 Labs

This allowed the acquisition of replacement laboratory test equipment (10 DMMs, 10 power supplies, 10 oscilloscopes, and 10 function generators) for EERE labs in Klamath Falls, Purvine 248 and Purvine 251. Current equipment is out of date and raised a concern at the last ABET visit. 50% discount from Tektronix Charitable Donation Grant allows to upgrade equipment for two labs for the price of one.

3. Circuits-Lab Equipment in Wilsonville

This allowed the acquisition of lab test equipment (4 power supplies, 5 function generators, 4 oscilloscopes, and 5 DMMs) to complete the circuits lab in Wilsonville (room 404). Prior to this grant, there was only enough equipment to fill half of the lab. The lab is used for EE, EET, REE, and ESET courses. A 50% discount from Tektronix Charitable Donation Grant provided a great opportunity to purchase needed equipment.

4. Electronics Lab Equipment in Wilsonville

This allowed the acquisition of lab test equipment (4 power supplies, 5 function generators, 4 oscilloscopes, and 5 DMMs) to complete the electronics lab in Wilsonville (room 408). Prior to this grant, there was only enough equipment to fill half of the lab, and the department was unable to accommodate enrollment demand for courses that use this equipment. Lab is used for EE, EET, REE, and ESET courses. A 50% discount from Tektronix Charitable Donation Grant provided a great opportunity to purchase needed equipment.

5. Improvements to Optoelectronics Lab in Wilsonville

This allowed the acquisition of six tool chests to store optics components in Optoelectronics lab in Wilsonville. An adequate storage solution was needed for some of the fragile and expensive optics equipment.

6. Microcontroller-Lab Equipment in Klamath Falls

This allowed the acquisition of replacement microcontroller-lab equipment for EERE labs in Klamath Falls. Existing equipment was out of date and limited the ability to maintain industry relevance of curriculum, as well as the use of more modern textbooks, since they incorporate information related to more modern microcontrollers. This upgrade was recommended by one of the ABET evaluators during the initial BSEE ABET visit.

7. Equipment for Power-Electronics Lab in Wilsonville

This allowed the acquisition of ten current probes with 50-Ohm terminators (one per station) for the power-electronics lab in Wilsonville (room 461). These were needed to perform laboratory experiments in Power Electronics and related courses.

8. Memory Upgrade for Lab Computers in Klamath Falls

This grant allowed the upgrading of memory in lab computers on the Klamath Falls campus. Prior to this, computers had 1 GB of RAM, and were too slow to run programs such as MATLAB, LTSpice, LabVIEW, and Powerworld. These programs are critical to both the EE and the REE programs' lab components. Previously, it could take up to 20 minutes just to start one of these programs. As a result of the funded proposal, for labs in Purvine (Klamath Falls) with 25 computers per lab were upgraded to 4 GB of RAM each.

9. Student-Response System for Classroom Instruction

This grant allowed the purchase of a student-response system and a small set of devices (sometimes known as "clickers") to help improve student understanding of lecture material, and to increase class interactivity and teaching effectiveness. Ten anonymous-feedback devices of the type previously (and currently) in use in classes in Oregon Tech's College of Health, Arts, and Sciences (HAS), as well as many other colleges and universities in Oregon and around the United States with positive results have been acquired for use in EE, REE, ENGR, and HUM courses that serve almost every major on campus, with the most populous group being EE students.

10. Chemistry Equipment in Wilsonville

As stated above, the Wilsonville campus was also awarded $16,200.00 for the purchase of equipment to be able to offer the CHE201/204 and CHE202/205 in Wilsonville. This proposal directly affects programs in the EERE department, since these were the only two courses remaining that are necessary for offering all EERE degrees in their entirety at the Wilsonville campus.

1.5 Industry Relationships

The BSEE program has strong relationships with industry, particularly through its program-level Industry Advisory Council (IAC), and through its EE and EET alumni. These relationships with our constituents allow the BSEE program to meet the institutional goal of maintaining the currency of our degree programs.

The IAC has been a mainstay in the development of the EE program since its early EET roots. The IAC provides advice and counsel to the EE program with respect to curriculum content, instructional resources, career guidance and placement activities, accreditation reviews, and professional-development assistance. In addition, each advisory-committee member serves as a vehicle for public-relations information and potentially provides a point of contact for the development of specific opportunities with industry for students and faculty.

1.6 Program Locations

The BSEE program is located at both main campuses (Klamath Falls and Wilsonville), serving a large portion of rural Oregon and California. Oregon Tech is the only university offering multiple classical engineering degrees at the Bachelor's (and some at the Master's) level from Corvallis, Oregon, in the north, to Chico, California, in the south, and from the Pacific coast in the west to Boise, Idaho, in the east.

The Klamath Falls campus includes a leading geothermal research facility, a large solar facility (under development), and a center for applied research in renewable energy, offering exceptional opportunities for students to gain experience in the subfields of power, energy, and renewable energy. These resources allow students access to research *and* practical experience in geothermal, solar, and other sources of green energy.

The Wilsonville campus offers excellent access to internships and other technological collaboration with the Silicon Forest (as the semiconductor industry in the Portland metropolitan area is known).

This arrangement satisfies the needs of the state of Oregon by placing a traditional EE program in the southern, rural part of the state to serve that region as well as providing a small-school EE program to students who desire a low student-to-faculty ratio and small classes. The EE program also supports the shift at the institution from four-year technology degrees to four-year engineering degrees. The addition of EE completes the College of ETM (Engineering, Technology & Management) along with Oregon Tech's Civil Engineering, Mechanical Engineering, and Renewable Energy Engineering programs.

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the Electrical Engineering Bachelor of Science degree program is to provide a comprehensive program of instruction that will enable graduates to obtain the knowledge and skills necessary for immediate employment and continued advancement in the field of electrical engineering. The program will provide high-quality career-ready candidates for industry as well as teaching and research careers. Faculty and students will engage in applied research in emerging technologies and provide professional services to their communities.

2.2 Program Educational Objectives

Program educational objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. The PEOs of Oregon Tech's Bachelor of Science in Electrical Engineering program are:

- PEO 1: The graduates of the BSEE program will possess a strong technical background as well as analytical, critical-thinking, and problem-solving skills that enable them to excel as professionals contributing to a variety of engineering roles within the various fields of electrical engineering and the high-tech industry.

- PEO 2: The graduates of the BSEE program are expected to be employed in electrical-engineering positions including (but not limited to) design engineers, test engineers, characterization engineers, applications engineers, field engineers, hardware engineers, process engineers, control engineers, and power engineers.

- PEO 3: The graduates of the BSEE program will be committed to professional development and lifelong learning by engaging in professional or graduate education in order to stay current in their field and achieve continued professional growth.

- PEO 4: The graduates of the BSEE program will be working as effective team members possessing excellent oral and written communication skills, and assuming technical and managerial leadership roles throughout their career.

2.3 Relationship between Program Objectives and the Institutional Mission

The Oregon Tech mission statement is as follows. "Oregon Institute of Technology, a member of the Oregon University System, offers innovative and rigorous applied degree programs in the areas of engineering, engineering technologies, health technologies, management, and the arts and sciences. To foster student and graduate success, the university provides an intimate, hands-on learning environment, focusing on application of theory to practice. Oregon Tech offers statewide educational opportunities for the emerging needs of Oregon's citizens and provides information and technical expertise to state, national and international constituents."

The "strong technical background" of PEO 1 corresponds to the rigor required by the institutional mission of Oregon Tech's degree programs.

The innovative aspect of our degree programs are reflected in the commitment to critical-thinking and problem-solving skills evident in the variety of courses offered and innovative teaching techniques employed throughout the institution as well as within the EE program. Critical thinking is built into the lectures, student work, assignments, and exams of many EE courses like the introductory circuit-analysis sequence, the junior electronics sequence, and senior courses like Communication Systems, as well as general-education courses like SPE 314: Argumentation, HUM 207: Informed Decision Making, and PSY 201/2: Psychology. Likewise, problem-solving is a pervasive aspect of the BSEE from the interdisciplinary course on the introduction to engineering to the often-interdisciplinary senior project.

PEO 2 is aligned with the institution's mission to fulfill the emerging technology needs of Oregon as the BSEE prepares students to take their place in the work force as design engineers, test engineers, characterization engineers, applications engineers, field engineers, hardware engineers, process engineers, control engineers, and power engineers.

The institution's mission emphasizes graduate success along with student success, and this is where the commitment to lifelong learning (PEO 3) aligns with the mission. Furthermore, the mission statement's specification that "to foster student and graduate success, the university provides and intimate, hands-on learning environment, focusing on application of theory to practice" is also in strong alignment with the BSEE program due to the prominence of small classes, the hands-on focus of the program, and faculty-taught laboratories.

2.4 Program Outcomes

The BSEE student outcomes include ABET's EAC (a)–(k) student outcomes. The program-specific outcomes (l) and (m) are de-emphasized this year by recommendation of ABET evaluators. What this means is that ABET evaluators have recommended that we focus on the outcomes (a)–(k), but because past assessment plans and reports have included certain commitments to assessing student learning in the areas addressed by outcomes (l) and (m), we will phase these outcomes out once we have completed out prior commitments to assessing them.

Having said that, the graduates of our Bachelor of Science in Electrical Engineering program must have:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multi-disciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in lifelong (independent) learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

(l) a knowledge of differential and integral calculus and advanced mathematics including differential equations, linear algebra, vector calculus, complex variables, Laplace transforms, Fourier transforms, and probability and statistics with appropriate applications.

(m) a knowledge of basic sciences, computer science, and engineering sciences necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components, as appropriate to program objectives.

3 Cycle of Assessment for Program Outcomes

3.1 Introduction, Methodology, and the Assessment Cycle

Table 3 shows the *minimum* set of student outcomes assessed during each academic year. Typically, many more are assessed per year than shown, some due to the process of continuous improvement (following up on recommendations by the faculty made at prior years' closing-the-loop meetings), some due to the institutional ISLO (Institutional Student-Learning Outcomes) assessment cycle, and some due to the department's or individual faculty members' assessment interests.

Assessment of the student outcomes is conducted over a three-year cycle. During the 2010–11 academic year, nine out of thirteen student outcomes (including the two program-specific outcomes) were assessed to establish a baseline. It was expected that, at this point, the number of students enrolled in the program would be sufficient to gather a substantial amount of data, and that the assessment process would have matured to a stable final version. In prior years, the assessment effort was in its trial-and-error phase as the faculty practiced student-learning assessment and discussed their findings of how to carry out the assessment process. There were slight changes made to the original assessment cycle proposed in 2007–08, as the assessment cycle and process were being fine-tuned based on additional experience gathered from previous year's assessment, as well as from ABET visits for other programs in the department. The columns for 2011–12 and on represent the current stable three-year assessment cycle.

Table 3: BSEE Assessment Cycle for Student Outcomes

		2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15
(a)	Fundamentals		**X**		**X**	**X**			**X**
(b)	Experimentation	**X**		**X**	**X**		**X**		
(c)	Design within constraints		**X**			**X**			**X**
(d)	Teamwork	**X**	**X**	**X**	**X**		**X**		
(e)	Problem-solving	**X**			**X**			**X**	
(f)	Ethics			**X**	**X**		**X**		
(g)	Communication	**X**			**X**			**X**	
(h)	Impacts of engineering			**X**			**X**		
(i)	Lifelong (independent) learning				**X**			**X**	
(j)	Contemporary issues			**X**	**X**		**X**		
(k)	Engineering tools	**X**			**X**			**X**	
(l)	Advanced mathematics		**X**			**X**			
(m)	Basic, computer & eng. sciences		**X**			**X**			

3.2 Summary of Assessment Activities & Evidence of Student Learning

3.2.1 Introduction

The BSEE faculty have conducted formal assessment since the 2007–08 academic year using direct measures such as exams, lab projects, presentations, and research papers. Additionally, the student outcomes are assessed using indirect measures, namely results from student evaluations based on methodology developed by the IDEA Center[1], and data from exit surveys of seniors.

3.2.2 Methodology for Assessment of Student Outcomes

The BSEE conducts direct and indirect assessments. The direct assessment process using assignments specifically designed to measure ABET-style outcomes as well as regularly occurring student work (such as exams and homework). As these assessments become regular parts of the courses in which they are used, they become *embedded assessment*.

The indirect assessment process derives assessment data from course evaluations and student surveys.

Direct Measure: ABET Assignments

This direct assessment process links specific tasks within engineering course assignments to EE program outcomes and then to PEOs in a systematic way based on rubrics for the EE student outcomes and a mapping of program-level student outcomes to the PEOs. The program outcomes are evaluated as part of the course curriculum primarily by means of comprehensive assignments. Some of these are standard assignments (embedded assessment for both program-level and course-level outcomes) while others are specifically designed to measure program-level outcomes. These assignments typically involve a project or lab experiment requiring the student to apply principles of mathematics, science, and engineering, as learned in the course (or throughout their student career), to solve a particular problem requiring the use of modern CAE tools and engineering equipment, working in teams, and writing a project report or giving an oral presentation.

Evaluations of these outcomes are then gathered in outcome-specific tables, analyzed and then summarized. Summaries for all student outcomes are then compiled into a comprehensive summary. This summary is evaluated for relevance with respect to the PEOs, and included in documentation for ABET.

The mapping process aims to systemize the assessment of engineering student outcomes, and to provide a mechanism that facilitates the design of engineering assignments that meet the ABET-general outcomes, (a)–(k), particularly focusing on those that are atypical for traditional engineering coursework. Rather than considering how the outcomes match the assignment, the assignment is designed to map to the student outcomes.

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[1] www.theideacenter.org
[2] www.theideacenter.org

Indirect Measure: KSU IDEA Evaluations

At OIT, course evaluations are conducted using the course evaluation form developed by the IDEA Center[2], an organization originating from Kansas State University. From collected student evaluation forms, an IDEA Center diagnostic report is generated and returned to the instructor.

Methodology for this indirect assessment was detailed under Criterion 3 of the 2011–12 BSEE ABET Self-Study.

Indirect Measure: Senior Exit Survey

This measure was developed and deployed during the spring term of 2012. Sample questions and an analysis of the first set of results are given in the appendices at the end of this document.

3.2.3 2012–13 Targeted Assessment Activities

The sections below describe the 2012–13 targeted assessment activities, and give a summary of student performance for each of the assessed outcomes. Unless otherwise noted, the tables report the percentage of students performing at developing, accomplished, and exemplary levels[3] for each performance criterion, as well as the percentage of students performing at an accomplished level or above.

The minimum acceptable performance level for any outcome is to have 80% or more of the students (taking part in that assessment activity) performing at the accomplished or exemplary level for *all* performance criteria (for that assessment activity)[4].

The following is a set of tables and analyses for the outcomes assessed during the 2012–13 academic year. The outcomes are (b), (d), (f), (g), (h), (i), (j), and (l).

Outcomes (b), (d), (h), and (j) are due only to the regular cycle. Outcomes (g), (i), and (l) are part of continuous improvement. Outcome (f) was required by the regular cycle, for continuous improvement, *and* by the institutional assessment for the current year.

Each table is a summary of the various course assignments used to assess the outcomes with the rubric for that outcome. For each rubric, the targeted outcome and the performance criteria are

[2] www.theideacenter.org

[3] Performance below the developing level is possible, although rare, and would correspond to little or no sign in the work sample for demonstrating understanding or accomplishment in that criterion.

[4] As of the end of the 2011–12 faculty reviews of assessment results at the closing-the-loop meetings, faculty have the option of setting the minimum percentage of students at a value other than 80, either for the entire rubric–assignment pair for an outcome, or for a specific performance criterion within the rubric. It is, however, paramount that any such change in the targeted level be made prior to the execution of the corresponding assessment activity.

fixed, but faculty have the academic freedom to make adjustments to the descriptors of levels of achievement, which they are required to share with their assessment coordinator.

3.2.4 Targeted Assessment of Outcome (b)

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

Assessment (b): EE 323, Winter 2013, Klamath Falls Campus

This outcome was assessed via a two-part project. In part 1, given the specs of a two-stage MOSFET voltage amplifier—a common-source stage followed by a common-drain (voltage follower/current booster) stage—the students were asked to design the amplifier to fall within spec over the course of two weeks. In part 2, the students were asked to change the voltage amplifier to a transconductance amplifier by incorporating the load resistance, and then design a feedback system with appropriate two-ports to obtain the open-loop and closed-loop parameters. This was followed by oral presentations (also assessed) and an IEEE-style report.

Nine EE students were assessed Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in each of the performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was not met on any of the performance criteria for this program outcome.

Some students did not describe or discuss their actual circuits, and showed no data values or graphs in their report. Much of the work either lacked sufficient explanations but provided data, or gave elaborate explanations but supplied little or no data. In some cases, the discussion of design specs or constraints was completely missing. Some students performed exceptionally with SPICE, but gave no indication of an actual working circuit having been assembled and tested. The students in the Exemplary category had outstanding, professional-quality reports showing complete design and implementation work.

Table 7: Targeted Assessment for Outcome (b)

(b) an ability to design and conduct experiments as well as analyze and interpret data				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students ≥ 2
Designing an experiment	3	2	4	67 %
Conducting an experiment	2	3	4	77 %

Analyzing and interpreting experimental data	5	0	4	44 %

Recommendations based on the End-of-Year Faculty Review of Outcome (b)

Reinforce concepts related to the design of experiments, as well as the analysis and interpretation of data in sophomore-level courses (primarily Circuits sequence), by:

(1) avoiding step-by-step lab instructions in favor of asking students for a result, and letting them figure out the steps to achieve it,

(2) providing direction on how to present their data in a technical report, and

(3) asking them specifically to include the following sections in their lab/project reports or other deliverables: methodology (so they recollect the steps they followed in their experiment); results (so they practice how to present data); discussion (so they analyze and interpret their data).

Reassess following regular cycle to observe improvements in attainment.

3.2.5 Targeted Assessment of Outcome (d)

An ability to function on multi-disciplinary teams

Assessment (d): EE 419, Fall 2012, Klamath Falls Campus

This outcome was assessed using a required lab project assignment for a senior course in power electronics. This course is required for REE students and an upper division elective for EE students. All students are required to do a final lab project for the lab portion of the course. In this assignment students were given a choice of three lab projects to work on, one project was an AC-to-DC converter and DC-to-DC converter, another was a sensor-driven control application using power electronic drivers, and the final was a user-defined instructor-approved power electronics project. The students worked in teams of 2-3 students for the three-week project and were required to submit a final project report at the end of the term.

Thirty-four students (mixture of EE and REE seniors) were assessed in the Fall 2012 term using the performance criteria listed below. (All students in the class participated. At this point in our assessment evolution, we had not required faculty to separate out the students into their majors for the purposes of obtaining and reporting assessment data. From spring 2013 on, this will be attended to. For the time being, this is the data we have.) The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they demonstrated their abilities to work on teams to solve engineering problems or design a project. The students showed ability to manage the team, assign project duties, have meetings to discuss progress and issues. All reports were done in a very professional manner with all members showing active participation in lab except one member of one team. All twelve teams showed a delegation of responsibility to all team members with design partitioning and work delegation between team members.

Table 9: Targeted Assessment for Outcome (d)

(d) an ability to function on multi-disciplinary teams (major project)				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Team Participation and Communication	1	10	23	97%
Develop a group consensus	1	9	24	97%

<u>Recommendations based on the End-of-Year Faculty Review of Outcome (b)</u>

Results are satisfactory. No recommendations are made at this time.

3.2.6 Targeted Assessment of Outcome (f)

An understanding of professional and ethical responsibility

<u>Assessment (f): EE 419, Fall 2012, Klamath Falls Campus</u>

This outcome was assessed using a graded homework assignment involving a case study type assignment for a senior course in power electronics. This course is required for REE students and an upper division elective for EE students. Students have the grading option of dropping a homework assignment so not all students in the class did this assignment (21 out of 34). In this assignment students were given a hypothetical situation where they had the role of lead project engineer for a power converter company. In this situation your firm had just won a competitive bid to design and manufacture a quantity of AC–DC converters for a wind turbine farm. The situation included some possible ethical dilemmas such as a conflict of interest, errors in product test data and schedule issues. The students were asked to use the IEEE code of ethics and identify the ethical dilemmas in the situation and evaluate the issues. They were then asked to discuss how they (as lead engineer) would resolve these issues.

Twenty-one students (mixture of EE and REE seniors) were assessed in the Fall 2012 term using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they demonstrated their abilities to identify a professional code of ethics and analyze the ethical dimensions of an industrial type situation. The main issue noted in this assessment was that there seem to be some misunderstanding between a conflict of interest and an actual bribe. Some students thought giving a contract bid to relative was a bribe and not a conflict of interest. Please note that performance criteria F3 was not evaluated in this assignment (it will be evaluated later by all program faculty on the senior class). This assignment was also used for the Institutional Student Learning Outcome (ISLO) assessment for AY 2012–13.

Table 13: Targeted Assessment for Outcome (f)

(f) an understanding of professional and ethical responsibility				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Demonstrating knowledge of professional codes of ethics	0	7	14	100 %
Evaluating the ethical and professional dimensions of engineering practice	2	2	17	90%

<u>Recommendations based on the End-of-Year Faculty Review of Outcome (f)</u>

The results are satisfactory. No recommendations are made at this time.

3.2.7 Targeted Assessment of Outcome (g)

An ability to communicate effectively

Assessment (g)1: EE 321, Fall 2012, Klamath Falls Campus

This outcome was assessed via individual oral presentations based on what was learned in a series of four BJT labs.

Fourteen students were assessed Fall 2012 using the performance criteria listed below. The minimum acceptable performance level was to have 80% of the students performing at the accomplished or exemplary level in each of the performance criteria for this assessment run. The performance criteria minimum acceptable level is lower for this outcome than others because we do not specifically teach communication skills in our classes, although a freshman-level Fundamentals of Speech class is required in the program.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was not met on all the performance criteria. Within these criteria, students' performances were weakest in terms of organization (with 43% performing below level 2), and strongest overall in visuals. If weakness in these areas continues to be observed, the EERE faculty may want to share these findings with Communication Studies.

Table 15: Targeted Assessment for Outcome (g)

(g) an ability to communicate effectively				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Oral communication: Content	5	4	5	65 %
Oral communication: Organization	6	3	6	64 %
Oral communication: Style	4	5	5	72 %
Oral communication: Delivery	7	4	3	50 %
Oral communication: Visuals	2	6	6	86 %
Acquiring information from various sources	NA	NA	NA	NA
Written communication	NA	NA	NA	NA

<u>Assessment (g)2: EE 325, Spring 2012, Klamath Falls Campus</u>

This outcome was assessed via lab presentations given for a design experiment. Most speakers were lab partner pairs; one was an individual.

Nine EE students were assessed Spring 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in each of the performance criteria.

The table below summarizes the results of this targeted assessment. The results initially suggest that the minimum acceptable performance level of 80% was not met on any of the performance criteria addressed by the assessment activity. However, in the case of criterion 3, Style, 78% met the standards. Due to the small class size, 78% is sufficiently close to 80% when the step size is 11% (one out of nine students). Nine was the entire class size; all students enrolled in the class took part in the assessment activity. It also included individual written reports, which are not addressed in this assessment. A third of the students produced excellent MS PowerPoint presentations to augment presentations. The other two-thirds had PowerPoint documents that were adequate, but lacked refinement, and subsequently detracted from, rather than enhanced, the presentations. While the criteria indicate a general weakness in the students when it comes to public speaking, a noticeable improvement was seen among certain individuals since the last assessment of this group. The exposure to more speaking opportunities in the curricula is clearly leading to improvement, at least in a small number. This indicates that the EE program needs to fit in more speaking assignments.

Table 16: Targeted Assessment for Outcome (g)

(g) an ability to communicate effectively				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Oral communication: Content	4	4	1	56 %
Oral communication: Organization	4	4	1	56 %
Oral communication: Style	2	4	3	78 %
Oral communication: Delivery	4	4	1	56 %
Oral communication: Visuals	6	0	3	33 %
Acquiring information from various sources	NA	NA	NA	NA
Written communication	NA	NA	NA	NA

Recommendations based on the End-of-Year Faculty Review of Outcome (g)

Students' performances were weakest in terms of organization and delivery.

Even though it is still too early to see much impact from the changes recommended in 2011-12, these results reinforce the recommendation to fit in more speaking assignments in the BSEE curriculum, particularly in the labs. In this process, faculty also need to encourage quality presentations where the organization of the speech drives the visuals, not the other way around.

3.2.8 Targeted Assessment of Outcome (h)

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

Assessment (h): EE 423, Winter 2013, Klamath Falls Campus

This outcome was assessed via an independent-learning project presented by each student in the form of a report.

Twelve EE students were assessed Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in each of the performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on both the performance criteria for this program outcome.

Table 19: Targeted Assessment for Outcome (h)

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Impacts of an Engineering Solution	2	1	9	83 %
Impacts in Various Contexts	1	4	7	91 %

Recommendations based on the End-of-Year Faculty Review of Outcome (h)

Results are satisfactory. No recommendations are made at this time.

3.2.9 Targeted Assessment of Outcome (i)

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

Assessment (i)1: EE 423, Winter 2013, Klamath Falls Campus

This outcome was assessed via an independent-learning project presented by each student in the form of a report.

Twelve students were assessed Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was set to have above 80% of the students performing at the accomplished or exemplary level in each of the performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on two of the three performance criteria for this program outcome. The students performed at the required level for the criteria of demonstrating awareness of knowledge to be gained through independent learning, and in terms of gathering and analyzing information: They identified an area of technology outside of the class discussion (for the most part), obtained information about the societal, technical, historical, and in a few cases, cultural aspects of the technology, its use, and its development, and presented this new information well. However, as in previous terms, the demonstration that knowledge is a continuous process (especially in such a way as to support the way this criterion is expressed in the rubric) was lacking almost entirely. The challenge is to devise an assignment, or a way of presenting it, that provides an opportunity to demonstrate this aspect of independent learning.

Table 21: Targeted Assessment for Outcome (i)

(i) a recognition of the need for, and an ability to, engage in lifelong learning				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% students >= 2
Demonstrating an awareness that knowledge must be gained	2	1	9	83 %
Identifying, gathering and analyzing information	1	4	7	91 %
Recognizing that the acquisition of knowledge is a continuous process	6	4	2	50 %

Recommendations based on the End-of-Year Faculty Review of Outcome (i)

Ideas for improvement are to improve the rubric, especially with regards to performance criterion 3, as it has been a challenge to provide an assignment that provides an opportunity to show attainment of this criterion as currently worded, as well as to explore methodologies and rubrics that have been successful at other universities.

3.2.10 Targeted Assessment of Outcome (j)

Knowledge of contemporary issues

Assessment (j): EE 412, Winter 2013, Klamath Falls Campus

This outcome was assessed via a discussion-paper assignment.

Six EE students were assessed Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in each of the performance criteria.

The table below summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was not met on any of the performance criteria for this program outcome. Strengths were that students were sensitive to the contemporary issue under consideration which involved cyber-bullying on a professional technology site. Weaknesses were that students had no solution to the problem. The opportunity for improvement would be cultivating greater sensitivity among our students to contemporary issues.

Table 26: Targeted Assessment for Outcome (j)

Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% students at 2 or 3
Knowledge of contemporary issues (type a)	2	2	2	67 %
Knowledge of contemporary issues (type b)	2	1	3	67 %
Temporal nature of contemporary issues	2	2	2	67 %
Historical context of contemporary issues	1	4	1	80%

Recommendations based on the End-of-Year Faculty Review of Outcome (j)

The faculty concluded that it is perhaps too early to see any changes due to seminars implemented this year. An additional recommendation was to improve the rubric to provide better guidance to students as to what is expected in each performance criterion. to improve the rubric for this outcome and reassess following the normal cycle.

3.2.11 Targeted Assessment of Outcome (l)

Knowledge of differential and integral calculus and advanced mathematics, including differential equations, linear algebra, vector calculus, complex variables, sequences and series, Laplace transforms, Fourier transforms, and probability and statistics with appropriate applications

Assessment (l): EE 401, Spring 2013, Klamath Falls Campus

This outcome was assessed via three final-exam questions.

Nine students were assessed Spring 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in each of the performance criteria. (This is the standard EERE criterion, and it was not altered because graduating seniors are expected to perform well in these areas.)

The table below summarizes the results of this targeted assessment. The results initially suggest that the minimum acceptable performance level of 80% was not met on either of the performance criteria addressed by the assessment activity. However, in the case of criterion 2, transform methods, this is a technicality due to the small class size. 78% is sufficiently close to 80% when the step size is 11% (one out of nine students). Nine was the entire class size; all students enrolled in the class took part in the assessment activity. Differential equations (criterion 3) are not addressed or used in this course. Strengths are clearly in the area of transform methods; students performed quite well in analyzing and representing the frequency spectrum of a DSB AM signal. Weaknesses are in the areas of Statistics and Probability. This second criterion was addressed via two questions. Success in answering one question indicated exemplary performance corresponding to evaluation in Bloom's taxonomy—students were asked to explain a step in the derivation of the autocorrelation of a specific random process. Understanding this step required realizing that the expectation operator acts on phase angle for this process, as opposed to the typical variable, time. One student came sufficiently close to explaining this distinction. The second question involved a series of SNR calculations and a verbal explanation of an unexpected result (analysis and application, in terms of Bloom's taxonomy). Scoring over 60% on this question was considered successful (again due to the large step size, this time in scoring the answers). Five out of nine students succeeded, one being the student who already performed at the exemplary level (in the higher-level question), resulting in 56% (due to rounding), which is below the target of 80%. This verifies what was found during the previous academic year: Not enough students have a strong grasp of stochastic processes. The opportunity here is to use these data to start a conversation with the math department, as well as internally in EERE, to see how we can prepare our students to grasp engineering-relevant Statistics and Probability concepts.

Table 27: Targeted Assessment for Outcome (l)

(l) a knowledge of differential and integral calculus and advanced mathematics including differential equations, linear algebra, vector calculus, complex variables, sequences and series, Laplace transforms, Fourier transforms, and Probability and Statistics, with appropriate applications				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Statistics and Probability	4	4	1	55%
Transform methods	2	7	0	78%
Applied differential equations	NA	NA	NA	NA

Recommendations based on the End-of-Year Faculty Review of Outcome (l)

The EE faculty's recommendation is to work with the Mathematics department in reviewing the content of the course in Mathematical Statistics, to ensure all the relevant topics are properly covered. Additionally, a brief review of these topics can be added at the beginning of the course.

3.3 Summary of Direct-Measure Assessment and Recommendations for 2012–13

The results of this year's academic assessment are promising, with about half the outcomes meeting targets. For the remaining outcomes, the faculty discussion was particularly fruitful, with all the Klamath Falls EE faculty engaged in analyzing the results, hypothesizing about the causes, and proposing potential solutions.

Outcome (b) was not met. The recommendations included specific ways to reinforce concepts related to the design of experiments, as well as the analysis and interpretation of data in sophomore-level courses .

Outcomes (d), (f), and (h) were found satisfactory.

Outcome (g) is to be simply reassessed following the assessment cycle.

The faculty reached the consensus that the rubrics for outcomes (i) and (j) need to be redesigned. These outcomes concern lifelong learning and contemporary issues. It was also recommended to explore methodologies and rubrics that have been successful at other universities.

Finally, regarding outcome (l), the faculty felt the need to work with the Mathematics department to evaluate the content of the mathematical Statistics course to make sure all relevant concepts are adequately covered, as well as providing a brief review of pertinent math at the beginning of math intensive courses such as Communication Systems.

Appendix A: The Year's Direct-Assessment Activities

Program Outcomes Assessed During the 2012–13 Academic Year

We have collected assessment data for the following outcomes.

(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(d) an ability to function on multi-disciplinary teams
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in lifelong (independent) learning
(j) a knowledge of contemporary issues
(l) a knowledge of differential and integral calculus and advanced mathematics including differential equations, linear algebra, vector calculus, complex variables, Laplace transforms, Fourier transforms, and probability and statistics with appropriate applications.

Appendix B: Indirect Assessment: Results of the Senior Exit Survey

10 students took the senior exit survey during the spring term of 2013.

For the institutional student-learning outcomes, the following chart (Figure 1) illustrates the student responses.

Table 1: Graduating EE seniors' self-report responses regarding their proficiency in the areas of the Oregon Tech institutional student-learning outcomes (ISLOs), which closely track departmental outcomes (a)–(k)

#	Question	No/Limited Proficiency	Some Proficiency	Proficiency	High Proficiency	Total Responses	Mean
1	Oral communication	0	0	7	3	10	3.30
2	Written communication	0	0	4	6	10	3.60
3	Mathematical knowledge and skills	0	0	5	5	10	3.50
4	Scientific reasoning	1	0	2	7	10	3.50
5	Critical thinking and problem solving	0	0	2	8	10	3.80
6	Lifelong learning	0	0	3	7	10	3.70
7	Cultural Awareness	0	3	4	3	10	3.00
8	Professionalism	0	0	3	7	10	3.70
9	Ethical practice	0	2	1	7	10	3.50
10	Team and group work	0	0	1	9	10	3.90

These results are reproduced below in visual form.

Figure 1: Graduating EE seniors' self-report responses regarding their proficiency in the areas of the OIT institutional student-learning outcomes (ISLOs)

In response to how well the EERE department prepared them for proficiency in the ABET outcomes, students' self-report is given in (Figure 2). Nine out of ten students report being *to some extent* adequately prepared in all areas, with the only area of inadequate preparation reported by one graduate being outcome (d). However, just as in last year's results, the same group of seniors responded with all favorable answers to the same criteria when listed under the Institutional Student-Learning Outcomes (ISLOs) one page prior in the same survey, as shown in Figure 1. Those answers show no one with self-report deficiency in teamwork, which outcome outperformed every outcome other than ethics. This raises the issue of reliability of student self-report data.

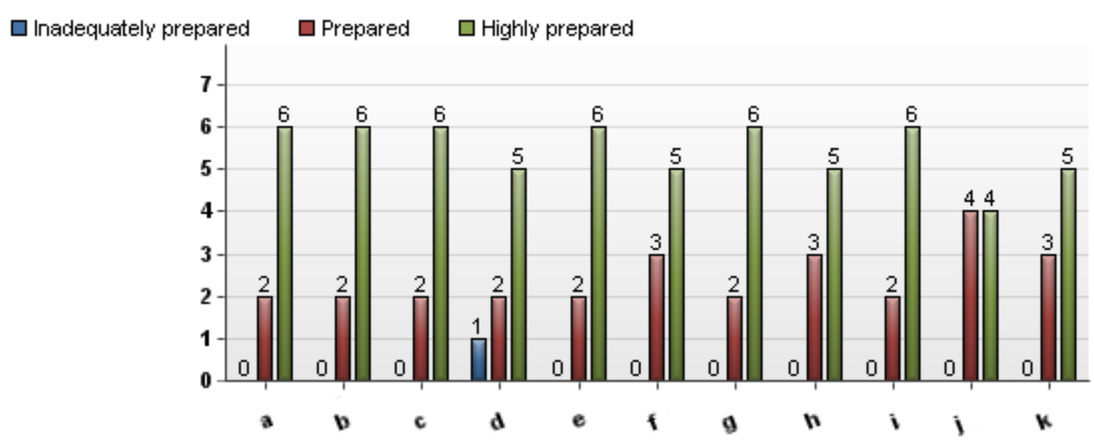

Figure 2: Graduating seniors' self-report responses regarding their proficiency in the areas of the ABET outcomes

Graduating seniors' responses to questions about the quality, relevance, and availability of the curriculum are summarized in Figure 3. There is some disagreement (less than half) from the students that the curriculum provides everything needed. For instance, one student disagreed with the statement that the "curriculum provides opportunities for hands-on experiences." Since the curriculum explicitly provides several such opportunities, this response may be understood in terms of specific written responses to this survey: One student wrote that they considered MATLAB experiments not to be sufficiently practical, and that the more "digital" courses suffered in this regard. It is the opinion of the faculty in general that MATLAB is the disciplinary standard for much industry work, and that favoring individual devices instead would rob the students of a critical skill required by most industry employers.

Similarly, there is one disagreement with the statement that the "curriculum provides courses that meet [students'] career needs." This is likely a result of the fact that the OIT EE curriculum provides a *traditional* EE degree, not an "Electrical and Computer Engineering" degree. There was one student in this group of seniors who was particularly interested in Computer Engineering, as opposed to traditional Electrical Engineering.

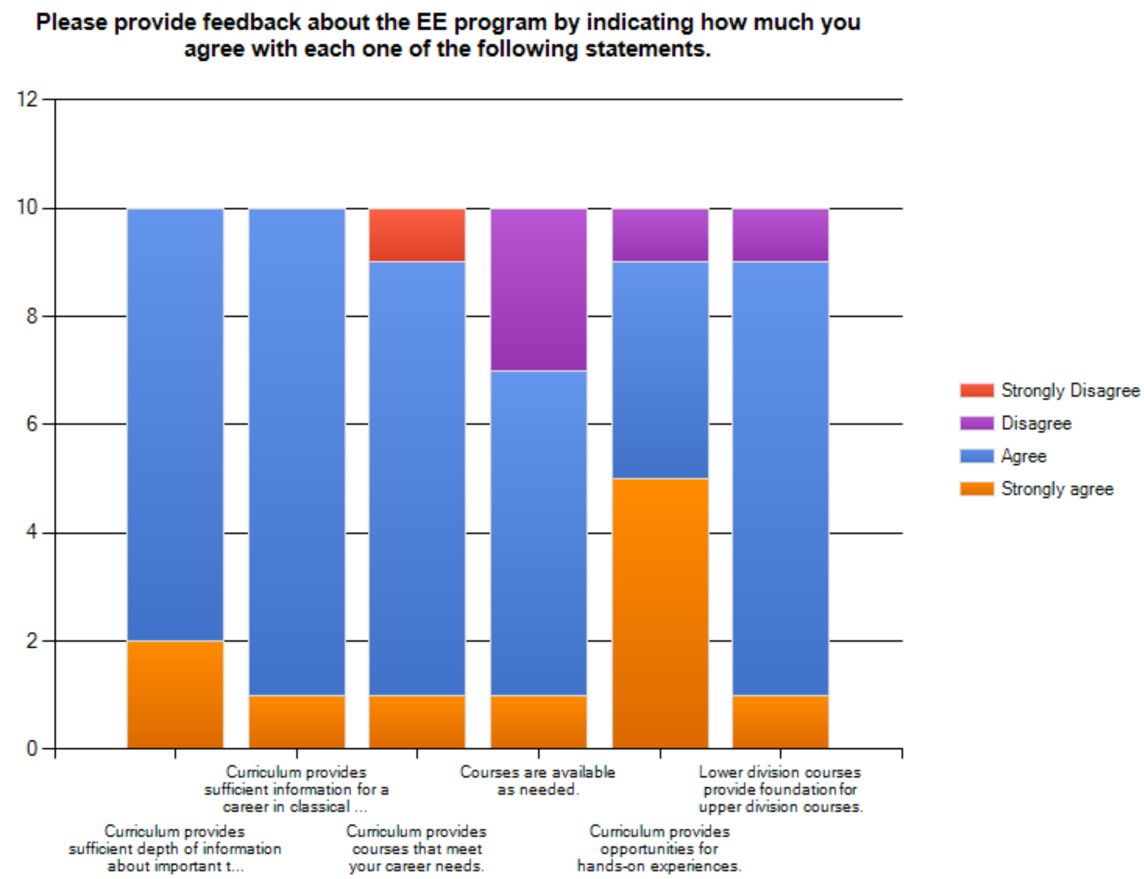

Figure 3: Graduating EE seniors' self-report responses regarding the EE program and its curriculum

The most common of the complaints is in terms of the availability of courses. While some courses are offered multiple times per year and have trailing sequences, it is true that some do not. The EE curriculum as listed in the OIT Catalog specifies "required courses and recommended terms during which they should be taken." The curriculum is rigorous and demanding. Those students who somehow do not to put in the necessary effort, or who were not adequately prepared prior to the program or face extracurricular difficulties may need to take courses out of the ideal sequence and timing. This is a natural aspect of college education, and every effort is made within departmental resources to make as many alternate-term courses available as possible. As indicated by the next figure, the students are indeed satisfied with the quality of education they have received (Figure 4).

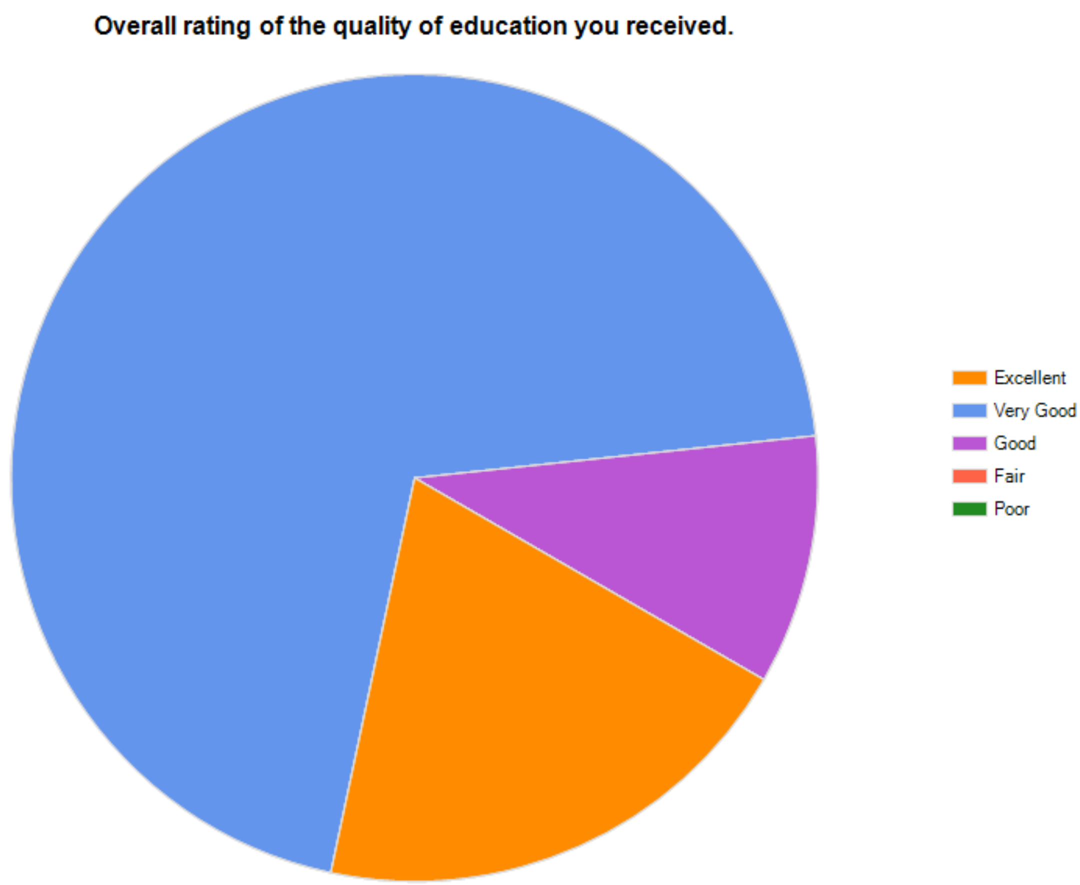

Figure 4: Graduating EE seniors' self-report responses regarding the overall quality of education at OIT

Appendix C: Course-to-Outcome Mapping

OUTCOMES COURSES	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
CHE 201: General Chemistry	X	X											
CHE 204: General Chemistry Laboratory	X	X											
ENGR 101: Introduction to Engineering I	X		X	X	X		X	X		X	X		
MATH 251: Differential Calculus	X												
WRI 121: English Composition							X			X			
CHE 202: General Chemistry	X	X											
CHE 205: General Chemistry Lab	X	X											
ENGR 102: Introduction to Engineering II	X	X	X	X	X		X	X		X	X		
MATH 252: Integral Calculus	X												
PHY 221: General Physics with Calculus	X	X					X						
WRI 122: English Composition							X			X			
EE 131: Digital Electronics I	X		X	X	X		X				X		
MATH 254N: Vector Calculus I	X												
PHY 222: General Physics with Calculus	X	X					X						
SPE 111: Fundamentals of Speech							X	X					
EE 133: Digital Electronics II	X		X	X	X		X				X		

EE 221: Circuits I	X	X		X	X		X				X		
[Social-Science Elective]		X						X				X	
CST 116: C++ Programming I	X	X			X						X		
EE 223: Circuits II	X	X		X	X		X				X		
MATH 321: Applied Differential Equations I	X												
MATH 341: Linear Algebra I	X												
EE 225: Circuits III	X	X		X	X		X				X		
MATH 253N: Sequences and Series	X												
WRI 227: Technical Report Writing							X	X		X			
[Humanities Elective]								X					
[Social-Science Elective]		X						X				X	
EE 321: Electronics I	X	X	X	X	X		X		X		X		
EE 331: Digital System Design with HDL	X		X	X	X		X				X		
EE 341: Electricity and Magnetism with Transmission Lines	X				X		X		X		X		
MGT 345: Engineering Economy	X							X					
EE 323: Electronics II	X	X	X	X	X		X		X		X		
EE 333: Microcontroller Engineering	X		X	X	X		X				X		
EE 343: Solid-State Electronic Devices	X				X		X		X			X	
WRI 327: Advanced Technical Writing				X		X	X	X	X	X			
EE 311: Signals and Systems	X		X	X	X		X				X		
EE 325: Electronics III	X	X	X	X	X		X		X		X		
EE 335: Advanced Microcontroller Engineering	X		X	X	X		X				X		

EE 411: Senior Project I	X	X	X	X	X	X	X	X	X	X	X	X	X
EE 431: Digital Signal Processing	X		X	X	X		X				X		
SPE 321: Small Group and Team Communication				X			X	X					
[Social-Science Elective]		X						X				X	
EE 412: Senior Project II	X	X	X	X	X	X	X	X	X	X	X	X	X
EE 423: CMOS Digital Integrated-Circuit Design	X		X		X		X	X			X		X
MATH 465: Mathematical Statistics	X												
[Social-Science Elective]		X						X				X	
EE 401: Communication Systems	X	X		X	X		X				X	X	X
EE 413: Senior Project III	X	X	X	X	X	X	X	X	X	X	X	X	X
[Humanities Elective]								X					
[Social-Science Elective]		X						X				X	

Appendix D: Mapping the IDEA Center Objectives to BSEE Outcomes for Indirect Assessment

At Oregon Tech, course evaluations are conducted using the course evaluation form developed by the IDEA Center[5], an organization originating from Kansas State University in the 1960s. Using the course-evaluation forms, an IDEA Center Diagnostic Report is generated and returned to the instructor. The report provides feedback from the students over a range of topics. Of interest in this indirect assessment is the "Progress on Relevant Objectives" section of the evaluation. These objectives are listed in Table 3-2. Note that IDEA Center uses the adjective "relevant" to indicate that the instructor selects which of the IDEA Center objectives are relevant to the course. Hence, not all the objectives in the list of "Relevant Objectives" are necessarily the relevant objectives for a given course.

The BSEE faculty uses these diagnostic reports as a means for collecting data for indirect assessment of program outcomes. Table 3-2 shows how the IDEA Center objectives map (loosely) to the ABET-based (a)-through-(k) program outcomes. Note this mapping does not allow for assessment of all fourteen ABET outcomes; only outcomes (a), (d), (e), (g), (i) and (k) may be reasonably mapped to the IDEA Center objectives.

The IDEA Center objectives are scored using a Likert scale (one-through-five numbering scheme), with the student asked to rate the amount of progress made on each objective. A score of one indicates no apparent progress, while a five indicates exceptional progress. For each course, the faculty member selects which "Relevant Objectives" are pertinent to the course. Typically, only three or four are indicated as essential. For the purposes of assessing program outcomes, the faculty assumes an average score of 3.5 (between moderate and substantial progress) on these objectives as indicating success in meeting the related program outcomes.

KSU IDEA Center Relevant Objectives	**BSEE Program Outcomes**
Gaining factual knowledge	(i), (j), (l), (m)
Learning fundamental principles, generalizations or theories	(l), (m)
Learning to *apply* course material	(a), (c), (e), (k)
Developing specific skills, competencies and points of view needed by professionals	(b), (c), (e), (k)
Acquiring skills in working with others as a team	(d)
Developing creative capacities (writing, etc.)	(g)
Gaining a broader understanding and appreciation of intellectual / cultural activity	(h), (j)
Developing skills in expressing oneself orally or in writing	(g)
Learning how to find and use resources for answering questions or solving problems	(e), (i)
Developing a clearer understanding of, and commitment to, personal values	NA
Learning to *analyze* and *critically evaluate* ideas,	(h)

[5] The IDEA Center, www.theideacenter.org

arguments and points of view	
Acquiring an interest in learning more by asking questions and seeking answer	(i)

Mapping the IDEA Center Relevant Objectives to program outcomes is justified as follows:

Program Outcome (a), *an ability to apply knowledge of mathematics, science, and engineering*, maps to one IDEA Center objective.

- *Learning to apply course material*: Assuming the course material is math-, science- or engineering-based, students who identify with having made progress on learning to apply course material should have the ability to apply that material.

Program Outcome (b), *an ability to design and conduct experiments, as well as to analyze and interpret data*, maps to one IDEA Center objective.

- *Developing specific skills, competencies and points of view needed by professionals*: Analyzing and interpreting data from experiments having to do with engineering design, development, or testing is one of the skills needed in the engineering professions.

Program Outcome (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*, maps to two IDEA Center objectives.

- *Learning to apply course material*: The design of systems, components, or processes to meet certain realistic constraints is an excellent example of the application of course material to engineering practices.
- *Developing specific skills, competencies and points of view needed by professionals*: The design of systems, components, or processes to meet certain realistic constraints is one of the fundamental and critical skills engineers must possess.

Program Outcome (d), *an ability to function on multi-disciplinary teams*, maps to one IDEA Center objective.

- *Acquiring skills in working with others as a team*: Though not specific to *multi-disciplinary* teams, this objective does ask students whether they have made progress in acquiring the skills need to function on teams. Students who report having made progress are developing the ability to function on teams. ABET takes this outcome further by requiring evidence of competence in multidisciplinary teamwork, which is captured in much of the department's assessment of senior-projects.

Program Outcome (e), *an ability to identify, formulate, and solve engineering problems*, maps to two IDEA Center objectives.

- *Learning to apply course material*: The formulation and solution of engineering problems is an application of course material to engineering problems.
- *Developing specific skills, competencies and points of view needed by professionals*: The formulation and solution of engineering problems is another of the fundamental and critical skills engineers must possess.

Program Outcome (g), *an ability to communicate effectively*, maps to two IDEA Center objectives.

- *Developing creative capacities*: Writing is explicitly identified by the IDEA Center as one of the ”creative capacities” applicable to this objective. Whether technical writing qualifies as a creative capacity is debatable, so the correlation between this objective and program outcome (g) is weak. Nevertheless, students who identify with having made progress towards developing writing capacities, though not directly stated by the objective, are gaining the ability to communicate effectively.
- *Developing skills in expressing myself orally or in writing*: Students who identify with having made progress towards developing oral-presentation and/or writing skills are gaining the ability to communicate effectively.

Program Outcome (h), *the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*, maps to two IDEA Center objectives.

- *Gaining a broader understanding and application of intellectual / cultural activity*: Engineering is an intellectual activity, and it may also be argued to constitute its own culture. The phrases “broad education necessary to understand the impact…” and “broader understanding” both refer to the need for engineers to be well-rounded in their exposure to and understanding of global, economic, environmental and societal issues.
- *Learning analyze and critically evaluate ideas, arguments and points of view*: Understanding the impact of engineering solutions in the contexts listed above necessarily requires the ability to analyze and critically evaluate ideas, arguments, and points of view.

Program Outcome (i), *a recognition of the need for, and an ability to engage in independent life-long learning*, maps to three Relevant Objectives.

- *Gaining factual knowledge*: Students who identify with having made progress towards gaining factual knowledge have noted their ability to engage in learning. While this is not necessarily *life-long* learning, the propensity to learn is a prerequisite to continued learning.
- *Learning how to find and use resources for answering questions or solving problems*: Finding resources for answering questions and solving problems is a direct example of *independent* learning, which is an indicator of life-long learning since post-college learning will likely and mostly take place independently.
- *Acquiring an interest in learning more by asking one’s own questions and seeking answers*: Acquiring an interest in learning suggests—though does not demonstrate explicitly—that the student has recognized the need for learning. Further, noting that learning is done by ”asking questions” and ”seeking answers,” students are showing that they have made progress on gaining the ability to engage in independent learning.

The potential to employ an indirect assessment of program outcome (i) is notable, since effective assessment of this outcome has shown to be problematic using the ABET-assignment direct-assessment method. Much of this difficulty has to do with assessing a student’s understanding of the need to engage in a life-long process of learning by using coursework that spans no more than ten weeks, and a degree program that takes place (typically) during the early years of a student’s life and career.

Program Outcome (j), *a knowledge of contemporary issues*, maps to two IDEA Center objectives.

- *Gaining factual knowledge*: In perhaps a trivial way, the gaining of knowledge of what contemporary issues exist (which is prerequisite to gaining knowledge of such contemporary issues overall) is a form of gaining factual knowledge.
- *Gaining a broader understanding and application of intellectual / cultural activity*: As established above, engineering is an intellectual—and possibly also cultural—activity. The knowledge of contemporary issues within and related to engineering is precisely the broadening of one's understanding and application of engineering.

Program Outcome (k), *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*, maps to two IDEA Center objectives.

- L*earning to apply course materials*: Assuming that the course curriculum covers the techniques, skills and modern engineering tools necessary for engineering practice, students who note they have made progress towards learning to apply course material should have the ability to apply them in practice.
- *Developing specific skills, competencies and points of view needed by professionals*: Students who identify with having made progress towards developing skills and competencies needed by professionals should have the ability to use those skills and competencies (in other words, "techniques" and "modern engineering tools") in professional engineering practice.

Program Outcome (l), *knowledge of differential and integral calculus and advanced mathematics including differential equations, linear algebra, vector calculus, complex variables, sequences and series, Laplace transforms, Fourier transforms, and probability and statistics with appropriate applications*, maps to two IDEA Center objectives.

- *Gaining factual knowledge*: The mathematical specialties listed in outcome (l) are factual knowledge (of the mathematical kind).
- *Learning fundamental principles, generalizations or theories*: Similarly, these are fundamental principles of mathematics, and hence, engineering.

Program Outcome (m), *in addition to mathematics, knowledge of basic sciences, computer science, and engineering sciences necessary to analyze and design complex electrical and electronics devices, software, and systems containing hardware and software components, as appropriate to program objectives*, maps to the same two IDEA Center objectives as outcome (l).

- *Gaining factual knowledge*: The broad scientific background required by outcome (l) constitutes factual knowledge central to engineering.
- *Learning fundamental principles, generalizations or theories*: Similarly, these are fundamental principles of science, computer science, and engineering.

<u>Assignment of Tasks relating to the Assessment of Course Outcomes:</u>
The EERE faculty meet during Fall Convocation (one week before each fall term) to evaluate the previous year's collection and make recommendations for program improvement. During this meeting, the faculty discuss and assign course outcomes for assessment during the upcoming school year. The assignments are based on the program outcomes assigned in the three-year timeline and courses that map to the program outcomes defined in the course-mapping matrix. The course-mapping matrix is reviewed for modification every three years with input from other faculty. There are various factors used to determine the actual mappings, including:

- the need to conduct assessment in various courses, not just one course for all outcomes,
- the need to involve all program faculty in the assessment process, and
- the need to obtain a mixture of student class levels (freshman, sophomore, etc.) for outcome assessment.

Appendix E: Relationship of Outcomes to Program Educational Objectives

The mission and program educational objectives (POEs) describe the capabilities of the graduates after they have entered their chosen career. The program outcomes are, then, used to develop the necessary foundation of knowledge and skills that a graduate will need to accomplish these objectives as they mature in their disciplines. The outcomes are mapped to the educational objectives. It is the student-learning outcomes that allow graduates to excel at the educational objectives.

The program outcomes provide the basis for the educational objectives and map to the objectives as shown in Table E-1:

Table E-1 Mapping between Program Outcomes (a)–(m) and Program Educational Objectives (PEO1, PEO2, PEO3, PEO4)

	PEO1	PEO2	PEO3	PEO4
(a)	X	X		
(b)	X	X		
(c)	X	X		
(d)		X		X
(e)	X	X		X
(f)			X	
(g)		X		X
(h)	X		X	X
(i)		X	X	X
(j)		X	X	
(k)	X	X		
(l)	X	X		
(m)	X	X		

Appendix F: Relationship of Courses in the Curriculum to the Program Outcomes

The course listing and program outcome mapping is shown in Table F-1. This table shows when and where the outcomes are assessed. The outcomes are assessed on a three year cycle and in specific courses as determined by the department. All of the required courses are mapped to at least one assessable outcome, and most map to more than one.

Table F-1 Mapping between BSEE engineering courses and the PEOs. X marks indicate that the faculty has identified the outcome as assessable in a particular class.

	PEO1	PEO2	PEO3	PEO4
CHE 201: General Chemistry	X			
CHE 204: General Chemistry Laboratory	X			
ENGR 101: Introduction to Engineering I	X	X		
MATH 251: Differential Calculus	X			
WRI 121: English Composition				X
CHE 202: General Chemistry	X			
CHE 205: General Chemistry Lab	X			
ENGR 102: Introduction to Engineering II	X	X		
MATH 252: Integral Calculus	X			
PHY 221: General Physics with Calculus	X			
WRI 122: English Composition				X
EE 131: Digital Electronics I	X	X		
MATH 254N: Vector Calculus I	X			
PHY 222: General Physics with Calculus	X			
SPE 111: Fundamentals of Speech				X
EE 133: Digital Electronics II	X	X		
EE 221: Circuits I	X	X		
PHY 223: General Physics with Calculus	X			
[Social-Science Elective]	X			
CST 116: C++ Programming I	X	X		
EE 223: Circuits II	X	X		
MATH 321: Applied Differential Equations I	X			
MATH 341: Linear Algebra I	X			
EE 225: Circuits III	X	X		

MATH 253N: Sequences and Series	X			
WRI 227: Technical Report Writing		X		X
[Humanities Elective]	X			
[Social-Science Elective]	X			
EE 321: Electronics I	X	X		
EE 331: Digital System Design with HDL	X	X		
EE 341: Electricity and Magnetism with Transmission Lines	X	X		
MGT 345: Engineering Economy	X			X
EE 323: Electronics II	X	X		
EE 333: Microcontroller Engineering	X	X		
EE 343: Solid-State Electronic Devices	X	X		
WRI 327: Advanced Technical Writing				X
EE 311: Signals and Systems	X	X		
EE 325: Electronics III	X	X		
EE 335: Advanced Microcontroller Engineering	X	X		
[Engineering Elective]	X	X		
EE 411: Senior Project I	X	X		X
EE 431: Digital Signal Processing	X	X		
SPE 321: Small Group and Team Communication				X
[Engineering Elective]	X	X		
[Social-Science Elective]	X			
EE 412: Senior Project II	X	X		X
EE 423: CMOS Digital Integrated-Circuit Design	X	X		
MATH 465: Mathematical Statistics	X			X
[Engineering Elective]	X	X		
[Social-Science Elective]	X			
EE 401: Communication Systems	X	X		
EE 413: Senior Project III	X	X		X
[Humanities Elective]	X			
[Social-Science Elective]	X			