ANNUAL ASSESSMENT REPORT

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

2013-2014

INTRODUCTION

This annual assessment report details the activities, events, decisions and actions in relation to the process of continuous improvement in the Department of Electrical and Computer Engineering. The following sections discuss curricular changes and updates as well as proposed modifications to the data collection process for assessment within the department. Included are descriptions relating to how we closed the loop on issues raised in previous years. We note that these changes are in response to feedback from various constituencies including faculty, students, graduating seniors and the industrial advisory committee. These changes are evidence of an active assessment process within the Department of Electrical and Computer Engineering.

UPDATES ON CURRICULAR CHANGES

Various constituencies provide inputs to the cycle of continuous improvement in the department. One of the areas where input is sought is in the area of the curriculum. Over the past several years, inputs from students, graduates, alumni, industrial advisors, and teachers have been collected. As data have been collected, the department executive committee, curriculum committee, and assessment committee have discussed with faculty ways to respond to data from the constituents. This year, several changes have been made to the curriculum--some changes are major, others are minor. This section documents these curricular adjustments. Since some of the changes apply to undergraduate courses that are taken by both electrical engineering and computer engineering majors, it should be recognized that these issues apply to both programs.

NEW ISSUES

1. When USU switched from quarters to semesters around 1998, two quarters of basic circuits were squeezed into one very-full semester-length course (ECE 2250 – Electrical Circuits). Inevitably there was insufficient time to cover all the necessary topics in one semester. Some instructors were able to cover more material than others in a semester, but the left-over uncovered topics were always pushed into and taught during the first few weeks of the follow-on course ECE 3620 – Circuits, Signals & Systems. In ECE 3620 this created an unnatural break a few weeks into the semester and stole time away from the topics that need to be covered in that class. Leftover topics from ECE 3620 got pushed deeper into the curriculum and were covered in the second semester of Signals & Systems (ECE 3640). Two semesters of Signals & Systems adequately absorbed the slippage that occurred in the introductory circuits course, but students found it awkward to be conceptually bridging between textbooks and topics. This problem and possible solutions have been the subject of debate among the faculty for about ten years.

Another factor driving the need for change was the observation that there was too much overlap between the second Signals & Systems course (ECE 3640) and the technical elective ECE 5630 – Introduction to Digital Signal Processing. Students complained about the significant overlap in course evaluations and in senior exit surveys, and ECE 5630 instructors expressed the desire to recover time to introduce additional topics.
Based on these inputs, the faculty in the areas of circuits and signals and systems organized an ad hoc committee to review the entire curriculum spanning the basic circuits course (sophomore year), the junior-level signals and systems courses, and the senior-level DSP course. These courses were torn apart and rebuilt from the ground up.
The committee proposed to introduce a second semester of circuits by taking one credit hour away from the first semester of circuits and taking two credits of technical electives. This change spreads the basic circuits concepts across a two-semester course sequence (3 credit hours each) in the sophomore year. The additional time provides the opportunity for greater depth of coverage and more time for practice to allow the concepts to sink in.
The re-designed signals and systems courses carry the same course numbers but the course titles and emphases have been adjusted, with the first semester focusing on continuous-time signals and system concepts and the second semester focusing on discrete-time signals and systems concepts. The overlap in the senior-level digital signal processing course was eliminated leaving open time to introduce concepts in two-dimensional/image processing. The newly designed course sequence is summarized below.

- ECE 2250 – Electrical Circuits I (3cr.)
- ECE 2290 – Electrical Circuits II (3 cr.)
- ECE 3620 – Continuous-Time Signals and Systems (3 cr.)
- ECE 3640 – Discrete-Time Signals and Systems (3 cr.)
- ECE 5630 – Digital Signal and Image Processing (3 cr.)

This change was implemented in the 2012-2013 school year when the new circuits sequence (ECE 2250 & 2290) was taught for the first time. To accommodate students who had taken the old courses, the old format for ECE 3620, 3640 had to continue to be taught for one year, and the old format ECE 5630 had to continue to be taught for two years. The new signals and systems courses are being taught for the first time in 2013-2014. The transformation will be complete in 2014-2015 when the new digital signal and image processing course will be taught. These changes to the undergraduate course structure have also impacted courses at the graduate level.
Students have not yet graduated from the revised curriculum, so no assessment from the senior exit surveys is available. However, students in the revised 3640 have expressed enthusiasm for the revised curriculum. And the instructor for the course provided the following feedback:
"It was obvious that the students had studied circuit analysis techniques, but were not fully comfortable with them. Their ability improved during ECE 2290. They had learned SPICE as an analysis tool sufficiently to be able to use it without further help. The students were able to complete the labs without great difficulty. Overall students felt more comfortable with circuit analysis and were better ready to go on to ECE 3620. Several topics were covered that had been part of ECE 3620 (RLC circuits, three-phase power, and filter circuits) were covered in the new ECE 2290, which allowed more time in ECE 3620 for signals. Time will tell if students actually do better in ECE 3620, but for now the students seem to be more confident in their circuit analysis abilities."
These changes affect both the electrical engineering and the computer engineering students.

2. New programming labs in ECE 3640 – Discrete-Time Signals and Systems. With the revised signals and systems curriculum, the opportunity was seized to replace the lab assignments accompanying ECE 3640. To strengthen

students experience with the C programming language, the labs were all to be completed in C in a Linux OS environment. A set of 13 new lab assignments were created with titles listed below.

a) Plotting in Matlab (self-study)
b) Reading and writing wave files in C
c) Using PortAudio a real-time audio C library
d) Periodic signal generation
e) DTMF and music
f) Tremolo and amplitude modulation (AM)
g) Time warping without pitch modification (overlap-add)
h) Doppler effect
i) Reverberation
j) FIR filtering
k) IIR filtering
l) Non-coherent demodulation of AM and FM
m) Adaptive noise cancellation

The first time these labs were used, there was only time to complete 8 of the 13 labs. We learned that, while students have taken two semesters of C++, they are unfamiliar with the differences between C and C++ languages. Next time these labs are used, C++ will be allowed.

3. Written and verbal communication was flagged as an issue over multiple years in the alumni survey. The alumni that were surveyed had been out long enough to appreciate the need for effective communication in the work place and expressed the opinion that education in written and verbal communication could be improved. At the time, students were required to take English 2010 – Research Writing in a Persuasive Mode, followed by a writing experience associated with the senior project. Another factor driving the need for change is that the faculty felt the quality of the writing in the senior project reports needed to improve.
   To address this issue, the ECE and English Departments discussed ways to strengthen technical communication skills for students in this program. In was determined that undergraduate students would be required to take English 3080 – Introduction to Technical Communication. English 3080 is a 3 credit hour class. To compensate for the increase in credit hours, the writing requirements in ECE 4850 – Senior Design III were reduced and the credit hour allocation was reduced from 3 to 2 credit hours.
   Feedback from students over time in senior exit surveys and senior exit interviews indicated that students appreciated having education targeted to written communication and oral presentation skills. Still, the faculty were not entirely satisfied by the quality of written senior project design documents. Graduating seniors reported mixed experiences in the English 3080 class, with the quality of the education being highly dependent on which instructor taught the class. The ECE Department continues to work with the English Department to achieve consistency across all sections of English 3080.
   The issue of written and verbal communication was raised to the college level. To benefit all the engineering programs administered within the college and to have more direct control over the instruction and the course content, the College of Engineering created a new course entitled Engineering 3080 – Introduction to Technical Communication, which is patterned after English 3080. The college hired a full-time instructor to teach multiple sections of this course each semester. Students are encouraged to take the College of Engineering technical writing course, but the technical writing course offered by the English Department still satisfies the requirement. Engineering 3080 is being offered for the first time in Spring 2014.
4. In the past, students expressed an interest in doing a senior project closely tied to one of the technical elective courses. The faculty viewed this as an opportunity to raise the technical level of senior projects. In response

to these inputs the faculty have designated certain elective courses as capstone courses. Because of the strong emphasis on engineering design, capstone courses can be substituted for ECE 4820 – Engineering Design I. There is a formal process that students must follow to make this substitution. Students are required to fill out a form that is kept in their file in the department office. Students involved in Capstone courses are still required to take other aspects of the Senior Design courses, including ECE 4850 Engineering Communication II.

5. Feedback in senior exit interviews and the senior exit survey indicate that students appreciate the opportunity to take capstone courses. Faculty and other senior project evaluators have observed an increase in the technical depth and quality of the senior projects.
6. Based on inputs from students and faculty, it was decided to remove ECE 3720 from the curriculum and to move the material into ECE 5720 – Computer Systems Programming and Architecture. This change was made to help prepare students for a graduate program in computer engineering. Feedback from students in exit interviews was very positive. One student commented that this course convinced him/her to pursue a degree in computer engineering. In the process of making this change, Dr. Chakraborty modernized the content of ECE 5720 to address issues relating to multicore parallel architectures.
7. Old equipment in the EM lab was starting to become unreliable. This was having a negative impact on student experiences in the labs associated with the EM courses. Two new network analyzers were acquired with one being specifically purposed for classroom and laboratory use. The instructor reports that the new equipment is excellent and fills the need for an educational laboratory.
8. ECE 5340 – Mobile Robots, a capstone course, has been very popular for many years. In this class students apply feedback control system principles to build and control wheeled robots. Both students and faculty have expressed an interest to transition from ground robots to flying robots (i.e. UAVs/drones). The ECE Department is starting to acquire UAV kits to respond to this interest. The greater sophistication required for controlling UAVs has been matched by adding ECE 5310 – (Linear) Control Systems as a prerequisite. This change is being implemented currently, and feedback is not available.
9. Enrollment rates in the Electrical Engineering and Computer Engineering Programs have been fairly flat over the last five years, while enrollment in other technical majors such as Mechanical Engineering and Computer Science have seen increases. As a move toward recruiting and retention, the ECE Department has instituted a freshman orientation program that gets faculty to sit down face-to-face with groups of freshman and talk over pizza for lunch. This gives the students contact with faculty before showing up in sophomore-level classes. During these exchanges, faculty talk about careers in engineering, talk about the major, ask and answer questions, and so forth.

CLOSING THE LOOP ON OLD ISSUES

1. Over the last few years, there has been extensive discussion and updates made to ECE 5530 to reduce the overlap (up to 70%) that this course has with ECE 2700. A committee consisting of computer engineering faculty and members of the curriculum committee was formed to discuss this course and make a recommendation. The committee has proposed dropping ECE 5530. Originally, the course was listed as a 5000 level course so that new international students could take the course and receive graduate level credit for it. However, it has been found that no international students currently take the course. The few new topics that are introduced into ECE 5530 can be absorbed into more advanced courses in the computer engineering graduate program (ECE 5/6740). This new material was reviewed by the curriculum committee and found to be material that is not typically required for BS programs anywhere in the country. It was determined that

ECE 5530 could be eliminated from the curriculum and the small amount of new material in the course could be absorbed into other courses in the curriculum. The faculty voted to approve this recommendation. Since this change was implemented, complaints about overlap between 2700 and 5530 have stopped and no new concerns have surfaced.

2. Digital circuits is an area where course content must evolve over time to keep up with innovations occurring in industry. Where once combinational logic was wired up at the gate and flip-flop level, programming FPGAs and CPLDs have become standard. To keep abreast of technology developments, the Industrial Advisory Committee suggested that lab work in digital circuits (ECE 2700) should emphasize programming logic devices using Verilog. This change was implemented. Surveyed graduating seniors report a high degree of confidence with Verilog programming.
3. This year the curriculum committee has responded to observations by students and teachers that it is difficult to complete the senior design project in a single semester. The committee investigated moving to a two-semester sequence for senior design. This affects the design course and the accompanying communication course taught by an instructor from the English department. Currently seniors take ECE 4840 (3cr) senior design and ECE 4850 (2cr) engineering communication in the spring semester of their senior year. In the new program seniors take ECE 4820 (1cr) design 1 and ECE 4830 (1cr) communication 1 in the fall semester and ECE 4840 (2cr) design 2 and ECE 4350 (1cr) communication 2 in the spring semester. The change is credit hour neutral. By stretching the senior project over a year it is hoped that students will have more time to conceive, propose and carry out their design projects. Feedback this year from students and the senior project advisor (Dr. Cripps) indicate that this change has change has been beneficial. Dr. Cripps indicates that the quality of students written reports, design documents and their presentations have improved.
4. In the Fall of 2012, Dr. Karl Locke, an experienced ABET reviewer, visited the College of Engineering. During his visit, he reviewed the program educational objectives (PEOs) for the electrical and computer engineering programs. Dr. Locke felt that our PEOs were stated more like outcomes than objectives. Based on this feedback, the ECE department undertook a review process, taking inputs from faculty and the industrial advisory committee (IAC). Based on feedback as well as surveying the PEOs for more than 20 ECE departments around the country, a new set of two PEOs were created, revised and finally accepted in a vote by the faculty. The PEOs are the same for the Electrical Engineering Program and for the Computer Engineering Program. The new PEOs are as follows.

   Program educational objectives (PEOs) are broad statements that describe what graduates are expected to attain within a few years of graduation. The PEOs support the mission of the department. The PEOs of the Electrical Engineering and the Computer Engineering programs are as follows.

   PEO1: *Graduates will succeed in pursuing their chosen career path. The primary indicator of success is that graduates will establish a reputation among their co-workers for technical expertise and sound ethical judgment. Other indicators of success include:*

   a) achieving professional advancement with increasing responsibility;

   b) engaging in technology-based entrepreneurial activities;

   c) engaging in advanced study in engineering graduate programs or related areas.

   PEO2: *Graduates will engage in a continuous process of life-long learning. Evidence of such engagement includes activities such as:*

   a) staying abreast of emerging technologies;

   b) obtaining new skills, developing proficiencies with tools and programming/hardware description languages;

   c) actively participating in professional communities.

These PEOs have been posted to the department web site and updated in the University General Catalog.

5. ECE 3710, Microcomputer Hardware and Software – Based on input from the industrial advisory committee (IAC) last year, the computer engineering faculty began discussing moving the lab assignments from the 8051 microcontroller to an ARM-based processor. Dr. Gerdes developed a whole new set of labs around the ARM processor, and new ARM-based hardware was acquired. The new labs were implemented during the 2012-2013 academic year. The first crop of students to take the new class are graduating in the 2013-2014 year. The re-design is having a positive impact as report by graduating seniors during exit interviews.
   Of the students interviewed, it was uniformly agreed that the labs were extremely time-consuming and also extremely educational. Students learned both hardware and software debugging skills. Students commented that this course solidified their programming skills. Debugging and programming skills are essential skills needed for engineering practice.
6. CS I and CS II (C/C++ programming) – Students feel that they are learning syntax but not good software architecture or software engineering principles. Students emerge from these classes confused about the difference between C and C++. Often they don't feel like they really learn the language until they have to use it in ECE classes. One student observed that the programming projects are like 1980s business applications. Students would like to learn to interface to libraries such as OpenGL. After doing some digging, we have found that feedback from students is strongly dependent upon who teaches the CS I and II classes. For example, when Dr. Mathias or Dr. Cannon teach the course, students come away with a good understanding of theses languages.
   Students take CS I and CS II during the two semesters of the freshman year. No programming courses are required in the sophomore year. When students encountered programming again in the junior year, they felt unprepared because a year had passed in which their programming skills had been underutilized. The faculty voted unanimously to require all students in the Electrical Engineering and Computer Engineering Programs to take ENGR 2450 – Numerical Methods for Engineers. The course would be taken during the sophomore year and would require programming. This change was implemented in Fall 2012. The course was taught by a faculty member in the Civil Engineering Department who did not demand a rigorous programming experience in C++. Hence, the benefit of the class was not realized at first. The department has communicated with this instructor who expressed a willingness to require that the EE and CE students be required to perform their programming assignments in C++. Senior exit interviews in the Spring of 2014 gave us the first opportunity to discuss this course with seniors who had taken the course in 2012. Student responses on this course were more negative than positive. The department will work to learn more about and address student concerns.