COURSE REVIEW: DESIGNING A SYSTEM FOR CONTINUOUS IMPROVEMENT

Mark E. Cambron¹ and Stacy Wilson²

Abstract – The Department of Engineering at Western Kentucky University (WKU) was given the rare opportunity to develop an entirely new engineering program. WKU’s Electrical Engineering Program has developed an assessment plan to insure a systematic pursuit of improvement. A major component of this assessment process is course review. Immediately following each semester, EE faculty conduct course review of all courses taught during the previous semester. This review is used to evaluate courses within the larger context of the program. Course review is also a place for implementation of changes due to the assessment process. The engineering faculty discuss how and where changes are needed in order to improve the program as a whole. In addition, course review is used to ensure that course outcomes are being met. If problems exist action plans are proposed to improve the courses.

Keywords: Assessment, Course Review, ABET

INTRODUCTION

Western Kentucky University had an engineering technology program for more than thirty years. However, due to the growth and development of local industries it was determined that engineering technology was under serving regional needs. In 2000 WKU decided to begin to phase out the engineering technology program and phase in the engineering program. In the spring of 2004 WKU graduated their first cohort of engineering students. The electrical engineering program at WKU is jointly offered with the University of Louisville.

Western Kentucky University vision has been to develop new engineering programs that are more suitable to the relevant local industries and the students’ learning styles. We have deliberately focused on building a new curriculum centered on the need for successful practicing engineers while not attempting to simply replicate existing engineering programs from other schools. Project-based learning model was adopted for this purpose [1]. Project-based learning is gaining more support in the American undergraduate engineering education [2, 3]. Our Electrical Engineering program has strong emphasis on the implementation of design experiences. The program is committed to producing graduates who are well prepared for the start of productive, successful careers as practicing engineers. We believe engineering practitioners are those with a foundation of basic science, mathematics, and engineering knowledge, combined with practical knowledge and hands-on experience in applying existing technology to contemporary problems. We believe an engineering program is a living entity, not just a list of courses and syllabi organized into a catalog.

We recognize the progression of student experiences required to help students grow from "Learners" into "Observers" and "Assistants" and eventually "Practitioners". These are our "Roles of the Student" [1] in a project-based curriculum and this philosophy has shaped our development of the curriculum and departmental faculty promotion policy [4].

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PROGRAM OUTCOMES

The EE program at WKU has defined the following six Program Outcomes [4,8], shown below. The Program Outcomes are entirely consistent with the goals of the Department of Engineering. These measurable outcomes then become characteristics of the graduates that they take into their careers. Through academic experiences and appropriate training, the graduates are prepared for their careers and will enjoy success and growth in their field of endeavor. These outcomes cover the ABET criteria 3 [5].

1) EE graduates possess knowledge of core EE topics including circuit analysis, electric machines, microprocessors, and control systems, and can develop mathematical representations of systems

2A) EE graduates plan and implement cost-effective electrical engineering designs using modern engineering equipment and software.

2B) EE graduates can effectively work with and on multi-disciplinary teams and understand the importance of teamwork in an engineering environment.

3) EE graduates are aware of trends in electrical engineering and are engaged in path of life-long learning.

4) EE graduates are committed to excellence in all professional endeavors and apply their understanding of ethics to solve engineering problems.

5) EE graduates effectively communicate technical material in an oral, written, visual, and graphical manner

6) Regional employers will employ WKU electrical engineering graduates.

The EE Program at WKU is dedicated to a systematic pursuit of improvement. Assessment is an integral part of the development of the program. WKU uses a multi-loop assessment process to evaluate the overall program outcomes and objectives. This multi-loop process is shown in Figure 1 on the next page. The interior loops represent the assessment of the Program Outcomes. The inner loop represents the course review process. Course review occurs at the end of every semester with all WKU EE faculty and any UoL faculty who have been teaching courses in the EE program that semester. This includes the evaluation of survey data, rubrics, and other information. The results of the assessment loops are then combined to determine if the program outcomes and have been met.

The assessment of each outcome is achieved using a variety of measures, including

- Review of course material using rubrics
- Fundamentals of Engineering (FE) Exam
- Surveys of graduating seniors
- Survey of our Industrial Advisory Board

Faculty evaluation of outcomes takes place in two forms. Each semester, faculty members hold a Course Review session to review every engineering course taught in the program. The primary function of the Course Review is to improve course outcome delivery; however the integration of the courses across the curriculum is also discussed. The second review is performed annually, where the faculty reports and discusses the data gathered for each Program Outcome.
The diagram presents a flowchart of the Program Assessment Process:

1. Annual IAB Survey
2. Three Year Alumni Survey
3. Exit Survey of Outcomes
4. Input from Other Constituents
5. Course Assessments
6. Alumni/Employers
7. Graduating Students
8. Faculty Provide Curriculum
   - Consistent with the Program Outcomes
9. Faculty Determine the Success in Meeting the Program Outcomes
10. Review and/or Establish Indicators for Measurement of Outcomes
11. Add, Delete, or Modify Action Plans and/or Program Objectives and Outcomes
12. Implement Action Plans
13. Continuous Improvement Cycle

**Figure 1:** Detailed view of Program Assessment Process
COURSE REVIEW

Course Review is used in the outcome assessment process and was implemented after the fall 2001 semester. Immediately following each semester, the EE faculty conducts the course review process. The purpose of this review is to:

1. ensure that course outcomes are being met,
2. examine student readiness for each course (relevance of pre-requisites),
3. ensure that the material specified in the syllabus is being taught,
4. compare the integration of topics throughout the curriculum, and
5. evaluate the success of previous changes due to course review and outcomes assessment.

Each faculty member creates a course review folder for each class taught ever semester. This folder will contain the following information:

2. Identification of the textbook(s).
3. Copies of materials provided to students.
5. Examples of graded work.
6. Grade distribution.
7. Other material or discussion deemed important by the instructor including experiments (if applicable).

RESULTS

Course review is important for improving courses and to ensure that course outcomes are being met. In addition, course review serves a larger purpose in ensuring that courses are integrated in a manor that program outcomes are being met. Many of outcomes are not completely provided within a single course. It is necessary to coordinate the efforts of multiple faculty members across all four years of the curriculum to assure that students are successful in developing these skills. I have included a section of the course review report created by the instructor for Circuits & Networks I.

<table>
<thead>
<tr>
<th>Course:</th>
<th>EE210 Circuits &amp; Networks I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td>5/13/2003</td>
</tr>
<tr>
<td>Instructor:</td>
<td>Mark Cambron</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EAC of ABET Outcomes</th>
<th>EE Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>a, c, e, k</td>
<td>1a, 1b, 2b, 6</td>
</tr>
</tbody>
</table>

Course Outcomes:

This course contains the fundamentals of electrical engineering. There are only a few basic ideas founded in the application of physical laws in the course. Through repeated application of these ideas and the physical laws, the students develop skills in problem solving that will be useful throughout their professional career. By the end of the course students will be able to:
1. Analyze simple resistive circuits including those containing operational amplifiers and controlled sources with loop and nodal analysis.
2. Analyze first order circuits containing switches, independent sources, dependent sources, resistors, capacitors, inductors, and operational amplifiers for transient response using loop and nodal analysis.
3. Analyze RLC circuits with sinusoidal excitation sources for steady-state response using loop and nodal analysis.
5. Steady-state responses.
6. Perform an AC steady-state power analysis on three-phase circuits.

**Summary of Course Assessment**

Students used self-assessment to determine the success of the course in enabling them to achieve the course outcomes, with 0 indicating no mastery and 10 very proficient. The results of this survey instrument and course grade based assessment (Instructor) of the course outcomes are shown below:

In order to work on Objective “6” an additional class needs to be added on 3 phase circuits. With only one homework the students have not seen enough problems in this area.

**Faculty Self-Assessment**

The course focus is to provide students with fundamental skills in the stated outcomes. Hence it is very fundamental in nature and it builds upon what they have initially learned in their Calculus and Physics courses.

This is a standard course taught for an accredited engineering curriculum. The grading is weighted the combination of labs, homework and examinations.
Action Plan For Next Offering:

- Assess the current course objectives and ABET syllabus. Make changes if needed.
- Change textbooks before the Spring 04 offering.

Action Plan From Previous Offering

- Create Student Evaluations and Feedback mechanism
- Change Pre-requisite to add MATH 227 (Calculus II), Co-requisite to add PHY 260 (University Physics II)

I believe that student self-evaluation is another method for assessing a course. The co-requisites and pre-requisites were changed and have been implemented. This change will slow the progress of a few students but will also keep students from getting into the class to early.

Table 1: History of Changes to the EE Program 2001-2004

<table>
<thead>
<tr>
<th>Sem</th>
<th>Issue</th>
<th>Corrective Action Taken</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>F01</td>
<td>Course pre-requisites/co-requisites</td>
<td>Many course pre-requisites/co-requisites were examined and updated</td>
<td>1A</td>
</tr>
<tr>
<td>F01</td>
<td>Discovered need for text in freshmen seminar</td>
<td>Text was chosen and required for next offering.</td>
<td>1A</td>
</tr>
<tr>
<td>F01</td>
<td>Increase difficulty of project and focus more on PLC programming in EE Design II.</td>
<td>Project was restructured for next offering and more programming was included.</td>
<td>1A, 2A, 2B</td>
</tr>
<tr>
<td>F01</td>
<td>Unprofessional presentations in freshmen seminar class</td>
<td>Included material to teach students to create professional presentations.</td>
<td>5</td>
</tr>
<tr>
<td>S02</td>
<td>No course review documentation on courses</td>
<td>Implemented requirement of course review documentation other than syllabus, graded material, handouts</td>
<td>All</td>
</tr>
<tr>
<td>S02</td>
<td>Need to modify Digital Circuits course outcomes to better support program objectives</td>
<td>Course outcomes modified before next offering.</td>
<td>1A</td>
</tr>
<tr>
<td>S02</td>
<td>Poor textbook for Electronics Course</td>
<td>New textbook was required for electronics course</td>
<td>1A</td>
</tr>
<tr>
<td>S02</td>
<td>More labs needed for Electronics Course.</td>
<td>More lab experiments were added to the Electronics course before the next offering.</td>
<td>1A</td>
</tr>
<tr>
<td>F02</td>
<td>Inclusion of PLC material in</td>
<td>Removed PLC material from EE Design II and</td>
<td>1A, 2A</td>
</tr>
</tbody>
</table>

Through the semi-annual course review process, the Electrical Engineering Degree Program requirements have been modified as a result of our internal course assessments.
<table>
<thead>
<tr>
<th>Course</th>
<th>Change</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE Design II</td>
<td>added circuit design material for next offering.</td>
<td></td>
</tr>
<tr>
<td>F02</td>
<td>Need more technical writing in EE Design I.</td>
<td>More technical writing was incorporated into next offering of EE Design I. 5</td>
</tr>
<tr>
<td>F02</td>
<td>Need more technical writing in EE Design II.</td>
<td>More technical writing was incorporated into next offering of EE Design II. 5</td>
</tr>
<tr>
<td>F02</td>
<td>Microprocessors course content needs to be revised.</td>
<td>Content revised to better meet the outcomes of the course. 1A</td>
</tr>
<tr>
<td>S03</td>
<td>Examined design courses (EE 101, EE 200, EE 300, EE 400, EE 401)</td>
<td>Restructured courses to better meet mission and objectives of program. 2A</td>
</tr>
<tr>
<td>F03</td>
<td>UC 101 no longer to be offered by university. Need to create freshmen seminar course for EE students.</td>
<td>Restructured freshmen seminar course (UC101) and created new EE Freshmen Seminar (EE 175) to meet university requirements for freshmen experience and EE program objectives. 1A</td>
</tr>
<tr>
<td>F03</td>
<td>Discrete Controls textbook had excellent problem set but inadequate text</td>
<td>A new textbook has been selected for the fall EE 460 offering 1A, 1B</td>
</tr>
<tr>
<td>F03</td>
<td>Circuits text was insufficient for Circuits &amp; Networks II component of class</td>
<td>A new textbook was found and used in the Circuits &amp; Networks I and II spring offerings 1A</td>
</tr>
<tr>
<td>F03</td>
<td>Students’ deficiency in structured programming skills</td>
<td>Discussed C programming course with CS department head 1B</td>
</tr>
</tbody>
</table>

**CONCLUSION**

WKU’s Electrical Engineering Program has developed an assessment plan to insure a systematic pursuit of improvement. Course review is an integral part of the assessment process. Course review is used to evaluate courses within the larger context of the program. In addition, course review is used to close the assessment loop. The engineering faculty discuss how and where changes are needed in order to improve the program as a whole. In addition, course review is used ensure that course outcomes are being meet. If problems exist action plans are proposed to improve the courses.

Assessment of student work and the results of the Peer Review of Course Effectiveness show that students are exhibiting an improved performance. This process will continue to be a cornerstone of the program’s ABET assessment plan.

**REFERENCE**


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Dr. Mark Cambron is an Assistant Professor of Electrical Engineering in the Department of Engineering at Western Kentucky University. He received his B.S. in Electrical Engineering from the University of Kentucky, and M.S. and Ph.D. degrees in Electrical Engineering from Vanderbilt University in Nashville, TN. His current research interest include: machine vision, robotics, learning systems, neural networks, controls, and engineering education.

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Dr. Stacy Wilson is an Associate Professor of Electrical Engineering in the Department of Engineering at Western Kentucky University. She received her B.S., M.S. and Ph.D. degrees in Electrical Engineering from Tennessee Technological University in Cookeville, TN.

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