

2007: THE CONTINUING EVOLUTION OF CAPSTONE DESIGN IN EECS

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The Continuing Evolution of Capstone Design in EECS

Abstract

In the past decade, a number of changes in the EECS capstone design sequence at the University of Evansville have occurred. Still other modifications will be implemented in 2007. Some of these changes are in response to continuing departmental assessment activities, while others are due to the recent adoption of a new university writing program requiring writing across the curriculum.

A previous paper¹ described the capstone senior design project course sequence at the University of Evansville as it existed in 1997. Although the basic structure of the three-course sequence was left intact, several changes, described in a later (2004) paper², were made to broaden the coverage of the engineering discipline and facilitate assessment of the outcomes of ABET Criterion 3³. The present paper provides an update of the capstone experience's ongoing evolution, including a detailed summary of recent revisions.

A brief summary of the course sequence, as given in¹, is as follows:

1. EE 494 Senior Project Seminar (0 credits)
2. EE 495 Senior Project Phase I (3 credits)
3. EE 497 Senior Project Phase II (3 credits)

The first course, typically taken in the spring term of the junior year, primarily serves to present possible design project ideas to the students, who choose their design projects by the end of the semester. The second course devotes a few weeks to discussion of professional ethics, with the remainder of the semester used to develop both written and oral presentations of the students' engineering design proposals. This second course also serves as part of the university writing program for electrical and computer engineering majors. The third course in the sequence requires students to validate their designs either by producing a prototype, or in a few cases, by completing a detailed simulation of the proposed system.

Although this description and organization remains unchanged, a completely new EE 497 will be offered for the first time starting in January, 2007, in an attempt to resolve problems noted in departmental review of the senior project experience. Additionally, future assessment of EE 495 will include the writing component as part of the university-wide writing program, requiring new guidelines for the faculty involved in the process.

Other modifications made since the 2004 paper include the use of a new text for EE 495 that includes chapters specifically devoted to the social and global issues in engineering, and a new procedure for assigning course grades in EE 497.

These and the other changes to our capstone design sequence described in this paper represent further steps in our attempt to enhance students' writing skills, grade their design projects consistently, and further refine the assessment of the methodology to discover yet other ways to improve their experience.

Assessment

Each semester the EECS department holds an “assessment day”. Courses are selected periodically for review according to a schedule prepared in advance so that not every course need be assessed every semester. For each of the courses scheduled for review in a given semester, five or six students are selected, given folders, and asked to put all their assignments, both draft copies and final copies in the folder. At the end of the semester, copies of all work are made, and the students’ names are deleted, so the reviewers will not know which students’ work is being used. For the assessment, a committee of department faculty, typically with three or four members, none of whom is the course instructor, is assigned the task of reviewing the collected student work and determining if the work demonstrates that the objectives formulated by the instructor (or in some cases by the department) are being met. The committee submits a report of their findings, and the report is used as the assessment document. The committee may make recommendations of how any lack of evidence that the objectives are being met might be provided in future assessments, as well as any suggestions of how the course might be modified to better achieve its objectives. EE 495 is reviewed in this fashion every second or third offering.

In addition to the individual course reviews described above, course sequence reviews are conducted. The capstone design sequence is reviewed annually. Revisions to one or more of the capstone courses are made as required in response to these annual reviews.

The University Writing Program

The writing program adopted in early 2005 at the University of Evansville has two components:

Two writing-intensive freshman seminars, World Cultures 110 and World Cultures 120, are part of the general education requirements and are required of all students.

A writing-intensive component in the student’s major, consisting of two writing-intensive courses or an equivalent experience designed by the department of the major and approved by the Writing Subcommittee, is also required.

A writing-intensive course is defined as one in which at least 20 pages of formal writing are required and at least half of that writing is revised.

The writing-intensive component in the major for electrical engineering and computer engineering programs consists of three courses: EE 380 Intermediate Electrical Projects Lab, EE 495 Senior Project Phase I, and EE 497 Senior Project Phase II. Approximately 20 pages of writing is assigned and may be revised in EE 380 and EE 497, and approximately 25 pages of writing, 20 pages of which must be revised, is assigned in EE 495.

The recent changes in the three courses of the capstone design sequence are summarized in the following sections.

EE 494

The senior project seminar has changed little in recent years. Potential senior design projects are presented to the class, primarily by department faculty, but sometimes by a representative of local industry. Students are tasked with choosing one of the projects to work on during the next two semesters of the sequence.

One problem noted during departmental review of the courses as a whole is the tendency for students to select a project in the first course and request to change to a different project, usually one they devised themselves, later. These "new" projects tend to require somewhat less design effort than the original projects. The faculty felt that this practice could well create a gradual decline in the overall quality of the projects as a learning experience. A new policy was implemented in January, 2007:

Any change in the project from the project selected in EE 494 will be allowed only if approved by the department faculty. Any request for a change in project must be submitted in writing, approximately one or two paragraphs giving a description of the proposed new project and the reason such change is being requested.

EE 495

The text used for EE 495 is a McGraw-Hill Primis custom book that includes chapters 1, 3, 5, and 6 of *Introduction to Engineering Ethics* by Schinzinger-Martin. Chapter 3 "Engineering as Social Experimentation" and Chapter 6 "Global Issues" were added in response to ABET guidelines. Students are divided into groups of four and assigned discussion questions from these and other chapters of the book. Each group presents and defends their response to the assigned questions and submits a written summary of their response as part of the writing for the class.

Each student in the class submits an engineering design proposal (approximately twenty pages). Various sections of the proposal are submitted in draft form, graded, and returned to the student. The entire proposal is then submitted as a draft, which is graded and returned. Most sections of the final copy of the proposal have thus been revised twice.

The proposal grading rubric shown below was developed for grading the proposals.

Proposal Grading Rubric

Grade Earned	Ideas/Content	Organization	Language
A	The proposal provides a complete description of the project background and a fully developed concept design including the proposed schedule, cost estimate, statement of capabilities, and equipment requirements.	The proposal shows a clear structure and evidence of thorough planning. The ideas are easy to follow and presented in a logical and cohesive manner.	The proposal has few minor errors and the phrasing is clear.

B	The proposal provides an adequate but less than complete description of the project background and concept design that is well developed, including proposed schedule, cost estimate, statement of capabilities, and equipment requirements.	The proposal shows a clear structure and evidence of thoughtful planning. The ideas are easy to follow and presented in a logical manner, although some lack of cohesion is evident. Transition between ideas could be improved.	The proposal has no major distracting errors and the phrasing is clear.
C	The proposal gives a minimal description of the project background, a poorly developed concept design, schedule, cost estimate, statement of capabilities, and/or equipment requirements.	The proposal shows a clear structure and the ideas are easy to follow, although there is a definite lack of cohesion.	The proposal has a few major errors, although the phrasing is somewhat clear.
D	The proposal gives an inadequate description of the project background and concept design. One or more of the schedule, cost estimate, statement of capabilities, or equipment requirements is missing.	The proposal exhibits no clear structure and the ideas are difficult to follow.	The proposal contains enough basic errors to distract the reader, and the wording is ambiguous.
F	The proposal fails to provide any real description of the concept design and little or no project background.	The proposal is poorly constructed and the ideas are impossible to follow.	The proposal contains numerous errors and the phrasing is difficult to decipher.

Since the course is now part of the writing program, a new form for department assessment of the writing in the course was also developed and will be used for the first time in the spring of 2007.

EE 495 Writing Assessment				
Place a check mark in the appropriate rating column for each category for the written proposal and for the other writing done in the course. Also answer the question in section III regarding the proposal.				
I Engineering Design Proposal				
	<i>Unacceptable</i>	<i>Marginal</i>	<i>Acceptable</i>	<i>Exceptional</i>
Ideas/Content	_____	_____	_____	_____
Organization	_____	_____	_____	_____
Language	_____	_____	_____	_____

II Other Written Work

	<i>Unacceptable</i>	<i>Marginal</i>	<i>Acceptable</i>	<i>Exceptional</i>
Ideas/Content	_____	_____	_____	_____
Organization	_____	_____	_____	_____
Language	_____	_____	_____	_____

III Writing Improvement

In comparing draft copies of the various sections of the engineering design proposal with the final draft, do you find any improvement in students' writing?

Yes _____

No _____

EE 497

Since EE 497 is also part of the university writing program, a grading rubric very similar to that used for EE 495 and a nearly identical writing assessment form will be used in the fall of 2007, when EE 497 is to be assessed as a course.

Departmental discussions in previous reviews of the capstone sequence included the observation that grading of the final projects appeared to be less than consistent. At the time, the course grade for the senior project presented as part of this last course in the sequence was determined and assigned by the project faculty advisor. In an attempt to assign course grades more consistently, the course grading procedure was changed to the following:

The grade will be determined by the department faculty in consultation with the faculty project advisor, based on performance (and overall project quality), documentation (notebooks, final report, and progress reports), the final presentation, and the poster presentation. The weighting of these factors will be as follows:

- 45% Performance and overall project quality
- 40% Documentation (notebooks, final report, progress reports)
- 10% Presentation
- 5% Poster presentation

Guidelines used by the faculty for assigning letter grades to projects are as follows:

- A: The project satisfies all or nearly all of the client requirements and exhibits significant original design.
- B: The project satisfies many of the client requirements and exhibits some original design, but does not represent a viable solution to the original problem.
- C: The project meets some of the client requirements and contains some element of original design but fails to address some important aspect of the original problem.
- D: The project meets few if any of the client requirements and/or shows little evidence of original design, yet is partially functional.

Although grades were assigned by the faculty as a group in 2005 and 2006, the guidelines were developed and first used in the spring of 2007.

Another change made to EE 497 was to count the course as part of the teaching load of the course coordinator, who would schedule weekly (in a few cases biweekly) meetings with students and their project advisors. (Previously, the course coordinator had not received teaching credit for the course as a regular course.) At each meeting the current status of the project was reviewed, problems were discussed, and action items in the form of goals to be met by the next meeting date were set. The course coordinator posted minutes of each meeting on a web site accessible to all faculty members for use in review of the projects in their grading discussions.

Conclusion

All indications so far are that the changes described above have improved the quality and consistency of the capstone projects. Assessment of the capstone design sequence with all the changes described above in place will take place in May of 2007, and it is possible that other modifications will occur as a result.

Bibliography

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