Poster Session for External Reviews of Capstone Projects

Dr. Christina Howe, University of Evansville

Christina Howe is an Associate Professor in the Department of Electrical Engineering and Computer Science at the University of Evansville in Evansville, Ind. She received her B.S. from the University of Evansville and her M.S. and Ph.D. from Vanderbilt University, where she studied the radiation response of focal plane arrays.

Dr. Dick Blandford, University of Evansville

Dick Blandford is the department chair of the Electrical Engineering and Computer Science Department at the University of Evansville.

Dr. Deborah J. Hwang, University of Evansville

Dr. Deborah J. Hwang is a graduate of Iowa State University and the Massachusetts Institute of Technology. She is an associate professor of computer science and has been the director of the computer science program at the University of Evansville since 1995. She is active in computer science education organizations and is a member of ACM, ACM SIGCSE, CCSC, IEEE-CS, and ASEE.

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Abstract

The capstone project course at the University of Evansville is a two-semester sequence in which students complete a project design in the first term and an implementation to verify the design in the second term. At the end of the second term all students present their projects. The presentations include an oral and a written report plus a poster presentation. In the past, all of these were graded and assessed separately. Working engineers from the local community were used to judge the oral reports while faculty assessed the report and poster presentation. However, analysis showed a disparity between the scores that the working engineers gave the projects based on the oral reports and the scores that faculty gave the same project based on more extensive data.

To address this issue, the working engineers now judge the poster presentations instead of the oral reports with faculty judging the oral presentations and papers. Each student or team is required to present a professional quality poster about their project to each of the working engineering judges. We typically have four judges and each judge spends about 20 minutes with each student project. This gives the judges time for more in-depth questions and a better opportunity to understand the design and implementation of the project.

In the spring of 2013 we refined the rubric which the judges used and tied it to ABET outcomes for the program. In this paper we present the course details, an assessment based on ABET outcomes, and feedback on results from students and the professional engineering community.

Introduction

Capstone projects are an integral part of an undergraduate engineering major's education. The 2015-2016 ABET criteria 5 states¹:

"Students must be prepared for engineering practice through a curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints."

Since the capstone project is a degree requirement and taken after a student has completed most of their required courses in engineering, it is common^{2, 3, 4} to use the senior project as a source of data for assessment. For the ABET *a* through *k* student outcomes in *General Criteria 3*, the obvious items that can be gleaned from the capstone project for assessment are

- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- (e) an ability to identify, formulate, and solve engineering problems;
- (f) an understanding of professional and ethical responsibility;
- (g) an ability to communicate effectively

Outcome (d) an ability to function on multidisciplinary teams, is also widely assessed by senior project data for those programs where the capstone project is done in teams.

Like other engineering courses, senior projects are graded and each student gets a grade for the term based on their project. Since the projects involve a number of complex factors such as project quality and complexity, communications skills, understanding of ethics, and an ability to solve engineering problems, the grade alone is not suitable for assessment.

For decades working engineering professionals have participated in the final evaluation and assessment of capstone projects at the University of Evansville. In the past, working professionals viewed the final oral presentation of all of the projects along with a brief demonstration of the final working project. Each project presentation consisted of a 15 minute oral presentation, including a brief demo, followed by a 5 minute question period. Faculty and working professionals completed rubrics for these presentations and scores were compared.

It was often the case that a student would get disparate scores from the two groups. Due to the intimate knowledge of the projects the faculty had, their scores tended to be biased while the working professionals only had a brief sampling of the project before assessing a score. The working professionals lacked much of the background information available to the faculty. In a few cases, the working professionals designated some projects for outstanding awards when the faculty had given the project relatively low marks. The converse of this also occurred although less frequently.

In the spring 2013, we revised the way in which the projects were evaluated by having the working professionals evaluate projects based on a formal poster presentation where each student met with each evaluator one-on-one for about 20 minutes. This allows the working professionals more time to ask specific questions regarding each project and they gain much more in-depth knowledge of the details. Results show much more harmony between the working professional's scores and the faculty scores for each student.

History and Structure of the Senior Project

The senior capstone design project course sequence was a novel idea in 1976 when it was introduced into the computer, electrical, and mechanical engineering curriculum at the University of Evansville. It began as a three course sequence on the quarter system with the first course being non-credit and used as a course in which the capstone project was chosen. The second course was the project design and the third course was the implementation. When the University changed from quarters to semesters in the mid-eighties, the non-credit first course was moved to the end of the junior year, the design course took the first semester of the senior year and the third course in the sequence was always taken during the final semester at the University. That structure remains in place today.

Capstone projects were originally industry sponsored, but the logistics of finding enough suitable projects from local industry proved daunting and that requirement was soon dropped. At this time, about half of the projects completed are sponsored from sources outside the University, although many of these are in the form of intercollegiate contests and not truly industry sponsored.

The computer science program was joined to the electrical and computer engineering programs in 1990 to form an EECS department. Capstone projects are currently completed in both computer science as well as electrical and computer engineering. All three programs follow the same format and have the same assessment procedure. Few of the capstone projects are truly interdisciplinary – most are not. Every year there are a couple of team projects with groups no larger than two. However, the majority of the capstone projects are done individually. Because of this, the senior project sequence is not used to assess teamwork. Teamwork is currently assessed in sophomore and junior level classes.

In 2002, we introduced posters to the senior project sequence. Originally this was done as a way for students to display their work to their peers and underclassmen while gaining experience in a real world setting. The poster session also allowed an opportunity for the underclassmen to see the exciting work done at the senior level, and to provide motivation for them to begin thinking of their own future projects. The poster session gradually grew into a more formal presentation used for assessment when the working engineers began participating in the session.

Present Structure of the Senior Project

This section details the three course structure of the capstone sequence at the University of Evansville mentioned earlier. The first course is EE 494, which is non-credit course but required for graduation. It is taken in the spring semester of the junior year and meets once a week. During each meeting a faculty coordinator arranges for a sequence of project ideas to be presented. Some of these come from industry while others come from faculty. Students are also permitted to create their own senior project, but it requires a formal detailed description before being approved by a faculty committee. At the end of EE 494 students write a one to three page "mini-proposal" which outlines the requirements of their project. The mini-proposal also requires that they have the agreement of a faculty member to serve as an advisor for the project. It is important to note that while enrolled in this course, students are also taking a junior level projects course, which helps prepare them for the much longer senior year design project^{5, 6}.

During the first term of the senior year, students take EE 495 which is billed as "Senior Project Phase One". This is a three credit hour class which meets three hours a week for lecture. The class covers writing, ethics, professional skills, and both written and oral communication. Students write a formal proposal for their project in multiple drafts, meet one-on-one with their project advisor, and do a formal oral presentation of their proposal as part of the course. They are also expected to complete a preliminary design of their capstone project.

The final course, EE 497, is taken during the spring semester of the senior year. This is the implementation phase of the senior project sequence. This class meets five times per semester for coordination and formal presentations. Otherwise, students meet one-on-one with their project advisor and course coordinator. Their final project report again goes through multiple drafts and they complete a practice session for their final oral presentation. Students must also prepare a poster describing their project. The posters are professionally printed and mounted and become a key part of the final project documentation and presentation.

Near the end of the semester, seniors participate in a final presentation day. There is a formal poster session held in the morning, which is attended by the working professionals, faculty, students, administration, loved ones, sponsors, and faculty from other departments. Lunch is then provided followed by the afternoon session consisting of the oral presentations. All are invited to this session as well, but it is generally attended by other senior students, faculty, and loved ones of the students.

Poster Session

During the poster session each student or team is given an appropriate space to allow for a demo of their project and an easel for the poster. The length of the poster session is dependent upon the number of capstone projects, but enough time is allotted so that the judges may spend at least 20 minutes with each project. Students are expected to stay next to their poster the entire poster session and provide a demonstration and answer questions to anyone who visits their area.

Typically there are three working professionals from each of computer engineering, computer science, and electrical engineering. The judges are asked to visit each project alone so they are not biased by each other's questions and/or opinions. Projects are then reviewed one-on-one by the working professionals. It is expected that the judges ask the students hard questions about their projects and dive into the details as much as possible within a 20 minute timeframe. Each working professional completes a rubric for each project after visiting the student(s).

At the end of the day, the department chair and program directors meet with the working professionals for a wrap-up session. Since this group is familiar with the abilities of the students, this session is also used for guidance on outcomes and objectives and to provide feedback on improving the program.

Assessment and Rubrics

The rubric used by the working professionals during the poster session is shown in Figure 1 in the Appendix. Figure 2 in the appendix shows the oral presentation rubric used by faculty during the afternoon session.

The first question on the poster rubric of Figure 1 is used as a supplementary assessment method for ABET outcome (a) *an ability to apply knowledge of mathematics, science, and engineering*. Other methods outside of the senior project sequence provide a more granular measurement that allows changes to specific courses for correction. We use the results of this question as a way to determine the suitability of a project for this class. Projects which score low on this question are further examined to determine if they should be avoided in the future.

The second question on the poster rubric pertain to ABET outcome (e) *an ability to identify, formulate, and solve engineering problems*. This question gets at the central focus of the senior design project. A student cannot get a good grade on the senior design project without demonstrating to professional reviewers that they have the ability to solve a real engineering problem.

Questions 3, 4, and 5 are all related to ABET (k) *An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*. For these questions the reviewers are looking at the student's demonstration of the use of engineering tools and methodology. One of the requirements for every senior project is that it must have a *product* which can be demonstrated. This demonstration, which is part of the poster presentation, allows the student to show off the use of engineering tools, design of circuit boards, algorithms used in software, and other skills used in the engineering and computer science profession.

Questions 3 and 7 are used in part of the assessment of ABET (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*. A more granular assessment of ABET (c) is taken from the senior project written report which must address issues in this outcome.

Question 6 pertains only to those projects done as a team. We don't require that the senior project include teamwork so this question is not used for ABET assessment. We do use this question to help determine what role each student played in the completion of the project.

Questions 8 and 9 apply to ABET (g) *an ability to communicate effectively*. Communication skills are also assessed in the oral presentation and in the written report.

Question 10 attempts to provides an assessment basis for ABET (h) *the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context*.

Conclusions and Feedback

After the professional reviewers have met with the students, viewed their posters, and assessed their projects, they meet with the department chair, program directors, and senior project coordinators. This meeting is considered critical since it provides additional feedback that is often difficult to convey by filling out a rubric. The following conclusions and comments are largely taken from feedback in these meetings.

- The industrial reviewers are enthusiastic about this process. Many have served as judges for oral presentations in previous years and have indicated that this process gives them a much better understanding of what the student has actually done on a project.
- Almost all reviewers are eager to return and serve in subsequent years. This is true because they feel the process is effective and, in some cases, because it gives them a much clearer idea of what they can expect from graduates of our program. (In some cases, job offers have been made and reviewers have asked to become involved in the senior project at an earlier point.)
- For the past three years that we have been doing this there has been 100% agreement between the faculty assessment of projects and the industrial reviewer's assessment of projects. We have eliminated the disparity produced when industrial reviewers saw only the oral presentation.

- Student feedback from surveys and antidotal sources is very positive. Nearly every student indicated that the process resulted in an assessment of their project which was both thorough and fair.

References

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Appendix

Senior Project Poster Scorecard

Project Title: _____

Engineer(s): _____

1) Knowledge of mathematics, science and engineering were used to solve the problem

5	4	3	2	1
clearly used		somewhat used		not used

2) A creative solution to the engineering problem was identified within the design constraints

5	4	3	2	1
very creative		some creativity		very little creativity

3) The design was successfully completed

5	4	3	2	1
all goals met		some goals met		no goals met

4) Manufacturing or build parameters met industry standards

5	4	3	2	1
professional prototype		some professional packaging		unprofessional

5) The use of modern engineering skills and techniques were demonstrated

5	4	3	2	1
solution was modern		somewhat modern		old-fashioned solution

6) The project was effectively managed; i.e. cost analysis, schedule data, division of labor, time constraints, etc.

5	4	3	2	1
managed well		somewhat managed		management unclear

7) Appropriate analysis of design, data and/or experiments were performed

5	4	3	2	1
analysis complete		some analysis		no analysis

8) Display meets current professional standards (e.g. text, graphics, audiovisuals)

5	4	3	2	1
very professional		semi-professional		not professional

9) Presenter was able to explain the engineering, science, and technical approach used for the project

5	4	3	2	1
clear, concise, complete		mostly clear, some explanations missing		incomplete, confusing

10) Presenter displayed knowledge of the impact of project on society

5	4	3	2	1

impact discussed

somewhat discussed

no mention of impact

Additional Notes/Comments:

**Figure 1 Poster presentation rubric
Senior Project Oral Presentation Scorecard**

Project Name: _____

Student(s): _____

1) Demonstrated ability to formulate a problem (1b)

5	4	3	2	1
project specs are clear		some specs are clear		unclear project specs

2) Demonstrated ability to design a creative solution to problem (1b)

5	4	3	2	1
very creative		some creativity		very little creativity

3) Demonstrated ability to verify project specifications (2b)

5	4	3	2	1
all goals verified		some goals verified		no goals verified

4) Demonstrated working project (2b)

5	4	3	2	1
complete demo shown		some pieces shown		no demo shown

5) Project was packaged in a professional manner

5	4	3	2	1
professional prototype		some professional packaging		no packaging

6) Project specifications were met (2b)

5	4	3	2	1
all goals met		some goals met		no goals met

7) Project is useful to the public and/or professionals in the field

5	4	3	2	1
very useful		somewhat useful		not useful

8) Overall project quality (2b)

5	4	3	2	1
excellent		okay		poor

9) Quality of oral presentation (2c oral)

5	4	3	2	1
clear, concise, complete		mostly clear, some explanations missing		incomplete, confusing

10) Professionalism of presenter (2c oral)

5	4	3	2	1
very professional		semi-professional		immature

Additional Notes/Comments:

Figure 2 Oral presentation rubric