A Process for Screening Capstone Senior Design Projects for Compatibility with Department ABET Program Outcomes

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1. Introduction:

The Department of Electrical and Computer Engineering (ECE) uses its senior capstone design course as a major source of data for its outcomes assessment process for ABET accreditation. Thus, we must insure that the projects we assign address our Program Outcomes (PO), which are our version of Criterion 3 in EC2000, to the extent possible. In this paper, this paper presents a description to the process that we have developed to screen projects before they are assigned to student teams.

There are four different sources of projects, each with its particular characteristics. They are the following: (1) projects from industry sponsors, (2) projects from ECE faculty sponsors, (3) projects from faculty in other departments across the campus, and (4) projects from the student teams themselves. Because of the diversity of project sources and projects, we have developed a process where the projects, collectively if not individually, address all Program Outcomes that we have determined that the capstone design course should address. The Program Outcomes that our project addresses are the following:

- Outcome a: Ability to apply knowledge of mathematics, science, and engineering
- Outcome b: Ability to design and conduct experiments
- Outcome c: Ability to function on multidisciplinary teams
- Outcome d: Ability to design a system or a component
- Outcome e: Ability to function on multi-disciplinary teams
- Outcome f: Ability to identify, formulate, and solve engineering problems
- Outcome g: Ability to communicate orally and in writing
- Outcome k: Ability to use engineering skills, techniques, and tools properly

In addition, the ECE Department has written additional outcomes and added them to our list. They are the following:

- Outcome l: Ability to use library and Internet resources
- Outcome n: Ability to use creativity
- Outcome o: Quality workmanship

Additional considerations in the evaluation of projects have been added to the process. They are the following:

- Do the students have the pre-requisite knowledge for the project?
- Is there sufficient expertise in the faculty or in adjunct faculty to supervise the project?
- Is there sufficient interest in the faculty to supervise the project if the course coordinator is not able to supervise it?

In this presentation, we will present the worksheets that we developed to screen capstone projects for suitability and the strategy that we have developed to insure that the projects collectively satisfy the ECE Program Outcomes assigned to the course.

2. Criteria for Projects

In order to satisfy the ECE Program Outcomes, especially the multi-disciplinary dimension of the assessment of teamwork for EC 2000, and to provide students with authentic learning experiences, the projects must meet the following criteria:

1. The technical problem must be solvable based on knowledge learned in courses already taken, DSP, telecommunications, software engineering, multimedia applications, microprocessor applications, and advanced C programming.
2. The projects must require students to work in design teams.
3. Students on the team must be responsible for non-overlapping aspects of the project.
4. Students must be required to do library and Internet search to supplement the knowledge that they received in pre-requisite courses.
5. The project must have industrial applications.
6. Faculty expertise must be present within the Department of Electrical and Computer Engineering to ensure that faculty will be available to supervise the projects.

In addition, all instructors of the senior design course are asked to include the following educational components into the project:

1. Creativity
2. Critical thinking
3. Brainstorming

4. Oral presentation
5. Report writing

3. The Screening Process

The screening process starts by the submission of project proposals that emphasize the technical and educational components of the project. A form is completed by the person proposing the project, including the following information:

1. Pre-requisite knowledge (courses) necessary for this project
2. Number of students required to complete the project tasks in one semester.
3. Non-overlapping responsibilities in the projects such as software design, hardware design, mathematical modeling, and computer simulations.

The senior capstone design committee looks at the various projects, selects the most suitable ones, and presents them to the students, who form teams and select their project. After teams have selected their projects from the project proposals, the senior capstone design committee checks for the following:

1. Does the team have the pre-requisite knowledge to complete the project?
2. Is there enough work for each student in the group for 15 week period
3. Does the project address the ECE Program Outcomes addressed by the course?
4. Are the expenditures needed for the project reasonable?

4. Classroom Activities

The fifteen-week activities throughout the semester are given below.

Week	Lecture Activities	Student Technical Activities
1-3	The approved projects are presented to the students, and students select their projects	Student teams are formed by matching student interests and pre-requisite knowledge to the projects.
4-5	Lecture on library and Internet research with guest lecturers	Reading and searching the Internet for information on the project and related problems
	Lecture on design methodologies and design principles	
6-7	Students receive instructions on making oral presentations	Researching existing techniques for solving the problem. Proposing approaches emphasizing advantages and disadvantages of each
	1st oral presentation	
8-12	Students receive instructions on writing technical reports and group dynamics	Writing, debugging, and testing software and hardware

	2nd oral presentation	
	Lecture on electronic manufacturing	
	Lecture on human factors in design	
13-14	A third oral presentation and draft report due.	Refining the design to meet the design specifications
15	Final presentation	Writing the final report

4. Sample Projects

The following are samples of senior design projects approved by the senior design committee. The approval based on quality of the design, internet and library search, use of proper engineering and design principles, and product testing.

Example 1: Video Compression and Error Concealment over the Internet

The goal of this design project is the improvement of the video quality and frame rate maximization for real time video transmission between two computers over the Internet or a local Area network (LAN). Since real-time video is used, the products of the development can be used for video-conferencing, real-time medical diagnosis, real-time control of industrial processes, or any other use of real-time video. A complete description for the assessment of this project has been described elsewhere (1).

Example 2: Non-Destructive Inspection System for Defects Quantification

This approach was developed to accurately detect any abnormality such as cracks or corrosion that could lead to mechanical failure. Traditional means of testing have required extensive hardware set-up, software, and time consuming assembling and disassembling the various components of the system. Often the failure part is embedded and hard to reach, and there may not be a simple way for detecting it. In this project, a non-destructive inspection approach was designed using image processing. The design was implemented to detect a very fine fracture that could be as small as a pixel size.

In this project, students have to use pre-requisite materials from image processing, and required to search in the library and Internet for various solving approaches that could be destructive in some cases. The project is suitable to satisfy the criterion, and therefore it is approved. Faculty involved in the course found this project as an interesting project to be continued and made applicable to detect cracks in printed circuit boards or IC chips.

Example 3: Remote Pressure Activated Vibration device

A compact pressure-sensing device was designed for a 2-year old patient who required help sensing objects with her feet through vibrations. Design specifications included frequency versus pressure linearly within a frequency range as set by the physician via a

remote communication system. The project was driven from St. Vincent's Hospital to be applied on a two-year patient who requires mechanical vibration to sense via her feet. This project was funded and approved for senior design since it satisfy the ABET Criterion

Example 4: Electronic Locator

A remote electronic locator was designed to locate 9 items in 3x3 keypad to locate up to 9 lost objects via a programmable transmitter-receiver system where the receiver is mounted on the object and the transmitter is designed as a hand instrument. Each receiver is set on a carrier frequency. This project includes software and hardware design components with requirement of library and Internet search.

The following are samples for projects that needed some modifications by the committee.

Example 1: Design of AC-DC converter where controlled rectified bridges are used. The project lacks the application in power system since it is just generic design. A modification to include 4-quadrant PWM converter for high power applications where GTO devices are utilized may add to the design more requirements and makes it appropriate to meet ABET criterion

Example 2: High Power Testing Cables. This is a project where students studying means of testing high power cables for maximum current strength. The project lacks the design criterion required by the ABET. This can be modified to include design circuitries for monitoring high currents via magnetic field measurements. Fault detection and automatic protection through high power switching schemes may add to the design components of the project.

5. Conclusion

We have described a new methodology that insures the design components for projects that meet ABET criterion. This is accomplished by forming a review committee that consists of members specialized in different areas that can judge and provide technical support to the various design components of the projects and insure the quality of each that meet ABET requirements. The committee may modify the projects with the consult with the advisor by proposing extra design work for the projects. The reviewing team will select the proper projects based on the background of the students registered for the course.

References

(1) Paul Salama, Maher E. Rizkalla, and Charles F. Yokomoto, "A Senior Design Model in Video Compression and Error Concealment over the Internet, "ASEE National Conference, Montreal, CA, June 21-24, 2001

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