AC 2010-1203: SUCCESSES OF AN EARLY CONCEPTUAL DESIGN PRESENTATION FOR SENIOR DESIGN PROJECTS

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Successes of an Early Conceptual Design Presentation for Senior Design Projects

Abstract

In the past, teams from the University of North Carolina at Charlotte College of Engineering two semester capstone senior design class first presented their project design at the end of the first semester. Their design consisted of a report and a poster presentation submitted to the faculty mentors, course instructors and company sponsors.

At the poster presentation (and in their report) we found that 35% of the teams did not include enough design detail and 25% had virtually no design details, which indicated they had not spent much time on the design effort. This caused project teams to start their second semester efforts behind schedule. By the end of the second semester, about 28% of all projects (but especially the late-starting projects) failed to meet their project requirements.

During the fall of 2009 we introduced a model in which each team presented the conceptual design of their project in the middle of semester one. This presentation, along with the discussion afterwards, has helped teams to focus on details of the design concept. The presentation has also given students a chance to enhance their presentation skills. The major beneficial result of the presentation is that teams are better able to complete the detailed design by the end of the first semester. Our goal from the early conceptual design presentation was to improve the quality of all projects design, and to eliminate the 25% project design failure from occurring.

Our initial results are that, based on our early focus on design instruction and presentation on design detail, nearly all teams had complete designs by the end of the first semester. Only 4% of the teams were judged as having virtually no design content, while 70% of the teams had completed designs.

Introduction

The University of North Carolina at Charlotte currently offers a two-semester, multi-disciplinary senior design sequence that spans all of the departments within the College of Engineering (COE). Industry-sponsored and faculty funded research efforts comprise the projects for the senior design sequence. This is particularly advantageous for the industry sponsors, since these sponsors are afforded the opportunity to initiate elective research projects in their respective areas of interest while working closely with seniors that the company may be interested in recruiting. Students prioritize their interest in available projects through analysis of posted Statements of Work and the course instructors, who represent all departments and programs in the COE, formed groups with three to four students containing diverse talents that would be representative of a typical engineering team in industry.

Students participating in the industry sponsored senior design program are expected to produce industry-standard deliverables throughout the two-semester course. The following documents are described in earlier papers[1,2,3] and include:

1. Requirements and Capabilities

2. Planning (Work Breakdown Structure, Schedule (Gantt Chart), Risk Assessment and Mitigation Plan)
3. Financial (Project Budget, Bill of Materials, Purchase Orders)
4. Engineering Notebook
5. Status Reports
6. Poster Presentation
7. Written Report – Semester I
8. Project Presentation
9. Written Report – Semester II

A group leader is identified by each team and held accountable for the production and updating of the project documents.

Missing from the course was instruction on design. The course faculty determined that design instruction in previous discipline courses was sufficient for students to complete a large design project. Later the senior design faculties learned that each department has unique instruction used in different nomenclature and processes. Therefore the multi-disciplinary teams did not know what processes to follow.

Further, the program had no assessment of design activities until the end of the first semester. This led some teams to struggle in the middle of the semester and finally focusing on a minimal design by the end of the first semester.

Implementation

The two major changes needed to improve the design content of team projects were: Increase the amount of instruction on design processes and include a graded deliverable in the middle of the semester that stressed a solid design.

The instruction on design was increased from one lecture presentation to three. These lectures actually included hands-on activities that stressed decision choices that fulfilled requirements. They also included concepts like systems engineering.

The design deliverable was defined as a presentation where team members described their requirements and how the proposed design met the requirements. All conceptual design presentations were completed within an eight-day period. The senior design committee formed a set of seven panels, each panel consisting of an Instructor (as the chair) and four panelists (faculty and industry sponsors). The committee developed a conceptual design rubric that follows the Estell and Hurtig[4] style of scoring.

Each team had five minutes to set-up, fifteen minutes to present the conceptual design of the project, and five minutes to answer questions. All presentations were evaluated by the instructor, the faculty mentor and an industry sponsor representative. Each individual team worked hard for this milestone, it was a sprint of two weeks with an intensive focus on the design of the project.

Rubric Used to Assess Team Presentations

The conceptual design rubric is used to assess team members' professionalism, design concept, and presentation skills; it measures each of these components of the design in the following ways:

- Feasibility of the design: The presentation and presenter should be able to demonstrate that the functionality of the design is feasible; they should show that appropriate analysis has been carried out in support of all design decisions. The team should prove that all aspects of the proposed design can be accomplished with the available resources, and all risks are identified.

- Professionalism: All presenters should maintain control of pace and should end on time, they should demonstrate confidence, and all team members are suitably attired. These specific behaviors should be evident during the duration of the presentation.

- Design Basis: The team should describe and identify all requirements and performance of the design and its goals. All requirements should be addressed in the proposed design.

- Design Concept methodology: This chosen design should be the best of multiple design options; a clear description of all other design alternatives should be highlighted.

- Presentation Material: The power point presentation should be neat, and clearly present a unified appearance. The materials presented should identify clearly why the material was chosen.

- Presentation Organization: The flow of the presentation should carry the audience through a logical progression, leading to efficient transfer of information.

The rubric for the conceptual design is included in Appendix A.

Results

The major beneficial result of the presentation is that teams are better able to complete the detailed design by the end of the first semester. Figure 1 show the percentage of project teams design effort at the end of fall semester 2008. Figure 2 show the same data after we implemented the conceptual design review process at the end of fall semester 2009. The final results of this new process was that now only about 4% of all projects failed to address their project requirements with an appropriate design (at least half-way completed), compared to 25% of the projects in fall 2008.

Another side benefit was that the presentation has given students a chance to enhance their presentation skills, which provides another assessment measure for communications in our assessment efforts.

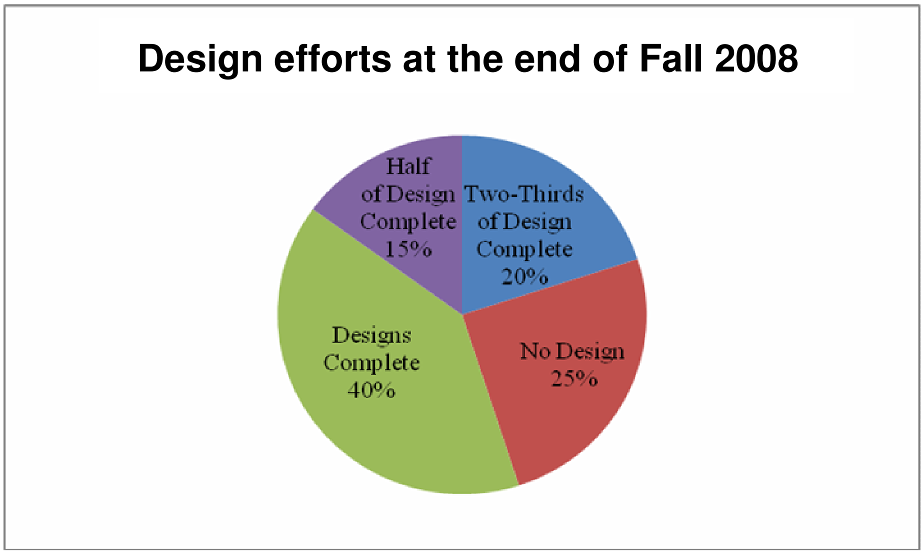

Figure (1) Fall 2008 Design effort at the end of semester

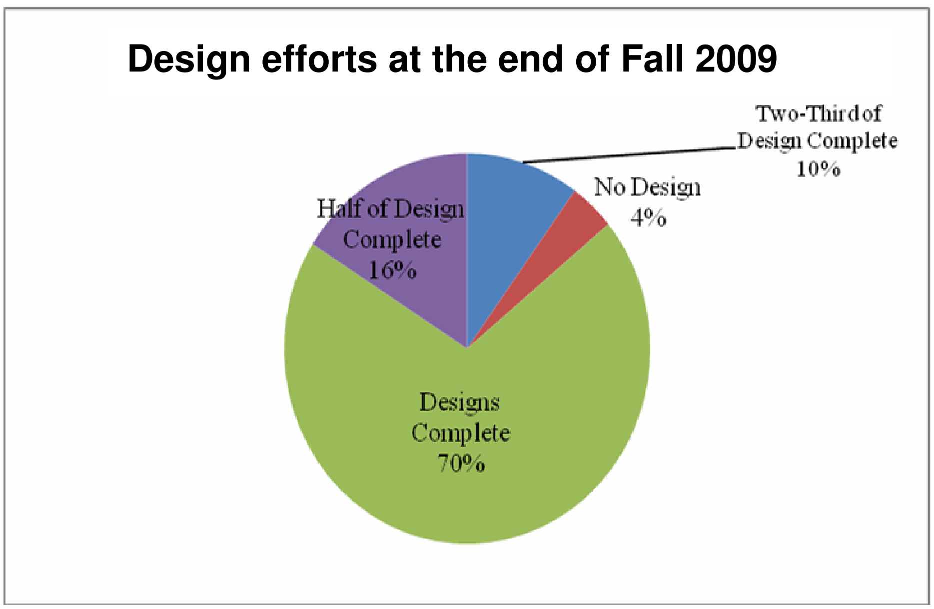

Figure (2) Design efforts at the end of semester one for the Fall 2009.

Future Enhancement

As seen in Figure 2, we still have some room for improvement. Our goal is to have 90% of the team with an appropriate and complete design at the end of semester one of senior design. To accomplish this goal, we may need to increase the grade weight for the conceptual design review from 10% to 15% and to consider more instruction for both the teams and the faculty mentors that advise the teams.

In addition to that, in the Fall of 2009 student attendance at the concept design presentations was optional for non-presenting teams. We believe teams could learn from each other by observing each other's presentations. Perhaps they may be able to use some of the design idea in their own application. We hope to advertize for this event more in the future and encourage juniors to attend so they can better prepare for their own senior design project experience.

Conclusions

Introducing this new process in the middle of semester one was an excellent tool to enhance the quality of the end product. Teams were excited to be engaged; they started the development process earlier than expected, which allowed them to order parts on time and to deliver a more viable prototype on schedule.

The design review process is a good mechanism to ensure the product design is in good standards.

With the adaption of this new method we are confident that this review will reduce the project failure rate at the end of semester II from its current 28% of the projects that do not meet their project requirements.

References

1. James M. Conrad, “Determining How to Teach Project Management Concepts to Engineers,” Proceedings of the 2006 ASEE Conference, Chicago, IL, June 2006.

2. James M. Conrad, Daniel Hoch, and Frank Skinner, “Student Deliverables and Instruction for a Senior Design Program Course,” Proceedings of the 2007 ASEE Conference, Honolulu, HI, June 2007.

3. James M. Conrad, Daniel Hoch, William Heybruck, Peter Schmidt, Martin Kane, Linda Thurman, and Frank Skinner, “Working with Industry Sponsors in a Multidisciplinary Senior Design Program,” Proceedings of the 2008 ASEE Conference, Pittsburgh, PA, June 2008.

4. John K Estell and Juliet Hurtig, “Using Rubrics for the Assessment of Senior Design Projects”, Proceedings of the 2006 ASEE Annual Conference & Exposition: Excellence in Education; Chicago, IL; USA; 18-21 June 2006.

5. James M. Conrad, Nabila Bousaba, Daniel Hoch, William Heybruck, Peter Schmidt, Martin Kane, Linda Thurman, and Deborah Sharer, “Assessing Senior Design Project Deliverables” Proceedings of the 2009 ASEE Conference, Austin, Texas, June 2009.

Appendix A

Attached to the end of this document is the actual rubric used to assess the team presentation.

Conceptual Design Review Rubric

Team:______________________________
Evaluator:_________________________

Section	3	2	1	0
Professionalism	All team members are suitably attired	Most team members are suitably attired	Some team members are suitably attired	Few if any team members are suitably attired
	Presentation setup is swift and sure	Team shows some unfamiliarity with equipment and procedures	Obvious awkwardness in setup for presentation	Major failure or missing component of presentation
	All speakers project confidence and transitions are smooth	Most speakers project confidence and most transitions are smooth	Some speakers project confidence and transition smoothness varies considerably	Speakers seem hesitant/faltering and most transitions are awkward
	Presenters maintain control of pace and end on time	Most portions of the presentation are on time	Some difficulty controlling pace resulting in loss of a minor portion of presentation	Significant lack of pace control resulting in substantial overrun or loss or material
Presentation Materials	All materials are neat, clearly visible and present a unified appearance	Most materials are neat, clearly visible and present a unified appearance	Materials are of variable quality with some being neat and others cluttered	Quality of most materials is poor
	Materials consistently explain or reinforce the point being presented. It is clear why the material was chosen.	Most materials support the presentation, though some are not a direct match. Some presentation points could have used a more appropriate aid.	Materials generally support the presentation, but often appear to have another primary purpose (e.g., detailed drawings). Many presentation points are unaccompanied by a useful aid or reference.	Major portions of the materials fail to support the presentation, and it is not at all clear why they were included. The presentation clearly calls for materials that were not used.
Presentation Organization	The flow of the presentation carries the audience through a logical progression, leading to efficient transfer of information	Overall organization is good, but some details are presented before context is developed and some items are treated in a disjoint way.	Many aspects of the design are treated out of order, and details are often introduced before necessary context is developed.	There is little evidence of an overall organizing principle to the presentation. Most details lack context. Presentation is generally disjoint.
Design Basis	All requirements and performance goals are clearly identified.	Many requirements and performance goals are clearly identified.	Some requirements and performance goals are identified.	Requirements are either absent or an insignificant factor in the review.
	All requirements are addressed in the design proposed.	Most requirements are addressed in the design proposed.	Some requirements are addressed in the design proposed.	The design is minimally related to the requirements.

Design Space	Clear understanding of available design freedom is demonstrated.	Much of the available design space is identified.	At least some of the possible design variations are recognized.	There is no evidence that alternative designs were considered.
	There is a clear and well-founded (e.g., not just personal preference) methodology for choosing among design alternatives.	Many design choices were made in a systematic way.	At least some of the possible design variations were considered in a systematic way.	The basis for the choice of specific designs is unclear.
	The superiority of the chosen design is clearly demonstrated.	The chosen design is shown to be a good one.	The chosen design is shown to be superior to some other possibilities.	There is no basis on which to assess the relative merits of the chosen design.
	All applicable standards have been identified and incorporated into the design.	Some standards have been identified and incorporated into the design.	Possible standards have been identified, but their implications are not considered in the design.	There is little or no evidence that standards have been considered in the design.
Feasibility	Analysis, experience and logic are sufficient to create high confidence that the proposed design will function as anticipated	Analysis, experience and logic are sufficient to suggest that it is likely that the proposed design will function as anticipated.	Analysis, experience and logic suggest that at least some portions of the design will function as anticipated.	Based on the material presented, there remains substantial doubt that the design will function as anticipated.
	All of the high and moderate risk aspects of the design have been identified and addressed.	Some risks have been identified and some of those have been addressed.	Few risks have been identified and these have not been adequately addressed.	What, me worry?
	All aspects of the proposed design can be accomplished with available resources	Most of the design can confidently be accomplished with available resources, but there are a few aspects that will be problematical	It is possible that the design can be accomplished with available resources, but there is no apparent reason to expect that it will.	Resources that are not currently available or supernatural aid will be required to accomplish the proposed design.
	Appropriate analysis has been carried out in support of all design decisions. Safety factors have been appropriately chosen and consistently applied.	Most major design aspects have received analytical consideration. Safety factors have been applied where called for and are usually well-chosen.	Some analysis has been performed in support of the design, but not all elements that should be so supported have been. Safety factors are used in an uneven way.	Little or no analysis underlies the design decisions. Safety factors are usually either absent or inappropriately chosen.