The Senior Design Project: From Concept to Reality

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Abstract

The senior design experience at the Department of Electrical Engineering of St. Louis University is a two semester course sequence with sixteen weeks per semester. The total of thirty two weeks for the senior design courses is divided into three major sections of twelve-twelve-eight weeks. The end result of each major section is, in order, the preliminary design review (PDR), the critical design review (CDR), and the final design review (FDR).

During the first twelve weeks, various social issues of engineering design are introduced as case studies, including legal, ethical, and environmental. In addition, practical design issues are introduced including cost, ease of use, packaging, resource efficiency, etc. Design students are divided into several working groups. Groups then select projects and develop proposals to be presented as the PDR to the department faculty at the end of the first twelve weeks. Upon approval of the proposed project, students generate a purchase order that contains parts list, quantity, cost, and vendors' addresses to the department secretary for processing.

During the second twelve weeks, students are guided towards proposed project completion. Parts are ordered and tested for validity of specifications. Various modules identified in the proposal are designed, tested, and interfaced together to meet project proposed goals. Upon completion of all the modules, prototypes are assembled and extensively tested. A mini-poster session is organized to present the working prototypes to the department faculty, invited guests, and students as part of the CDR. Upon successful completion and presentation of the proposed projects, the student groups earn the right to proceed to the third and final phase of the design sequence.

During the last eight weeks, students are to package their completed projects, perform extensive tests, and develop operational and technical manuals. The final products are presented in a poster session for review and are fully demonstrated in front of an audience consisting of faculty, students, and invited guests. This constitutes the FDR.

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I Introduction

The department of Electrical Engineering at the Saint Louis University is ABET accredited and fully dedicated to undergraduate teaching and research. The department offers concentration in either traditional electrical engineering or concentration in computer engineering. The department was established in 1987 by the generous support of local industry.

The Bachelor of Science in either of the concentrations offered by the department requires completion of 127 credits over four years.

Programs within the department place an important emphasis on the integration of design throughout the curriculum starting with introduction to Electrical Engineering (EEP-101) in the freshman year. The design components are then continually strengthened in the sophomore and junior years. During the final (senior) year a sequence of two design courses are offered. Two sixteen weeks courses, Design I (EEP-490) and Design II (EEP-491), are expected to be completed by graduating (senior standing) Electrical Engineering students. During these thirty two weeks students are expected to undertake major design challenge(s). Students are encouraged to carry out interdisciplinary projects. This will allow a greater emphasis on team work and a better synthesis of real world projects.

Prior to registering for the design sequence students are to meet with their respective academic advisors and complete a graduation application and receive a clearance and permission for registration. This insures all students registering for senior design courses have successfully completed all EE/CpE courses leading to the senior year.

Senior design I and II are divided into three phases. Phase I (twelve weeks) is dedicated to generating a proposal while introducing students to various aspects in engineering. Phase II (twelve weeks) is dedicated to hardware/software implementation of proposed project (prototype). In the Phase III (eight weeks) students are expected to package and carry out final test of proposed product and then prepare technical and operational manuals.

II Phase I: Primary Design Review

This phase of the design students attend two hours of lecture and two hours of lab each week. Upon entering senior design I students are normally divided into several groups. Grouping is done based on established tests such as the Meyers-Briggs tests and students individual strengths and academic performance. As much as possible it is the aim to insure equal strength with mix of abilities in each group. In the first two weeks students are either assigned a project or choose a project worthy of the allotted time and students' ability. Each group is expected to present an initial qualitative and quantitative description

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of their project. Upon approval of chosen projects students are then led through a successful preparation of a proposal.

In addition to emphasis on generating an acceptable proposal students are introduced to various issues important to the engineering environment. These issues are technical, ethical, legal, economical, environmental, safety, social, and etc.

Students are expected to play a major role in the teaching and learning process. Groups take turn preparing and presenting assigned topics to their classmates. There exist vast resources that are encouraged to be used. Two textbooks [1, 2] are chosen for this course. Lectures are not limited by the contents of these two books. Additional references (books [3-5], internet resources, journals, magazines) are also used. The group responsible for the week's lecture is also asked to prepare and administer a quiz to the rest of the class a week following their lecture.

Although an EE faculty is assigned as the course facilitator, other professors within the department play important mentoring role. Students are encouraged to seek the advice of professors within the department and also faculty from various other fields as possible.

During Phase I, students attend two hours of lectures and two hours of laboratory. Every week a handout is presented to students to state more specific tasks for the week. Lecture hours are dedicated to:

1. Introducing students to a methodical approach in preparing a proposal.
2. Workshops dedicated to various issues important to engineers. Expert guest speakers are invited to carry out several of workshops in legal, ethical, economical, technical, etc.
3. Introducing available resources (library on line and reserve).
4. Lectures by students and faculty on assigned topics from design textbooks and assigned resources.
5. Quiz.
6. Handouts related to design are distributed.
7. Etc.

Laboratory hours are dedicated to students reporting on their progress, case studies, question and answer, addressing concerns, individual group meetings, and guest speakers. During the first six weeks students are to meet with EE faculty on a weekly basis to report on their individual concerns. Group representatives (leaders) are also required to meet with the professor on a weekly basis throughout Design I and Design II to report on group dynamics and concerns.

It is important to note that students in Design I are expected to play the role of a mentor to Freshman EE students. Intro to EE students are invited to join seniors on a semi-regular basis to experience various stages of reporting on progress. There are several benefits to both freshman and senior students. Freshman EE students get a better feel for

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their chosen major and gain insight into major design experience. Senior students are placed in a position of mentoring. In the intro to EE course students are guided through a design project on paper. The experience has led us to believe in a greater cooperation between freshman and senior students on a continual basis.

The evaluation of students' work during this phase is based on the following categories:

1. Bi-weekly written and oral reports
2. Laboratory logbooks.
3. Quiz.
4. Case studies (NSPE cases).
5. 8th week poster session (pre-proposal)
6. Assigned topic presentation.
7. Attendance and contributions.
8. Final proposal presentation.

Upon completion of the first twelve weeks students are ready to present their proposals to the school of engineering faculty and students. A request for a budget is made at the conclusion of proposal presentation. Parts lists with all costs and respective vendors are expected as a part of their proposals. Upon approval of the proposal students are guided to next phase of the design. If a proposal is found to be deficient then a maximum of 4 weeks (with 10% of the final grade penalty per week) are allowed for the group to address concerns raised by dept. faculty. By rectifying all concerns these students are then allowed to continue to the next phase. In some cases it may be necessary for students to repeat Design I.

III Phase II: Critical Design Review

Students entering this phase are to have generated parts lists with individual item's cost and vendors. Each group places a purchase order through the dept. secretary while ensuring to stay within the assigned budget. Each student is provided with a $200.00 budget. Hence a group of four or five students have $800 - $1000 to carry out their project. There have been rare occasions of cost overruns. In such circumstances groups are expected to make a special request to the department for additional funds.

The course scheduling in this phase of the design is changed to place a greater emphasis on laboratory hours. Class meets one hour per week for lecture and four hours per week for laboratory. Major tasks in Phase II that follow the time line (Gantt chart) presented in proposal are given below:

1. Ordering parts.
2. Establishing testing and verification procedure (s).
3. Building and testing major modules.
4. Connecting individual modules and testing.

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5. Final assembly of the prototype and testing.
6. Demonstration to faculty and students.

It is expected that groups will adhere to the time lines presented in their proposals. The major part of a student grade in this phase will be based on meeting proposed deadlines. Groups are expected to continue presenting bi-weekly progress reports. Attendance is strictly monitored to ensure a steady progress toward the final goal. Logbooks are collected regularly to ensure all out effort by students. As stated earlier a major part of their grade for the phase II is based on successful implementation of their proposed project. Major modifications such as alternate approach to designing a module within a proposed project must be presented to the faculty for a review. Modifications are accepted as long as project timely completion is ensured.

By the end of the second twelve weeks each group is expected to have successfully completed a working prototype of their proposed project. At this time department faculty and students are invited for the demonstration. Completed projects are compared to proposals presented in Phase I to ensure all proposed work is completed. Projects needing additional time are given 4 more weeks (with 10% penalty per week) to complete and demonstrate their prototypes. Failure to meet this deadline will result in a very low grade for the Design II.

Successful demonstrations of the prototypes permit groups to proceed to the final phase of design sequence.

IV Phase III: Final Design Review

In this phase of the design projects are completed by packaging and final testing of the working projects. Then two manuals in addition to the final report are expected from each group. These are the technical manual and the operational manual. The technical manual is written with other engineers in mind. It is a guide for troubleshooting of possible problems. The second manual is for non technical people interested in operation and use of the product. Manuals are presented to EE dept. faculty for their review and final approval. The final product is presented in a poster session for review by faculty and students. Upon product demonstration, and presentation of manuals students earn passing grades based on their group and individual performances.

V Conclusion

The procedure detailed in this work has led to establishing a set of guidelines that has been used for leading EE students to successfully complete a major design experience. The goal of leading students through major and meaningful design projects while covering issues important to engineering practices has been successfully met. Continuous evaluation of our approach is expected and whenever necessary improvements will be made to ensure a high level of design experience for senior EE students at the Saint Louis University.

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