UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Senior Design Program

Project Supporter Guide

Faculty Mentor Guide

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1. Overview

1.1 Overview of this Document

Thank you for your interest and support in the Lee College of Engineering Senior Design course. This document is designed to assist you in the mentoring process and provide an overview of the course and the expectations of students and technical contacts. If after reviewing this document you still have questions regarding the course, please feel free to contact one of the course instructors listed on the cover sheet.

1.2 Overview of the Externally Supported Senior Design Program

The Lee College of Engineering (COE) Senior Design program brings together students and external partners in a collaborative research environment. As they tackle real-world engineering projects, the COE students and their project supporters are afforded unlimited possibilities for learning and achievement.

COE students profit from:
- Practical "hands-on" experience.
- An opportunity to learn design philosophies.
- Meeting and working with potential employers.
- The development of team problem-solving skills.
- The performance of project management skills and experience in budgeting time and finances.

External partners profit from:
- The opportunity to initiate elective research projects in collaboration with UNC Charlotte research faculty.
- The creation of innovative and competitive products utilizing a low cost method.
- The development of improved manufacturing or business processes.
- The opportunity to see students at work and recruit seniors.
- Networking at the end-of-semester presentations and competition.

1.3 Expectations of Students

Students are expected to have the necessary technical knowledge from classes and independent investigations to perform the projects. All pre-requisite coursework through the junior year must be completed prior to enrolling in Senior Design. Each student is expected to work on his/her project outside of class approximately 10 to 15 hours per week as a general rule. This time also includes conducting research, generating and maintaining planning documents, writing progress reports, preparing for design reviews, completing formal reports and presentations, and communicating with the project supporter and mentor. Grading rubrics will be used to evaluate student performance across all departments in the college and the disciplines within the departments.

Students are expected to submit all assignments on time, to the designated location and in the proper format. It is suggested that students send documents to their faculty mentor and project supporters for review at least 24 hours prior to the deadlines posted in the course schedule. The faculty mentor and project supporter are encouraged to provide additional feedback and requests for enhancements. The course instructors will grade each assignment using a grading rubric and will post the grade for each deliverable.

It is the team's responsibility to establish a weekly or bi-weekly meeting time with the faculty mentor and project supporter, although the frequency of these meetings should be determined at the mentor and project supporter's discretion. Electronic communications are also strongly encouraged, as needed. The team will identify a Project Lead (PL) and this person will be the only team member that corresponds via phone and email with the project supporter and faculty mentor. The faculty mentor must be copied on any email correspondence between the PL and project supporter.

In keeping with the spirit of a first job experience, the team is expected to come prepared to each meeting with an agenda that clearly justifies the meeting's time commitment and includes a report of action items from previous meetings.

1.4   Expectations of Project Supporters

Project Supporters of senior design projects must have a product or project in mind with well-defined requirements and constraints. The scope of projects must be suitable for teams of 3-6 students working steadily over a 21 week period spanning the two academic semesters. In most cases, supporters provide a $7,000 contribution for prototype parts and materials, travel costs for site visits, and UNC Charlotte shop and laboratory consumables. Since the Lee COE senior design is fully self-supporting, a portion of these monies will also be used to provide the venue and meals that occur during events where student work is showcased (e.g. expositions).

The supporting company must identify a point of contact that will act as the liaison between the company and the student team/faculty mentor. This external technical consultant should be accessible for approximately one hour per week during the school year to provide regular guidance and encouragement to the team, so that important design issues can be resolved satisfactorily and promptly. While the technical consultant is not expected to do any of the student work, the success of the student team and supported project is often strongly linked to technical consultant's involvement and accessibility.   The consultant should provide timely and constructive feedback to ensure that the team's final solution meets specified requirements.

The technical consultant will assist the team in resolving design, development, and test issues. They should review the posters planned for the poster display exposition at the end of both semesters and the submitted reports to verify all materials do not include any proprietary information provided by the project supporter. Should the project supporter require the report delivered to them to include the shared proprietary information, the student team should be directed to compose two reports: one proprietary and marked as such, and one non-proprietary report for academic evaluation and public display as in the case of project posters.

The technical consultant will be asked to use provided rubrics to grade certain student team deliverables and the overall project, this is needed to ensure the team remains on schedule and the project is developing in a manner satisfactory to the project supporter.

An outline of the tasks required by the technical consultant is listed below:

Semester 1

1. Propose a project description with appropriate depth and scope that is finalized in cooperation with the Director of the Industrial Solutions Laboratory.

2. Attend the kickoff breakfast to discuss the project with the student team and faculty mentor and adjust the project description as required.

3. Meet or correspond with the team, ideally on a weekly basis.

4. Attend and grade the Conceptual Design Review and Preliminary Design Review.

5. Attend the Senior Design Poster Exposition at the end of the semester.

Semester 2

1. Meet or correspond with the team, ideally on a weekly basis.

2. Attend and grade the Prototype Review in the middle of semester two.

3. Attend the Senior Design Exposition at the end of the semester and grade the technical design aspect of the project with a provided rubric.

At all times, the technical consultant should immediately contact the faculty mentor or one of the course instructors if there are concerns about the team's performance.

1.5   Expectations of Faculty Mentor

The goal of the senior design course is to emulate a first job experience. Therefore, the mentor should not do any of the research, technical calculations, design, construction, or testing required for the project. Although it is helpful if the mentor has some technical expertise associated with the project, it is not necessary. Rather, a successful mentor is an effective coach and process facilitator that promote good team skills, disciplined use of the engineering design process, and effective project management techniques. The mentor's role is to provide sufficient direction and support to the team so that they can be self-motivated, independent problem solvers. A good mentor will help students identify appropriate questions, resources to obtain answers, and strategies for overcoming obstacles. A good mentor will hold students accountable for meeting project deadlines and satisfying all design requirements and performance capabilities. A good

mentor will also help guide the team toward the right decisions by making sure that they have fully explored the design space and viable methods or strategies. Consequently, the team, and not the mentor, is ultimately responsible for decisions that enhance or limit their success.

Micromanaging the team is discouraged. However, weekly or bi-weekly in-person meetings are suggested as are electronic communications, as needed. Since the mentor often has the most insight into the team's performance due to the frequency of meetings, it is also strongly encouraged that they serve as the team's grading instructor.

Most projects will have a design, build, and test requirement and funds will be made available for the development and testing of a prototype. Funding will vary depending on the level of support and prototype requirements. Additional funds may be available, as needed, at the discretion of the mentor and course instructors. However, there is no guarantee of additional funds and a formal request must be made for committee deliberation.

The faculty mentor is expected to participate in the kickoff breakfast to meet the team members and technical consultant. During breakfast, the mentor should facilitate a discussion between the team and technical consultant to ensure that requirements and performance specifications are clearly articulated. If not, the project description needs to be adjusted until the description is clear and the technical consultant indicates satisfaction. The faculty mentor must monitor the team's progress and deliverables to ensure that the final solution achieves the project supporter requirements. The faculty mentor will review the poster prior to the poster display at the end of both semesters. The poster should not include any proprietary information provided by the project supporter. Additionally, the faculty mentor is expected to track the development of the prototype product for the exposition at the end of semester two and resolve any development and test issues in a timely manner.

An outline of the tasks required by the faculty mentor for the two-semester course sequence is listed below:

Semester 1

1. Grade the team deliverables using course rubrics, and provide bi-weekly Progress Evaluation grades using published course guidelines.

2. Attend the kickoff breakfast to discuss the project with the student team and technical consultant and facilitate the adjustment of the project description as required.

3. Meet or correspond with the team on a weekly or bi-weekly basis.

4. Monitor the team's progress and process to ensure project requirements and capabilities are satisfied.

5. Provide timely and constructive feedback to the team.

6. Attend and grade the Conceptual Design Review and Preliminary Design Review presentations.

7. Attend the Senior Design Poster Exposition at the end of semester one.

Semester 2

1. Grade the team deliverables using course rubrics, and provide bi-weekly Progress Evaluation grades using published course guidelines.

2. Meet or correspond with the team on a weekly or bi-weekly basis.

3. Attend and grade the Prototype Review Presentation in the middle of semester two.

4. Monitor the team's progress and process to ensure project requirements and performance specifications are satisfied.

5. Provide timely and constructive feedback to the team.

6. Attend the Senior Design Exposition at the end of semester two and grade the technical design aspect of the project with a provided rubric.

At all times, the faculty mentor should immediately contact one of the course instructors if there are concerns about the team's performance.

2. Overview of Senior Design Projects

Projects may address the design of hardware, processes, or analysis. In all cases it is necessary that the project be oriented towards design. But the object of that design can vary considerably,

just as fields of engineering vary substantially. The primary engineering results delivered in Senior Design will be a set of rational decisions, where the rationality of those decisions will be supported by the appropriate analysis and testing. The quality of the design will usually, but not always, be reflected in a prototype of either the hardware or software system. In some cases (particularly large industrial systems) the end point will be a finished detail design with supporting analysis. In the case of process design the result may be a detailed process description coupled to a demonstration which verifies the design.

2.1   Major Criteria for a Senior Design Project

1. The project should provide an opportunity to integrate and apply the academic material previously covered in the B.S. program

    To meet the first criterion, the project needs to have significant <u>engineering</u> content. If the project can be carried out without recourse to engineering calculation, it is unlikely that the project will serve well. One should critically examine potential projects that are comprised of interesting and challenging fabrication and assembly of known designs. In many cases such projects lack sufficient engineering content to be suitable.

2. The project should provide the opportunity to practice the professional disciplines of engineering and engineering technology.

    Most projects will meet the second criterion if the scope of the project lies within the control of the student. But care must be taken when senior projects are carried out in conjunction with an outside entity. In these cases it is important to establish that there is sufficient discretion in the student team to actually drive the execution of the project. If insufficient progress on the part of a student team would lead to intervention on the part of the outside entity, the project is probably not suitable. While we strongly discourage project failure, it is important that project failure is understood to be at least a theoretical possibility.

3. There should be a reasonable expectation that the project can be executed successfully.

The third criterion relates to the availability of sufficient resources to complete the project. The primary resources to consider are student time (is the scope sized to match the available time of the students for the design), student knowledge (can the engineering be done by someone with B.S.-level skills), availability of prerequisites (are mating parts, interface specifications, necessary personnel for interviews, company-supplied equipment or facilities, etc. available?) and financial support for required activity of the project team. Where resources will be supplied from the outside, it is particularly important to have a realistic understanding of the magnitude of the required resources and the reliability of the source for the full length (two semesters) of the project.

2.2 Potential Risks

The most common sources of problems (outside of student performance) relating to senior projects are inappropriate technical scope (both too much and too little) and unrealistic support expectations (both internal and external). It is very important that students not place their successful progression to a bachelor's degree at risk by taking unnecessary risks with their senior project.

2.3 Team Structure

The following list describes the preferred makeup of Senior Design teams based on best practices:

1. The ideal senior design project would be one identified, supported, and funded by an external entity. Therefore, a technical consultant from the supporting organization must be identified at the start of the project and be available for consultation throughout the two semester life of the project.
2. All projects must have a faculty mentor/coach, and preferably a stakeholder outside of the university if the project is not externally supported.

3. Teams should be multidisciplinary.

4. Team size should be a minimum of 3.

5. Single person projects should be discouraged and, in the limited case where they are warranted, managed outside of the COE Senior Design program.

3. Overview of Project Staffing

An electronic copy of each project description is made available to the students on the course website http://www.srdesign.uncc.edu before the first day of class during the first semester of the senior design course sequence. The students are asked to review all of the project descriptions that pertain to their discipline and choose the top five projects that are of most interest to them. A company profile is usually included with the project description to provide the students more insight into the project supporter. During the first week of class each student submits a resume and indicates their top five project choices via an online survey. The course instructors review all submissions and place students on project teams. In keeping with the overall philosophy of senior design, placements are made with the same kind of approach that would be taken by a business. The primary criterion for the placements is maximizing the likelihood of success on all projects. While an attempt is made to assign students to projects of their own choice, student choice is not a primary consideration, and is optimized within the constraint of likely project success. While it would be possible to maximize staffing resources for a particular project, or project choice for a particular student, the data set makes it manifestly impossible to do so for either all students or all projects.

As in industry, job satisfaction can vary. In many regards that is a personal choice, and most of us who have been in the business for a while have learned how to choose to be satisfied and even enthusiastic about jobs that were not our first choice. The leadership of the faculty mentor and project supporter can make a tremendous difference in how students view and execute these projects.

4. List and Explanation of Deliverables

Templates and rubrics for all deliverables are made available to students, and will be available upon request to faculty mentors and project supporters.

4.1   Resume – Semester 1

Resumes of all students, regardless of major, are available to any project supporter for the asking. Project supporters may specify which major(s) they are interested in and corresponding resumes will be delivered on a CD.   Options are: Mechanical Engineering, Mechanical Engineering Technology, Electrical Engineering, Electrical Engineering Technology, Electrical and Computer Engineering and Systems Engineering. Send an e-mail to coesrdesign@uncc.edu with your request.

4.2   Statement of Work and Project Performance Specifications – Semester 1

Using the project description supplied, independent research and interaction with the project mentor and supporter, each team will generate a Statement of Work (SOW) that describes exactly what work will be accomplish during the course of the project, who will perform the work, what specific work product will be delivered, the expected performance and verification of the deliverables and a budget that includes all sources of funding and a not-to-exceed value.

The Project Performance Specifications section of the SOW is developed at the start of the first semester based on the project requirements and expected outcomes provided by the project supporter. This section is used to reinforce the disciplined application of scientific principles and techniques for developing, communicating, and managing the specific details of the project.

The Project Performance Specifications also serve as the rubric with which the project supporter can verify that the end product has all of the desired functionality. To generate this section, students are instructed to first identify all relevant sources of requirements (capabilities, project description provided by the project supporter, proposals, etc.). Next, they determine what

information is needed and analyze the gathered information looking for implications, inconsistencies and unresolved issues. Finally, they synthesize appropriate statements of the requirements and confirm their understanding of the underlying issues with the project supporter. The requirements of the project may change as development continues, but the original Project Performance Specifications section remains intact. If alterations are required, the request must receive approval of the project supporter and faculty mentor.

The document is assessed by the course instructors based on a system of grading rubrics. Input from the faculty mentors, and the technical consultant will be valuable. This rubric is provided to the students before the assignment is due so that they may ensure their document meets the high-level of standards the project supporter will expect.

4.3 Project Plan – Semester 1

This document consists of the Work Breakdown Structure of the project and Project Schedule.

4.3.1 Work Breakdown Structure

Students use the Work Breakdown Structure document to identify as many individual tasks that need to be done for the entire project as possible. An initial list is usually produced during a group brainstorming session, and a time estimate for each task is assigned. The team then groups the tasks by precedence, that is, similar tasks that may depend on each other. Finally, the individual tasks are assigned to the various team members.

4.3.2 Project Schedule

The students are required to enter all of the information outlined in the Work Breakdown Structure into a project schedule and produce an appropriate timeline. The project schedule will be continually maintained throughout the life of the project.

4.4   Progress Report – Semester 1 and 2

Progress reports outline the team's accomplishments related to the Project Performance Specification document, updates to the timeline and any shortcomings. The format of the progress report is similar to the Project Performance Specification document.

4.5   Time Recording

Each student will record the date and amount of time spent on each task, and list how that work was documented. The team's PL will be responsible for compiling this information into a provided Excel spreadsheet template and submit this document according to the class schedule. The time reported by each student carries the full weight and responsibility of any assignment for the class and therefore the rules of Academic Integrity apply (The UNC Charlotte Code of Student Academic Integrity).

4.6   Peer Evaluation

Each student will assess their project teammates and their effort twice each semester. The results of the evaluations may lead to adjustment of the final course grade based on the course instructor's discretion. Results of the evaluations will remain anonymous, but will be provided to the faculty mentor. Students that do not submit a peer evaluation for each teammate before the deadline posted will receive a 0 for their evaluation and a reduction in their final grade.

4.7   Conceptual Design Review (CDR) – Semester 1

Each team will present to a panel of faculty and project supporters describing the design options considered and the final choice. This will give all teams a chance to receive input and feedback from the faculty mentor, instructors and project supporters.

4.8   Preliminary Design Review (PDR) – Semester 1

Each team will present to a panel of faculty and project supporters demonstrating that the preliminary design meets all project performance specifications within the cost and schedule

constraints and establishes the basis for proceeding with detailed design. It will show that the design is verifiable and that the risks have been identified, characterized, and mitigated where appropriate.

4.9   Poster – Semester 1

Each team will produce a poster to be displayed at an end of the semester expositions where they showcase their efforts to students, faculty, alumni and industry members.

4.10 Final Design Package – Semester 1

A Final Design Package is required by each group at the end of the first semester and reviewed by both the team's faculty mentor and project supporter. The document outlines the group's accomplishments to date and their ability to adhere to the requirements, performance specifications, and proposed time line. The format of this document is similar to the Project Performance Specifications document.

4.11   Revised Final Design Package – Semester 2

The Revised Final Design Package is a continuation of the first semester's Final Design Package and a starting point of the second semester. Deficiencies in the first semester's report should be corrected in this version. This is a go/no-go assignment from the design perspective. It must be approved by both the faculty mentor and the team's grading instructor. Project teams will rework this document until the mentor and instructors are satisfied. This then becomes the benchmark for progress and grading later.

4.12   Prototype Status Review Presentation – Semester 2

A 20 minute PowerPoint presentation will be given by each group describing the project status and outstanding milestones that need to be reached. Evidence of progress towards developing a prototype is expected.

4.13   Prototype Demonstration – Semester 2

In the middle of the second semester each team will present to a panel of faculty and project supporters the preliminary functioning prototype of the project (the design should be frozen by then). This will give all teams a chance to receive input and feedback from the faculty mentor, instructors and project supporter.

4.14   Poster – Semester 2

Each team will produce a poster to be displayed at an end of the second semester exposition and banquet where again they showcase their efforts to students, faculty, alumni, and industry members. Students with a physical end product will also display their deliverable device.

4.15   Final Report and Comprehensive Document Submission – Semester 2

A final project report is required outlining the final design, cost, and testing performed to verify that the end product conforms to the defined requirements and performance specifications. The format of this document is similar to the Project Performance Specifications document. Additionally, each team will submit a comprehensive document submission electronically that includes all supporting documents generated over the life of the project.

4.16   Technical Design – Semester 2

The merit of the technical design of the project is also evaluated at the end of the second semester.   This assessment looks at the overall project including identifying the problem, executing the plan, and the technical level of the proposed solution.

5.   Grade Distribution

Grades are based on the quality of work and adherence to pre-published criteria. These criteria are posted on the course Canvas site in the Assignment Rubrics section. Final course grades will be based on a combination of a series of biweekly progress evaluations and end-of-semester project deliverables.

Progress Evaluation Guidelines are also posted in the Assignment Rubrics section of the Canvas site, and provided in this manual, and describe what kind of progress would be expected of a team. In making a progress evaluation, the performance on written deliverables up to the point of the evaluation will be considered, but there is no fixed percentage coupling since the value and timing of these deliverables will vary from project to project. The Progress Evaluation itself is a 0-100 rating based on deliverables and actual progress of the team, including meeting any stated expectations of the mentor. This evaluation will appear on Canvas as a team assignment to allow straightforward grade assignment to a team. But as in the case of all team assignments, grades may also be individually assigned to particular students. This method of grading is particularly useful where there are individual students who are either doing exceptional work on an average team, or students who mistakenly believe that they can do little or nothing and coast on the performance of the remainder of the team.

The course schedule, syllabus, and progress evaluation guidelines and schedule are available as separate documents on request.

Date	Rev	Author	Comments
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