The Administration of Senior Design Projects In a Distance Learning Environment

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I. Abstract

A method for administering a senior level capstone design course in Electrical Engineering Technology in a distance learning environment is described. Several avenues are explored that help the students successfully conceive, develop, and present their design projects from off-campus locations that are consistent with the requirements placed upon their on-campus peers. Several problems that are unique to offering a senior project course in a distance learning environment are explored and solutions are described.

II. Introduction

The senior design project, which has become a popular addition to many engineering and engineering technology programs, provides a number of challenges for both the student and faculty supervisor. These challenges include selecting an appropriate project by the student, creating and meeting a schedule agreed upon by the student and the faculty supervisor, and developing a suitable presentation of the completed project. Further complicating the process is the administration and execution of the senior project in a distance learning environment.

A senior design project requirement was introduced to the Engineering Technology curriculum at Old Dominion University in 1998. Since the Old Dominion University Engineering Technology program is heavily involved in distance learning, this presented the challenge of also administering the course in a distance learning environment. After several years of evolution, the following outline is presented for a semester-long senior design course with justifications for each step where appropriate. As is the case with all distance learning courses, the paramount issue is to not provide a discernable advantage to students that are in residence.

III. Course Requirements

Project Proposal

The first step is the project concept and its approval. Requirements of the project include a degree of complexity that warrants three hours of academic credit. This is very much a judgment call made by the academic supervisor since many distance learning students and nearly all on-campus students have had little or no experience in developing their own project in this program

of study. The student often underestimates the amount of time required to fully complete the proposed project and, if left unchecked by the supervisor, two unfortunate results can occur. First, the student may find himself or herself overwhelmed by the effort required to bring the project to a successful completion. Second, rumors will spread (even among distance learning students) that the senior design course is extremely difficult, resulting in underclassmen dreading the upcoming course.

Within the first two weeks of the term, the student must communicate directly with the faculty supervisor regarding the proposed project. This communication is either face-to-face, via telephone, or via E-mail. The latter is discouraged primarily due to the amount of information that is exchanged during the initial meeting. During this meeting the student is encouraged to volunteer a project idea that holds some personal interest. The functional requirements as well as the deliverables are discussed and, when these are mutually agreed upon, a formal proposal and development timeline are prepared and submitted to the faculty supervisor based upon an acceptable project proposal format. The minimum set of elements that are required to be addressed in the project proposal are:

- Abstract
- Introduction / Background
- Description of Proposed Work (Deliverables)
- Project Schedule including Goals (Timeline)
- Conclusion

The student is provided with this list prior to the proposal submission deadline and is also informed that this set of elements may be expanded as dictated by the nature of the project. Additions to this may include such items as graphics and documentation of prior art. The faculty supervisor reserves the right to modify the proposal if deemed necessary. Upon acceptance of this proposal it becomes a contract between the student and the course supervisor.

Discussing the project concept prior to submission of the formal proposal is well worth the effort since it provides the student with some level of confidence that the proposal will be accepted. In some instances project ideas are provided by the faculty supervisor or other faculty member, but this is the exception more than the norm. It is desirable to have this step in the course completed within the first three weeks of the term and the proposal carries a graded weight of approximately ten percent.

Since most of the ODU distance education students are employed in technical positions, many submit a proposal in which an on-the-job project is to be used for the senior project. Although this has the advantages of being financed by their employer and the student having ample time to complete it, it is strongly discouraged because in most cases on-the-job projects are subject to changes, delays, and even cancellations, all of which are out of the realm of control of the student. Although on-the-job projects are not prohibited, students are warned that they are undertaken at their own risk with the possible consequences of delayed completion of the course. Additionally, some distance education students who work in technical positions request to use an

on-the-job project that they have completed in the past. Because one of the measurements of the student's performance in the course includes working with unforeseen problems, designing workarounds, and keeping the project on schedule, use of a prior project is not allowed. If students are allowed to choose a prior project, they will naturally choose one that was very successful, encountered no problems, and was delivered on schedule.

Status Reports

The submission of status reports is a necessary part of the project process. As with the on-campus students, two such reports are required from the distance student during the course of the term. They are approximately spaced over one month intervals from the date of the project proposal submission. The status report is important for two primary reasons; the first being that it keeps the faculty supervisor advised as to the progress of the project, highlighting any problems that may prevent the project from being successfully completed. Secondly it encourages the student to keep pace with the project timeline. With regard to the weight of the status report relative to the final course grade, it is kept at the relatively low level of five to ten percent. The rationale being that it must be significant enough to secure the student's attention, but not weighted heavily enough to detract from the overall goal of the course which is the completion and delivery of a final project and report. The grading of the status report is based upon form, grammar, and content.

Preliminary Formal Report

This step was introduced within the past several semesters to assist the student in bringing the project to a successful conclusion, especially the distance learning student who is somewhat more disconnected from the day-to-day reminder of the urgency of keeping the project on schedule. It involves the submission of an early draft of the final project report. There are three needs that are addressed by this step. First, this report serves as a third and final status report. If there are last minute problems that develop, this offers the student a way to document them and bring them to the attention of the faculty supervisor. Hopefully, if problems of this type occur there is enough time for resolution prior to final report submission.

Second, it provides the student with feedback prior to submission of the final document. The preliminary report is not graded as rigorously as the final project report, the grade mostly being based upon structure and content rather than technical and grammatical details. The grade awarded for this submission is only in the range of five percent of the course grade since this is truly a rough draft. The structure of the final project report is discussed under that subheading.

Third, it encourages the student to follow proper writing procedure in that a first or "rough" draft is needed. Many students choose to wait until just prior to a final report submission deadline to create their final document, and as any reviewer of documents is aware, procrastination usually is evident in the final product. Although some students do not see the need in submitting this document, most admit that it reduces a great deal of last minute stress late in the term.

Formal Report

The formal report, which covers the project in its entirety, is due during the final week of classes. It, like any other technical report is to include certain elements that are communicated to the student early in the semester. These elements include:

- Title Page
- Table of Contents
- Introduction
- Body
- Conclusions
- References
- Appendices

The Title Page, Table of Contents, References and Appendices are to be presented in a format would be considered appropriate for the technical workplace. The Introduction needs to fully explain the motivation and the strategy involved in the development of the project. The Body of the report must be complete, documenting all obstacles encountered during the development process. It must also correctly reference any tables or figures that are included. The Conclusion section must analyze what was learned during the development process and offer alternative solutions where appropriate.

As stated previously, the preliminary formal report should be presented using this or a similar structure. The weight of this document is approximately 35 percent of the final course grade. It is felt that since the written format is the predominant method for technical reporting, the senior design project course should stress the importance of the final written report above all of the other deliverables.

As with all written papers submitted for the course, distance learning students are required to submit their proposals and reports by mail. Submitting papers in electronic form is not permitted because of the heavy printing burden placed on the department due to the typical size of the report. Additionally, since most students do not own Adobe Acrobat, the papers submitted as word processing files would undergo reformatting when printed on a department printer.

Project Demonstration

In conjunction with the final project report, a functional demonstration of the completed project is required. As previously stated, of paramount importance is uniformity of the requirements between local and distance learning students. Since the outset of the senior project course, the project demonstration phase has evolved.

Because one of the goals of the senior project course is a demonstration of the student's oral communications skills, the project demonstration originally required a videotaped presentation in conjunction with submitting the project hardware to the faculty advisor for grading. Since the distance learning student requires the flexibility of submitting an asynchronous presentation, the videotaping requirement was imposed upon both distance and local students to remove any perceived advantage of a pre-recorded presentation over a live presentation, or vice versa. However, after several semesters it was recognized that this method presented problems in the case of the distance learning students because the shipping of the project to the campus in many cases resulted in damage to the project. Additionally, some projects included some rather expensive equipment (especially in cases of on-the-job projects), which was risky to ship.

Therefore, some modification was made in the project demonstration so that the videotaped presentation included a demonstration of the operation of the project. The main focus of the project presentation is to demonstrate the operation of the final project prototype. It is important that the student present detailed views of the final project hardware as well as any other ancillary materials being used in the functional demonstration. The student is expected to clearly describe the operation of the project and demonstrate a level of understanding that is consistent with the quality of submitted work. It is important to note that in the event that the project does not meet all of the functional goals, the demonstration must present the attained level of functionality. The weight of this step in the final grade determination is significant, possibly being as high as 25 percent.

The videotaping of the presentation is entirely the responsibility of the student. The department does not provide equipment or facilities to local students for the purpose of recording their presentation so that no perceived advantage can be claimed. Students are instructed to make their pre-recorded presentations as if they were speaking to a live audience and that they should make extensive use of visual aids. The required video media is VHS format as opposed to other video media (VHS-C, 8 mm, DVD) due to the high level of confidence that it can be successfully viewed by the faculty advisor.

IV. Example Project

Since a student's typical project formal report is in excess of 50 pages, it is beyond the scope of this paper to exhibit such a report. However, to illustrate the effort in designing and constructing the project and writing the report, a synopsis of a sample project is included below.

In the fall of 2004, an ODU EET senior undertook a senior project titled "Security Alarm for the Deaf and Hard of Hearing". At the start of the fall semester, the student submitted to the senior project instructor a project proposal via email attachment in which she described an alarm system for the hearing impaired consisting of flashing lights that would indicate opened doors or windows, a fire alarm, a telephone ringing, and a doorbell ringing. The frequency of the flashing light would indicate the urgency of the alarm; e.g., a fire alarm would trigger a rapidly flashing light, while a telephone ringing would trigger a low frequency flash.

After evaluation by the instructor, the student was notified via email that the project was too simple, and more complexity would need to be added in order for it to be approved. She was also told that if she encountered problems in determining how to "beef up" the project, the instructor was available to make suggestions. Approximately one week later, the student resubmitted the proposal which added a 4x4 numeric keypad and an RS-232 alphanumeric LCD display. The system functions would include the arming and disarming of the security portion of the system (the door and window switches) with a 4-digit code number entry, and the LCD display annunciating the warning detected by the system. For example, if the fire detector sounds, the system rapidly flashes the light and indicates "FIRE!" in the LCD display. The heart of the system would be a PIC16F84 microcontroller communicating serially with the LCD display and scanning the keypad as a 4x4 matrix. All other I/O would be individual bits.

The proposal also included a timeline which scheduled status reports, preliminary formal report, preliminary design, assembly code development, hardware detailed design, parts procurement, final testing and debugging, recording of the video presentation, and project completion (It should be noted that a majority of the milestones are fixed as due-dates in the course syllabus; however, the student is required to include them in his/her timeline.) Approval of the project was then emailed to the student.

For this particular student, the remainder of the course tracked the student's timeline. Status reports and the preliminary formal report were mailed to the instructor on time, and were deemed to be satisfactory with minor corrections being sent back to the student via email. At the end of the semester, the student submitted the formal report and videotape via parcel service. The report was 83 pages in length, and included the text of the report followed by appendices, which included flow diagrams, assembly source code, electrical diagrams, and IC data sheets. The video presentation began with an introduction, description of the project, and views and descriptions of the hardware, and concluded with a demonstration of the system operation using a mockup of windows and doors, and toggle switches for the fire alarm and telephone inputs. In the video, the student armed and disarmed the system using the keypad, and close-up views of the LCD display showed that it was functioning as designed. Because a portion of the system did not function correctly, and due to some technical errors in the formal report, the student was awarded a grade of A- for the course.

V. Results

When final grades are compared, the results to-date indicate that, even though the distance learning students do not have face-to-face access to the instructor and ready access to the campus lab equipment, the off-campus students perform better (on average) than the their on-campus counterparts in the senior project course. In the fall 2004 semester, the on-campus student mean score was 82.8 with a standard deviation of 15.0. For the off-campus students, the mean score was 93.6 with a standard deviation of 2.4.

Although the reasons for this difference in performance are difficult to determine, the available demographics of the off-campus students point to several possible reasons:

1. The off-campus students are older, which would imply that they are also more mature.

2. Most work in a technical job, which implies that, in addition to having more experience in working with electronic circuits and instrumentation, they also have ready access to the necessary instrumentation.
3. Most are seeking a baccalaureate degree for the purpose of advancement at the workplace, which adds a motivation factor.
4. The off-campus students are either exposed to technical writing on the job on a daily basis, or they perform technical writing as part of their job requirements. Since the grading of the course is heavily dependent on the quality of the formal report, the off-campus students would naturally excel.

In the last ABET accreditation visit, feedback from the visiting team regarding the senior project course was positive. However, since that visit was nearly six years ago, many changes have been made in the course format and requirements in an effort to give neither the on-campus nor off-campus students any advantage in the course. Therefore, ABET feedback on the course in its current configuration is not available. The next ABET accreditation visit is scheduled for fall 2005.

VI. Summary and Conclusion

A senior capstone project design course can be successfully implemented in a distance learning environment. However, if the course is offered in both on-campus and distance learning formats, care must be taken to insure equity in course requirements for both the on-campus and distance students. Additionally, although it is recognized that many distance learning students have some project management experience, all students must be required to submit reports showing project progress in order to stress the need to keep the project on schedule. Finally, the student is required to bring the project to completion by describing the details of the project and demonstrating its operation in a video presentation.

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