A Directed Project using Underclassmen

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Abstract
Directed projects can be a great learning experience. Although often reserved for graduate students, and occasionally upperclassmen, they can also sometimes be very successful with younger students. Moreover, many schools do not have graduate students to help with teaching, research, grading, and other pedagogical activities. They do, however, have undergraduate students. As a satellite of the main campus, this is our situation. A directed project for such students can be a win-win situation if managed carefully, providing a fulfilling educational experience for the student(s), while at the same time giving the faculty member leverage to accomplish more than would be possible alone.

This paper describes a project that used two volunteer students, both underclassmen, to do much of the work updating a pair of lab manuals at one of Purdue University's satellite campuses. A change in the department's simulation software necessitated the update of two freshman lab manuals, which totaled over 200 pages and contained dozens of figures. These figures had been done using the previous schematic capture tool and were not editable with the new software. The paper briefly describes the project, and then explains the experiences of the team, including the challenges of doing this type of project with such young students, and the lessons both they and the professor learned.

Introduction
During the 2008-2009 academic year our department decided not to renew the license for one of the software tools we used to do schematic capture and circuit simulation. Since the schematic capture function was used to create dozens of figures for the lab handouts in two of the first-year courses, the professor needed to generate dozens of new figures for them.

One of the freshman students told the professor he might be interested in doing some extra work outside of class, and recruited a second student to help. The willing students seemed like a perfect match for this kind of course development work, so the professor requested a directed project be added to the schedule for the first summer term. Using a directed project formalized the effort, and had two purposes: It provided a mechanism of accountability for the students and gave them credit on their transcripts. At Purdue these projects are typically worth a single credit, so three of them can fulfill the free elective in the Electrical and Computer Engineering Technology plan of study.

The lab manuals were written in MS Word[1], and it was desirable to be able to edit the schematics from within MS Word[1] where practical. Thus, for labs that did not require student simulations, the new schematics were drawn in MS Visio[2] so they would be easily editable from within MS Word[1]. Many of the labs in the second semester course, however, did require student

simulations. These new schematics were drawn in Multisim[3] so they would more closely match the schematics constructed by the students (although that meant they would not be editable from within MS Word[1]).

The professor reviewed the two lab manuals and estimated the workload as follows:
- 32 Visio drawings, 32 hours;
- 24 Multisim simulations, 24 hours;
- One Multisim tutorial to help students learn the program basics, 4 hours.

He then drafted a project proposal (see Atch 1), got the students' feedback, and they signed it to formally begin the project, which was set up as a one-credit course for each student. The grading standard was set up in a manner that allowed less than an "A" grade if not fully completed.

The remainder of this paper provides a brief overview of the project plan, then describes the problems encountered and lessons learned, followed by a few concluding remarks.

Project Plan

The first student performed the role of project lead, responsible for setting up the schedule, managing the work, and meeting deadlines. The summer term was only six weeks long, so he set up an initial schedule that divided each week into two parts (Monday - Thursday and Friday - Sunday), and assigned semi-weekly tasks for each student to accomplish (see Figure 1). The deliverables included an electronic file for each figure and for the tutorial (see Atch for details), plus an end of course report. The professor communicated with the students primarily via email, while the students regularly used both email and phone to communicate with each other.

	Sean's Tasks		Nate's Tasks	
Week Starting Date (Monday)	Weekly Block 1 (Mon-Thurs)	Weekly Block 2 (Fri-Sun)	Weekly Block 1 (Mon-Thurs)	Weekly Block 2 (Fri-Sun)
May 18 2009	Create and Submit a Schedual	Create Multi-sim circuit simulations 107 Lab Book ((Procedure 12-2, Figures 12-7, 12-8), (Procedure 14-2, Figure 14-3)	Create and Submit a Schedual	Create Multi-sim circuit simulations 107 Lab Book (Procedure 12-1, Figures 12-2, 12-3, 12-4)
May 25 2009	Create Multi-sim circuit simulations 157 Lab Book ((Procedure 3-1, Figures 3-1, 3-2), (Procedure 3-2, Figures 3-3, 3-4), (Procedure 3-3, Figures 3-5, 3-6))	Create Multi-sim circuit simulations 157 Lab Book (Procedure 5-2, Figures 5-9, 5-10)	Create Visio versions from 107 Lab Book (11-7, 11-8, 11-9, 12-1, 12-2, 12-3)	Create Multi-sim circuit simulations 157 Lab Book (Procedure 1-2, Figures 1-1 & 1-2 (1 sim for both is OK) Procedure 2-2, Figure 2-1 Procedure 2-3, Figure 2-3)
June 1 2009	Create Visio versions from 107 Lab Book (1-1, 1-2, 2-1, 2-2, 2-4, 2-6, 2-8)	Create Multi-sim circuit simulations 157 Lab Book (Procedure 7-1, Figures 7-1, 7-2, 7-3, 7-4)	Create Visio versions from 107 Lab Book (4-3, 4-4, 4-5, 5-1, 6-5, 6-6, 7-1)	Create Multi-sim circuit simulations 157 Lab Book ((Procedure 4-1, Figure 4-2), (Procedure 4-2, Figure 4-3), (Procedure 4-3, Figures 4-4, 4-5))
June 8 2009	Create Visio versions from 107 Lab Book (7-2 (fix D), 7-3 (fix D), 7-4, 7-5, 10-2, 11-6)	Create Multi-sim circuit simulations 157 Lab Book ((Procedure 8-1, Figure 8-1), (Procedure 8-3 (optional))	Create Multi-sim circuit simulations 157 Lab Book ((Procedure 6-1, Figures 6-1, 6-2), (Procedure 6-2, Figures 6-3, 6-4)	Create Multi-sim circuit simulations 157 Lab Book (Procedure 7-2, Figures 7-5, 7-6)
June 15 2009	Create Visio versions from 107 Lab Book (12-4, 12-5, 12-6 (a), 14-1, 14-2, 14-3)	Create Multi-sim circuit simulations 157 Lab Book (Procedure 10-3)	Create Multi-sim circuit simulations 157 Lab Book ((Procedure 10-1, Figure 10-1), (Procedure 10-2, Figure 10-2)	Create Multi-sim circuit simulations 157 Lab Book ((Procedure 11-2, Figure 11-1), (Procedure 11-3, Figure 11-2)
June 22 2009	write a short illustrated Multi-Sim tutorial and complete any unfinished task	complete any unfinished task	write a short illustrated Multi-Sim tutorial and complete any unfinished task	complete any unfinished task

Figure 1: Project schedule

Problems Encountered

The difficulties that arose during this project were centered around three issues:

- software availability,
- schedule, and
- standardization/attention to detail.

Both students needed three pieces of software to complete the project: MS Word[1], MS Visio[2], and National Instruments' Multisim[3]. The first two were not an issue, but the latter proved to be problematic. The lead student started out using a student edition of Multisim v9, which he got from the CD that came with his textbook[4]. This version of the software proved problematic, primarily because it could not create a file that was compatible with the version we had on campus (v10). The software on campus was available in our labs on weekdays, but not weekends. After some looking online, however, the lead student managed to find a free edition of the latest version of the software, so after downloading it both students were able to continue their work.

The next few issues were all related to scheduling. First, the summer sessions are only six weeks long, so there was not much time to accomplish the project. Second, an out-of-town vacation for one of the students was not accounted for in the schedule, which caused some schedule slips. Finally, no time was allocated in the schedule for reviewing and reworking any of the deliverables. The professor initially gave both students an incomplete, and ultimately ended up doing a fair amount of rework on some of the drawings.

The last set of problems had to do with standardization and attention to detail. There were a number of figures that depicted the student prototyping board (proto-board) in some manner. Not only did each student do the rendering differently, at least one of them did multiple renderings, resulting in several different versions of the same proto-board (and accompanying terminal wiring) in several different figures! Some were pretty good, some were not so good, but there was significant duplication of effort. This problem also occurred with a couple of op amp circuits, but it was much less significant. The professor ended up spending a substantial amount of time "cleaning up" the proto-board drawings.

There were two other relatively minor problems. First, the students each used a different naming convention for their submissions, which made it more difficult for the professor to keep track of their progress and to find specific figures. Second, their first submission was missing a few of the scheduled deliverables.

Interestingly, the problems were all pretty "normal" problems that might be encountered with upperclassmen, graduate students, or even faculty. The professor expected to find some issues that could be attributed to the youth of his students. Although their age probably contributed to the problems noted above, they could occur with older, more experienced persons as well.

Lessons Learned

Following completion of the project, the professor met with each student helper to review the project and discuss lessons learned. Everyone learned several lessons from doing this project. First, better planning at the beginning would have helped substantially. Time should have been

allotted in the schedule to allow for review and rework of the deliverables. It also would have been good to make the initial schedule part of the proposal, instead of being the first project deliverable, and link it to the grading standard.

Second, once the initial plan was set, the whole group should have reviewed the project together in detail. In particular, a template could have been developed for the proto-board renderings that would have saved everyone time and resulted in a higher-quality finished product. Moreover, a predetermined file-naming convention would have made it easier to track progress.

Third, although the above steps would have reduced problems, it still would have made sense to do more frequent and thorough quality checking during the course of the project. A couple of face-to-face meetings probably would have been wise to clarify expectations.

Finally, both students gained a keener appreciation for the amount of work that can be required to do certain types of course development.

Conclusion
The goal of this project was to create several dozen figures to update the lab workbooks for a pair of first-year electronics courses, and generate a tutorial for using the new circuit simulation software. Although it could have been better in some ways, as described above, the project was successful. The group achieved their goal, learned several valuable lessons, and saved the professor several hours of work in the process.

It is worth noting that this effort was a well-bounded directed project, not an ambiguous task requiring in-depth research and analysis work. Nevertheless, for such projects underclass students can be a valuable resource.

Attachment
Project proposal

References
1. Microsoft Office Online Word 2007 home page. Retrieved January 8, 2010, from http://office.microsoft.com/en-us/word/default.aspx.
2. Microsoft Office Online Visio 2007 home page. Retrieved January 8, 2010, from http://office.microsoft.com/en-us/visio/default.aspx.
3. National Instruments Multisim home page. Retrieved January 8, 2010, from http://www.ni.com/multisim/.
4. Herrick, R. J. (2003). *DC/AC Circuits and Electronics: Principles & Applications*. Clifton Park, NY: Delmar Learning.

Biographical Information

GENE L. HARDING is an associate professor of Electrical and Computer Engineering Technology at Purdue University, where he is finishing his eighth year. He has three years of industrial experience with Agilent Technologies and over 24 years of combined active and reserve service in the United States Air Force.

SEAN HAGAN was the student leader of this project. He is a sophomore studying Electrical Engineering Technology at Purdue University's South Bend campus.

NATHANIAL STROZIER was the other student worker supporting this project. He is a junior studying Electrical Engineering Technology at Purdue University's South Bend campus.

<u>ECET299 Independent Study Project Proposal</u>

Project Title: ECET107 and 157 Lab Workbook Updates.

Students: Sean Hagan (team lead), Nathanial Strozier.

Purpose: Generate updated figures and simulations for the ECET107 and ECET157 lab workbooks and grading keys, and create a Multi-sim tutorial. Learn the simulation aspects of Multi-sim and become proficient in the use of the program Visio. Develop better, more professional writing skills. Gain valuable knowledge and experience in project management, teamwork, and teaching preparation.

General Steps:
1. Lay out a weekly schedule for completion and delivery of the items listed in steps 2-5.
2. Create Visio versions of the following figures for the ECET107 lab workbook:

1-1	4-3	7-2 (fix diode)	11-8	12-6 (a)
1-2	4-4	7-3 (fix diode)	11-9	14-1
2-1	4-5	7-4	12-1	14-2
2-2	5-1	7-5	12-2	14-3
2-4	6-5	10-2	12-3	
2-6	6-6	11-6	12-4	
2-8	7-1	11-7	12-5	

3. Create Multi-sim circuit simulations of the following procedures and figures for the ECET107 lab workbook:
   Procedure 12-1, Figures 12-2, 12-3, 12-4   Procedure 14-2, Figure 14-3
   Procedure 12-2, Figures 12-7, 12-8
4. Write a short illustrated Multi-sim tutorial to help new students learn Multi-sim.
5. Create Multi-sim circuit simulations of the following procedures and figures for the ECET157 lab workbook:
   Procedure 1-2, Figures 1-1 & 1-2   Procedure 10-1, Figure 10-1
   (1 sim for both is OK)   Procedure 10-2, Figure 10-2
   Procedure 2-2, Figure 2-1   Procedure 10-3
   Procedure 2-3, Figure 2-3   Procedure 11-2, Figure 11-1
   Procedure 3-1, Figures 3-1, 3-2   Procedure 11-3, Figure 11-2
   Procedure 3-2, Figures 3-3, 3-4
   Procedure 3-3, Figures 3-5, 3-6
   Procedure 4-1, Figure 4-2
   Procedure 4-2, Figure 4-3
   Procedure 4-3, Figures 4-4, 4-5
   Procedure 5-2, Figures 5-9, 5-10
   Procedure 6-1, Figures 6-1, 6-2
   Procedure 6-2, Figures 6-3, 6-4
   Procedure 7-1, Figures 7-1, 7-2, 7-3, 7-4
   Procedure 7-2, Figures 7-5, 7-6
   Procedure 8-1, Figure 8-1
   Procedure 8-3 (optional)

Instructor signature: _____   Date: _____

Deliverables: Paragraphs 1-5 below correspond to paragraphs 1-5 above in the General Steps section.
1. Schedule for project completion. Any reasonable format is OK, as agreed between students and professor.
2. An electronic file in Visio 2007 format for each figure.
3. A set of electronic files in Multi-sim 10 format for each simulation, and an electronic file in Word 2007 format containing all of the figures for each procedure.
4. An electronic file in Word 2007 format.
5. A set of electronic files in Multi-sim 10 format for each simulation, and an electronic file for each procedure in Word 2007 format containing all of the figures for that procedure.
6. End of course report. The report will detail the results of the project, any deviations from the original criteria, and lessons learned. The final report is a <u>requirement</u> to receive a passing grade.

Grading Standard: This section describes the standard to be used for assigning a grade.
   A: All steps completed.
   B: Steps 1-3 completed.
   C: Steps 1 and 2 completed.
   D: Step 1 completed.
   F: Step 1 not completed.

Each student hereby certifies that he will not share the electronic simulation files created in this project with other students.

Student signature: _____   Date: _____

Student signature: _____   Date: _____

Instructor signature: _____   Date: _____

NOTE: The project proposal and end-of-course report will become a permanent part of each student's file with Purdue.