New Directions For A Junior-level Projects Course

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Abstract

A paper at FIE'95 described a new projects course for Juniors. Students worked in teams of 3-4 to complete a project in one semester. The second offering of the course has added significant changes. An arbitrary grouping into teams based on a short questionnaire has replaced self-selection. This has reduced personality problems. Rather than each team doing the entire project, each team chooses a sub-project. The entire class, (7 teams), together produced a single implementation of the final project. While reducing the per-student load and cost, this led to far more realistic, industry-like coordination problems between groups. The course focus has further shifted to teaching project management and coordination.

Students spent the last half of the semester also planning individual projects to be carried out over the following two semesters. The first group planning experience helps in the planning process for the individual projects.

Introduction

The EET department has recently established a sequence of five design-related courses. The freshman course deals with fabrication of electronic enclosures and circuit boards. A sophomore course deals with the process of going from an engineer's sketch through the finished printed circuit board layout, including the testing and manufacturing processes. A junior course, described in a paper at the last FIE conference, teaches students to work in teams and to manage planning, scheduling, and system integration for a project. A senior two-semester course sequence uses the steps of the previous courses for an individual project.

Group assignments

In this junior-level course students work in teams, firstly, because they can undertake a larger project if several students work together. One semester is too short to carry out an electronic project with not only planning, but also building and debugging. Combining students permits a non-trivial project.

Secondly, most projects carried out in industry use teams. Students should experience this "cooperative" setting at least once before graduation. While EET students have worked in groups for various English and Communication projects, they have seldom worked in more than twos in EET courses and then only for short durations. Efforts to have students work in teams throughout the semester have been rare. The goal is to have them work with others over an extended period of time on a single project.[1, 2, 3, 4]

As was mentioned, the first course offering allowed groups to form by their own choice. There were significant problems. One group, formed of very conscientious older students, who worked independently and had very little patience with each other's ideas. If one approach was not going well, they started several other approaches before the first one had a fair test. Reaching consensus was very difficult. The second problem group formed with a lone (volunteer) leader and three students who did not particularly want to work. While it is not uncommon for a group to have one shirker, it was difficult to have one student and three shirkers! The other three groups included a group of hard working, strong students and two groups of somewhat weaker students. If they had difficulties, it was not apparent. One group listed as a strength the fact that they never had any arguments.

So the second offering used assigned groupings. It would have been nice to have access to one of the personality tests. Students filled out a brief questionnaire where they listed what they considered their strong subject areas and whether they considered themselves leaders or followers. From those responses the instructor made up arbitrary groupings attempting to have someone with microcontroller experience, someone with analog electronics, and a mix of "leaders" and "followers.".

After the first semester, it was surprising to see how well the groups seemed to work. Other than a bit of grumbling about one or two non-participants, they seemed to function well and be reasonably balanced. That problem seems solved.

Work load and cost

This class is not intended to teach new concepts in electronics, but the first offering went into a lot of specific material relative to the project of that semester—opto emitter-detector pairs, switching regulators, and motor drivers. At that point teach team of four was building a complete project and the material was relevant to their immediate needs.

For the second offering, each team did a different part of the total project, so there was not the commonality of needs. The lab exercises were cut back significantly to allow each team to work more on their own. By having only one part to do among three or four students, reduced the work load and presumably each student's share of the cost.

The decision to do only one project for the whole class was made part way into the semester, so each team had been exploring the overall design for some time. The entire class carried out the block partitioning. The most amazing thing was that, when the time came to assign teams to blocks, there was no problem. All the blocks (judged to be approximately the same in complexity by the instructor) were listed and the teams were left alone to first discuss their preferences within teams and then hammer out the team assignments as a class. Apparently there were no fights for particular blocks; rather teams decided which blocks they wanted to avoid and bid on the ones that remained. From that point on each team went in a different direction from the others.

Coordination

Team selected their leader and set policies. They had to determine how they would divide the team's points at the end of the semester, but they also had to appoint a representative to the overall project committee. There was also a "project leader" appointed to oversee the entire class' effort. The committee met about weekly to discuss coordination issues relative to schedule and hardware interconnections. There were a few points assigned to the members for the extra time they had to contribute.

System integration

The first course offering there was trouble toward the end with class room attendance. The project integration and testing seemed to take precedence. With the second offering the problem repeated. Even though each team was responsible for only one block of the project, the overall schedule approved by the class only allowed two weeks for integration (something the instructor warned against but allowed). Sure enough, the last few days entailed many late nights and struggles to get the allegedly working parts working together.

The schedule will be revised in the future to force block development to end about mid-semester. Students just cannot appreciate the effort required to integrate pieces developed by different groups, even with the best planning. They need the time, even if they do not appreciate the fact.

A second start (senior project planning)

One of the surprising comments from the first group of students was the comment that they obtained no particular advantage in the final design course over the students who did not take the course. They had to carry out the same planning steps on the same schedule as the "regular" students. Apart from the grief of all the electronic design for the team project, what was the gain?

As a result of those comments, the second offering was restructured to replace the guest speakers and later lectures with team work planning the individual projects for the following two semesters. The first eight weeks were largely spent on the planning and design stages of the team project, but the last eight weeks when the implementation and integration needed to be happening in the lab were an ideal time to restart (and reinforce) the planning process in the classroom. The process they were led through with the team project could now be repeated for individual projects. As a result, they went through the process of developing overall goals, alternative approaches, block diagrams, overall specifications, block I/O specifications, and a formal written proposal. They had to bring the proposal to two additional faculty members for approval, so the document became more than just a writing exercise.

In addition to making better use of the later class time, the planning makes a significant improvement in the following semesters. Instead of planning for the first eight weeks and then hurriedly getting parts and building blocks in the last eight weeks, students arrive with the plan completely approved, ready to start building. The Summer or Christmas break can have absorbed the time delay in obtaining parts, so they can have the full semester to build and test the pieces. Rather than ending with some disparate blocks working that may or may not work together, they will be expected to have the entire breadboard working as a unit—much easier to evaluate than a set of blocks. It also avoids another problem faced by instructors—if they fail, it is a semester ahead of graduation and there is time to adjust to the delay rather than having it come at the last

moment. Also, failure to work is a much more intuitive basis for failure than a series of somewhat artificial block checkoffs.

Results and Conclusions

The overall project was nearly a total failure! It was to have been a remotely aimable, directional microphone that would locate a human speaker. The RF link was to transfer direction commands to the microphone and the audio back to the control center. They could only show the control center sending direction commands over a wire to the aiming system.

That is not to say that the class failed. Students have developed a remarkable appreciation for the importance and difficulty of system integration. It was obvious that about 30 students cannot all be in there fixing bugs at the same time. There was not room to get close to the hardware at the end!

In future semesters the system integration phase will be forced to begin sooner. The projects will be done one-to-a-lab rather than for the entire class. This will hold the numbers at about 15 per project rather than the 30 or even more if it is done as an entire class as the course becomes required. That will allow only three or four teams per project and should simplify the inter-team coordination problems that arose with teams in different lab times. The conclusion is that 30 are too many and four are too few—hopefully 15 are just right.

Virtually all the students come out of the class ready to start their individual project next semester. They complained that there was too much to do at the end (probably due to their own procrastination), so the individual project planning process will be started about he 5^{th} week with the final proposal due about the 13^{th} week. That should leave the end of the semester unencumbered for the group project work.

In conclusion, the students gained appreciation for the development process and should do better in the senior design course.

References

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