Innovative Student Projects at the University of Southern Indiana

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Abstract

The current paper describes the author's search for proper lecture and laboratory materials. It details how some classes were restructured and how student construction projects were influenced by a regional competition sponsored by the Institute of Electrical and Electronic Engineers.

Introduction

A slew of problems confront the new teacher - minimal teaching experience being the biggest one, followed closely by a serious lack of teaching material. When the author found himself in this situation, it was soon apparent that there *was* more than a series of lectures, endless laboratory experiments, two weeks off at Christmas, one week of Spring Break, and the entire summer off. The author was about to discover how difficult those lectures and laboratory experiments are to invent and organize, as his sense of reality soon had him attempting to remember old formulas, theories, lab experiments and such, and trying to formulate lectures and laboratory experiments – all while keeping the students interested in the material. There was also a student branch of the Institute of Electrical and Electronic Engineers[1] (IEEE) to manage.

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While searching for useful and interesting laboratory experiments, countless books and magazines were read, the Internet was searched, and discussions on the topic were held with colleagues. During the discussions, a regional student hardware competition of the IEEE was suggested.

The competition involved a small, autonomous, robotic car that would negotiate a course and perform pre-determined tasks[2]. The competition sounded difficult enough to pique

student interest, but simple enough that it would suffice for USI's first attempt at the regional competition under the author's leadership. It was decided to utilize the competition to engage the senior-level *Advanced Electronic Circuits* class to design, prototype, test, construct, and troubleshoot some sensor circuitry for the car, and the IEEE club members would then assemble, test, troubleshoot and enter the car in the competition. Therefore, one stone would kill two birds.

Using the car as a full-scale laboratory project was intentionally avoided in an attempt to prevent the "homework" tedium, and to keep the project fun. Designing and building some components would fulfill *some* laboratory experiments for *Advanced Electronics*, while the IEEE students (mostly sophomores) had some assistance in designing the car from higher-level students. Therefore, no single group had to do it all, and no one's grades depended on the success of the robotic car.

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One of the classes taught at USI in the Spring semester is *Electrical Project Construction (Project* class*)*. The students are allowed to start with a schematic, but the use of pre-packaged kits is not allowed. The students are encouraged to choose a project that they will enjoy owning and using, thereby utilizing desire as a motivational tool. The *Project* class is structured as a first-time co-op work session[3], with the author as the Engineering Manager of the *Southern Indiana Engineering Corporation (SIEC)*, a fictional engineering company that has manufacturing and marketing arms that constantly seek new, innovative, electronic consumer products for development.

The students are to select a project and develop a timeline. They must submit weekly status reports detailing their accomplishments, trouble spots **and** their alignment with their timeline. They then must prototype their project and document it fully - including an owners' manual with a troubleshooting section. Finally, they must deliver a Powerpoint presentation to a "selection committee" for evaluation for mass production.

The skills developed in this class are major milestones toward the student's Senior Design Project (Capstone requirement), giving them the necessary experience, *as sophomores*, to succeed with oral presentations, writing formal documentation, setting and meeting deadlines, prototyping, Powerpoint software, scrounging for parts and data, and dealing with vendors. These skills may then be polished and refined over the two remaining years of the curriculum and will also serve them well if they participate in real coop sessions, or after graduation when they enter the world of work.

Student Project

The President of the student branch of IEEE was one of the students in the *Project* class. He chose to build an autonomous, robotic car *(Diligent Obedient Gadget, or DOG)* similar to the IEEE hardware competition car (IEEE car). He was quite ambitious at the outset, desiring to build a voice-activated robotic car that was far too sophisticated for

the short time that was available, but he quickly downscaled the project when he saw just how much effort and expense were involved.

Parameters were adjusted so that he performed all hardware construction duties (*Project* class requirements) while a junior-level student who was also an IEEE member provided software programming and brainstorming services. The *Project* class student decided to utilize the same microprocessor that the IEEE car used, so that one set of software modules could be used for both cars. This was acceptable because the *Project* class is focused on electronic construction techniques, not on software development.

With the IEEE car kept at school, and the *DOG* at the student's apartment, software could be developed at either location, because a car was always available for testing purposes. Transporting a car then became a matter of choice, rather than need, thereby minimizing travel damage potential.

The junior-level assistant was in a computer software programming class, and while the programming languages were incompatible, his part in this project honed his skills, too. A third student also helped to build the IEEE car, but was developing a guitar amplifier for the *Project* class.

The IEEE car, on which construction was started before the *DOG*, had already depleted our meager supply of contact switches, dc motors, and other components before the *DOG* was ready for construction. This forced the student to scrounge for parts, as some of the necessary parts were rather expensive and he needed to limit his expenditures.

One item he needed was switches, which would be mounted around the *DOG* in 4 locations: left front, right front, front center, and all across the rear of the *DOG*. When an obstacle is contacted, it closes a switch, which inputs a signal to the microprocessor that an obstacle is in the path. The *DOG* would then take evasive action, based upon which switch was closed and the programming. Microswitches were tried first, but were too expensive to be feasible, and required too much contact force to actuate. Switches from an old keyboard were found to be perfectly suited to this application. They required minimal contact force to actuate them, they were robust, and they were free.

The three IEEE students had researched electronic components on the Internet, and had purchased the components to interface the microcontroller and the motors on the IEEE car, and these same components were purchased and installed on the *DOG*. All of the electronic circuitry was designed for the *DOG*, constructed and tested on the IEEE car and duplicated on the *DOG*.

Since the IEEE car used the same software as the *DOG*, hardware construction became the issue for the IEEE car. As a group, it was decided that the IEEE car would be constructed using the *KISS* philosophy. The *KISS* philosophy (Keep It Simple, Stupid) led us to prioritize the prescribed tasks, and implementing first those of highest

importance. It is well that this approach was used, because construction was completed and the car was working properly only 4 days before the competition.

The Region 3 Convention - Nashville TN

Upon arrival at the IEEE convention, the USI team immediately took the car to be inspected. As Murphy could have predicted, it failed. A rule stating that a bumper must go around the entire car had been overlooked. The team got directions to a home improvement store and went shopping. The manner in which the team brainstormed as various materials were examined and evaluated was truly impressive. When they had made their selections, they started to work. They worked, unsuccessfully, for some indeterminate amount of time, returning to the inspection point as necessary. Failing, and noting that the stores would be closing soon, they admitted temporary defeat and returned to the home improvement store for another brainstorming session. They returned to their rooms and proceeded to complete the car. It took until 2:00 am, and several inspections, to finally get the car to pass inspection.

In the first round of the contest, it was found that the surface treatment on the ball bearings utilized in the competition caused a problem in the dispensing mechanism and the team was forced to remodel the car before round 2. After the mechanism was modified, the car functioned according to plan for the remainder of competition. Out of the three rounds of competition, they won twice and lost once, to finish 9th out of 19 schools. They were very proud of their first entry in the competition, and deemed it a success.

In review of the competition, some details bear pointing out:

Details of the competition results		
	Competitors	University of Southern Indiana
Team consists of	Mostly seniors	2 sophomores & a junior
Years in competition	Many	First attempt
Cost of entry	Many hundreds to thousand(s)	$400
Type of school	Engineering	Engineering Technology

In examining the results of the competition, it is important to realize that a small group of dedicated students were successful against larger, more experienced schools. Next year, while most other teams will again consist of seniors, who were not directly involved in previous competitions, the USI team will be intact, and will bring in younger students. This provides a continuity that allows student experiences to be passed on. Each student will gain experience from being directly involved in the competitions.

Fall 2000

Following this successful competition, the IEEE group decided to duplicate some ideas that had been seen on other cars, and others gathered from discussions with other teams. The software programmer, now enrolled in the *Advanced Electronic* class, designed and built a Liquid Crystal Display module for the IEEE car, so that the program flow could be monitored. Other students designed and built some sensor circuits, and research was performed in electromagnetics.

The skills learned in constructing the IEEE car and entering the competition, *and* those taught in the *Project* class and the *Advanced Electronic* class, has prepared the students to prioritize their needs, to brainstorm effectively, and to work together to get the job done. Obstacles were defeated by the use of the collective group imagination, by persistence, and by perseverance. These are exactly the skills that will allow students to succeed in their careers, and in life.

Bibliography

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