AC 2009-389: DEVELOPMENT OF A SOLID MODELING COURSE FOR ELECTRICAL AND COMPUTER ENGINEERING TECHNOLOGY (ECET) STUDENTS

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Development of a Solid Modeling Course for Electrical and Computer Engineering Technology (ECET) Students

Abstract

This paper is a collaborative effort between a faculty member of the Electrical and Computer Engineering Technology (ECET) department and a faculty member of the Mechanical Engineering Technology (MET) department at Penn State Erie, The Behrend College.

For years, ECET students at Penn State Behrend were instructed on how to create schematic or wiring diagrams using AutoCAD. The student's conceptualization and visualization skills were minimally exercised throughout the course and therefore students lacked the ability to understand or communicate 3D components or assemblies. Electrical and Computer Engineering Technologists are responsible for working with Mechanical Engineers and Mechanical Engineering Technologists to perform applied design of electronic packaging, electro-mechanical parts and assemblies, as well as operator controls and indicators. Therefore it is of the utmost importance to understand and be able to convey shape, size and assembly descriptions of those parts or assemblies. The ability of increased knowledge of solid modeling has become crucial to the success of ECET students.

The new Solid Modeling course exposes ECET students to creating 3D models, creating 2D drawings of components, and 3D assemblies.

This paper will discuss the development of a solid modeling course for ECET students. It will include the following information: discussion on the need for the course (i.e. driving factors), course objectives, course content, and the student's capstone project in the course and student comments about the course.

Background and Desired Outcomes of the Course

The development of the course started with meetings between the MET and ECET department representatives (i.e. the authors of this paper) discussing the desired outcomes of the course. We had to totally abandon the old paradigm of previous drafting courses. The last two course models included mechanical drafting and using AutoCAD, respectively. Mechanical drafting has been abandoned and the AutoCAD based course served its purpose well; however, lacked the development of the student's visualization and conceptualization skills as well as the graphical communication with ME's and MET's. Also, the courses were strongly based around schematic and wiring diagrams.

Mechanical drafting is outdated and time consuming. For these reasons, it has been abandoned by industry so the switch was made to drafting/solid modeling software based courses. Drafting/solid modeling software based courses are more technologically advanced and more comparable to industry standards[1]. This is similar to having students abandon the slide rule and switch to the calculator or personal computer as the industry standard.

The AutoCAD course taught the ECET students at Penn State Behrend emphasized schematic and wiring diagrams which was thought to be relevant and appropriate to prepare the students for industry. After soliciting feedback from the Industrial Advisory Board, students and personal experience of one of the authors of this paper whom consults a lot in industry; the paradigm of teaching students how to create schematic and wiring diagrams was considered okay, but not fully preparing students for industry. There were two main reasons for this: students are taught how to create schematic and wiring diagrams in many of their core electrical course s using specialized CAD software for schematic capture and printed wiring layout, so there was somewhat of a redundancy occurring and ECET's in industry are required to be able to graphically communicate with ME's and MET's on teams. While the ECET's did an excellent job at creating the diagrams which allowed the manufacturing of the circuits, they could not visualize the mechanical components that the circuit would control. This left a tremendous gap in the ability to communicate with the ME's and MET's that would be responsible for the design and interface of the mechanical components of the assembly. This new course overcomes the issues discussed above.

The following outcomes were developed to overcome the issues discussed above:

1. Students will visualize physical (electrical and mechanical) part (s) 2-D to 3-D and vice versa.
2. Students will incorporate design intent into solid models using extrusions, revolves, shells, ribs, chamfers and rounds.
3. Students will properly execute duplicating operations to create circular and linear patterns of features and mirrored features.
4. Students will use mathematical relations to drive solid models.
5. Students will create a detail drawing of a mechanical part.
6. Students will create 3D assemblies.

Course Development

This course is basically an introduction to solid modeling course with a few advanced topics included. The natural way of the developing a course is to find a textbook that discusses each of these topics. A few textbooks were found but at an exorbitant cost to the student because the few advanced outcomes called for an all encompassing textbook. The Pro/ENGINEER Wildfire 4.0 textbook written by Toogood was selected along with a few added course materials[2].

The course outcomes shown above may seem to be easily attainable; however, a few issues needed to be considered. First, ECET students, as a general characterization, lack visualization skills compared to their ME and MET counterparts. Next, this is a two credit course. Compared to other solid modeling courses taught to the MET students, past and present, the outcomes were thought to be a reach. This was due to the fact that most solid modeling courses taught to the MET's are 3 credits and most of the above outcomes were taught to the MET students over two semesters. Finally, getting students to buy into a graphics course where they would not be taught schematic and wiring diagrams would be challenging. Most ECET students, in the infancy of the course, had the mentality that this was an MET course and that they were in fact ECET's and the course was unneeded by them. The issue of developing student visualization skills remains far more serious than making engineering graphics an interesting experience[3]. These issues were overcome by employing repetitive simple object creation in the beginning of the course, scaling back the level of expertise achieved with the solid modeling program, and by employing a final project for the students to experience how the knowledge of the software could be help them in industry as well as developing team skills.

The course topics, and their definitions, to achieve the desired course outcomes are as follows:

- Introduction – Overview of the software, proper displays, file manipulation
- Creating Simple Objects Part 1 – creating basic extruded protrusions and extruded cuts
- Creating Simple Objects Part 2 - creating basic extruded protrusions and extruded cuts with the additional creation of datums
- Creating Revolved Protrusions, Mirror Copies, Rounds, and Chamfers – self explanatory
- Modeling Utilities – using tools within the program to understand how the models were created and the options for displaying items associated with part files.
- Creating Datum Planes and Sketcher Tools – self explanatory
- Creating Patterns and Copies – self explanatory
- Creating Engineering Drawings – self explanatory
- Assembly Fundamentals – teach how to assemble bottom-up assemblies
- Assembly Operations – creating datums and parts within assembly

The course is basically taught as lecture/demo and lab combination. The students are shown how to execute the commands and are given activities to reinforce knowledge of the commands. There are two exams and a final project given in the place of the final exam.

Student's Capstone Project

In the place of a final exam, the student's are required to complete a capstone project. The project forces the student to employ the teachings of the course and to examine the student's grasp of the course content. Also, the students benefit from working on a team to better prepare them for an industrial setting.

Figure 1
Oscilloscope

Students are permitted to propose their own projects or are assigned projects. Student project teams consisted of 3 to 4 students. Below are examples of student projects from the spring of 2008 semester (course is only offered once per academic year). Only the 3D assembly is shown; however, the students were required to submit models and drawings for each component of the assembly. Students were required to perform team assessments and perform a write-up about Reengineering. Also, students were required to give an oral presentation of their project. Their presentation needed to include how the components were constructed as well as the assembly, any difficulties with the creation of the models and/or assembly, and answer questions from the audience (instructor and fellow students).

Figure 1 shows the project of an oscilloscope. Figure 2 shows the project of a DC Machine.

As shown, the projects tested the students on their knowledge of how to create the components. Students were permitted lab time work on the projects. Students were given basic instruction on the use of various measuring devices to aid them in the creation of the components and assembly.

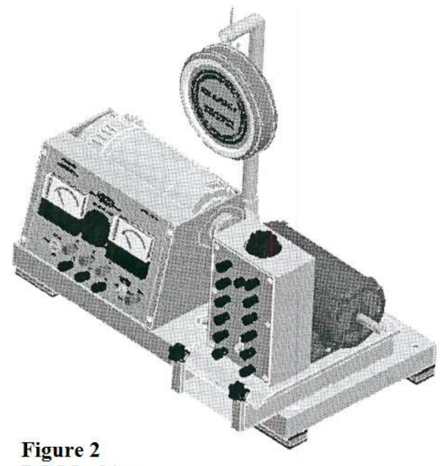

Figure 2
DC Machine

Student Comments

The general, reoccurring comment from students about the course was that they surprised themselves with their ability to complete the projects. They use many of the devices that their projects consisted of and now have a better appreciation for the engineering that goes into the creation of the devices. Another reoccurring comment was the importance of working on teams to accomplish the project. Time management was critical to their success. No teams stated that the projects were too time consuming or overbearing. They felt with the extra lab time given towards the end of the semester (approximately 8 hours) that there was an adequate amount of time to complete the projects.

Conclusions

ECET graduates will be working on multidisciplinary teams and they often will have some mechanical as well as electrical responsibilities and this course addresses those concerns. They also need to be a team member and be able to communicate their ideas as well as understand other engineer's ideas. Some of the other direct and side benefits of the course include the following:

- Students will be able to quickly develop customer proposals for new projects.
- Students will be able to better convey their ideas.
- Students will be able to use 3D CAD to design user interfaces, displays, indicators, control knobs, etc…
- Students will be able to use 3D CAD to interface between machine and electronics, such as actuators and sensors.
- Students will be able to use 3D CAD to design and lay-out electronics packaging.
- Students will be able to properly size and position of electronic components in 3D.
- Students will be able to properly place component terminals.
- Students will understand fasteners for electronic components and assemblies.
- Students will understand size limits for replacement parts.
- Students will be able to prepare better looking reports or presentations.
- Students will be able to provide accurate manufacturing instructions diagrams.
- Students will be able to produce professional looking installation and user instructions.

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