Digital Video Presentation of Student Projects in Engineering Technology Courses

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Abstract

Group projects and project-based learning are essential parts of teaching and learning in many Engineering Technology courses. In Dynamics students learn kinematics and kinetics of particles and rigid bodies. The egg drop contest designed for this course gives students an opportunity to apply their theoretical knowledge to an actual situation. In Fluid Power the working principle of a pneumatic actuator is demonstrated using an air motor. The specialty of this project is that the air motor is designed and built by our students using rapid prototyping and CNC machining techniques. The author has developed digital videos that illustrate different aspects of the egg drop contest and the air motor.

I. Introduction

The author teaches Engineering Technology (ET) courses such as Statics, Dynamics, Strength of Materials, Fluid Power,

Thermodynamics, Computer-Assisted Drafting/Design (CADD). Some of these courses have a hands-on lab component. However, all these courses need additional instructional tools to help students better understand the engineering concepts and principles. Master classrooms have been very helpful in teaching our classes. Teaching lecture courses including Statics and Dynamics in a conventional classroom with blackboard and chalk is a tedious process. It takes a lot of time and effort to draw figures and list given information on the blackboard while lecturing or solving problems. The author spends a considerable amount of time in the class to solve problems interactively. In the last two years, we have been fortunate to get several new master classrooms with a computer and the Internet access at each student station.[1] The versatile overhead projector *Elmo* at the master workstation has not only replaced the conventional unit but also allows projection of opaque and three-dimensional objects on the screen. The need for writing problem statement and drawing figures and diagrams on the blackboard has been completely eliminated with the use of this projector. The VCR and stereo receiver are also useful in showing instructional videotapes. Ability to switch between the master workstation computer, Elmo or VCR instantly is very useful while teaching topics that require multimedia presentation.

Web-based and web-enhanced instruction has become a very powerful tool and many instructors and students have embraced it. The author attended a workshop on Blackboard organized by the Tennessee Board of Regents[2] in 1999 and has been using web-enhanced instruction in his courses.[3] In 2000, Middle Tennessee State University (MTSU) obtained a license from Blackboard.com and developed a site called CourseInfo and later switched over to WebCT for various administrative and academic reasons. The author attended the CourseInfo and WebCT workshops[4,5] organized by the Information Technology Division (ITD) at MTSU and developed sites for his courses. It is his experience that

WebCT is a more powerful tool than CourseInfo and has many efficient file transfer, grade posting, and communication features.

The tools discussed above contribute to better teaching and learning in all Engineering Technology courses. However, there are certain course specific issues which require additional instructional tools. Group projects and project-based learning are two such tools which can be used in some lecture courses. In ET 3840 – Dynamics, students learn kinematics (time-space relationship) and kinetics (time-space-force relationship) of particles and rigid bodies. In the egg drop contest that is designed for this course students are given an opportunity to apply their theoretical knowledge to an actual situation. In ET 4850 – Fluid Power, the working principle of a pneumatic actuator is demonstrated using an air motor. Although the egg drop contest rules and guidelines are posted on the WebCT site students will have several questions related to the structure, contest procedure, results and report. Similarly, they will have several questions about the working principle and different parts of the pneumatic motor. Some parts are very small and cannot be seen unless they get extremely close to the motor. The author has developed digital videos that illustrate different aspects of the egg drop contest and the air motor. Currently, they are used in the above mentioned classes as part of instruction. At the poster session we will be showing these videos.

II. Egg Drop Contest

Egg drop contest is conducted as part of Dynamics in an effort to make learning fun (Figures 1, 2 and 3). Groups of two or three students build structures using balsa wood and glue the parts according to the guidelines. An egg will be placed inside the structure so that it is supported at three points only.

Figure 1. ET 3840 – Dynamics students are preparing for the contest.

Figure 2. Egg drop contestants are ready to drop their structures with egg.

The structure and egg with and without a parachute attached will be dropped from the second floor of a building. The students are required to write a report showing necessary calculations. The contest will be evaluated considering several factors including aesthetics of the structure, dimensions and construction, weight, location of the unit measured from the target after landing, condition of the structure and egg after reaching the ground, and correlation between theoretical and experimental results.

Figure 3. ET 3840 students are about to test their structure.

The author conducts the egg drop contest annually at MTSU for Middle School students as part of the Expanding Your Horizon in Science and Engineering (EYH – Figures 4, 5 and 6), and Building a Bridge to College (Figure 7) activities. The ET 3840 – Dynamics students normally get four weeks to build their structures following the stringent guidelines. But the students who participate in the other two activities will have approximately forty five minutes to build their structure with the egg and test it. But the competition rules in their case are much simpler not only because of the time constraint but also we want these Middle School students to have fun while they are at MTSU. The author shows a relevant digital video at the beginning of each contest and it has helped students enormously because all most all of them have fared really well. The ET 3840 students will have several

opportunities to watch the contest video as it is posted on the WebCT site and they also receive a grade for the contest.

III. Pneumatic (Air) Motor

The specialty of this project is that the air motor (Figure 8) is designed and built by the ET students as part of their Advanced Machine Tool Technology class. CADD drawing files were directly sent to the rapid prototyping machine and parts were fabricated using ABS plastic. Metal parts were machined on CNC machines after converting the CADD files into CNC codes.

Figure 4. Egg drop contest – EYH 2003

Figure 5. Egg drop contest – EYH 2003

IV. Project Based Learning in Other Engineering Technology Courses

The author has adopted project based teaching/learning techniques in his CADD classes. Students in the ET 2310 – CADD I class designed and drafted objects of geometrical shapes of their interest. The drawing files were sent electronically from the CADD lab to the laser engraving machine (located in our machine shop) where they were converted to the appropriate format to produce the parts out of plastic sheets using a 0.004-inch diameter laser beam. Students assembled these parts to create physical models. They not only enjoyed working on this hands-on project, but also learned the basics of computer-integrated manufacturing and the significance of fits and tolerances related to manufacturing.

Figure 6. Egg drop contest – EYH 2003

Figure 7. Egg drop contest – Building a Bridge to College Activity.

A student who worked as an engineer at a manufacturing company in Nashville was taking CADD II in our department. The company made plastic parts using computer integrating manufacturing techniques. For individual projects, he and a few other students designed parts in our CADD lab using Mechanical Desktop 5.0 and the drawing files were sent electronically to the company. The author and CADD II students visited the company where the engineer/student downloaded the DWG files, translated them to DSN files using Surfcam 2000. The DSN files were then converted to CNC codes and the parts were manufactured as we were observing. During this demonstration we learned how the x, y and z movements of the cutting tool was controlled by the CNC program.

Figure 8. Pneumatic (air) motor designed and built by Engineering Technology Students.

In 2001, one of our colleagues purchased two rapid prototyping machines through a grant. One of the machines operates like a 3-D printer building parts in layers. Each layer is made of 0.004-inch thick plaster-type material coated with a bonding agent. The other machine has a tool head that has x, y and z movements and builds parts using a very fine molten ABS plastic jet. Both machines accept solid model files (DWG and STL) created using Mechanical Desktop, Inventor, or ProEngineer and convert them to appropriate format for building or machining. A graduate student in the CADD II class built two prototypes for her additional project using the 3-D printer. The student created the solid models using MDT 5.0 in our CADD lab and sent the drawing file to the 3-D printer workstation electronically where it was converted to the

appropriate format and the parts were built. She also submitted a written report describing the procedure in detail. The two prototypes are currently used in CADD I to teach the basics of multiview drawing.

Digital Videos

The author developed two instructional videos on the egg drop contests and one on the air motor. He used a Panasonic Mini DV palmcorder to video tape different aspects of these student projects. The 20x optical zoom feature of the palmcorder helped show the tiny details of the components and assembly depending on the projects. In the egg drop contests video, fabrication of the structure, placing the egg, attaching the parachute, weighing the completed units and dropping them, timing the fall, and measuring the distance from the structure to the target are shown in detail. This helps students understand the contest procedure much better than what they learn from the written guidelines. The high optical zoom is used effectively to show the minute details and parts in the air motor video. The working of the motor at different flow and speed conditions are shown in the demonstration part. The video also features a lecture by Rick Taylor who helped our students in designing, building and assembling different components. Discussion of AutoCAD drawings showing the three primary orthographic views of the air motor and its components is also featured in this video. Currently, these instructional videos are used in ET 3840 – Dynamics, EYH egg drop contest, and ET 4850 – Fluid Power.

Video editing was done using Ulead Video Studio 5.0 SE software which is a powerful although it came free with the purchase of a video card. The AVI or MPEG video clips can be imported to the computer using a *Firewire* data port. The software provides five tracks such as video, title, special effects, voice, and

music. It comes with dozens of transition (special) effects, titles, voice effects, and short music clips. We can add our own music either from a CD or from a file. We can use the available titles or add our own and include display effects such as static, fade in, fade out, starting on the screen and ending off the screen, starting off the screen and ending off the screen, moving from left to right, or moving from top to bottom. Another feature of Video Studio is that we can watch a video clip frame by frame and download any frame as still photo in the BMP or JPEG format. The Make Movie feature allows us to make movies in several formats including AVI, DVD, VCD, MPEG-1, MPEG-2, and Streaming Video. Optionally, we can export the final version of the video clip or movie to the palmcorder and later copy it from the Mini DV tape to a VHS tape.

Conclusions

There is a saying, "A picture is worth a thousand words" and we can rephrase it as "A video clip is worth a thousand pictures". In fact, there are approximately a thousand pictures (frames) in a forty five seconds video clip. The feedback that we have obtained from the students is that egg drop contest and air motor videos are very helpful in understanding even difficult concepts. The author intends to adopt project based teaching/learning techniques in other Engineering Technology courses and develop appropriate instructional videos.

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