Development of a Multimedia Laboratory Supplement for an Introduction to Materials Course: A Computer Graphics Technology Senior Design Project

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Abstract

The Introduction to Materials course at Indiana University-Purdue University, Indianapolis (IUPUI), is notorious for its laboratory experiments and report procedures. The course is in the Mechanical Engineering Technology department of the Purdue School of Engineering and Technology and identified as MET 141. This is one of the very first courses that entering freshman take, usually in the first semester, and one with generally large enrollments for a laboratory-based course. Much of the effort spent on this course is in the way of repeatedly explaining experimental procedures to several small groups, identifying the various equipment and how it is used, and going over the expectations of the laboratory report format and content.

The previous method of conveying this information to the students was by the instructor and a laboratory manual with procedural instructions. The difficulty with this delivery method is that the students are not familiar with the equipment so the procedures mean very little to them. This often results in more confusion. In an effort to be more efficient and to present the laboratory information in a way that is more beneficial to the students, the idea of enhancing the lab manual was being considered.

A Computer Graphics Technology (CGT) Instructor and a Senior Design student presented the perfect solution to the problem. Why not create a multimedia laboratory supplement that combines audio, video, text, and more that the students can utilize for the course? The next several months involved considerable amounts of effort to compile all the necessary information, produce the video, add the audio and text, and then organize everything into a suitable format. The result of this effort is a CD-ROM and laboratory manual combination that is currently being tested on a limited basis and will be tested in full scale in the fall of 2002.

MET 141

MET 141 is a freshman level, Introduction to Materials course taken by students within the Mechanical Engineering Technology (MET) and Computer Integrated Manufacturing Technology (CIMT) programs. As with many courses within the MET and CIMT programs,

Introduction to Materials has a laboratory component associated with it. The goal of the laboratory experiments is to supplement and enhance the information presented during the lecture portion of the class. The lecture material covers metals, polymers, composites, and ceramics during the 16-week semester. The nine laboratory experiments cover mainly metals and polymers. Areas detailed by the experiments include: physical properties, metallographic specimen preparation, tensile testing to produce stress-strain curves, hardness and hardenability, heat treat, plastic processing and properties, impact strength, wood compression and tension tests, and adhesive properties. The freshmen entering the course, generally, do not have any prior knowledge in the materials area and the laboratory equipment is unfamiliar as well.

The class is set up for twenty-five students and generally fills two sections in the fall and one section in the spring. On lab days, the students are broken down into smaller laboratory groups to perform the experiments, however, all groups perform the same experiment during the allotted two-hour time period. Without a teaching assistant, the instructor must explain and/or demonstrate the laboratory procedure to several groups prior to each start-up. This takes a considerable amount of time and slows the groups down, but has always been a necessary component. Also, unless the instructor takes the time to predict how long each group should take to do the experiment and schedule the groups to come in on a staggered timetable, several students must wait for the equipment to become free as the groups progress through the experiments. This, no doubt, can become frustrating for everyone involved and it is therefore desirable to minimize any unnecessary delays.

Each experiment is detailed in the lab manual students purchase along with their books. This helps clarify the procedure, but questions and confusion still arise because the students are not familiar with the equipment and there are no diagrams or pictures. Since many of the experiments require high temperatures or possibly have other dangerous aspects, it is important that the students understand completely what they are supposed to do and how they are supposed to do it. This is another source of repetition that could be minimized.

These factors prompted the department to look at new ways of conveying the necessary and important information about the laboratory procedures to the students in a manner that could reduce or eliminate the current obstacles. Upon examining the issues, it seemed that the best way to address all the difficulties would require visual, audio, and textual components. This is where the Computer Graphics Technology faculty and students come into play.

CGT 415/416

The Computer Graphics Technology degree program encompasses many areas from sketching and AutoCAD to digital animation and multimedia production. The students have their choice of three tracks within the degree program, each having a different focus: Manufacturing Graphics Communications, Interactive Multimedia Developer, or Technical Animation and Spatial Graphics.

The programs are constructed so that the freshman year of each track is identical. This allows each student to obtain the necessary background and structural information prior to branching off into his/her chosen track. The next two years give technical detail within the students' track,

allowing them to specialize in their chosen field of coursework. The senior year of the program brings the students back together for their culminating senior projects.

The senior year of any CGT degree track contains, in part, two senior design project courses. CGT 411 is a group senior design project that brings together students from the different tracks in an effort to pool their resources for the development of a common design task. This type of project brings to light the dynamics of groups as well as the individual and group skills necessary to complete the project. The second senior design project is a two-semester, individual effort project where the student can showcase the skills he/she has obtained within his/her area of concentration. Submitted proposals are reviewed by all CGT faculty members, and progress is monitored by a CGT faculty member assigned to the project.

After some preliminary discussions between MET and CGT faculty, both parties agreed that the proposed project was useful, had merit, and could conceivably be completed during the allotted timeframe. At this point, an interested student was assigned to the project and the process began. An interesting characteristic about this project that was different from other CGT projects was the considerable amount of technical information necessary from outside of the computer graphics realm. This meant that the faculty from MET 141 was the client and also a content expert for the project as CGT students are not required to take MET 141 or another materials science related course. This also helped the MET 141 instructor with the procedural revisions since the CGT student, who has no prior experience with materials or the equipment involved, had to understand the equipment and procedure before incorporating it into the supplemental material.

The Project

The proposed project consisted of a revised laboratory manual and a CD-ROM to accompany the lab manual, along with additional information that may be useful for the course. Artistic license was given on the layout of the lab manual and CD-ROM, while the MET instructor verified material content and the CGT instructor monitored the quality of the design.

During the first semester of the project, the proposal was written and reviewed, the timeline was generated with progress milestones identified, the background research was conducted, and all the necessary programs and equipment were secured for usage during the next semester. Interviews were also conducted with the MET 141 instructor to determine the technical scope of the project and how that factored into the proposed timeline. Once this information was documented, reviewed, and accepted, the production work began.

The first step was to video tape the experiments being performed by the instructor. This was done without audio so that the focus was on the experiment, and it simplified video editing. Several sessions were needed to obtain all of the necessary video as well as re-taping any segments that were not acceptable from the first shoot. Focus, detail, camera and instructor placement, lighting, and more were important to capture therefore considerable time was given to this portion of the assignment.

Once the video was compiled, the remaining portions of the project could be worked on

simultaneously. The laboratory manual contents were reviewed by the MET 141 instructor, edited for clarity and content, and then given to the student for placement into the lab manual document and CD-ROM. The layout and design of the CD-ROM soon followed, once the video was complete and the laboratory procedures were available and sound could then be added once the video editing was finished.

Care was taken to eliminate the most confusing areas for the students by having several modes of transmission for the important information. The theory behind the approach was simple: additional understanding can be obtained by engaging more of the senses, and being more thorough in the presentation of the details. The laboratory experiments involve the "hands-on" learning, but the supplemental materials attempt to enhance that learning by adding elements that utilize visual and audio components. One portion of the project resulted in a CD-ROM with video demonstration of each laboratory experiment, accompanying audio to explain the procedure as it is performed, and textual reference to the laboratory procedures alongside the window containing the video.[1] Also, the revised lab manual attempted to address areas of confusion from the original manual's procedural information and was rewritten in a manner more compatible with the level of understanding of the students. .

Results

This paper includes some examples, excerpts, and comparisons between the old lab manual, the new lab manual, and the CD-ROM to help identify the improvements made by the project, and the usefulness of the new format. Please refer to the Appendix for this information.

Conclusion

The project was completed during the summer of 2001 and implemented on a test basis during the fall of 2001. Positive comments resulted and so minor changes and revisions are expected during the spring and summer of 2002 and full-scale implementation is expected for the fall of 2002.

As with many applications, the computer and its multitude of available programs, has helped enhance the way we live, work, and learn. This project is yet another example of how technology can be utilized to benefit the learning environment for the students, upgrade the way information is transmitted to the students, and progress more towards a virtual and paperless approach to laboratory instruction.

Appendix

Example 1 and 2 are sections of the old and new laboratory manuals with the procedures given for preparing a metallurgical specimen for view under a microscope. Figure 1 and 2 are pictures saved from the video files used in the CD-ROM to help explain the same process. Audio and text are used in coordination with the video, but these cannot be shown in this format.

Example 1

Laboratory 2: Specimen Preparation

Objective: To develop some familiarity with the process of metallurgical specimen preparation for microscopic inspection and to study the microstructure of various metals under the metallurgical microscope.

Procedure: Please refer to instructor for the explanation of this process.

Example 2

LAB #2
SAMPLE PREPARATION

OBJECTIVE: To develop some familiarity with the process of metallurgical specimen preparation for microscopic inspection and to study the microstructure of various metals under the metallurgical microscope.

PROCEDURE:
CAUTION: Specimen furnace will be hot. Please use care when placing and removing specimen from the cylinder.

1. **Obtain a resin sample and a metal sample to begin.**
2. **Unscrew lid from specimen cylinder. THIS WILL BE HOT. Place aside.**
3. **On the front of the machine, turn the cylinder lock dial into the locked position.**
4. **Using the handle on the right side of the machine, begin pumping the piston up the cylinder.**
5. **When the piston is close to the surface, stop, and place the metal specimen onto the piston.**
6. **Place the resin specimen on top of the metal specimen.**
7. **Slowly unlock the cylinder lock and allow the pieces to move down into the cylinder.**
8. **Replace the lid, and tighten.**
9. **Again, turn the cylinder lock dial into the locked position.**
10. **Using the handle on the right hand side, begin pumping. This will increase the pressure in the cylinder.**
11. **Continue pumping until the pressure reaches the red dot on the inside scale. (4000 psi on the 1in scale)**
12. **Once the pressure is stabilized (make sure the pressure doesn't fall off), set the timer to the mark on the machine.**

continued

Figure 1

Figure 2

Bibliography

1. MET 141 Materials I, CD-ROM, Gregory Smith, 2001
2. Smith, G., MET 141 Materials I Laboratory Booklet, Tichenor Publishing, 2001
3. Westcott, R., MET 141 Laboratory Manual, Tichenor Publishing, 2001

Biographical Information

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