

Engineering Graphics Tutorial CD and Lecture Presentations

Stephen W. Crown
Assistant Professor, Department of Engineering
University of Texas Pan American
1201 W. University Dr.
Edinburg, Texas 78539-2999
(956)384-5015
E-Mail: swcrown@panam.edu
Web Site: <http://www.engr.panam.edu/~scrown/graphics>

Engineering Graphics Tutorial CD and Lecture Presentations by Stephen W. Crown, Ph.D. was developed in response to the tremendous need of students to receive individual help in Engineering graphics, a freshman-engineering course. The objective of the material is to provide students with quality one on one instruction in the use of AutoCAD and to provide helpful review material for students of engineering graphics. The successful use of the developed material has led to its use as a self-paced online course in engineering graphics. The set of four CDs includes 15 Screen Cam movies which walk the student through the basics of AutoCAD, a 5 to 10 minute screen capture video of the solution to every homework problem assigned in AutoCAD, games and quizzes which emphasize significant course material, and stand-alone lecture presentations used for the online course or student review. The material serves as a stand-alone course, however, its format is such that it can be easily edited to fit an instructor's personal teaching objectives or used in part to supplement existing course material. Since the introduction of the CD in the engineering graphics course the number of students enrolling in the course has increased due to the added flexibility offered to students through an online course. Additionally, students are exiting the course with a better and more thorough knowledge of engineering graphics as reflected by their performance on projects and exams.

Note: The following narrative has been largely adapted from a journal article discussing the instructional materials developed. The paper will be published in the October issue of IMEJ (Interactive Multimedia Electronic Journal of Computer-Enhanced Learning) (<http://imej.wfu.edu>).

Background

Engineering Graphics is an introductory engineering course that teaches the fundamentals of graphical communication and how to use a specific computer aided design drafting (CADD) software package. The course is often the first engineering course that students take and many base their decision about their future as an engineering student on their experience on this course. Area high school students who are making decisions about engineering and their choice of colleges also take the graphics course. A positive experience in this course commits students to the engineering program and motivates them toward completion of their degree.

Several obstacles however stand in the way of providing a positive experience in engineering graphics. Economics dictate high student to teacher ratios even in a laboratory setting. Laboratory assistants do not have the same level of training or motivation as the professor. Students enter each course with varying backgrounds, learning abilities, and learning styles. Some students with limited computer skills require over an hour of individual instruction each week. The instructor is often forced to teach to the average student leaving slower students confused and brighter students bored.

The objective for development of the engineering graphics materials was to provide a positive first experience in engineering, which included giving students hours of individual instruction, while reducing the teaching load of the instructor. In a first attempt to accomplish this objective a video taped tutorial session was developed. The tutorial was a compilation of staged individual tutorial sessions that addressed the most common problems which students encountered while completing the homework. Students who came for individual tutoring were first

required to watch the tutoring video as most of the student's questions were addressed on the tape. The feedback from the experiment was very positive and required only a few hours of staged tutoring. One criticism as to the effectiveness of the video tutoring was the separation of the tutoring and application. Students would go to the

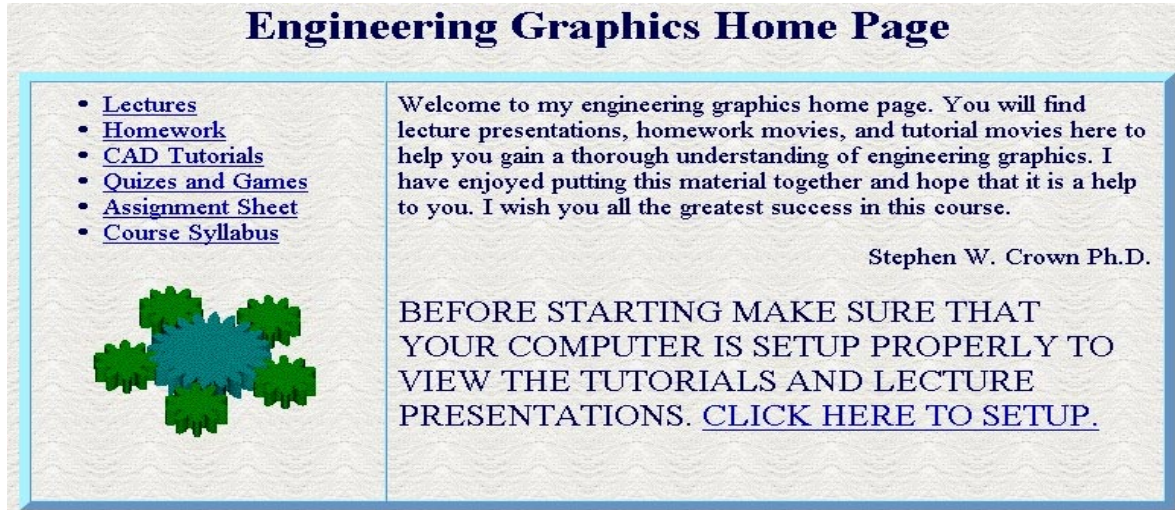


Figure 1: Navigation Page for Instructional Web

library to watch the video and understand the technique presented, but would forget the material when they later tried to apply the information at the computer lab.

To address this student concern a screen capture program was used to record screen activity and audio for the staged tutorial sessions. The reception of these tutorials which could be viewed in the computer lab and run simultaneously with the CADD software was exceptional. Individual tutoring of every student in the lab by the instructor was now possible and did not require additional time or staff. Encouraged by the results, the tutorial movies became the first step in the development of a comprehensive multimedia instructional CD/web page (Figure 1). The project to date includes hours of tutorial movies, lecture presentations of all class lectures for the semester, web based games to reinforce significant course topics, and a series of interactive web based quizzes that prepare students for class exams. The site is made available to students on CD and is maintained on a local server as a public web site, www.engr.panam.edu/~scrown/graphics. Similar multimedia teaching projects have been developed for other courses and disciplines such as engineering (Haugsjaa & Woolf, 1996, Hill et al., 1998, Kirkpatrick et al., 1997, Reed & Afjeh, 1998, Suni & Ross, 1997), mathematics (Antchev et al., 1996), and computer science (Marxhal & Hurley, 1996).

The project has been successful to the point where students rarely seek individual tutoring during lab and almost never need help outside of lab. The CD/web page accommodates the different learning styles and abilities of students in the class by providing a wide range of instructional material (Carver et al., 1996, Ellis, 1996). What was only partially accomplished in the lab with the constant presence of an instructor and lab assistant is now accomplished with a single lab assistant who spends the bulk of his time grading. The most recent stage of development to the project has been the addition of full multimedia lecture presentations. The entire course is now offered as an on-line course with hours of interactive tutorial and review material that gives students a positive first experience in engineering while requiring less faculty time.

Methods and Tools

The information contained on the CD project is accessed through a series of linked HTML pages highlighted with animated GIFS created in AutoCAD and AVI clips obtained with a video capture card. The lecture presentations

are accessed through links to Microsoft PowerPoint presentations (Figure 2). The laboratory tutorial material is presented using Lotus Screen Cam movies. The games and quizzes are HTML files that use simple Java Script code. The entire project requires slightly more than 2GB, the multimedia lecture presentations taking over 80% of the disk space.

Lecture Presentations

The lectures were developed and presented in class using Microsoft PowerPoint. Since the notes were developed in this presentable electronic format they could easily be adapted for use on the tutorial CD. The lectures were video taped during class in the fall semester of 1997. Segments from these videotaped lectures were combined with the original PowerPoint presentation to create the full lecture series used in the on-line section of the engineering graphics course.

The full multimedia lecture series is made available to all students in the course. The lectures are included on the tutorial CD without audio or video clips and only occupy 2MB of disk space. The lecture presentations with full audio and video clips are included on 3 additional CDs as they require over 1.5GB of disk space. Students taking the course on-line solely view the multimedia lecture presentations. Students attending the live lectures may use the multimedia lecture presentations for review. There is more time in class for questions and interaction since all the information needed for the course is in a format that is easily accessible to the students.

Tutorial Movies

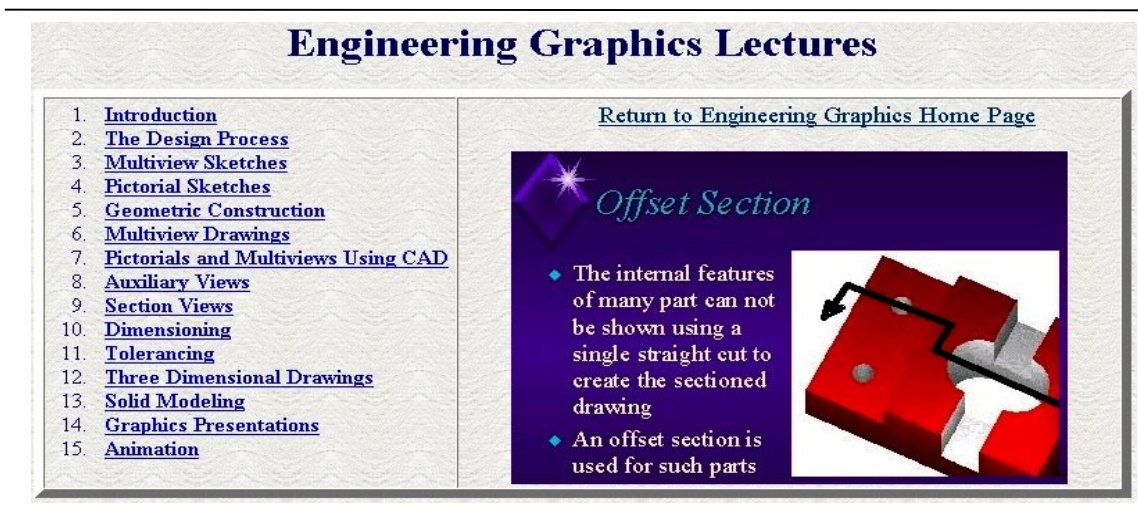


Figure 2: Web Navigation Page for Links to Lecture Presentations

The tutorial movies used in the Engineering Graphics course are created using a video capture program which allows for real time screen capture synchronized with audio. This type of screen capture program allows for the simple creation of tutorial movies. A survey of engineering graphics students using the CD were asked to respond to the question "What material on the tutorial CD is most helpful?" Over half (66%) of the responses indicated that the tutorial movies were most helpful. One student commented, "The homework tutorials are the most helpful. They teach you how to do your homework if you get stuck."


The engineering graphics tutorial movies were created following a simple format. The instructor does each homework assignment using the CAD program while the screen capture program records the session. The accompanying audio is recorded with the video or added later. The finished product is a set of 5 to 20 minute narrated tutorial movies that walk the student through each assignment.


The usefulness of the tutorial movies lies in the fact that they run on the same platform as the CAD program that is being taught. The movie can be paused while the student completes a portion of the assignment and then continued. In this fashion students having difficulty with the homework will follow the tutorial step by step while more advanced students will watch the entire movie and then complete the assignment on their own. The movies are broken into major segments that allow the user to jump forward or back to the start of each segment.


Java Script Games and Quizzes

One of the objectives for the project was to give the students a positive first experience in engineering. Each student has unique interests and learning styles, which were addressed in the project development by including a variety of teaching tools. The games provide an interactive visual approach for developing the students visualization skills. In a study by Shabo et al., (1997) where students were introduced to web-based multimedia courseware on computer graphics, students visited the module on visualization most frequently. The games are effective because they cause the students to think and interact (Dockertman, 1995) while holding their interest and providing immediate feedback; functions that printed worksheets do not support. The interactive instructional games allow the student to both learn and see a concept, such as the manipulation of coordinate systems, in an integrated approach. An integrated approach is the most effective way to teach these concepts to those who can not easily visualize (Mayer & Anderson, 1991, Mayer & Sims, 1994). The quizzes and games give the student immediate feedback as they apply a new concepts learned.

Lecture #4
Review Quiz


[Return to
Home Page](#)


[Return to
Games and Quizzes](#)


[Review
Lecture Notes](#)

1. Which of the following statements about pictorial sketches is not true?

- ☐ Pictorial sketches are particularly useful for non-technical audiences.
- ☐ Pictorial sketches are helpful for visualizing a part.
- ☐ Pictorial sketches represent the way we picture objects in our mind.
- ☐ Pictorial sketches are more difficult to draw than multiview drawings.
- ☐ Pictorial sketches are often used to draw isometric and oblique pictorial.

☐ ☐ 9. The first step of a pictorial is to draw a box representing the perimeter of the

☐ ☐ 10. Lines that are parallel on an object converge at vanishing points on parallel

Figure 3: A portion of a self graded lecture review quiz.

A game and quiz were written to supplement the material covered in each lecture and associated lab. The quizzes use forms with radio buttons to record answers to True/False and multiple choice questions (Figure 3). The answers are stored in an array and compared to the array containing the correct answers when the user selects the grade button. The number of questions missed are displayed using an alert window. The students can then change incorrect answers until they receive a perfect score. The quizzes give instant feedback to the student, are interactive, and are very simple to create. Once the format for the quiz page is set up it only takes a few minutes to adapt questions for another chapter.

The games give students exposure to images and animations that were created in the CAD program that they are learning to use. The games were all developed using JavaScript code to manipulate graphic images based on user input. The simple manipulation of images based on user input allowed for the development of a wide variety of games which each effectively teach some element of engineering graphics. The first and simplest game gives an palette of images that must be placed on a grid in the proper order (as in a puzzle) to reveal a computer generated model of a utility van generated in CAD. On completion of the puzzle a full screen animated GIF is displayed which shows the vehicle in motion and a simulated impact with an automobile. Another game allows the user to manipulate a 3-D object such that it will fit correctly into a hole. Two other games use image maps (Figure 4) to record input from the user while the graphics change according to their response. With the development of 5 different game formats a variety of new teaching games could easily be developed using the same formats. The second most common response to the survey question "What material on the tutorial CD is most helpful?" was that the games and quizzes were helpful. Several of the games have also been used as interactive quizzes to test the students understanding of new concepts. The web-based games used as quizzes are well received by the students.

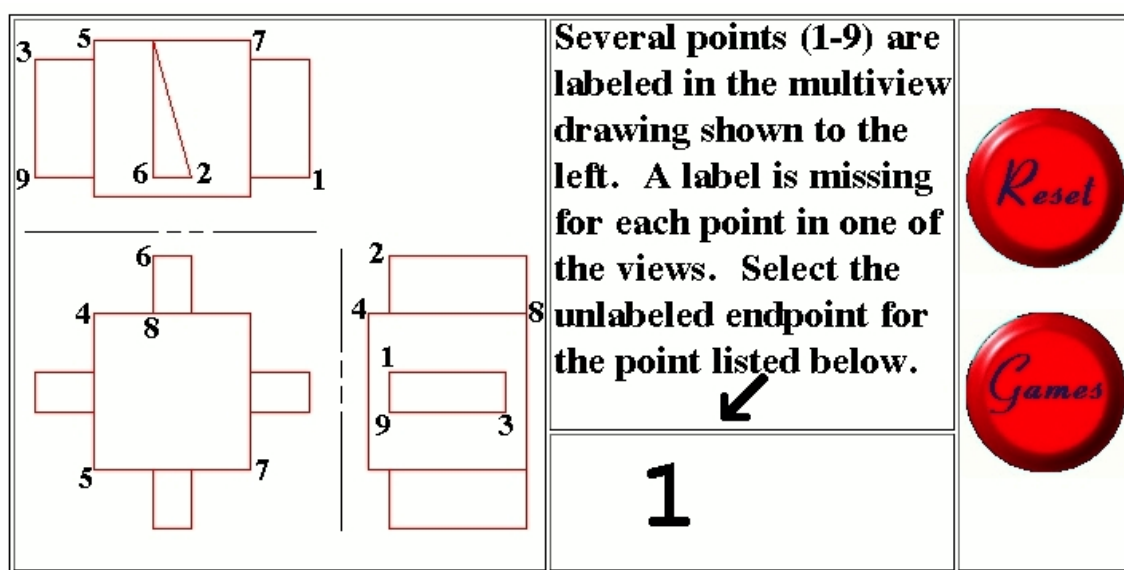


Figure 4: A JavaScript Game That Uses an Image Map to Aid Students With Visualization Techniques

How the Project Has Impacted the Course

The development of the CD has impacted the course in several significant ways. In previous semesters the graphics course was taught by a number of faculty and the lectures were given in the lab to relatively small class sections. With the development of the CD instructional material it is now possible for one faculty member to teach all sections of the course. The lecture material is now presented to a large class and via the multimedia lecture presentations to the online students. An undergraduate teaching assistant helps to monitor the lab sections. By combining lecture sections the total lecture time has been reduced by 80%. The use of the tutorial CD in the lab has in many ways eliminated the need for an instructor in the lab. On the negative side, the laboratory environment has become more impersonal. A semester group design project has helped to reintroduce interpersonal communication in the lab. The instructional material has freed the instructor to focus on encouraging and challenge students rather than on basic instruction since that need has been met.

As the students are provided with full presentations of the lecture notes, more material can be covered during the lecture time. Students don't need to spend as much time copying information of the lecture slides since they are all available to them on the computer. The first semester that full multimedia lecture presentations were

made available, a majority of the class (about 60%) elected to forgo the live lecture for the multimedia lecture presentations. Students are encouraged to use the multimedia lecture presentations and attend class only when they encounter difficulties. This has reduced the combined lecture section to a size where meaningful student / teacher interaction can occur.

Several students are formally registered for an on-line section of the course that completely relies on the multimedia lecture presentations. Students taking the course on-line are also enrolled in a three-hour lab section where there is an opportunity for personal interaction with the instructor or lab assistant. The on-line section is especially helpful for area high school students who take the course for college credit and can not attend class during the day. The results of a current study comparing attitudes, retention, and class performance of students in the on-line section as compared to those attending lecture will impact the future direction of the course. Should the study show positive results student participation in the on-line course will be expanded and the computer lab sections converted to open lab periods.

How the Project Has Impacted the Students

The greatest positive impact that the project has had on students is they now use their time more efficiently. Labs are no longer filled with students with hands raised waiting for an instructor to respond. Instead, students work quietly and independently on their homework using the tutorial movies to answer their questions. Bright students use the tutorials as a backup when they encounter a difficult problem and quickly complete the assignments. Slower students follow the tutorials step by step and rarely need to ask for assistance. Both, however, learn the material and complete the homework assignments. Students who don't finish the work during lab can return any time to complete the assignments while still receiving instruction. The number of students who don't complete the homework or complete the assignments with errors has dropped noticeably. This has led to a slight improvement in the performance on exams.

A student who falls behind because of uncontrolled circumstances is more likely to catch up and perform well in the course because of the accessibility of the instructional material. In the past a significant effort from the instructor and special meeting times had to be scheduled with students who fell behind. The visualization tools that are developed by the student as they interact with the game pages are invaluable to the student and difficult to teach using other methods. As the students visualize objects repeatedly in the games with positive and negative feedback they exercise a developing skill that would otherwise be tedious if done using a printed worksheet. By the end of the course the students have been exposed to a breadth of examples using interactive graphics to teach and communicate. The students seem motivated and intrigued by use of engineering graphics as a powerful communication tool whereas in the past they had a much narrower focus for the application of engineering graphics.

Student Evaluation

Two separate surveys have been administered to students in the engineering graphics course to formally evaluate the effectiveness of the pedagogical methods used in the course. The first is a standard course/faculty survey used by the university. This survey has been used in engineering graphics both prior to and following the introduction of the tutorial CD. Results of the survey, shown in Figure 5, are used by the university for tenure and promotion decisions.

The first item in Figure 5, the overall rating of the instructor, is used as a benchmark for teaching effectiveness. It is interesting to note that the overall student evaluation of the instructor has not been significantly impacted by the introduction of the new teaching methods and materials. This indicates that the students have adapted well to the changes in the course, specifically the substitution of personal contact with the instructor for computer based tutorials. It is likely that if a personal connection was developed between students and the

Students rated the following statements on a scale: A) Excellent, B) Good, C) Average, D) Fair, E)Poor							
	% Response as excellent or good						
Statement	Weekly lab instruction w/o tutorial CD			Tutorial CD in use and no regular lab instruction			
	12/95	12/96	Avg.	12/97	12/97	5/98	Avg.
1. Overall rating as an instructor in the course.	92	85	88	87	91	83	87
2. Clarity of communications in the classroom.	67	85	76	87	100	78	88
3. Encouragement of students to express ideas.	92	85	88	87	73	81	80
4. Enthusiasm with which you would recommend this instructor to other students.	83	80	82	87	80	89	85

Figure 5: Results of student opinion survey given during the final week of the semester.

instructor by establishing a significant physical presence in the lab that there would be a marked increase in evaluations.

Two responses on the survey suggest that the students have benefited from the change in pedagogy. The first is in response to the "clarity of communications in the classroom." A 16% increase in student response indicates that students are understanding the material presented to them. This is especially significant since the breadth of material covered in the course has been increased. A slight increase was also measured in their response to "enthusiasm with which you would recommend this instructor to other students. This increase is of importance relative to the project goal of providing the students with a positive first experience in an engineering course.

A significant negative drop was measured in response to "encouragement of students to express ideas." This decrease was expected as the opportunity for interaction between the student and instructor has been significantly reduced. One opportunity to increase the expression of ideas from student to instructor is to give the students greater exposure to design problems in the homework. The time and effort that students repeatedly give to the open-ended design project demonstrates that students enjoy communicating their ideas to the instructor. Further development of the project will include simple open-ended design homework problems. Innovative student solutions could be posted on the public web site as an encouragement to students.

A second survey specifically targeting student opinions about the CD tutorial was given to students mid-semester before significant attrition occurs. Percent responses to the fifteen questions included on the survey are shown in Figure 6. All responses on the survey strongly indicate that the students believe that the CD is a benefit to their learning and to the course. In response to the statement "The tutorial CD is a useful tool for this course", 83% indicated that they strongly agree. No one responded negatively. In response to the survey question "How could the CD be improved?" one student answered "Doesn't need improvement." Such a response was more than twice as frequent as any other response indicating that the students find the CD an effective teaching tool.

Other responses indicate that the students regularly use the CD in lab and find it helpful for understanding and reviewing lecture material and understanding and completing homework assignments. Approximately 90% found the information well organized and easy to access. These responses indicate that the students adapt well to the html web-based format. Use of this popular media gives the students a familiar environment in which to explore and learn engineering graphics.

Two questions deal specifically with the use of the CD tutorial as compared to the traditional textbook as a reference source. Over 80% of responses favored the use of the CD to a textbook and stated agreed that "the CD supports the course in a way that a textbook could not." These responses suggest development of similar

Students rated the following statements on a scale:
5) Strongly Agree, 4) Agree, 3) Neutral, 2) Disagree, 1) Strongly Disagree

Statement	% Response				
	5	4	3	2	1
1. The tutorial CD is a useful tool for this course.	83	15	3		
2. I have viewed the lecture notes on the CD and find them helpful for understanding and retaining the lecture material.	48	35	15	3	
3. The homework tutorial movies aid in my understanding and completion of the homework assignments.	68	25	3	5	
4. I have used the practice quizzes on the CD and found them helpful for reviewing the lecture material.	35	53	10	3	
5. The web-based games give a helpful interactive approach to teaching key concepts in the course.	35	38	23	5	
6. The material on the CD is easy to access.	53	35	10		3
7. The material on the CD answers most of my questions.	38	50	13		
8. I regularly use the CD in lab.	80	18	3		
9. The material on the CD is well organized	63	33	3	3	
10. I prefer the use of the CD to a textbook that covers the same material.	58	25	18		
11. The CD is supports the course in a way that a textbook could not.	68	25	8		
12. At the start of the course I had difficulty visualizing multiview drawings.	13	33	21	13	21
13. The games have helped me to develop my visualization skills.	18	43	40		
14. The CD has helped me understand engineering graphics.	43	48	10		
15. A tutorial CD would be helpful for other courses	67	18	15		

Figure 6: Results of student opinion survey regarding use of the tutorial CD.

projects for other course content might be more effective than traditional methods, especially if provided as additional resources to the student. In specific response to the statement "A tutorial CD would be helpful for other courses", 85% indicated a positive response.

UT System Peer Evaluation

The project was evaluated in five areas by the committee for Best Practices of Multimedia in the University of Texas System and found to be an excellent example in all areas for which it was evaluated. In all five areas the project was sited as one of the top two examples reviewed. The areas of evaluation are listed as follows:

- Instructional Design: Are the individual needs of the learner taken into account?
- Integration of Media: How well does the project combine different media to produce an effective whole? Is the media used necessary for the overall effectiveness of the project?
- Innovation: Use of multimedia technology in a unique way to attain some objective(s) that otherwise could not be attained, which results in a changed learning and teaching paradigm.
- Evaluation of Learning: The extent the project assesses the learners' mastery of the objectives. Was practice and feedback included in the project?
- Educational Value: Can this project enhance students' learning?

The multimedia best practices web site, <http://uts.cc.utexas.edu/~best/index.htm> provides links to numerous other example of multimedia used in teaching and a variety of tools and helps for those developing similar projects.

Dissemination

Implementation of the project has been a success in that required faculty time in the course has been significantly reduced while measures of student learning and attitudes about the course have increased. The average student has adapted well to a major change in pedagogy, where the multimedia instructional approach produced minor improvements in overall performance and depth of knowledge gained on the course. The material has been successfully used outside of the U.T. System (see letters included in appendix) and has been well received by the educational community as evidenced by selection of the paper "The Development of a Multimedia Instructional CD-ROM/Web Page for Engineering Graphics" (Crown, 1999-A) in the AACE list of best works and evaluation by the U.T. System Best Practices. An expanded version of the paper will appear in the Interactive Multimedia Electronic Journal of Computer-Enhanced Learning (<http://imej.wfu.edu>). A paper (Crown, 1999-B) specifically discussing the use of web-based games used in the instructional CD was presented and published at the CATE '99 conference.

The impact of the instructional CD material has been positive with a significant increase in the breadth of material covered and flexibility of delivery. With the completion of the multimedia instructional material the course has successfully been exported off campus to area high schools students and to those who wish to take the course on-line for convenience. The scheduling flexibility for students taking an on-line course will likely increase future course enrollment.

The cost of developing the project was significant. Several hundred hours were required to bring the project to its current level. Use and adaptation of the material at other institutions will allow instructors to impact students in engineering graphics without having to develop all the computer-based instructional tools themselves. With little effort the material can be personalized to meet an instructor's particular objectives and take on the personality of the instructor. A scaled down version of the project using the basic framework of the original project has since been successfully developed for another engineering course with a fraction of total time invested indicating that the pedagogical approach and specific materials can be successfully adapted to other courses and disciplines.

References

- Antchev, K., Luhtalahti, M., Multisilta, J., Pohjolainen, S., & Suomela, K. (1996). A WWW microworld for mathematics. *1996 ED-TELECOM Conference on Educational Telecommunications*. Boston, Mass. June 17-22, 1996. 5-10.
- Crown, S.W. (1999-A). The Development of a Multimedia Instructional CD-ROM/Web Page for Engineering Graphics. *Proceedings of ED-MEDIA 99 World Conference on Educational Multimedia, Hypermedia, and Telecommunications*. Seattle, WA. June 19-24, 1999. 1026-1031.
- Crown, S.W. (1999-B). Using Web-Based Games to Enhance the teaching of Engineering Graphics. *Proceedings of the IASTED International Conference, Computers and Advanced Technology in Education (CATE '99)*. Philadelphia, PA. May 5-8, 1999. 155-160.
- Carver, C., Howard, R., & Lavelle, E. (1996). Enhancing student learning by incorporating learning styles into adaptive hypermedia. *1996 ED-MEDIA Conference on Educational Multimedia and Hypermedia*. Boston, Mass. June 17-22, 1996. 118-123.
- Dockterman, D.A. (1995). Interactive learning: It's pushing the right buttons. *Educational Leadership*, 53(2), 58-59.
- Ellis, A. (1996). Learning styles and hypermedia courseware usage: Is there a connection? *1996 ED-MEDIA Conference on Educational Multimedia and Hypermedia*. Boston, Mass. June 17-22, 1996. 217-222.
- Haugsjaa, E. & Woolf, B. (1996). 3D visualization tools in a design for manufacturing. *1996 ED-MEDIA Conference on Educational Multimedia and Hypermedia*. Boston, Mass. June 17-22, 1996. 288-293.
- Hill, M., Baily, J., & Reed, A. (1998). Hypermedia systems for improving knowledge, understanding and skills in engineering degree courses. *Computers and Education*, 31(1), 69-88.

Kirkpatrick, A., Lee, A., & Wilson, B. (1997). The engine in engineering- Development of thermal/fluids web based applications. *Proceedings of the 1997 IEEE/ASEE Frontiers in Education Conference*. Pittsburgh, PA. November 5-8, 1997. 744-747.

Marshall, A. & Hurley S. (1996). Delivery methods for hypertext-based courseware on the World-Wide-Web. *1996 ED-TELECOM Conference on Educational Telecommunications*. Boston, Mass. June 17-22, 1996. 191-196.

Mayer, R. & Anderson, R. (1991). Animations need narrations: An experimental test of dual-coding hypothesis. *Journal of Educational Psychology*, 83, 484-490.

Mayer, R. & Sims, V. (1994). For whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia learning. *Journal of Educational Psychology*, 86(3), 389-401.

Reed, J. & Afjeh, A.(1998). Developing interactive educational engineering software for the World Wide Web with Java. *Computers and Education*, 30(3/4), 183-194.

Shabo, A., Guzdial, M., & Stasko, J. (1997). An apprenticeship-based multimedia courseware for computer graphics studies provided on the World Wide Web. *Computers and Education*, 29(2/3), 103-116.

Suni, I. & Ross, S. (1997). Iterative design and usability assessment of a materials science hypermedia document. *Journal of Educational Multimedia and Hypermedia*, 6(2), 187-199.