Session 3520

Teaching a Multimedia Course in Engineering

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Introduction

Much has been written lately about multimedia and how it will turn education upside down and solve all our teaching problems. This may be true, but currently there are very few multimedia based instructional software programs, or courseware, available for teaching basic engineering courses, much less advanced courses. One obvious reason for this scarcity of courseware is the lack of engineers active in the development of multimedia. While computer science departments can contribute to the development of multimedia shell programs and other software development tools, engineering departments must take direct responsibility for the content and structure of the multimedia program, but this requires, in addition to the basic technical knowledge, a good understanding of multimedia, its development tools, and the relevant pedagogical issues. To date, few faculty have achieved this level of expertise and competency.

A closely related issue is the role of multimedia in the communication and documentation of engineering practice. Today, these activities are accomplished almost entirely in traditional paper formats, but in the future, comprehensive multimedia presentations or proposals may be more important. Multimedia and scientific visualization may become essential engineering tools and the subject of elective courses for undergraduate and graduate students.

This paper discusses the implementation of a new course, 'Multimedia in Engineering,' that has been taught for the last two years in the School for Aerospace Engineering. The main objective of the course is to teach the students to integrate video, animation, sound, text, and graphics into an effective instructional program or engineering presentation. All topics in the class center on engineering and particularly on how multimedia can be used to illustrate three dimensional motion, time-based physical actions, and real or practical situations. Being able to illustrate the motion of a rocket or a water pump and abstract the behavior to fundamental engineering models greatly enhances the effectiveness of the presentation or learning environment. The course emphasizes that developing an effective multimedia program is much more than just throwing pictures and video together. These and other multimedia objects must be woven together in a navigation shell that lets the user explore and learn at the same time. Problem layout and use of color are also examined in the course.

The course is open to all engineering students and is the only multimedia course that is offered at Georgia Tech primarily for engineering students. The students include both undergraduates (60%) and graduates (40%). The only prerequisite for the course is to be at the junior engineering level or better. This requirement insures that the students can deal with advanced engineering principles and that the course does not deteriorate into a general communications course with no engineering content.

In addition to examining the use of multimedia in engineering, this paper also discusses hardware and software issues. In particular, basic multimedia software will be reviewed, including software tools for authoring, rendering, animating, sound and video editing, equation editing, photo editing, and simulation. Hardware issues will be addressed for both the Macintosh and Windows computer platforms. The results of student's projects and what the students learned from the class are also presented and discussed.

Multimedia Software used in the Course

One of the most misunderstood aspects of developing multimedia presentations or courseware is that it requires more than just the main multimedia authoring program like Authorware or Toolbook. Other software tools are needed to construct the graphics, sounds, and animations that are the ingredients of a good multimedia program. As a minimum, there are 6 major types of programs (listed below) and several utilities that should be learned in order to be able to develop a good multimedia program.

1. Authoring program
2. Graphics/Drawing program
3. Video Editing program
4. Sound Editing program
5. Modeling/Animation/Rendering program
6. Data creation program

Of course, the cost of software can be large, and this can be the biggest obstacle to developing a multimedia course

in engineering. However, to help higher education institutions, most software companies offer their programs at a very reduced price (10% to 90% of list) in hopes the student will influence future purchases of the product. Nonetheless, the cost still can be great even if only one copy of each program is purchased, and this causes the programs to be a target for illegal copying. In the School of Aerospace Engineering at Georgia Tech, all programs are placed on a server or on local machines that are directly connected to the server. All programs at start-up must access the server and obtain a 'key' for the software to run. The programs can be copied, but unless the program can get a 'key' from the server, they will not run. This has eliminated most problems with software pirating (although the sheer size and complexity of these programs is often an effective deterent in itself!).

The software used in the 'Multimedia in Engineering' course is listed below along with comments about each program. More than the basic 6 programs are described since some capabilities overlap. Most programs are available for both the Windows and Mac platforms.

Macromedia Director 4

This is a general purpose authoring tool and is in some respects like a vastly expanded HyperCard-like programming environment. It is easy to use for simple tasks but takes time to learn all of its many capabilities. It is very powerful and is currently the program of choice for most commercial multimedia developers. The program is organized along a timeline (or score) and you place objects (called cast members) on the screen (called a stage) at different times. It is very good at 2D animation since it is based on a timeline, but it does not have any 3D motion or animation capabilities. Built into Director is a good basic paint program, but it is not a complete bit-graphic program like Photoshop. One of the great advantages in using Director is its cross-platform capabilities. Any source file developed in the Mac version will play in the Windows version and vice versa. It even accepts both Video for Windows and QuickTime movies. If the students (or instructors) plan to distribute their work, this cross-platform capability may be very important.

Macromodel 1.5

Macromodel is one of the newer 3D modellers available. It is touted as CAD-accurate (but not as accurate as an engineer would like), and it allows some very interesting 3D construction. All shapes are based on bezier curves which permits extensive control over curved surfaces. Operation of the program is not the same as a CAD program, and this can frustrate CAD-oriented engineers, but it is often easier to use and you have more artistic control over curved shapes. Several special effects allow twisting and deformation of models. It should be pointed out that this program is only a modelling and not a rendering or animating program.

Macromedia 3D

This program is the main animator and renderer for the models constructed in Macromodel. It has the ability to create a few basic geometric shapes, but it is not a good modeler. It is a very good animator and gives you total control of the position, rotation, color, lights, transparency, textures, etc. It is based on a timeline, and all objects and lights can be modified over as a function of time. The renderer allows texture, bump and reflection maps to be applied to objects. It is fairly easy to use and very powerful, but it takes a lots of experimentation to fully understand and master rendering. This software allows non-artistic engineers to produce some rather good illustrations.

Spyglass Dicer 2.01

This is a scientific data visualizer that plots 4D data sets (three space dimensions and one value range). A good example would be a plot of the temperature in a rocket motor case where there are three dimensions in addition to the temperature values themselves. The program allows slices through the data set geometric volume and has transparent layering capabilities. More powerful data visualization software is available on workstations, such as AVS, Wavefront, and PV Wave, but Dicer does about 75% of what those programs will do and is much cheaper.

Photoshop 2.5 LE and 3.0

This is currently the standard paint/photo-editing program for graphic artists. Its strong point is modifying existing images such as photographs that have been scanned into the computer (other programs such as Fractal Painter are more useful for creating paint graphics). It can do about anything to an image (e.g., a photograph) that you can dream up (after using this program you will never believe a photograph again). It is not a good drawing program, and you will be frustrated if you try to use it to make technical pictures. The 2.5 LE version is a low-cost 'Limited Edition", but the limits have not seriously affected multimedia classroom use, and the price is very attractive.

Canvas 3.5

This program does what Photoshop does not do. It is a good 2D technical drawing program with all of the capabilities of a regular drawing program and many of the features of a 2D CAD program, but it also has dozens of paint and special effects tools to make technical illustrations easy to produce. The dimensioning tool is especially nice. Some users say Canvas has too many tools and tries to do everything for everybody, but then it is often better to have too many features than too few, especially on a tight budget.

Premier 3.0 LE and 4.0

This is the current standard program for digital video editing. This program lets you import videos, animations, sound tracks, pictures, graphs, etc. and combine them together to make a single linear video or QuickTime movie. There are hundreds of special effects such as fades, transparencies, overlays, moving TVs, etc. This program is a basic video production studio where you can create about 75% of what a commercial broadcast studios can do. Direct output to a VCR is also possible, but without high end VCR equipment, you

will only get about 60% of the quality you see on TV. (Sorry, you will not be able to make TV commercials with the software!) With all this video power, you must be careful to watch the size of the video files which can quickly become VERY large (hundreds of megabytes).

Clip Art and 3D Swivel Models

Constructing basic pictures and models can consume a lot of time. To minimize the time required in the course, various clip art and pre-constructed models are provided. Many of these models were made for an animation program called Macromedia Swivel 3D, but they can be readily used with most major 3D programs. They include many planes, cars, ships and other common geometric models.

Working Model

Working model is a simple and elegant mechanical simulation program with good graphics for visualization of working mechanical systems. The program has a graphic editor that lets you build 2D models (3D is scheduled to be released in the summer of 1995) using rectangles, circles, polygons, springs, dashpots, rods, actuators, pulleys, sliders, etc. The program then assembles and solves the relevant system equations using numerical integration. The program will output Macromedia 3D files that can be rendered as 3D objects.

SoundEdit 16

Multimedia is not multimedia without sound. This program lets you record and edit sounds. It will read and write out most major sound file formats. There are many special effects that can be used to modify the sound. The sound is digital, so it is easy to add a number of special effects such as an echo or change of tone level. You can even make yourself sound like the 'Chipmunks' with is single button.

QuickTime Utility Programs (MovieShop, Movie Converter, Movie Player)

These are small, special purpose utility programs from Apple Computer that help manage QuickTime files. For example, Movie Converter will take a series of pictures (PICT or PICS) and combine them into a movie (QuickTime). All three have compressors to make the file size smaller.

Other Useful but Not Essential Multimedia Software.

Over a dozen other programs have been used in the AE Multimedia Lab at Georgia Tech, including Authorware, Hypercard, SuperCard, Toolbook, Illustrator, Color It, 3D Studio, Studio Pro, Swivel, Sketch, MatLab, COSMOS, Mathematica, KPT Tools, Bryce, and others. All have some strong points and weaknesses. It is important to choose those programs that best fit the development needs, and experimentation is often the only, and at times expensive, recourse. If too many program are used, it quickly becomes a unmanageable task to remember the operation and details of each program.

Hardware

This can be a very touchy topic. Which hardware platform should be used? The two most obvious choices are the Windows-based computer (486 or Pentium) or the Macintosh-based computer. Both have advantages and disadvantages. Generally, the Macintosh is better for developing multimedia because of its more mature graphics-based operating system. Also, more animations, rendering, modeling, video editing and graphics programs are currently available on the Mac, and interoperability is almost always assured on the Mac. This graphics edge is slowly eroding, and within the year, most programs will be available for Windows. On the other hand, both platforms offer about equal capability for the playback of multimedia. The choice of platform is thus a personal decision (or controlled by budget). If the program is to be distributed outside of the developing university, then a cross-platform authoring program should be used, such as Authorware or Director, which run on both machines.

For the course taught at Georgia Tech, five-year old Mac IIci's with 16 Mb of RAM, 24 bit graphics and a 250 Mb hard drive are used. This is on the lower end of computers today, but yet it is sufficient to introduce multimedia. Serious development work requires faster computers with bigger hard disks and larger (and multiple) video monitors. Floppy diskettes quickly become useless when dealing with multi-megabyte multimedia files, and so other storage media are used. A server is available for student use, and a single 128 Mb optical drive is available to the students in the computer lab so that they can personally back up files.

Examples of Student Projects

The main objective of the course is to teach engineering students how to use and develop multimedia programs for technical demonstrations and for education. To accomplish this goal, a course project is required in which the students must demonstrate their knowledge and ability to integrate all the different aspects of multimedia together. It also gives the students something to take with them to use as a model for future presentations and programs using multimedia principles. The projects are chosen by the students and are usually in his or her field of interest. Some of the graduate students have coordinated the project work with their dissertation research. Figures 1 through 6 show various introduction screens from student projects.

The feedback from the students revealed that the project was the most important learning activity of the class. It was not until the students put together a complete multimedia program that they understood how to use the various programs and tools. Each project was presented to the class in order to allow open discussion on how and why certain things were done, and in general, everybody was able

to learn from others. The biggest complaint in the class was the large number of complex programs that had to be learned. The 10 week quarter has turned out to be a problem because ideally the course needs an additional 4 to 5 weeks in order to allow students sufficient time to master each of software tools needed in developing a multimedia program. A semester based course with 15 weeks of instructional time would be ideal.

Textbook

Finding an appropriate textbook for a general multimedia course is difficult ,but trying to find a text book for multimedia in engineering is impossible. This is probably due to multimedia being a new topic, and thus there has been very little written on how to teach the topic, especially in engineering. There are a lot of books that discuss what multimedia is and how it is going to change the world [1-10], but there are virtually no books that teach you how to develop good multimedia courseware. In particular, there is no book that teaches what tools to use and how to use them to put together a good technical based multimedia program.

This will change over time, but until then, general multimedia books such as Multimedia, Making it Work [8] or Multimedia Powertools [11] can be used to introduce the basics of multimedia. The Multimedia Powertools book is more up-to-date on the capabilities of the software tools and has a nice CD to demonstrate programs and sample multimedia programs. This book also gives excellent descriptions of how multimedia is put together and what software tools should be used to accomplish various tasks. It covers all the basics about graphs, sound, animation, rendering, authoring, and interface design. The book also covers how to start a multimedia project and see it to completion. It even talks about important topics such as storybook layout and copyright problems. However, it lacks information on 'how to' techniques to help students use the various software packages. One problem in writing such a book is the vast number of software tools needed to put a multimedia program together. One needs at least 6 or 7 basic tools (painting, drawing, modeling, rendering, animation, sound, authoring) to construct a multimedia program and each category of tools will have at least 4 to 6 different competing programs. Therefore, the book needs about 40 different chapters to describe each of the major software tools available. This is obviously too much for anyone to put together in a single book. For the foreseeable future, multimedia courses will have to use a general book on multimedia and then specialize the lectures to cover those software programs used in the particular curriculum.

Schedule

The course schedule is oriented around introducing 6 or 7 major software tools that are used to develop useful multimedia programs or presentations. One of the difficulties of the course is that everything needs to be known at once to produce a complete multimedia program. While the main goal of the course is using multimedia in engineering, before the programs can be constructed, the tools must be mastered. To avoid turning the course into learning software application programs, each program is used as it might be applied to engineering. For instance, the Macromedia 3D modeling/rendering/animation program was used to animate the orbits of the earth and moon around the sun. Only those parts of the program that pertain to the goal of animating orbits was taught. (Surprisingly, this simple exercise required

Table 1. Basic Schedule for 10 Week Quarter System

Week	Topic	Lab/Homework
1	Introduction, MM overview, Software Introduction, Course Project, Demonstrations	Lab - Word/Excel
2	Hardware Issues, CD recording Using MS Word, Working Model, and QuickTime	Lab - Wrk. Model
3	Technical Multimedia Data Creation, Dicer, COSMOS, Working Model	Lab - Dicer
4	User Interface Program layout, Director	Lab - Director
5	Graphics Editing, Canvas, Photoshop Test	
6	Video Editing, Premier 3D Modeler, Macromodel	Lab - Macromodel
7	Technical Animation Animator-Renderer, Macromedia 3D	Lab - Macromedia 3D
8	Program organization Director	Lab - Director (Lingo)
9	Navigation and Scripting Director	Lab - Project
10	Other Elements, sound Presentations - Lab	

learning over 50% of the program's capabilities!) This teaching method is directly associated with case-based learning which has been shown to be very effective. In multimedia at present, there is very little choice, and one learns best by doing.

The timing and introduction of software is critical and needs to be carefully structured so that each software tool can be integrated into the authoring program later in the course. Each week a software tool is introduced and used in the weekly lab assignment as outlined in Table 1. The lab and homework assignments for the week are based on the new software introduced that week. For instance, the first week reviews how a word processor and spreadsheet can be used for multimedia. The assignment is to organize movies and sounds into a document that enhances the learning of the topic (oriented around Engineering of course, no Boggart movies here). This allows students to see immediately the impact that other media types can have on a simple text document.

During the next couple of weeks, students learn how to construct basic engineering data and to construct visualizations of that data. Data visualization is an important aspect of multimedia and is introduced through simulation programs like Working Model and visualization programs like Dicer.

In week 4, the main authoring program, Macromedia Director, is introduced so that the students can begin actual assembly of the previous graphics and movies into an organized program. Director is a large and complex program that takes time to learn. Introducing it early allows the students to grasp the main objective of the course, i.e. to develop a useful multimedia program. At this time the final project assignments are made, based on initial proposals (and simple storyboards) prepared earlier by the students.

The next couple of weeks are devoted to learning both 2D and 3D graphics programs. Good drawing and painting programs are needed throughout the multimedia development process. For example, Photoshop does well for pixel level painting and 2D art while Canvas is good for object-oriented drawing. Both types of programs are generally easy to learn and use. In addition to paint and drawing programs, video editing program like Premier are introduced. The real fun begins with 3D modeling, rendering and animating programs. Multimedia's real strength lies in its ability to show 3D motion. However, 3D programs are new and relatively harder to learn. Two weeks are spent introducing a 3D modeling program like Macromodel and a rendering/animation program like Macromedia 3D. Overall, this portion of the course is that toughest due to the sheer number of complex programs introduce to the students. The students are not expected to be masters of the programs, and thus only the basic capabilities of each program is introduced.

The last two weeks are devoted to the class project and learning more about Director's scripting (programming) language called Lingo. To reach the full potential of multimedia programs, scripts must be used to direct the navigation and interaction of the program. Some authoring programs advertise that no programming or scripting is needed, but the end result with those programs is a linear 'page-turning' program that is no better then a presentation program. The final week is devoted exclusively to the class project. An important part of this is the student presentations of their work to the others, including their own explanations of their development rationale and the ensuing lively discussion.

Summary

Multimedia is a growing method of communication, and with its ability to visualize three dimensional space and motionis, it is well-suited for engineering . It is becoming important for the practicing engineer to know how to utilize this technology to both present engineering concepts and to educate new engineers more effectively. Over the last two years, Georgia Tech has been offering a one-quarter multimedia course in engineering to help educate both undergraduate and graduate students about its development and use. The course's main objective is to teach students how to use multimedia in engineering. The course includes teaching the basics of 8 popular commercial software programs that are used in the construction of multimedia, and these include Director, Premier, Macromedia 3D, Macromodel, Dicer, Canvas, and Photoshop and SoundEdit. The course is taught over a 10 week quarter. Students are required to have basic knowledge of computers and junior-level standing in engineering.

The course has been successful in giving students a basic understanding of data visualization and multimedia applications in engineering. It also has exposed them to numerous software programs that can be used throughout their careers in engineering for presentations, reports and demonstrations. One of the best indications of the success of this course is through follow-up communication with students who are now using multimedia in their jobs and in graduate schools.

Acknowledgment

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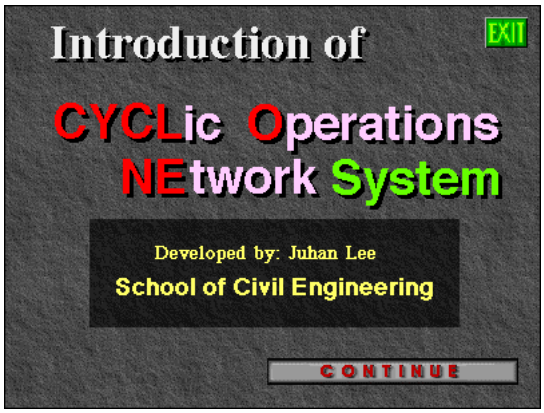

Figure 1. Juhan Lee - Construction.

Figure 2. Hector Chaviano - Jet Engines.

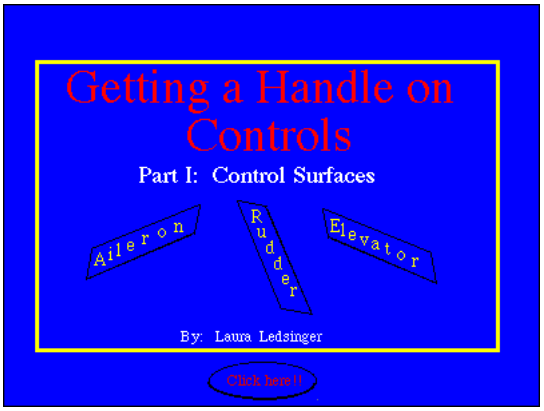

Figure 3. Laura Ledsinger - Control Surfaces of Aircraft.

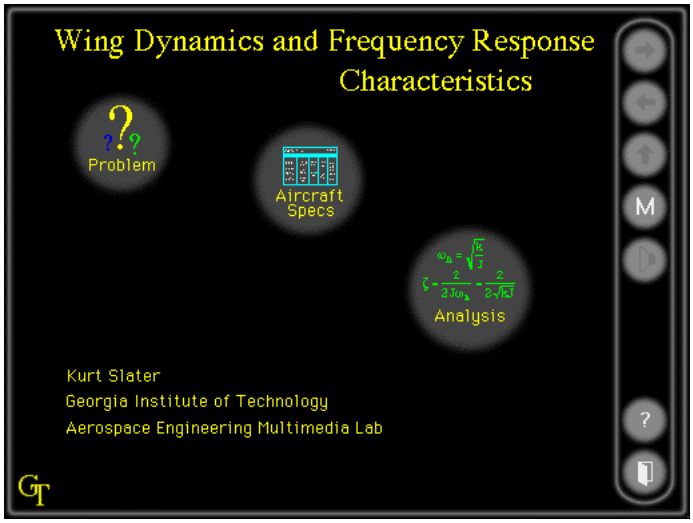

Figure 4. Vibrations of Aircraft Wings

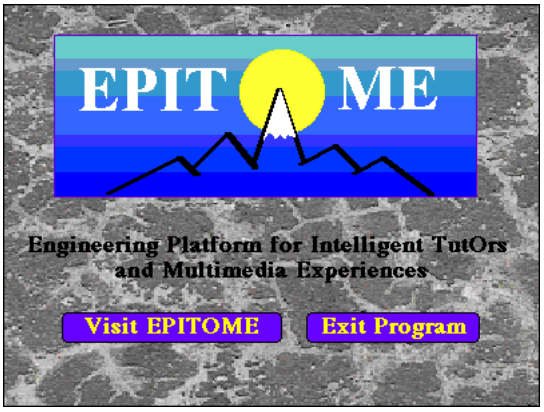

Figure 5. Rob McConnell - Concrete Structures.

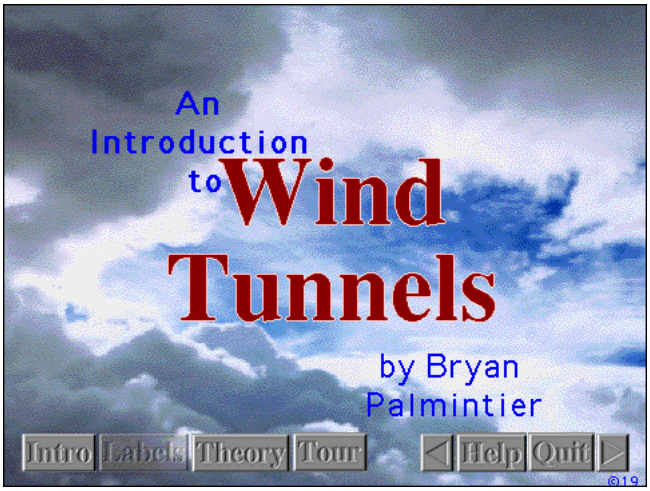

Figure 6. Bryan Palmintier - Wind Tunnels.

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Dr. Kurt Gramoll is currently an Assistant Professor in the School of Aerospace Engineering at Georgia Institute of Technology. He graduated from the University of Utah with a BS in Civil and a MS in Mechanical Engineering. Later, after working at Thiokol, Inc., he received his Ph.D. in Engineering Science at Virginia Tech in 1988. Since then he has taught at Memphis State University and worked at the Japanese National Institute for Space and Astronautical Science. His technical research work involves filament winding of composite structures and fluid-structure interaction. He is also heavily involved educational research, particularly in the development and use of multimedia programs in engineering.

Teaching With Multimedia. Why teach with video? When students have access to video content to watch outside of class, class time can be used for comprehension checks, discussion, and reinforcement of content. Multimedia content helps to vary and enhance the learning process, and leads to better knowledge retention. Educational video can provide more opportunities for students to engage with the content. Students around the world can learn from course content made available through video. Video can sometimes demonstrate complex ideas and access other times and places better than speaking can. V Using diverse multimedia technology in your teaching of a foreign language can be a real boon to language learners, as well as to you and your educational institution administrators. Here are some hows and whys to help get you started.Â Check with most English as a foreign language (EFL) teachers and youâ€™ll likely find many traditional tools heavily in use in some cases, in moderate use in most institutions, and noticeably lacking in the vast majority of others. Technological tools as applied to the classroom teaching and learning of a foreign language are in a drastically reduced state of use, as shown in a recently conducted study done with the participation of 168 students and 40 professors at five institutions of higher education in Bogota, Colombia.