

Teaching Multimedia Development to Engineering Students through Web-based Modules

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Abstract

Multimedia training modules are powerful educational tools that provide students with engaging experiences in the classroom. This paper presents an approach to implement web-based modules for teaching engineering students multimedia development at the University of Oklahoma. In particular, the strategy used to teach the courseware is discussed with a brief review of common problems in conducting such a course.

The paper also examines the software tools and hardware that is used to teach the students. A brief overview of the software tools for authoring and editing different media types is presented, along with hardware issues. In summary, student responses and examples of student projects are given. The overall responses were found to be positive with strong approval to the inclusion of student projects.

I. Introduction

During the past decade, the Internet has grown into a potent medium for disseminating information. The proliferation of the World Wide Web (WWW) in particular, provides a fertile medium for interaction between instructor and student. A case in point is the multimedia course currently taught to engineering students at the University of Oklahoma. The course uses web-based multimedia modules to illustrate concepts, and to teach techniques in creating effective interactive technical presentations.

For many years, multimedia has been touted to be the preferred medium in revolutionizing education. However, there is a shortage of software and courseware available for teaching engineering concepts on the World Wide Web. One reason for this is the lack of engineers involved in the development of multimedia. Multimedia is a combination of different elements – text, graphics, animations, simulations and sound. It is used to form an informative and interactive learning environment.

The role of multimedia is also evident in the documentation of engineering practices. Today, engineers are beginning to create digital reports on computers instead of generating them on paper. These activities, however, do not include creating interactive elements in benefit of the viewers. Therefore, engineering documentation often involves only a passive response from the viewers.

As computers become more prevalent in the industry, multimedia and scientific visualization may become essential tools in teaching engineering courses to both undergraduate and graduate students. At the University of Oklahoma, engineering students are required to purchase a laptop computer with wireless network connection capability. In addition to the educational benefits, this program helps students become competent on the use of computers and the Internet. It also provides a large sampling of students who are actually involved in web-based learning through multimedia modules.

This paper discusses the implementation of a course, “Multimedia in Engineering,” that has been taught for the last three years in the School of Aerospace and Mechanical Engineering at the College of Engineering, University of Oklahoma. Previous to teaching the course at Oklahoma, the second author taught the course at the Georgia Institute of Technology for five years. The main objective of the course is to teach engineering students to integrate video, animation, audio, text, and graphics into an effective instructional technical program or engineering related presentation. The course structure centers around engineering concepts, particularly on how multimedia can be used to illustrate and model real life engineering problems. Figure 1 shows a web-based module for teaching drawing tools.

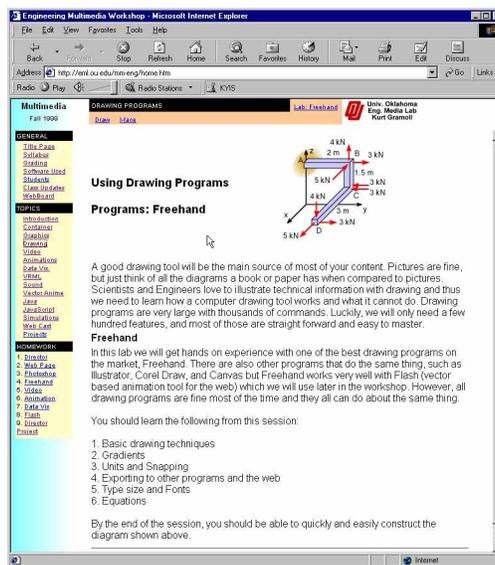


Figure 1. Web-based Modules for Teaching Drawing Tools

The course emphasizes that the development of an effective multimedia presentation is more than just a combination of pictures and video, but also in the creation of an interactive

environment that allows the user to explore and learn simultaneously. These and other multimedia elements must be combined in an intuitive navigation shell to encourage exploration of the student produced multimedia presentation.

II. “Multimedia in Engineering” at the University of Oklahoma

“Multimedia in Engineering” is currently one of two multimedia courses geared towards engineering students at the University of Oklahoma. The students consist of a mixture of both undergraduates and graduates. The only requirement for the course is to be at least a junior in a technical discipline, such as engineering, science or mathematics. This requirement ensures that the students are prepared to approach advanced engineering principles, and that the course does not become a general communications course with no engineering content.

In addition to discussing the uses of multimedia in engineering, this course also analyzes issues involved in hardware and software. Basic multimedia development software are reviewed, which includes tools used in authoring, rendering, animating, audio and video editing, equation editing, image editing, simulation and scripting. For hardware issues, only the Windows-based computers are discussed. Other than hardware and software issues, the students’ projects, which are based upon the knowledge acquired from the course, are an important aspect of the course. The project requires the students to make closure on the knowledge he or his has gained and produce a useful multimedia module that is web accessible.

III. Teaching Strategy in “Multimedia in Engineering”

The course is structured around introducing 9 to 10 multimedia software tools that are used to develop interactively rich technical presentations. One of the main difficulties in teaching the course is that everything pertaining to multimedia needs to be known at once to produce a viable multimedia presentation. Therefore one of the basic goals of the course is to master the software tools involved. However, since this course does not center about the learning of multimedia software, each tool is used as it might be applied to engineering. For example, Macromedia Director was used to create a simulation program to calculate the position of a ball rolling in a two-dimensional bowl. Similarly another tools are used to show the concepts behind jet propulsion. This teaching method is directly associated with project-based learning which has been shown to be effective.

Currently, there are no suitable textbooks that discuss multimedia in engineering, nor teach the development of technical multimedia presentations. However, there are a few that provide a general overview of multimedia. This is probably due to multimedia being a relatively new topic in higher education as mentioned in Multimedia Computing: Case Studies from the MIT Project Athena ^[1]. Some books such as Multimedia, Making it Work ^[2], Multimedia Producer’s Bible ^[3] and Multimedia Powertools ^[4], Building a Web-Based Education System ^[5] can be used as an introduction to multimedia, and as additional reference.

The course schedule is important since concepts learned in one software tool will help lead the student to the understanding of the next tool. Unfortunately since this is a relatively new course, there is no proven method of organizing the schedule. Almost every week, new software is

introduced and incorporated into the weekly lab assignment (shown in Table 1). The lab and assignments for the week are streamlined according to the new software tool that is introduced that week. For example, referring to week 3 in Table 1, the class is taught how to create simple web pages that include pictures and text using Macromedia Dreamweaver. The accompanying assignment for that week requires the student to create a web site that contains a combination of different media types. Figure 2 shows a sample of a homework assignment page. Homework assignments only concentrate on certain software tools, whereas the student projects at the end of the semester requires an integration of all the different tools learned during the semester. Both homework and student projects are submitted to a file server that is attached to the computer network in the College of Engineering.

Course Syllabus			
Week	Topic	Software	Assignment
Week 1	Introduction, Multimedia Overview		
Week 2	Multimedia Simulation, Containers, Web vs. CD	Macromedia Director	Director Movie
Week 3	HTML	Macromedia Dreamweaver	
Week 4	Graphics, Color, Equations	Adobe Photoshop	Web Page
Week 5	Drawing, Video Editing	Macromedia Freehand	Graphic Creation
Week 6	QT concepts, Modeling, Rendering, Animation	Adobe Premiere	Drawing
Week 7	Sound	Sound Forge	Video Production
Week 8	Data Visualization	Working Model / Slicer Dicer	
Week 9	Test		Data Visualization
Week 10	3D Internet Graphics, Vector Animation	MetaCreations Infini-D	Animation
Week 11	Vector Animation	Macromedia Flash	
Week 12	Flash, Interactive Scripting	Macromedia Director	Flash
Week 13	VRML	SitePad	Shockwave
Week 14	Projects Discussion		
Week 15	Copyrights, JavaScript, Publications, Distribution		
Week 16	Projects, Test, Presentations		

Table 1. Basic Schedule for a 16-Week Semester System

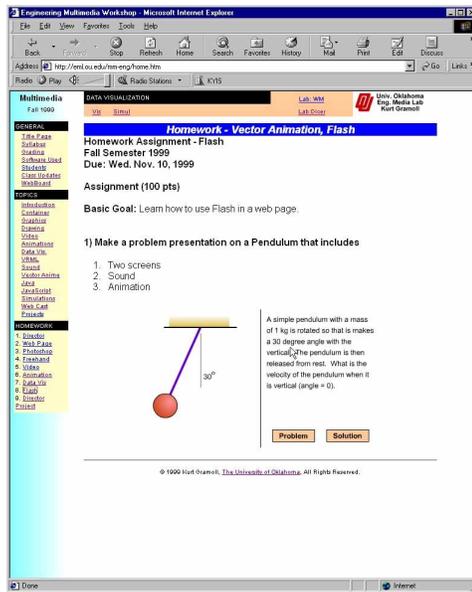


Figure 2. Sample of Homework Assignment Page

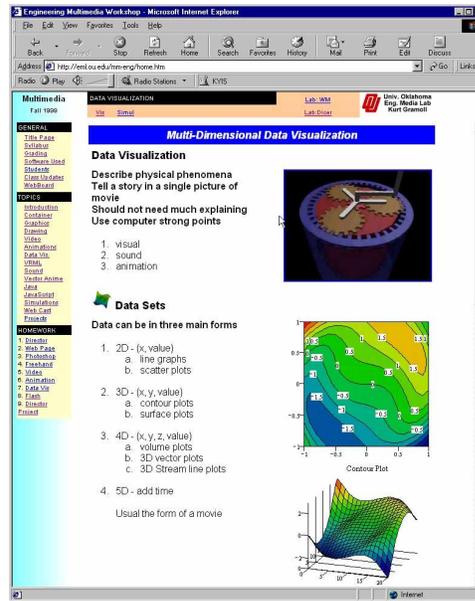


Figure 3. Different Possibilities for Data Visualization Using Multimedia

Throughout the semester, the students are exposed to numerous media elements, such as movies, sound, animation, and data visualization. Using the acquired knowledge in creating different media types, the students can immediately see the impact multimedia can make in constructing technical engineering presentations. For example, weeks 6 to 9 in Table 1, shows at least 4 different multimedia development tools that are taught. These tools are then used to create interesting content that can effectively show different aspects of an engineering problem. A good illustration would be the operation of a construction crane. With Infini-D, a 3D modeling, rendering, and animation tool, a model of the crane can be built and animated to show how it operates. Sound editing can enhance the level of realism in the 3D model. Next, data visualization of the stresses in the trusses of the steel structures can be shown using Slicer Dicer. Working Model can then be used to simulate, in 2D, the operations of the crane, including the loads and constraints. Figure 3 shows the different possibilities for data visualization using multimedia.

The entire course leads the students from the basics of creating multimedia presentations to the more advanced stages where students can actually build working simulation programs that accept input from users in real time. Understanding how the various media elements come together helps the students work on their individual projects. The projects are not only important because it demonstrates an understanding of the capabilities of the tools, but they show how these different tools and ideas work together to construct an effective interactive multimedia presentation. Ultimately the goal of the project is to create a multimedia presentation that conveys the engineering concepts and techniques in a clear and interesting way to a pre-determined audience. To facilitate in answering the many different questions the students have, a

collaboration tool is set up on the web server called a Web Board. The Web Board operates as a knowledge base for students in the course. Figure 4 shows a screen shot of the Web Board.

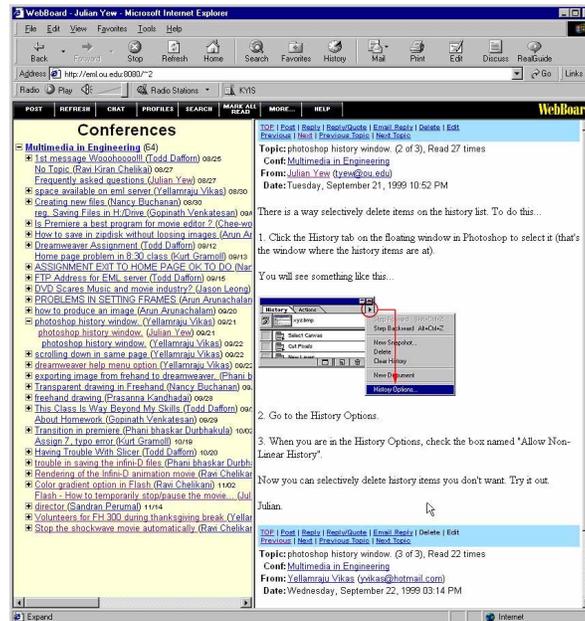


Figure 4. Use of the Web Board for Online Collaboration

IV. Software Tools Used

The main focus of this course is to create multimedia engineering content. Therefore, instead of building the tools for multimedia development, various commercial development tools are used. One of the misunderstandings in developing multimedia content is that it requires just one or two multimedia software tools. There is no single software tool that can equal the capabilities of several individual specialized software tools combined. In general, there are at least 7 major types of tools and several utilities that are used to develop a good multimedia presentation.

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

One major drawback for having so many tools is the cost. This is the largest obstacle to developing multimedia courses in engineering. However, to assist higher education institutions, most companies offer their software at a reduced academic price in hope that in the future, these students will purchase more products from their company. Nevertheless, the cost is still a large factor making these tools a target for piracy. At the University of Oklahoma, the required

software tools are installed on 20 workstations in the multimedia laboratory. The software programs are licensed to the university at a cost of about \$1,500 per workstation.

Another problem is that different students have different computer expertise. However, the initial difficulty involved in learning a new software tool diminishes with familiarity of the tool.

Table 2 lists the software used in the "Multimedia in Engineering" course. The following describes 10 software tools with several having overlapping capabilities. All of these tools are cross-platform and are available in both Macintosh and Windows versions except the sound editing programs, Snag-it and SitePad (equivalent programs available).

Basic Software	
Authoring	Macromedia Director
HTML editor	Macromedia Dreamweaver
Graphics editor	Adobe Photoshop
Drawing	Macromedia Freehand
Vector Graphics	Macromedia Flash
Modeling/Animation/Rendering	MetaCreations Infini-D
Video editor	Adobe Premiere
Sound editor	Sound Forge (Win), SoundEdit (Mac)
Data creation	Microsoft Excel, Working Model 2D
Simulations	Macromedia Director, JavaScript
Other tools/Utilities	TechSmith Snag-it, Apple QuickTime, SitePad

Table 2. Basic Software Used in Creation of Multimedia Content

Macromedia Director

This is a general-purpose commercial multimedia-authoring tool. The latest release version, 7.0, has excellent features that allows for CD-based material to access the Internet. Director is an easy tool to use in constructing animations and powerful in producing Internet and CD-based simulations through their Shockwave technology. The software is organized along a timeline (called the score), with objects (cast members) placed across the screen (stage) at different times. An advantage of using Director is in its cross-platform capabilities. A Director source file developed on the Macintosh platform can be accessed on the Windows platform and vice versa. The strong scripting language in allows Director to be used as a full-fledged programming language. Director can also export its scripts as Java if required however, about 30% of the functions in Director cannot be translated to Java.

Macromedia Dreamweaver

Dreamweaver is a good visual HTML editing software. Visual web page editors, like Dreamweaver, make creating web site easy without having to type the HTML tags in manually. Dreamweaver has two advantages over most other editors. The advantages include an excellent Dynamic HTML feature and 'Round-Trip' code editing. The 'Round-Trip' feature allows editing the HTML code visually without adding (or subtracting) software proprietary HTML codes.

There are also site management tools that aid in managing large web sites. Dreamweaver also integrates Director and Flash Shockwave files into web pages easily.

Adobe Photoshop

Currently, Adobe Photoshop is the industry-standard pixel-based paint and image editing software for graphics. Its main strength is in its capability to modify existing images such as photographs that have been imported or scanned into the computer. These modifications include actions such as creating drop shadows or changing the hue and color saturation of an image. However, Photoshop does not perform well as a drawing tool.

Macromedia Freehand

Macromedia Freehand is a good 2D vector-based drawing tool with several paint and special effects tools to produce technical illustrations. Freehand is good at exporting graphics for use on web pages, and does a good job in anti-aliasing GIF and JPEG format images. Other similar tools are Adobe Illustrator, Canvas, and Corel Draw.

Macromedia Flash

Macromedia Flash is a vector-based tool that is used to produce 2D vector animations for the Internet. Flash uses vector-drawing techniques to keep the file size small and has become the standard on the Internet for advanced streaming animation. Since the drawings are rendered at the local computer, the graphics quality is high and they can be resized without the pixelization of the graphics when enlarged.

MetaCreations Infini-D

Infini-D is a 3D modeler, renderer, and animation tool that is used in the construction of photo-realistic animations. This tool is not a high end modeling and animation software like Form Z, or Lightwave, or 3D Studio Max, but covers all the main capabilities of a general purpose animation tool. Common commands that can be used in Infini-D is extrusion, lathe, sweep, and skin tool. Advance features like meta-balls and particle generators are easy to use. Material textures allow multiple maps that increase the level of realism. The animation effect uses a time-based score to set keyframes that control motion.

Adobe Premiere

This software is the current standard for editing digital video. It allows the import of videos, animations, sound tracks, and pictures to be combined into a single linear video. Premiere includes several special effects such as fades, transparencies, and overlays. Direct output to a VCR is possible. One problem with Premiere is the files can become large.

Sound Forge (Win) or Sound Edit (Mac)

Sound Forge (Windows-based) and Sound Edit (Macintosh-based) are identical in purpose. Both tools allow the recording and editing of audio. Also, both will read and write most major sound-file formats. Many special effects are included in the software that can be used to modify the sound. Since the audio is digital, it is easy to add a number of special effects such as an echo or to amplify the tone level.

Working Model 2D

Working Model 2D is a basic mechanical simulation tool. It uses basic graphics for the visualization of working mechanical systems. This software has a graphic editor that is used to build 2D models using basic shapes such as rectangles, circles, polygons, springs, dashpots, rods, actuators, pulleys, sliders, etc. These shapes are used to assemble and solve the relevant system of equations using numerical integration.

Visualogic Slicer Dicer

This software is a program to visualize scientific data with 3D graphing and plotting. Its specialty is in plotting 4D data sets (three space dimensions and one value range). The software can be used to visually slice through a geometric volume data set. Slicer Dicer can also create transparencies in the layers of data.

V. Hardware Used

There are generally two types of hardware platforms to develop multimedia presentations. The obvious choices for the two are the Windows-based computers (x86 or Pentium) or the Macintosh-based computers. Macintosh-based computers have several advantages over Windows-based computers. These range in ease of use to assured interoperability. The main strength of the Macintosh is in its maturity in graphics and animation software. However, this advantage is slowly diminishing as Windows-based machines continue to be built with better multimedia hardware components. All the software listed in the previous section will run on both platforms.

At the University of Oklahoma, Windows-based computers are installed in the engineering multimedia teaching laboratory. These workstations consist of Pentium 200 MMX computers, and are pre-loaded with the software listed in Table 2. Although these machines constitute the lower-end of computers today they are still sufficient to introduce and teach multimedia. However, serious development of multimedia courseware requires faster computers with higher capacity hard disks and memory, as well as larger screens.

VI. Examples of Student Projects

The course ends in the exhibition of the student projects. The projects are based upon engineering concepts since the main goal of this course is to teach engineering students to use and develop multimedia presentations for technical demonstrations. To accomplish this, the project requires the student to demonstrate the ability to integrate the different aspects of multimedia. The project also requires the student to have a working understanding of how to create effective storyboards using multimedia principles. Good references for creating storyboards are *Creating Killer Web Sites: The Art of Third-Generation Site Design*^[6] and *Mind over Media, Creative Thinking Skills for Electronic Media*^[7].

For this course, the projects are based upon creating web presentations for teaching introductory college-level Physics to high school students under the K-12 education system. Figure 5 shows the main projects page, which is the navigation shell where all the different student projects will

be combined under the common Physics theme. Some of the graduate students have coordinated their project work with their thesis and dissertation research.

VII. Student Response

The comments from the students revealed that the project was the most important learning activity of the class. The project allowed them to put together the entire program, which involves the use of a variety of tools instead of just individual software. By doing the project, the students understand the role that different multimedia elements play in the creation of a successful engineering presentation. Each project was presented and discussed in a special class session. This discussion of the different presentation building techniques allowed the students to learn from each other.

The two main complaints in the class were the large amount of tools that have to be learned, and the lack of higher-end computers. The time span for learning the tools was about sufficient for the learning of all the tools although it was inadequate to teach the tools in detail. The lower-end machines used in the multimedia course was adequate in learning the basics of building effective technical multimedia presentations, but higher-end computers can improve the efficiency of the software tools. Nevertheless, higher-end machines do not guarantee an improvement in the pace of the multimedia course as dictated in the course syllabus. Additionally higher-end machines do not significantly increase the delivery speed of the web-based multimedia modules.

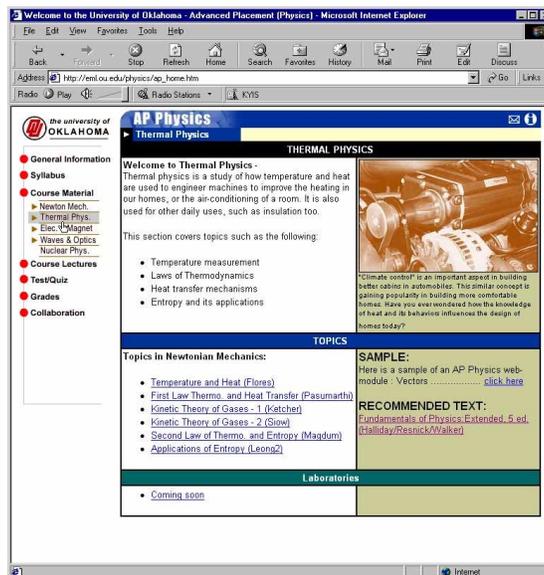


Figure 5. Navigation Shell of the Student Projects

VIII. Summary

Multimedia is changing the way engineering concepts are communicated on the Internet. It has the ability to visualize normally abstract engineering ideas from a different perspective. Instead of teaching a course from a textbook, the web-based course content actively involves the student.

This allows the student to see the capabilities of multimedia firsthand, and also how different media elements can be combined to create an interactive learning environment.

It is becoming more important for an engineer to understand how to apply this new form of technology to current engineering concepts. Multimedia brings a new dimension to training new engineers. During the last three years, the University of Oklahoma has been offering a web-based multimedia course to help educate both undergraduate and graduate engineering students in how to use multimedia in the engineering profession. The main objective of the course is to teach students to use multimedia in communicating engineering concepts and practices. This course includes teaching the fundamental tools behind creating multimedia programs such as Macromedia Director, Macromedia Flash, Adobe Photoshop, and Visuallogic Slicer Dicer. The only prerequisite for taking the course is that the students have basic knowledge of computers and a junior-level standing in the engineering curriculum.

Overall, the course has been a success in providing the students with a basic understanding of multimedia and its applications in engineering. The course also exposed the students to a number of software tools that can be used for reports and demonstrations. A recommendation is to provide an advance course in multimedia development. This new course can include the integration of dynamically generated multimedia components based on the knowledge acquired in the current multimedia course. A further follow-up communication with past students currently using multimedia will determine the success of the current multimedia course.

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Bibliography

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