THE UNIVERSITY OF OKLAHOMA
GRADUATE COLLEGE

THE DEVELOPMENT AND IMPLEMENTATION
OF ONLINE MULTIMEDIA ENGINEERING COURSES
FOR DISTANCE LEARNING

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OF ONLINE MULTIMEDIA ENGINEERING COURSES
FOR DISTANCE LEARNING

A THESIS APPROVED FOR THE
SCHOOL OF AEROSPACE AND MECHANICAL ENGINEERING

By

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ABSTRACT

This thesis presents research on using electronic media and the internet for teaching engineering courses. The purpose of the research is to develop a web-based application that allows an instructor to teach an engineering course through the internet. As the result of this research, a prototype was developed in the Engineering Media Laboratory (EML) using advance multimedia and internet technology. This prototype has been tested and was implemented in teaching a sophomore course, Engineering Rigid Body Mechanics or simply known as Statics, for three semesters, Spring 1998, Fall 1998, and Spring 1999.

The online course system enabled the instructor and students to conduct five activities of a class using electronic media over the internet. These five activities are class lecturing, student-instructor and student-student interaction, homework submission, examinations, and presentation of course information. In addition to those five activities, a number of multimedia simulations and tools were developed and used for demonstration and helping students solve engineering problems.

The prototype course was designed for the standard semester length of 15 weeks and was implemented during Spring 1999 for the core engineering course, Engineering Rigid Bodies (Statics). The original schedule required students to meet twice a week in a class and each class session last for 75 minutes. However, with the use of internet video lectures, student attendance in class was not necessary except for the final exam.

Streaming video technology was used to deliver the online video lectures. This research includes extensive video capturing, compression, and delivery experiments. Comparisons of different kinds of compression software, streaming format, video
cameras, audio equipment were done and the best solution for preparing video lectures was suggested.

Homework was assigned each week in multiple choice format and students were required to submit them before the due date. The submission was to be done through a web browser. Six quizzes and a final examination were also given throughout the semester in the same manner. However, students were required to be at the designated exam locations when taking the exams. This is to prevent collaborations among the students during the exam.

Instead of using a textbook, an interactive multimedia CD-ROM was used as the primary courseware. The CD-ROM contains all the topics required by the course syllabus. In addition to theories, it provided examples, simulations, and case studies with sounds, animations, simulations, and video to help students understand and visualize the real engineering problems.

By having all these activities in electronic form, the time and effort for an instructor to prepare and teach a course could be reduced significantly. For instance, the course contents and the lectures can be reused and be distributed easily. The online submission, auto-posting, and auto-grading system for the homework can helped in lessening the burden of the instructor teaching the course. The prototype course developed also consists of 400 Engineering Statics practice questions. They are all properly documented and formatted to fit into a database system.

This research also examines and discusses the pros and cons of teaching engineering courses through the internet. A comparison was also done between this
system and the existing commercial products. The result shows that this prototype does hold a few important advantages in teaching engineering courses.
CHAPTER 1

INTRODUCTION

1.1 Trend of online education technology

Over the past few years, the internet has been widely used for education and research purposes. People have realized that it will significantly affect the trend of educational technology. In particular, the ease of access, visualization, and information delivery of the internet have caused an increased interest in teaching college courses in part or completely online. The web based tutorial and application software has become a popular demand in the market. Currently, there are many large software companies developing course tools that help instructors to prepare online tutorial, for example, World Wide Web Course Tools (WebCT) by Universal Learning Technology Inc. and Attain by Macromedia Inc.

Many educational institutions have begun using commercial courseware development tools such as WebCT and Macromedia Attain to provide course material via the internet. However, there are numerous problems with the currently available courseware development tools. Researchers and professors [1] in many colleges are putting effort in developing efficient online course system.

Although the online course system developing process is time consuming, once it is perfected, it can be implemented to other courses. All that is required of the professors to extend the system to other courses is to generate the relevant content. These courses can be offered to students in other states or even in other countries. There are no space, time difference, or location constraints. It is also cost effective and time saving to maintain and update course contents.
1.2 Ideas behind the initiatives

Currently, there are commercial software tools that help instructors prepare online courseware but most of the companies focus on developing a system that fits a wide variety of disciplines and lack content-specialization. Therefore, there are limitations on using these web course tools. In addition, most of these tools do not provide actual contents and it only provides a system or a container for the instructor to place his or her content.

The online course system that was developed in the Engineering Media Laboratory for this research was designed specifically for teaching engineering courses. The system emphasizes the differences between teaching art or business courses, for example, free body diagrams, equations, and animations that are common to engineering. Most of the video lectures on the web today, especially for those teaching art or business courses, contain only ‘talking heads’ and the video clarity is not emphasized. Nevertheless, explaining a diagram on a black board or showing a 3D shape with both hands is often necessary in explaining an engineering concept.

Distance learning is a common term for describing a learning process where students carry out classroom activities, such as listening to lectures and submitting homework from a remote location. These activities can be done through the conventional postal service approach as well as through the internet. The ultimate goal is to allow students to complete a degree at home yet gain better understanding of the knowledge through an exciting learning experience.

In order to accomplish this goal, a complete system for teaching an online engineering course is necessary. This thesis has suggested alternatives for each of the
classroom activities and the course presentation to make the whole course available online. The alternatives were tested to be useful and beneficial for both students and instructors.

Since the online system was developed to conform to the university environment, the course schedule was set according to the semester system. Although, an ideal online course would allow students to take the course at his/her own pace, this system is designed for courses within the duration of one semester. Meanwhile, the students are expected to submit their homework and test according to a uniform schedule.

For presenting a class lecture, streaming video was used as a substitution. These video lectures can be viewed at any time and at any place over the internet. Meanwhile, to compensate for the lack of interaction between the students and the instructor due to the video lecturing implementation, an online chat-room, a drawing board, and a message conferencing were set up so that the students can post their questions.

With the use of advance technology such as video, interactive multimedia simulation, animation, and sound, engineering students can better understand and visualize engineering concepts.[2] Therefore, the content of the textbook can be better presented through the interactive multimedia CD-ROM. Since the course is offered through the internet, homework and tests should also be administered online. The online homework system has made both the assigning and grading of homework sets easier. These activities are discussed in detail at in Chapters 3 and 4.
1.3  **Efforts and infrastructure provided by the College of Engineering**

1.3.1  **Laptop program**

In the Fall of 1998, the College of Engineering (COE) at the University of Oklahoma (OU) implemented a Laptop Program, which requires every freshman engineering student to own a laptop. This program extends the use of electronic media for enhancing the engineering education. The College of Engineering has envisioned the future of the emerging internet technology and is encouraging the students and the instructors to make use of multimedia-based courseware to maximize the usefulness of the laptops. Over the next 4 years, all the undergraduate courses will be taught with the help of a laptop computer. The basic requirements for the laptops in 1999 are listed in Figure 1.1.

<table>
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<td>32 Mbytes RAM</td>
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<td>Hard disk</td>
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<td>Sound card</td>
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<tr>
<td>Operating system</td>
<td>MS Windows 98</td>
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<td>Other software</td>
<td>MS Office Pro</td>
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<tr>
<td>Other accessories</td>
<td>CD-ROM</td>
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<td></td>
<td>PCMCIA slots</td>
</tr>
<tr>
<td></td>
<td>Floopy drive</td>
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</tbody>
</table>

Table 1.1 Basic laptop requirement

As the Laptop Program is phased-in, COE suggests that all of the engineering freshmen courses utilize the laptop computer. Instructors are also encouraged to use multimedia and internet technology to present their course material such as animation or simulation.
1.3.2 Wireless network connection

A radio-frequency (RF) wireless network connection using Transmission Control Protocol/Internet Protocol (TCP/IP) is one of the services provided by the College of Engineering in conjunction with the laptop program. This allows the students and faculty to be connected to the network anywhere in the engineering buildings of the campus, both the Internet and OU's local area network. This program has greatly motivated research in the use of electronic media and Internet for creating a better learning environment due to the ease of use and the universal use of computers in all courses.

Furthermore, the RF wireless has a high data transmission rate (actual rates of 200-300 Kbps) than traditional infrared or modem-based connections, which helps with multimedia applications over the network. Therefore, the problems of having low bandwidth connection are almost eliminated. The wireless connection is made available in most of the engineering buildings, the student union, and in the library. It provides high-speed instant connection at anywhere and at anytime within a broad campus area. Also, the wireless connection is more stable compare to modem connection.

1.4 Literature review

There have been a lot of efforts in developing online courses both in the industrial and educational research institutions. The technology that was used in this online course system is new in the industry as well as in the educational institution. Many companies have been trying to find out the best way to educate or train their employees on the skills that are required for performing their responsibilities. A literature survey was done and
Some of the ideas were found to be agreed with the online system developed for this research.

Many educational institutions have begun to use electronic media to deliver the course material online. Hillman, A. L. and Wells, D.M.[1] mentioned the implementation of online courses with WebCT at their university as an experimental project and since then they have started moving towards offering electronic courses. They were amazed with the positive feedback of the students and instructors concerning the online course they developed. Currently, the system is widely used by professors at many universities as a supplementary teaching tool.

The delivery of course material over the internet proved to be an efficient way of offering distance learning courses. Monson H. Hayes and Lonnie Harvel[3] described that the distance learning is necessary and important so they can offer a masters degree curriculum at another university in France. They deliver the material via high-speed connections because both universities are connected with high bandwidth connections. However, for the online course system in this research, the targeted optimum bandwidth is 100 kbps, and therefore, the methods they are using are not applicable to the students with only wireless connection. In addition, the cost of implementation for delivering course material over high bandwidth network is high.

Murray Goldberg [4], a senior instructor at the University of British Columbia and CEO of WebCT Inc., said that the online course system with the real-time chat room helps students set up a networking with other students over the world. This statement supports the implementation of online chat room and message conferencing as useful for allowing students to interact among themselves and with the instructor.
Fazil T. Najafi et al [5] from University of Florida suggested a few options for having online conferencing. They implemented synchronous video conferencing over the internet. This helps the students to have direct cyber face-to-face interaction. This method is an alternative for having online chat. However, the high cost of high bandwidth connection limits this type of video conferencing.

There are some articles and papers that raise concerns having video lectures online. W. Timothy Holman [6] points out some of the key features that must be included in a video lecture. Among them is the need for a drawing board, a chalkboard or a whiteboard, so students can see what the instructor is explaining. Most of the online courses now being offered focus on ‘talking heads’ which is no different than just audio explanation with a picture of the instructor’s face. Some instructors add PowerPoint slides, nonetheless, for teaching engineering courses, instructor needs to be pointing at the diagram while explaining the concept.

Various articles were found agreed with what was discovered in the video compression experiment. Jae Yang et al. [7] published an article on PC Magazines, saying that the use of high quality digital camcorder in capturing video is not much different in final video quality compared to a cheaper one. This agreed with the finding from this research. Since the video lectures have been compressed so much, an inexpensive digital camera will serve the purpose for capturing the streaming video.

Jan Ozer [8] has commented that today, the only solution for posting videos is by putting them in streaming format. Internet users no longer have the patience to wait for large movies to download. Since the introduction of the streaming video technology, the video and audio quality of the compressed streaming video has been improved. This has
validated the implementation of the on-demand lecture using streaming video format is the solution for broadcasting video on the web.

For having online homework and quizzes, Jacob et al [9] said that providing immediate feedback is an important part of reinforcing desirable behavior. They replaced the manual homework in the first semester Electrical Engineering Technology circuits course with problems generated, administered, checked, and immediately graded over the World Wide Web. The results were displayed on the student’s screen allowing drill and mastery learning in a non-judgmental mode. These features conform to what have been done in the research for the online homework system, however, the software (Test Pilot) they used is only for teaching that particular course.

Grading tests is a tedious process especially for instructors teaching large classes. Il-Hong Jung et al [10] have developed a Multimedia Quizzer that allows the instructors to post the quiz online and the student submission will be automatically graded. In addition, the Quizzer will do an interpretation and analysis of student results, item analysis and test refinement, and report test results back to students. These evaluation features provide analysis for both instructor and students, which is helpful in understanding the overall student performance in the class.

1.5 Introduction to the objective of research

The purpose of the research is to develop a web-based application that allows instructor to teach an engineering course via the internet. This research also carries a goal of enhancing the efficiency of teaching and learning engineering courses by utilizing the advance multimedia and internet technology.
To make the learning experience more interesting and exciting, interactive multimedia courseware, which made use of animation, three dimensional graphics, and sound in presenting engineering concepts, should be utilized. A simulation should also be included at the end of each topic in the courseware to help the students further investigate into the case study by allowing the students to change certain parameters in the problem and view the results.

The repeatious and tedious nature of lecturing the same content every semester can be substituted with web based video lecturing. The online homework and quiz system provides auto posting, grading, and score retrieving features to both students and instructor. An efficient way of communication among the students and between the students and instructor is needed. Therefore, the use of a web based message conferencing tool is required. It allows students and instructor to communicate even after office hours.
CHAPTER 2

PRESENTATION OF COURSE MATERIAL

This chapter discusses the methods and technologies that were used for delivering course material such as course contents, course information, announcement, fundamental computer tutorial, and online video lectures. All the course materials were delivered via the internet except the course contents. The methods and technologies mentioned were used for the Statics class during Spring 1999.

2.1 Course website

The course system that was developed for this research used web pages as the primary container. All the course information such as class schedule, syllabus, grading scale and instructor’s information were posted on a dedicated course website using basic HyperText Markup Language (HTML). This site can be found at eml.ou.edu/statics/home.htm. The title page contains the information about the instructor and the class announcement.

The website was divided into two frames as shown in Figure 2.1. On the left frame, a global navigation menu provides an interface for the students and the instructor to access four different categories. The four categories are General, Homework, Quizzes, and Lectures on Demand. Later in this section, the elements in the General section will be explained. Functions and features of Homework and Quizzes categories are discussed in Chapter 3, while the Lectures on Demand category is discussed in Section 2.3. The right frame is a content page that displays the current category that the user is accessing.
Within the General section, there are links to all the course information, utilities, message-conferencing, and administration site. The course information pages contain information on the course syllabus, grading scale, computer use guidelines, and student information. Also, in this group of links, there is a link to WebBoard. WebBoard is a commercial software that allows users to post messages and pictures. Since the students are not meeting in the classroom, all questions are posted through the WebBoard. The full features of WebBoard will be discussed in Section 3.5. Snapshots of course syllabus, grading scale, guideline on computer use, and student information are shown in Figures 2.2, 2.3, 2.4, and 2.5.
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</tr>
<tr>
<td>Week 14</td>
<td>13, 15 Apr</td>
<td>8.1, 2</td>
<td>Friction</td>
</tr>
<tr>
<td>Week 15</td>
<td>20, 22 Apr</td>
<td>10.1, 2</td>
<td>Work and Energy</td>
</tr>
<tr>
<td></td>
<td>27 Apr</td>
<td></td>
<td>Quiz 6, 11:00 - 11:45 (Week 12-14)</td>
</tr>
<tr>
<td>Week 16</td>
<td>27, 29 Apr</td>
<td></td>
<td>Problems, Review</td>
</tr>
<tr>
<td></td>
<td>3 May Mon</td>
<td></td>
<td>Final 8:00-10:00 (All materials)</td>
</tr>
</tbody>
</table>

Figure 2.2 Course syllabus
http://eml.ou.edu/statics/syllabus.htm
Figure 2.3 Grading scale

Figure 2.4 Guidelines of computer use
2.2 Course content

For the electronic course system in this research, the course content was also completely done in electronic form. Instead of using the regular textbook, an interactive multimedia CD-Rom called Multimedia Engineering Statics (MES) developed by Engineered Multimedia Inc, was used. Students were required to purchase the CD-Rom costing $7.80 each. It was cheaper than a standard textbook with just pure texts and diagrams.

The CD-Rom contains ten topics that were taught in the class. The main menu of the courseware is shown in Figure 2.6. For each sub-topic, the theories are presented based on a case study. The case study involved real life engineering problems such as a
crane structure, utility truck, and roof trusses. Animations, sounds, video, and 3D graphics were used in illustrating the cases and theory for each course concept.

In each sub-topic there is an introduction, theory, solution, and simulation section as shown at the bottom of Figure 2.7. An engineering problem is introduced to the students each time they start a topic section. In the introduction, the question statement is given and the approach is discussed. Then, the engineering theory that applies to the problem is explained and followed by the solution of the problem. This step-by-step approach provides a guideline on how to solve an engineering problem in the future.

At the end of each topic, there is a simulation. The simulation, as shown in Figure 2.8, allows student to change a few parameters of the problem and view the results instantaneously. MES has efficiently made use of multimedia capability in presenting engineering ideas. The use of 3D animations, simulations, sounds, and interactivity help increase the excitement of the learning experience.
6.1 Howe Roof Truss
2-D Trusses: Method of Joints

Introduction
- A physical Howe roof truss must support roof loads and a building load. Both types of loads are modeled as point loads at the truss joints.
- What is known:
  - The width of the truss is 10 ft.
  - The angle B is 45°.
  - Load A is 4 kips.
  - Load B is 0 kips.
  - Load C is 4 kips.

Question
- If the Howe roof must withstand all three loads, A, B, and C, at the same time, then which member will have the largest tension force and which member will have the largest compression force? What is the value of each of these loads?

Approach
- Use the method of joints to analyze each pin joint using the basic statics equations:
  \[ \Sigma F_x = 0 \]
  \[ \Sigma F_y = 0 \]
- Each joint must be in equilibrium. Only two unknown member forces can be determined per joint. Each member is a two-force member.

Figure 2.7 Example of a chapter in MES [11]

Figure 2.8 Example of a simulation in MES [11]
2.3 *Video lecture*

With the current advances in network technology and streaming video over the Internet, it is now possible to broadcast actual engineering lectures over wireless networks with reasonable quality. Since lectures are a critical part of most engineering programs, it is important that any distance learning course, whether on or off campus, include quality video of lectures. Also, making the ordinary classroom lectures into video clips and having them available on the Internet enables students to review the lectures much easier, allowing students to learn at their own pace.

2.3.1 *Research performed on the technology*

In order to put video on the Internet, video-streaming technology needs to be utilized so that the viewers do not have to wait for a long download time before begin viewing the video. With streaming techniques, a student can be viewing while having a new video transferred concurrently over the Internet. This means students can see the movie as soon as their browser has downloaded the first few seconds (depending on the buffering time) of the movie. However, there are a number of concerns and problems that must be overcome. First is the data rate of the streaming video. Second is the quality, which is directly tied to the data rate. And third, the classroom environment needs to be considered to insure a quality video. Overall, what seems to be a simple problem, becomes complex when other factors are considered such as, which streaming technology should be used (NetShow, Vivo, QuickTime, Real Player, etc.), camera type (VHS, Digital, Hi8), viewport size, room lighting, sound capture, and compression time.
The main purpose of this section is to look into the issues mentioned above and to compare different solutions. All testing and evaluation in this section was done for engineering lectures where data on the board is more important than seeing the professor's face. This introduced a unique set of comparison parameters that have not been addressed in traditional review papers in trade publications. Each of these are covered in this section. This section will first look at video capturing, then video compression. Following that, video and audio properties will be addressed. Editing software, hardware requirements, and server hosting will also be discussed.

2.3.2 Video capturing in classroom

Before a video lecture is digitized or brought into a computer, the lecture must first be captured using a video camera and stored on tape. The quality of the video and sound captured is important for reproducing quality streaming video. The old saying, "garbage in, garbage out" is certainly true for producing quality streaming video. There are several issues taken into consideration while capturing the video lectures such as the lighting in the classroom, the contrast of the board and the writings, and the distance of the camcorder from the green chalkboard.

The videos presented in this section were captured during a regular 50-minute class lecture. A typical lecture was given in a conventional classroom with a green chalkboard at the front and equipped with fluorescent lights. The camcorder was stationed at the back of the classroom on an ordinary tripod. For an engineering lecture, the action of a professor or a lecturer in the class is less important than equations and diagrams written on the board. Therefore, the capturing process needs to focus on the board at all
times, and not on the professor. This also requires the professor to write clearly and not move around. All motions cause compression difficulties and make the data rate larger.

Although, most of the camcorders have sensitive built-in microphone they are generally of low quality and do not clearly capture voice recording with background noises that are common in a large classroom. This is due to the relatively long distance between the lecturer and the camcorder. In addition, student voices are also recorded when the camcorder's built-in microphone is used. As a solution, a small, inexpensive remote microphone was used as the sound input device instead of the built-in microphone. It is small and can be clipped onto the lecturer’s tie or collar. The remote microphone is connected to a pocketsize transmitter, which then sends the signal back to a receiver. The output of the receiver is then connected to the camcorder as an external microphone. The sound quality is excellent when even using inexpensive wireless microphones.

The next main issue with the classroom is the actual writing surface. A black or dark green chalkboard and white chalk under normal classroom lighting works well. An important factor in recording writings on a board is the contrast and glare. The plain green chalkboard used in this study provided one of the highest contrast and the best visibility. Additional lighting actually made the texts and drawings look blurry on the board. However, one problem with the chalkboard is the smeared chalk marks when erasing. This is easily solved however, by using a wet sponge instead of a regular eraser, for cleaning the board. This eliminated the thin chalk film and greatly increased the contrast. The disadvantage of using the wet sponge is the board takes about 30 - 45 seconds to dry. Substituting the chalkboard with a whiteboard solves that problem, but
because of its smooth surface, whiteboard generally produces a glare on its surface. The glare regions do not view well on video.

Another major concern is how far should the camcorder be positioned. Although camcorders come with digital zoom feature, some digital zooms simply dither the image which gives a false sense of zooming. Therefore, the camcorder should be placed close enough to the board so that it will stay within the optical zoom range.

### 2.3.3 Video compression for streaming format

After capturing the lecture, the video needs to be brought into a computer that has a video capture board installed. The videos discussed in this section were digitized using both PC and Macintosh computers. Therefore, both Audio/Video Interleaved (.AVI) and QuickTime (.MOV) file format were used as the general file types in this study. They are the main two file formats currently available for basic digital video, capture and storage.

When the video is actually captured, most video-capture boards use their own proprietary hardware compression techniques whether it is AVI or QuickTime. The built-in hardware compression is generally faster in compression time compared to software compression because the video is being compressed while it is being imported from the camcorder. The software compression requires the video to be first captured and stored in the computer, and then compressed using special compression software. Although the quality of the hardware-compressed video is higher, two problems exist. First the file size is still too large and the compression and decompression schemes (codecs) are not common to other play back systems. If a movie file is big, a higher data transfer rate is required to play the movie smoothly. Since videos are designed for streaming over the
Internet that can only transfer up to 200 kbps over the wireless network connection, the size of the video files has to be small. In addition, for viewing the compressed video, the viewer needs to have the similar codecs and the plug-ins or players installed. Hence, the common codecs for audio and video needs to be used which is possible with recompression in software. This step is further discussed in the following sections.

Next, the movie size is also another important consideration because some of the compression techniques require the movie to be compressed to a certain size for optimum compression. There are two types of raw video format being discussed in this section. First is the analog video format, which is used in VHS or Hi 8 camcorders. The second is the digital format, which is used by digital camcorders. The digital format was used for the three test courses at OU because it provided slightly higher video quality and the digital camcorder is relatively inexpensive. The standard movie size captured in digital format is 720x480 (3:2 ratio), while for the analog format is 640x480 (4:3 ratio). Currently due to the video capture board limitation, a digital video can only be captured at the standard settings, of 720x480, 30 frames per second, and uncompressed. Thus the maximum file size is 2 Gbytes which is about 9.5 minutes long. On the other hand, for analog video, the file size depends on how well the hardware can compress. With the video capture board (Radius Moto DV board) used in this research, a 5 minutes analog video (30 frames per second, 24 bits color depth, 44kHz and 16bits stereo sound) is about 284 Mbytes. The final compressed video lecture using software compression for a 9.5 minutes segment is approximately 8 Mbytes for both formats. Although the processing time is longer for compressing a digital video, the final quality of the compressed video is
higher. The video capture boards and camcorders used in the experiments will be further discussed in section 2.3.6.

2.3.4 Video and audio properties implemented

Currently, there are several software tools available in the market that can be used to produce streaming video for teaching engineering courses. However, this section only studies four common video compression software: Netshow Encoder 3.0, Real Publisher 5.0, Apple QuickTime with Sorenson codec, and Vivo Active Producer 2.0. Netshow and Real Publisher movies can be encoded only on the Windows NT platform while the Vivo Active and QuickTime movies can be encoded on both Macintosh and Windows NT. In this research, a movie size of 320x240 pixels and a frame rate of 10 frames per second were found to be sufficient to be able to view equations and diagrams. The audio settings were set at the minimum audible level, so that the streaming rate for audio could be minimized.

As mentioned above, an analog movie size has an aspect ratio of 4:3, whereas it is 3:2 for a digital movie. These ratios are set by the camera hardware and can not be modified during capturing. In addition, most of the compression techniques recommend the movie size (height and width) to be divisible by 16 for higher compression. Since the analog and digital formats use different movie size ratio, if a uniform movie size is forced, the final compressed video will most likely be stretched vertically or horizontally. Therefore, in order to avoid scaling effects, different movie sizes were implemented for compressing digital and analog videos. The sizes chosen for different compression techniques are for the optimum quality and streaming performance. Table 2.1 shows the
general video information and parameters that were used in the experiments discussed in this paper where four different kinds of compression methods are compared.

<table>
<thead>
<tr>
<th></th>
<th><strong>Analog Video</strong> (pixels)</th>
<th><strong>Digital Video</strong> (pixels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Netshow Encoder</td>
<td>320 x 240</td>
<td>336 x 224</td>
</tr>
<tr>
<td>Vivo Active Producer</td>
<td>320 x 240</td>
<td>342 x 228</td>
</tr>
<tr>
<td>Apple QuickTime</td>
<td>360 x 240</td>
<td>360 x 240</td>
</tr>
<tr>
<td>Real Publisher</td>
<td>320 x 240</td>
<td>360 x 240</td>
</tr>
</tbody>
</table>

*The movie size is not necessary divisible by 16.

Table 2.1 Movie sizes for different compression software

The other settings for the movies that effect the data rate include setting the frame rate to 10 frames per second (fps), the audio to 11kHz and 8 bits, and mono voice quality. As will be identified in Section 2.3.6, the digital format provided the highest quality among all formats and thus used for capturing the classes in this study.

2.3.5 **Editing software**

There are several features that need to be considered while choosing compression software. First digital format produces large file sizes (2 Gbytes for 9.5 minutes), so the actual lecture needs to be divided into smaller segments when importing them into the computer. For a 50-minute lecture, the video can be divided into six segments and stored as different movie files. Usually, a 9.5-minute movie might take up about 40 to 100 minutes to be compressed into streaming format depending on which software is used. Therefore the total processing time is about 4 to 10 hours for a single, one-hour lecture. For this reason, without the batch-processing feature, each movie needs to be attended to at all times to get all movies processed. On the other hand, analog format produces
smaller video file sizes (450 Mbytes for 9.5 minutes) and thus the compression time is also shorter. However, the video quality is lower than digital video.

Platform dependency and the player control panel are another two criteria to be evaluated. To serve the purpose of teaching an engineering course, the targeted viewers, students, generally uses computers with Windows. However, there are still some researchers and faculty members using Macintosh and Unix platforms. Table 2.2 provides a comparison of the different platforms where the streaming videos can be both compressed and played.

<table>
<thead>
<tr>
<th></th>
<th>Netshow Encoder</th>
<th>Real Publisher</th>
<th>Apple QuickTime 3.0 Sorenson</th>
<th>Vivo Producer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Batch processing</strong></td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Player control:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seek bar or movie slider</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Information display</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Direct to markers</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Common codecs:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio</td>
<td>MPEG 3</td>
<td>Real Audio</td>
<td>QDesign Music Sorenson</td>
<td>H. 723</td>
</tr>
<tr>
<td>Video</td>
<td>MPEG 4</td>
<td>Real Video</td>
<td>Sorenson</td>
<td>G. 263</td>
</tr>
<tr>
<td><strong>Compression time</strong></td>
<td>2:30</td>
<td>5:00**</td>
<td>25:00</td>
<td>10:45</td>
</tr>
<tr>
<td>(for one minute actual video)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* QuickTime 3.0 is a video format that uses various codecs that can be installed and used by any other editing software such as Media Cleaner or Premiere on both Windows and Macintosh platforms.

** Does not automatically compress the movie size. Resizing was done in Premiere (5 min)

Table 2.2 Comparison of features of four different compression techniques
For playing a relatively long video clip, having a dynamic navigation control over the video is helpful. For example, a student can always use the slider or the seek-bar to get back and forth to the section that he/she missed or is unclear about without playing the whole video again. Most of the players will allow the video producer to display information about the movie on the player such as the author, the date, and copyright information (refer to Figure 2.10 for information display panel on Netshow player). Some players such as Netshow player and Real player even allow users to directly forward to a certain preset marker. Table 2.2 gives a comparison of several features in 4 different kinds of software mentioned. Figure 2.10 shows different interface of the players. All of the playback players or plug-ins are free and downloadable from the web.

The four compression streaming video tools studied in this paper are capable in producing quality streaming video, however, there are pros and cons in each of the software. For the Statics course mentioned, Apple QuickTime with Sorenson compression technique was used for compression because of its batch-processing capability (using Media Cleaner Pro) and its slider function on the player.

The whole video lecture is first brought into the computer in about six 9.5-minutes segments. Then, they are processed using a video editing tool such as Media Cleaner Pro for further compression with QuickTime using Sorenson compression format and other desired video settings (frame rate, movie size, audio quality, and streaming rate). Among the four software studied, Media Cleaner Pro take relatively long hours to process a video into QuickTime with Sorenson format. However, Media Cleaner, which has a batch processing feature, can be set to process all the segments overnight and thus reduces the total man-hours required.
In comparison to QuickTime with Sorenson codec, Netshow has a faster compression rate but the quality produced is lower. The compression rate determines how soon can a streaming video lecture be prepared once the lecture is captured. Vivo Active movie does have comparable quality as QuickTime but there is no navigation bar or slider available on the player. Hence, the viewer needs to replay the whole movie in order to get back to a particular section. Real Publisher produces reasonable quality video but it does not resize the raw movie into the desired size. The movie needs to be compressed down to the desired size in another editing software before it can be run in Real Publisher and thus adding editing time.

2.3.6 Hardware and video format

Choosing the right equipment can increase the cost effectiveness of producing quality streaming video. Essentially, there are only three pieces of equipment required, a camcorder, a computer, and a video capture board. However, to produce higher quality video, other tools can be used such as remote microphones and fast hard drives. The compression time is directly related to the hardware performance such as CPU speed, hard drive speed, and memory capacity.

After the video capture board and software are installed, video can be captured from the camera (or VCR). The video capturing software is first started and then the video is played. Next, the video can be saved as a movie file onto the local hard disk for latter compression. For importing digital video, a SCSI hard drive is required because of the large amount of data being brought in per second. If the writing speed of the hard
drive cannot handle the capture rate of the board, loss of data, such as frame drops, will occur. The Windows and Macintosh systems configuration used are listed as in Table 2.3.

<table>
<thead>
<tr>
<th>Windows NT platform</th>
<th>Macintosh platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Pentium II 266 MHz</td>
<td>- PowerComputing PowerCenter Pro 210</td>
</tr>
<tr>
<td>- 9 Gbytes Ultra Wide SCSI hard drives</td>
<td>- 128 Mbytes RAM</td>
</tr>
<tr>
<td>- 128 Mbytes SDRAM</td>
<td>- 13 Gbytes Ultra SCSI hard drives</td>
</tr>
<tr>
<td>- SCSI interface card</td>
<td></td>
</tr>
<tr>
<td>Video capture board:</td>
<td>Video capture board:</td>
</tr>
<tr>
<td>- Analog : Winnov Videum Capture board</td>
<td>- Analog : Miro DC 20</td>
</tr>
<tr>
<td>- Digital : DPS spark DV board</td>
<td>- Digital : Radius Moto DV board</td>
</tr>
</tbody>
</table>

Table 2.3: Computer used for video compression

For this project, three different types of video format were examined, Digital, Hi-8, and VHS. These three were used to represent the standard video format for broadcast, industrial, and home consumer quality. To obtain the digital format, a Canon digital camcorder was used for capturing the video. On the other hand, VHS and Hi-8 format were used for capturing analog video. Figure 2.9 below shows three snapshots of the movie compressed using the different video formats. As shown, digital video has the highest contrast and video resolution. The number of horizontal pixels shown in Table 2.4 portrays that the quality or resolution of the digital video is higher than Hi-8 and VHS video.
Figure 2.9 Quality comparison on three types of video format. All were compressed using Netshow Encoder at 336x224. (Printed size is half of the original size at 144 dpi)

<table>
<thead>
<tr>
<th>Camcorder model</th>
<th>VHS</th>
<th>Hi-8</th>
<th>Digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of horizontal pixels</td>
<td>240</td>
<td>400</td>
<td>480</td>
</tr>
<tr>
<td>Standard</td>
<td>Consumer</td>
<td>Industrial</td>
<td>Industrial/Broadcast</td>
</tr>
<tr>
<td>Common tape length(min) in short play mode</td>
<td>30</td>
<td>120</td>
<td>60</td>
</tr>
<tr>
<td>Signal</td>
<td>Composite</td>
<td>S-video</td>
<td>Digital (Firewire IEEE 1394)</td>
</tr>
</tbody>
</table>

Table 2.4 Standard comparison of 3 different kinds of video format.
Vivo Active Player
(Embedded into web page)
342x228, 144 dpi

Windows Media Player
(Netshow files, .asf, .asx)
336x224, 144 dpi

Real Player
(Real Video files, .ram, .rm)
360x240, 144 dpi

Apple QuickTime 3.0
(QuickTime Movie, .mov)
360x240, 144 dpi

Figure 2.10 Comparison of four different kinds of player interface. Note that the size indicated is the size of movie region and the printed size is half of the original.
2.3.7 Serving and hosting streaming video

A major concern in configuring a server for hosting streaming videos is the network bandwidth. Without determining the bandwidth that the user’s Internet connection can handle, the streaming video will not be continuous. For example, if the streaming rate is set higher than the maximum data rate a user can receive, then the video will pause half of the time and this can be annoying to the user. Therefore, the video was designed for low bandwidth (100 kbps or lower) capabilities on campus. Wireless connection provided by the College of Engineering at the University of Oklahoma can transfer up to 1.5 Mbps for each transceiver, which are installed around the College of Engineering as the signal transmitter and receiver. However, a transceiver can serve up to 10 connections at a same time. Therefore, the target-streaming rate was set to 100 kbps. It is also found that to provide reasonable audio and video quality of streaming video, 100 kbps was sufficient.

There are two ways of serving out streaming video. The first one is streaming it from a regular web server without any special software and the other is to use a video-streaming server. For serving only a few videos, a basic web server works well. However, if the number of videos and viewers increase to over 30 or 40, a dedicated streaming server becomes necessary. For the experiments described throughout this paper, all the streaming videos were tested on a web server running Microsoft Windows NT Server 4.0. The processed videos were placed on the server and then linked by HTML code to the video on the server. This required no special streaming software on the server.

It should be noted that QuickTime, Vivo and NetShow videos do not need any server software to broadcast. RealPlayer streaming video requires a special software
program running on the server to allow users to stream the video. In all cases, each visitor to the web site starts a separate video streaming session. If the number of visitors is large, then a multicasting technique can be used to minimize the number of streams at any given moment. This technique requires a dedicated server and special server software, which can be costly.

2.3.8 Cost and Ease of Implementation

The equipment that was used for this research to produce the streaming video for both courses at OU, Statics and Leadership, were relatively inexpensive. First, the digital camcorder was approximately $1500 (Note: all prices is based on Dec. 1998). A computer with digital video capture board and an Ultra Wide SCSI hard drive installed was less than $3000 (the SCSI interface is needed for high data transfer from the camera to the hard disk). Additional accessories such as remote microphone, tripod, and compression software cost another $1000. The above figures do not include the cost for Internet connection, the cost of setting up server, and or the time needed to tape the video or process it for serving on the web. The computer that was used to process the video was also used to serve the video. Once the video lectures are organized properly, they can also be reused in subsequent semesters and thus save time, money, and effort.

For the courses mentioned, the whole process for preparing a streaming video was done by a single person. Once the initial video is set up and developed, the whole process of taping a 50-minute lecture, processing the tape, and placing the final files on the server will take less than one and a half-hour. The video compression can be done automatically in batches and thus the actual operator time is minimal. For processing a
regular 50-minute video lecture, the total computer time required is about 12 hours, of which only one or two hours of actual operator time is needed. It should be noted that the live streaming is possible so that the full process can be automated, but the quality of the compressed video will be low. For best results, the video should be processed off line.

2.3.9 Discussion on implementation of video lecture

Implementing streaming video is actually fairly simple and can be done with a small investment. From the test done at the University of Oklahoma for two different engineering courses, it was found that producing streaming video for a lecture was time consuming, but if the lectures are properly organized, they can be reused, which will save time and justify the initial large time investment. It was also determined that the type of camera (Digital Video, Hi8, SVHS) had only minor effect on the final quality of the streaming video. The compression methods had the largest effect on the size and quality of the final video.

Furthermore, to decrease the data rate and still have high quality, the movement in the video must be keep to a minimum. The camera should not pan and the instructor needs to use only a predetermined portion of the writing board. This does cause the instructor to change his or her writing style, but the increased video quality is worth the effort.

Throughout the research, QuickTime was found to be the most suitable format for the video lecturing purposes. Among the video formats, QuickTime provided the highest video quality at 100 kbps data rate. It was the easiest to be compress and embed on web pages. Also, QuickTime allowed the students to download the movie by clicking on the
option menu and selecting save movie. The saving process can be done immediately because the movie is saved in the browser cache when the student views for the first time. The file size of the final version of movie is as small as 7 Mbytes for 9 minutes. In addition, there are some basic editing capabilities, such as cropping, resizing, rotating, cutting, copying, and pasting provided by the QuickTime player after compression editing.

There are several other future research possibilities in this area that can improve and enhance the implementation of streaming video. For example, currently, to view a streaming video, viewers are required to download and install a plug-in for any given video format. One of the research possibilities would be developing a streaming technique that requires no plug-ins. It could be either using Java or other built-in function of the browser.
CHAPTER 3

ONLINE HOMEWORK AND TEST

Besides course materials, homework and tests are also major components of a course. Hence, a good homework and test system is very important in providing useful practice and evaluation for students. This chapter will focus on discussing an online homework and test system that allows the instructors to set up and the students to submit homework and quizzes totally online. In this system, students are encouraged to share their difficulties with others. A message conferencing software tool, WebBoard, was used as a communication tools within the instructor and the students outside of the classroom.

3.1 Online homework assignment and submission

In order to allow students to submit homework from a remote location, homework web page is required. Once the students click on the homework page link, a login page will be brought up on the right frame as shown in Figure 3.1. At the lower right is a table that contains the homework schedule. From this page, student can access to the homework question, solution, review submission, and score pages. Several sections among the course website were personalized and secured with password so that only enrolled students can gain access. This is needed because each student is assigned an account and through the account they can submit their homework, quiz, and check their individual assessment in the class. In order to identify which student access to what information, a login name and a password is required.

The online system requires students to first create their personal login information and a confirmation page will prompt the student once all the information are submitted
and verified. This section will focus on how the students and the instructor use the online homework assignment and submission system whereas Section 3.1.1 to Section 3.1.3 will explain in detail the actual programming structures.

During the semester of Spring 1999, a total of 14 homework were assigned to students and they were done electronically via the internet. Each homework consists of 7 to 8 questions and their relevant graphics that were put together using HTML. The graphics were drawn using Macromedia FreeHand (a vector-based graphic drawing tool) as shown in Figure 3.2.

Since the course has been offered for three semesters, all homework questions were put together in a uniform format for future use. They were organized in a large database (about 400 questions) according to topics. Unique HTML tags were included in each question so that they can be retrieved and posted in multiple-choice format.

To reduce the difficulties of accessing pages that need password, a web cookie was placed in the students’ computer memory for storing login information after the student has logged in for the first time. The student can then navigate around the rest of the pages that require password without retyping their username and password. This is because these pages will first try to retrieve the cookie from the student’s computer memory, then if it is not found the web site will prompt the student for username and password again. However, the cookie is only an optional feature and students can turn off the cookie option on their browser to avoid other security concerns from other public web sites.
Figure 3.1 Homework login page
3.1.1 **PERL as the primary web based programming language**

In order to allow students to submit their information to the server and get an instantaneous response based on their input via the internet, a Common Gateway Interface (CGI) is required. Practical Extraction and Report Language (PERL) was chosen as the backbone CGI programming language in this research because of its platform compatibility and its robust variable handling capability. There are several other options, such as Visual Basic scripts, ASP, and Java programming language, however, PERL was found to be the simplest to use and was best suited to provide network data transfer.
PERL was originally developed on UNIX platforms as a network programming language. Nevertheless, throughout the years, as Windows platforms become more popular, various PERL compilers have been developed for the Win32 as well. This project used the PERL compiler from Active State Inc. PERL scripts remain in ASCII text format while being executed through the PERL compiler installed on the server. PERL compiler is free and made available on the Active State web site for download. On the other hand, Visual Basic script, an alternative to PERL, that generates the Active Server Pages(ASP) can only be placed on Windows NT servers.

3.1.2 Login setup process

Before a student can get into any of the pages that requires password, they must setup their login information, such as last name, first name, email address, student ID, and a selected password. The login setup page is shown in Figure 3.3. Once the student clicks on the submit button, a PERL script will be executed and input data will be submitted to the server. The PERL script will then check for the following errors and requirements:

- All the information must be entered
- Email entered cannot contain space
- ID number must not already exists in the database
- ID number must exists in the class roll (meaning that the student must be enrolled in the class)
- ID number must consists of exactly 9 digits
- The first entered password must be the same as the confirmed password
Figure 3.3 Login setup form

Figure 3.4 Login setup confirmation
If data entered by the student passes all criteria, then an account will be created. A confirmation page will be printed to the browser showing the recorded student information as shown in Figure 3.4. The student information is then stored into a database and a directory is created for storing homework data in the future.

3.1.3 Homework page layout, question formatting, and solution page

The homework page contains 2 major columns. The left column is set at 240 pixels wide for a GIF or a JPEG picture while on the right is set at 320 pixels wide for the problem statement. Therefore, the diagram graphic is restricted to 240 pixels wide. Figure 3.2 shows an example of the homework question page. Each question in a homework set was pull out from a database that was mentioned in Section 3.1.

A homework set normally consists of 7 to 8 questions and each of the questions is stored in different directory in the database. The mechanism for retrieving a particular question from the database and posting them onto the web page is done using PERL. Once students successfully login to the homework page, a PERL program reads a set of question numbers that are preset by the instructor and retrieves the individual homework HTML files. An example of homework HTML code file can be found in Appendix A.1.

There were 5 special tags embedded into each question HTML file. They are <start>, <pic>, <endpic>, <submission form>, and <end>. These tags, developed for this project, are indicators for the PERL program to perform certain functions. First the program will read through the HTML codes line by line and search for <start> tag. Then, the program will start printing the following HTML codes in the remaining of the HTML file (refer to Appendix A.1 for an example of HTML file) file onto the browser and until
it finds `<pic>` and `<endpic>`. That tells the PERL program to print an image tag with the proper image file location onto the page. The PERL script then continues to read on until it finds the `<submission form>` tag, where the multiple choice form tags as shown in Figure 3.2 will be printed. Finally, the `<end>` tag in the HTML source code will stop the reading process and move on to the next question until all the questions are printed.

In addition to the problem statements, students can also access the solution online. This process allows all the questions to be placed in the same frame with a single submit button. The solution page for a particular homework is only accessible after the homework is due. However, students are allowed to review their submission before the homework is due. Solution page consists of 2 columns and has the similar format as the question page. Figure 3.5 shows an example of the solution page that was used in Spring of 1999.

The online homework system also helps the instructor to post homework on the web by just selecting the questions they want to assign. These will be further discussed in Section 3.3. Most of the instructor using the conventional textbook teaching method will assign questions from the book. This online system uses similar approach except the questions and solutions are kept in a database and the answers submitted by the students can be automatically graded. Students can also retrieve their score and grades immediately after the homework is due. Both the instructor and the students will save significant amount of paper work in keeping track of the records. An additional feature that will be added to this system in the future would be allowing instructor to add more questions into the database.
3.2 Tests and quizzes

Throughout the semester of Spring 1999, 6 quizzes were given and all of them were taken by students completely over the internet during the class session. However, students were required to take the quiz at a specific start and finish time. The login and page format was similar to the homework except there was a timer provided. The timer synchronized the server clock and showed the exact remaining time for the students who were taking the quiz.
Since the students were taking the test at the same time, the automated timer also allowed the instructor to preset the quiz posting and due time. For example, if the quiz starts at 10:30 am and lasts for 50 minutes, the instructor only needs to set the timer to start at 10:30 am, end it at 11:20 am, and the quiz date. Then, the quiz page will only be accessible at that particular time. When the quiz time has ended, the timer will automatically prompt the students to submit their answers. If they do not submit within 5 minutes, points will be deducted from the final score. The source code of the PERL programs can be found in Appendix B.

3.3 Course administration for instructor

To offer an online course, managing the students' information, course material, and homework questions over the internet is compulsory. This feature enables the instructor to set up the whole course completely from a remote location. The course administration site is simply an interface for the instructor to set up a course and manage the course material. The PERL program on the server takes the form data and then does changes on the course information files in the database. The administration page contains 4 sections, student, homework, quizzes, and lecture on demand.

The student section is for managing the students’ information, such as adding and deleting a student in the class, overwriting homework score for a particular student, and changing students’ information. The second section is for administering the homework questions. This feature allows the instructor to add and delete homework set, select the homework questions from the database, editing the score distribution, and changing the homework schedule.
The quiz section provides similar features as homework administration. The last section provides an interface for instructors to select which video lectures to be included in which week. These features have made the administration of the whole course much easier than asking each instructor to do the editing of the settings on the server. Figure 3.6 shows the interface of the administration site. The source code of the PERL programs can be found in Appendix B.

Figure 3.6 Course administration site
Figure 3.7 Homework question management

To set up homework, instructor can select questions from the homework database. Figure 3.7 shows how the instructor can assign homework questions with a user-friendly interface. The left frame displays all the chapters and subchapters in the course. All the homework questions were categorized into 2 groups, easy and hard. The right top frame shows the questions of that group in that section. To add a question into the homework set, the instructor can simply click on “Add this question”. This page will then be refreshed and the selected question will be added into the table at the right bottom frame. If the question is selected for a homework set, statement telling which homework set and which problem number it has been assigned to will replace the ‘Add this question’ button.
3.4 Grade and score report

One major advantage of using electronic media for homework and testing is that, the students’ scores and grades can be calculated automatically. When a student submits a homework or a quiz, a PERL script will automatically compare the submitted answers and the correct answer on the server. Then the calculated score is recorded in the student’s directory at the server. Students cannot access their grade until the homework or quiz is due.

There are 4 options in the homework login page as shown in Figure 3.1. Once the homework or quiz is due, the link to the score and solution is automatically activated and students can see and compare their answer with the instructor’s answer. However, before the homework or quiz is due, students can always check what they have submitted to make sure they have made their submissions correctly. Examples of student’s score report for homework is shown in Figure 3.8. The time and date of submission are recorded as well. Students can make as many submissions as they want before the due date, however, only the last submission is graded.

Before any homework or quiz is assigned, the instructor needs to enter the weight of total homework and quiz on the overall grade. This is compulsory in calculating the averages and final grades. For the Spring of 1999, the students were given a chance to drop one score from both the homework and quizzes. The PERL program automatically drops the lowest score and then computes the final grade. Prior to the final examination, a predicted grade is given based on the up-to-date scores from homework and quizzes. Figure 3.9 shows a web page where students can review a summary of their scores and the grades in the class.
Sometimes students will have special excuses for submitting their homework late or not taking the quiz. Therefore, this system allows the instructor to overwrite the students score in the database. There are two columns for scores in the table shown in Figure 3.9. The first column is for the actual score that the students should get if there is no special changes. The second score is the recorded score or final score that has taken consideration of late submission or other special excuses.

Figure 3.8 Individual homework score report
Score Report for John Smith

**Homework (the lowest score is automatically dropped when calculating average)**

<table>
<thead>
<tr>
<th>Homework #</th>
<th>Actual Score</th>
<th>Recorded Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>67</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>55</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>9</td>
<td>84</td>
<td>94</td>
</tr>
<tr>
<td>10</td>
<td>82</td>
<td>92</td>
</tr>
<tr>
<td>11</td>
<td>85</td>
<td>95</td>
</tr>
<tr>
<td>12</td>
<td>94</td>
<td>94</td>
</tr>
<tr>
<td>13</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>14</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

The average for 13 highest homework scores is 94.3.

**Quiz (the lowest score is automatically dropped when calculating average)**

<table>
<thead>
<tr>
<th>Quiz #</th>
<th>Actual Score</th>
<th>Recorded Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>86</td>
<td>86</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>90</td>
</tr>
</tbody>
</table>

The average for 5 highest quiz scores is 93.4.

**Final exam score**: 90

Your current average is 93.0.

Your final grade is: A

"na" means not available yet.
Please report any mistake immediately so that we can get it fixed.
Remember, homework is 20%, quiz is 40%, and final is 40%.

Figure 3.9 Overall student score report
3.5 Interaction between students and instructor

A large concern of both instructors and students about online courses that use video lectures is the lack of interaction between students and instructor. To compensate for this deficiency, an online message conferencing and an online chat room was used. As a result of this research, a commercial software, WebBoard as shown in Figure 3.10, was chosen to be a channel for students to ask and instructor to answer questions.

WebBoard is a web-based conferencing program that instructors can administer via the internet. Both students and instructor can access the WebBoard 24 hours a day and hence increases the communication between students and instructor. Students do not have to wait for office hours that are only two or three times a week to meet with the instructor. Students can also answer their classmate’s questions, which saves time for both students and the instructor. This allows the students to work as a team and help each other to solve problems. The time for an instructor to conduct a large class could also be reduced because some of the student difficulties are the same.

During the Spring of 1999, the quizzes and test were given online and most of the students were in other rooms or buildings (quizzes only). Therefore, an online chat room was made available so students could ask question. Students were asked to login to the WebBoard chat room and keep an eye on the messages from time to time. The instructor logs in and monitors the messages at all times and answers any question that the students have during the test or quiz. The whole process went smoothly and students were comfortable with this approach. The students’ feedback will be further mention in Chapter 4.
In addition to the WebBoard, a vector-based, multi-user drawing board, was developed by the Engineering Media Lab that can help students present their ideas through the internet by drawing diagrams. A vector based drawing program allows user to edit individual object in the picture. User can change the properties such as color, thickness, border, shape, and size of each of the objects in the drawing. These are useful tools for drawing engineering diagrams. This program allows all users who logon to the web page to draw something and the rest can view it instantaneously. An interface of the drawing program is shown in Figure 3.11.

Figure 3.10 Message conferencing software, WebBoard
3.6  **Engineering utilities**

Three utilities were developed and implemented on the web site to help students solve engineering problems. The purpose of these utilities was to minimize the time needed in solving basic problem tasks such as finding unit vectors. Also, these utilities were used as prototypes to show what could be done to demonstrate the capabilities of internet-based applications. The 3 utilities, as shown in Figure 3.12, are a 3x3-matrix solver, a unit vector calculator, and a cross product calculator.

The 3x3-matrix solver is a convenient tool for students when solving three unknowns with three equations. It helps students get familiar with organizing equations into the matrix form and they only need to key in the coefficients of the 3 equations to solve for the 3 unknowns. The source code of the solver can be found in Appendix C.
The second utility is used for calculating unit vectors. Again, for a student to repeat the unit vector calculation for every single question is very tedious, especially, if a student is required to repeat the same fundamental procedure for solving hundreds of questions a semester. The third utility solves the cross product for two vectors.

The utilities were developed in Macromedia Director and then exported as a Shockwave file, which is a web-based application format, by Macromedia, that allows delivery over the internet. Macromedia Director provides wide varieties of functions through the use of a scripting language known as Lingo that allows developers to create useful web based application.

Figure 3.12 Engineering utilities
CHAPTER 4

IMPLEMENTATION OF THE ONLINE STATICS

This chapter presents the requirements and considerations for implementing online courses. The presentation of course materials, video lectures, homework, and tests were given completely online. Throughout this research, the pros and cons were studied and the students’ concerns were taken into considerations when designing the system. A survey was done for students from two classes, Spring and Fall 1998.

4.1 Software and hardware requirement for students

To implement any online course system, users will be required to meet standards. In addition to the basic laptop hardware requirements, students are required to have access to the internet through a modem or wireless connection. Students also need to install additional plug-ins or viewers. These plug-ins or viewers enable developers to extend the usage of the browser so they can provide special viewing capability to the browser such as online simulations, engineering utilities, and video.

This electronic course system uses the internet extensively and all the application developed were based on the HTML 4.0 technology. Hence, a 4.0 version browser or higher such as Internet Explorer or Netscape Navigator are required. All the software required for the class are free except the courseware which is on a CD.

To view the on-demand video lectures, students need to download the basic QuickTime player at www.apple.com. Students can buy the full version of the player if they wish to have the video saving and editing features. The utilities as discussed in previous sections were made in Macromedia Director and an additional browser plug-in
is required to use them. This plug-in is the Shockwave Director plug-in and can be downloaded from Macromedia web site at www.macromedia.com for free.

The use of these advance technologies provides students with a flexible learning environment, allowing them to carry out the learning process from virtually any physical location with internet connections. For example, the on-demand lecture allows the students to view the lecture from any location and at any time. Therefore, students can always review the class lecture if they do not understand the concept for the first time.

4.2 Software and hardware requirement for developer or instructor

This online engineering course was designed to be installed on any web servers with a high bandwidth connection. The Statics course was implemented using Windows NT server 4.0 with IIS 4.0 web server during the Spring of 1999 semester and it was designed so that it can be transferred over to another server by just copying the complete site.

HTML editors such as Macromedia Dreamweaver and Symantec Visual Page are useful tools in helping developers construct web pages. Macromedia Freehand was used for drawing most of the diagrams and pictures used for the homework. Sometimes, when the graphics get became, Adobe Photoshop was used to refine the quality. Notepad and SitePad text editors were to edit the PERL scripts and Javascripts.

For hosting the course website such as the Engineering Statics course, a large hard disk space is required. A semester of video lecture, which has about 15 weeks/semester, 2 lectures/week, 7 video clips/lecture, and 7 Mbytes/video generates 1.6 Gbytes of disk space. In addition, the overall homework questions, PERL scripts and HTML files take
up another 100 Mbytes. Therefore, a total of 1.7 Gbytes is required. As the course is offered more times, additional homework questions will be added and the site will grow. The server that was used during the Spring of 1999 for the Engineering Statics course used a 9 Gbytes SCSI based hard drives.

4.3 Advantages and disadvantages of having online engineering courses

The advantages and disadvantages of implementing an online engineering course have been studied throughout this research. From the feedback of the students and instructor, it was found that the online system has more advantages than disadvantages both for students and the instructor such as time saving, ease of accessing the course material, and the excitement of learning through the courseware.

For delivering standard course information such as course syllabus, schedule, and grading scale, the conventional course system generally uses handouts that the instructor will prepares, and then distributes one by one in class. Any changes to the course information after the information has been distributed must be done by informing the students in the class. However, an online course system can use a website to post announcements concerning changes and where to get the latest information. Since, uses the website for the course, it is the students’ responsibility to keep up with the class updates. Students can always refer to the latest information on the website for handouts and not have to rely on others for information. The distribution process is also easier, and the instructor only needs to direct students to the particular page for particular information he or she wants.
The conventional classroom lecturing is repeated semester over semester and the effort to prepare the lectures each semester by the instructor over the years is tremendous. The reusability of the video lectures can greatly reduce the effort of teaching the same class every semester. Once the video lectures are digitized and properly set up, the instructor only needs to keep them organized into the chapters or weeks he or she wants and direct the students to view the lectures week by week according to the class schedule. This then allows the instructor to have more time helping students in other research or giving extra individual tutorial helps.

The CD-Rom based courseware as described in section 2.1, can replace the conventional textbook as a more efficient way to present the course content. Cost of updating and maintaining the content is much cheaper than the conventional textbooks. The interactive multimedia form of presentation of engineering problems helps students grasps basic principles faster and makes their learning experience more interesting.

Although there are many instructors would like to set up their own homework questions for the students, most of the instructors simply assign questions from the textbooks or reference books as homework problems. By putting the homework online in multiple choice format and auto-dated, the homework can be automatically posted, collected, and graded. This online course system has developed the homework questions over 3 semesters and has organized them into a database. The biggest advantage of this online homework system is the score can be posted right after the homework is due. There is no need for teaching assistance or instructor to grade the homework by hand. This is a tremendous help for instructors that teach a 200 students in one class. However, the test format is restricted to multiple choice format and partial credit can not be
assigned. Referring to some of the general and professional exams, such as Graduate Record Examination (GRE), Graduate Management Admission Test (GMAT), and Fundamental in Engineering (FIE) exams, which are multiple choice exams, this method can help them prepare.

The online test system is not as secure as giving the test in a normal classroom since there is no way to prevent collaboration between students at a remote location without a proctor. For this project, students were required to come to the campus area at a dedicated location to take some quizzes and all tests. However, the posting, submission, and grading system still was used. This made the whole process easier to manage and the students could know their grade immediately after test.

4.4 Students’ feedback

At the end of each semester, students were required to complete an evaluation form concerning their thoughts about the course. Two special surveys on educational technologies were carried out during Spring 98 and Fall 98. The survey from Spring 98 was drop when preparing the statistic because the online system implemented was not complete. For example, there was no online testing and chat room implemented. Besides, the homework and test questions were not in multiple choice formats and the student submissions were graded manually by a teaching assistant and returned by email. However, the suggestions and comments on the video lecturing and WebBoard message conferencing implementation were taken into consideration.

For the Fall 1998 survey, a total of 13 students completed the survey and a general report show positive feedback on the online course system. The general report is
shown in Appendix D. Most of the students like the idea of having online course, however, they still wish to have a more efficient way to communicate with each others.

Some students commented on the video should be made available off-line so that they can view it wherever they want. This is possible if students request a CD-Rom copy of the lectures. Most of the student stated that, they do not think the attendance is needed at all if the video lecture is made available before class.

The students have commented that learning through the CD-Rom courseware is more enjoyable than reading a textbook. They feel it is easier to learn and visualise by looking at the 3D animation and sound. The simulations allowed them to better understand the engineering concepts when different scenarios occur.
CHAPTER 5

CONCLUSION

Although, the development process of this online course system is time consuming, once the system is implemented the maintenance effort is minimal. Assuming all the technologies have been identified, the development process of a course can take up to 2 man-years which includes CD based content development, video lecture processing, homework question generation, and PERL programming. Since the online course system was designed to be used for other engineering courses as well, the instructor only needs to develop relevant contents to make a new course. The cost of implementation is also low. Most of the software, such as PERL compiler, Internet Information Service (IIS) 4.0, and plug-ins are free to download from the web.

This research shows that the use of electronic media and an online system is efficient in delivering course material. This system provides education to any location in the world and it has no classroom size constrain, no time difference problem, and no class size limitation. With the same amount of effort, an instructor can teach a course to thousands of students from anywhere in the world.

Another advantage of an online course is students can gain access to the course material 24-hours a day through the internet. Generally, students will work on their homework or revision at night or beyond the office hours. With a message conferencing software tool, such as WebBoard, and a vector-based Drawing Board, the students can ask and discuss problems without having to visit the instructor’s office. This allows students to ask questions any time they want and the instructor or other students can provide clarification or explanation even when they can not get together physically.
The use of high technology does help in making learning process more efficient and an exciting experience for students, however, the side effects such as the lack of face-to-face interaction is a major concern. Students think that having the course in electronic media format is a good idea, however, there is room for improvement in implementing the online interaction between students and instructor.

As for the instructor, the implementation of the on-demand video lecturing and automated homework grading system is a tremendous help. The time that the instructor spent on preparing a lecture and grading the homework is enormous. In addition, the instructor need not worry about the bookkeeping process of recording the student grades one by one.

As the result of this research, a prototype of an online course system for teaching Engineering Rigid Body was developed. In Spring 1999 semester, a complete set of on-demand course lectures was developed and ready to be reused in the following semesters. It consists of 15 weeks of lectures covering 10 topics included in the MES, the interactive multimedia CD-Rom courseware that is used with the online course. Besides explaining of theory, the video lectures include illustration of examples using diagrams, application of theories to different problems, and tutorials for solving problems.

Throughout the research, the homework questions that were assigned in Spring and Fall 1998, and Spring 1999 semesters were compiled and organized into a database that consists of about 400 Engineering Rigid Body. Since the homework questions were posted on the web, they have to be generated by the instructor. To avoid copyright issue, the instructor has to make sure these questions have not been published or been used in any other textbook before. Each of these questions is complete with individual solution.
page and is stored in separate directory according to the topics. The online homework administration capability allows the instructor to retrieve the questions from the database and use it for the following semester. These questions can be reused in homework as well as in tests and quizzes.

The course material delivery system is run by PERL scripts except for the CD-Rom based courseware. The PERL scripts that are developed serve as an interface for the instructor to set up a class completely via the internet and for the students to submit homework and retrieve grades. There are more than 20 PERL scripts written, such as, auto grading the students’ submission, calculating the homework average, and providing an interface for the instructor to set up homework questions.

This online course system can be used for other engineering courses by developing relevant contents. In order to develop another course, an instructor needs to have an interactive multimedia CD-Rom or web-based courseware, on-demand video lectures, and homework questions that can be used as test questions.

The online system developed for this research is good for implementation but there is room for improvement. Currently, there are about 400 homework questions in the database, however, if certain parameters in the homework questions can be randomly generated so that each student will get a different set of questions, the number of questions will be multiplied. Also, the student information and course configuration such as homework schedule, score distribution, student login name and passwords are currently stored in encrypted text files. The sorting and processing time will become slow if the database gets large. Therefore, a better database system should be incorporated using commercial database application such as Microsoft Access or Oracle.
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APPENDICES

APPENDIX A

I. EXAMPLE OF HOMEWORK HTML CODE

Problem 4_1_easy_1

```html
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2//EN">
<HTML>
<HEAD>
  <META HTTP-EQUIV="Content-Type" CONTENT="text/html;CHARSET=iso-8859-1">
  <META NAME="GENERATOR" Content="Visual Page 2.0 for Windows">
  <TITLE>Statics - Kurt Gramoll</TITLE>
</HEAD>

<BODY TEXT="black" BGCOLOR="white">
  <P>
    <TABLE BORDER="0" CELLPADDING="0" CELLSPACING="0" WIDTH="570">
      <TR>
        <TD WIDTH="240" VALIGN="TOP">
          <P ALIGN="CENTER">
            <pic>
              <IMG SRC="graphics/1.gif" WIDTH="206" HEIGHT="126" ALIGN="BOTTOM" BORDER="0">
            </pic>
          </P>
          <p ALIGN="CENTER">
        </TD>
        <TD WIDTH="10" VALIGN="TOP">
          &nbsp;
        </TD>
        <TD WIDTH="320" VALIGN="TOP">
          What is the magnitude of the resultant moment at A due to the four forces? <BR>
          <TABLE BORDER="0" WIDTH="300">
            <TR>
              <TD WIDTH="10">
                &nbsp;
              </TD>
              <TD WIDTH="20">
                a.
              </TD>
              <TD WIDTH="270">
                -20.9 kN-cm
              </TD>
            </TR>
            <TR>
              <TD WIDTH="10">
                &nbsp;
              </TD>
              <TD WIDTH="20">
                b.
              </TD>
              <TD WIDTH="270">
                -47.6 kN-cm
              </TD>
            </TR>
            <TR>
              <TD WIDTH="10">
                &nbsp;
              </TD>
              <TD WIDTH="20">
                c.
              </TD>
              <TD WIDTH="270">
                -92.3 kN-cm
              </TD>
            </TR>
            <TR>
              <TD WIDTH="10">
                &nbsp;
              </TD>
              <TD WIDTH="20">
                d.
              </TD>
              <TD WIDTH="270">
                35.8 kN-cm
              </TD>
            </TR>
          </TABLE>
          &nbsp;
        </TD>
      </TR>
    </TABLE>
</BODY>
```

What is the magnitude of the resultant moment at A due to the four forces? <BR>

```html
</TABLE>
```

<submission_form>
APPENDIX A

II. EXAMPLE OF THE FORMAT OF AN INDIVIDUAL HOMEWORK QUESTION IN THE DATABASE

What is the magnitude of the resultant moment at A due to the four forces?

a. -20.9 kN·cm
b. -47.6 kN·cm
c. -92.3 kN·cm
d. 35.8 kN·cm
I. STRUCTURE OF THE ENGINEERING STATICS WEBSITE

appendix B

Engineering Statics: http://eml.ou.edu/statics

<table>
<thead>
<tr>
<th>folder</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>general</td>
<td>General images and CSS</td>
</tr>
<tr>
<td>system</td>
<td>pathfind.pl, password.pl, system</td>
</tr>
<tr>
<td>quizzes</td>
<td>cgi-bin</td>
</tr>
<tr>
<td>utility</td>
<td>Director shockwave simulation</td>
</tr>
<tr>
<td>video</td>
<td>week1, week15</td>
</tr>
<tr>
<td>homework</td>
<td>cgi-bin</td>
</tr>
<tr>
<td>admin</td>
<td>ad_hw.htm</td>
</tr>
<tr>
<td>student</td>
<td>ad_std.htm</td>
</tr>
<tr>
<td>help</td>
<td>adduser.htm, score.htm</td>
</tr>
</tbody>
</table>

*1: Video lecture files from week 1 to week 15

*2: Perl script that carry out all homework posting, submission, grading and solution posting. (hwlogin.pl, hwlogin.pl, grading.pl)

*3: Database that contains all the homework questions for this course. Ranging from topic 1.1 -> 10.2

*4: Important data related to the homework. (answer.pl, dates.pl, hwqset.pl)

*5: Perl script that carry out all administration task. (addid.pl, addq.pl, adlogin.pl, hwadmin.pl, hwqset.pl, question.pl, deleteq.pl, checksol.pl)

*6: Perl script that perform changing of student information and score posting task. (score.pl, adduser.pl)

*7: A folder that stores all the student information (allinfo.pl, email.pl, idlist, passwd.pl, logfile.pl) and a student record

*8: A data folder with all the students' homework and quizzes record.

*9: This folder contains the Perl scripts that manage the quiz questions, starting and end time, grading, and timer.

*10: A folder that contains all required information for the quiz.
II. EXAMPLES OF PERL PROGRAMS FOR STUDENT LOGIN SETUP

#adduser.pl

#####################################
# Automatic search for directory path
#####################################
$temp=substr($ENV{PATH_INFO},1);
while($first ne "student")
{
    ($first,$temp)=split('/',$temp);
    if ($first ne "student")
        {$systempath=$systempath.$first."/";}
}
$systempath=$systempath."system/pathfind.eml";

#####################################
#     Main Program
#####################################
print "Content-type:text/html\n\n";
print "<html>
print "<head><title>Login Setup Information</title></head>";
print "<body bgcolor="white" text="black">";
print "<table border="0" cellpadding="0" cellspacing="0" width="400">

<table1

check_entries();
print <<table2;

<TH>
<TR>
<TD WIDTH="400" BGCOLOR="#FFCC99">&nbsp;</TD>
</TR>
</TABLE>

print "</body></html">

die();

sub createdir
{
    $studentdir=$stdir . $id;
    mkdir($studentdir,"777777777");
}

#####################################
#     Check for all user input
#####################################
sub check_entries
{
readpath();
if ($ENV{'REQUEST_METHOD'} eq "get") { $buffer = $ENV{'QUERY_STRING'}; } else { read(STDIN, $buffer, $ENV{'CONTENT_LENGTH'}); }

@nvpairs = split(/&/, $buffer);
$c=0;$loopy=0;$er=0;
foreach $pair (@nvpairs)
{
    ($name, $value) = split(/=/, $pair);
    $name =~ tr/+/ /;
    $value =~ tr/+/ /;
    $name =~ s/%(..)/pack("c", hex($1))/eg;
    $value =~ s/%(..)/pack("c", hex($1))/eg;
    $value =~ s/\n/                        /g;
    $userinput[$c]=$value;
    $c=$c+1;
}
$lname=$userinput[0];
$fname=$userinput[1];
$email=$userinput[2];
$id=$userinput[3];
$passwd=$userinput[4];
$pwde=$userinput[5];

# Lastname check
if ($lname) {
    $er=1;
    ($first[1],$first[2],$first[3],$first[4],$first[5])=split(/ +/,$lname);
    $temp=$first[1];
    $a=2;
    while($first[$a])
        {
            $temp=$temp ."-".$first[$a];
            $a=$a+1;
        }
    $lname=$temp;
} else {
    print "There is no last name provided.<br>";
}

# Firstname check
if ($fname) {
    $er=$er+1;
    ($first[1],$first[2],$first[3],$first[4],$first[5])=split(/ +/,$fname);
    $temp=$first[1];
    $a=2;
    while($first[$a])
        {
            $temp=$temp ."-".$first[$a];
            $a=$a+1;
        }
    $fname=$temp;
} else {
    print "There is no first name provided.<br>";
}

# Email check
if ($email) {
    ($first,$second)=split(/ +/,$email);
    if ($second) {
        print "There is a space in the email you entered.<br>";
    } else {
        $er=$er+1;
    }
} else {
    print "There is no email provided.<br>";
}
# ID check
if ($id)
{
    $idfoundornot="no";
    if (open(openidlist,$idlist))
    {
        @idlistarray=<openidlist>;
        close(openidlist);
        foreach $idline (@idlistarray)
        {
            chop($idline);
            if ($idline eq $id)
            {
                $idfoundornot="yes";
            }
        }
        if ($idfoundornot eq "yes")
        {
            $er=$er+1;
        }
        else
        {
            print "Your ID number is not found on the class roll. Please contact your instructor.<br>";
        }
    }
    else
    {
        print "<b>Error 30C4_1</b>. Please contact your instructor.<br>
    }
} else {print "There is no ID number provided.<br>";
}

# Password check
if ($passwd) {$er=$er+1;}
else {print "There is no password provided.<br>";
}

# Password confirmation and space check
if ($pwdc)
{
    ($first,$second)=split(/ +/,$pwdc);
    if ($second)
    {
        print "There is a space in the password you entered.<br>";
    } else
    {
        $er=$er+1;
    }
} else {print "There is no password verification.<br>";
}

# Password verification
if ($passwd eq $pwdc) {$er=$er+1;}
else {print "Two passwords entered are different.<br>";

# ID length check
if (length($id)==9) {$er=$er+1;}
else {print "The ID number entered is not correct.";
#
Completeness check
if ($er != 8) {print "Login setup failure. Please hit the back button or <a href="javascript:history.back()">here</a> and reenter.";
else
{
write_file();
if ($written eq "written")
{
print "Your login account has been created successfully."
print "The following information have been stored in the system.";
print "Last name : $lname<br>
First name : $fname<br>
I.D. #: $id<br>
Email : $email<br></b>";
}
}
"# Read in directory paths and files for all system information from a main directory info file#                     
sub readpath
{
$first="";
if (open(pathreader,"$systempath"))
{
@patharray=<pathreader>;
close(pathreader);
foreach $directory (@patharray)
{
chop($directory);
($first,$second)=split(/\,$directory);
if ($first eq "b4")
{
pwd=$second;}
if ($first eq "c1")
{
allinfo=$second;}
if ($first eq "c2")
{
emailfile=$second;}
if ($first eq "c3")
{
passid=$second;}
}
if ($first eq "c4")
  {$idlist=$second;}
if ($first eq "c5")
  {$logfile=$second;}
if ($first eq "c6")
  {$stdir=$second;}
}
else
{
    print "<b>Error 10B3_1</b>. Please contact your instructor.";
}

# Write Files
sub write_file
{
    if (open(info,$allinfo))
    {
        $idexist="no";
        $counting=0;
        @infoarray=<info>;
        check_existent();
        close(info);
        if ($idexist eq "no")
        {
            writeallinfo();
            writeemail();
            writeidpasswd();
            createdir();
            writelogfile();
        } else
        {
            print "Your ID number already found in the
            database.";
            print "You can only change your information with
            correct password.";
        }
    } else
    {
        print "Your ID number already found in the
        database.";
    }
}
writeemail();
writeidpasswd();
createdir();

##### First time creating all info file.
$wallinfo="">$allinfo;
if (open(info,$wallinfo))
{
    $writen="writen";
    select(info);
    $~="outp_info_title";
    write;
    print info "----------------------------------------------------------
---------------------------------------------------
";
    $~="outp_info";
    write;
    close(info);
    select(STDOUT);
}
else
{
    print "<b>Error 20C1_1</b>. Please contact your instructor.";
}

##### First time creating log file.
$wlogfile="">$logfile;
if (open(logf,$wlogfile))
{
    select(logf);
    $~="outp_all_title";
    write;
    print logf "----------------------------------------------------------
---------------------------------------------------
";
    $~="outp_all";
    write;
    close(logf);
    select(STDOUT);
}
else
{
    print "<b>Error 20C5_1</b>. Please contact your instructor.";
}
# Check if the student already created an account

```perl
sub check_existent {
    foreach $eachinfo (@infoarray) {
        chop($eachinfo);
        ($first,$second,$third,$fourth)=split(/ +/,$eachinfo);
        if ($id eq $fourth) {
            $idexist="yes";
        }
    }
}
```

# Write ID and encrypted password to the idpw.eml file

```perl
sub writeidpasswd {
    if (open(pwdii,$pwd)) {
        @pwdarray=<pwdii>;
        close(pwdii);
        $a=0;
        foreach $pwdli (@pwdarray) {
            ($first,$second)=split(/ /,$pwdli);
            chop($second);
            if ($first eq "aa") {$code=$second;}
        }
    } else {
        print "<b>Error 30C3_1</b>. Please contact your instructor.<br>";
    }
    $wpassid=">>" . $passid;
    if (open(idpass,$wpassid)) {
        $encpw=crypt($passwd,$code);
        $encpw=substr($encpw,2,11);
        print idpass "$id   $encpw
";
        close(idpass);
    } else {
        print "<b>Error 30C3_1</b>. Please contact your instructor.<br>";
    }
```
{print "<b>Error 20C3_1</b>. Please contact your instructor.<br>
}

############################################################
#     Write ID and email to email.eml file
############################################################
sub writeemail
{
    $wemail=">>" . $emailfile;
    if (open(emailout,$wemail))
    {
        print emailout "$email\n";
        close(emailout);
    }
    else
    {print "<b>Error 20C2_1</b>. Please contact your instructor.<br>
    }
}

############################################################
#     Write the students info to allinfo.eml
#     (this is the main info file for
#     retrieving student info)
############################################################
sub writeallinfo
{
    $counting=0;
    $wrien="notyet";
    $wallinfo="">".$allinfo;
    if (open(info,$wallinfo))
    {
        foreach $infoline (@infoarray)
        {
            ($first,$second,$third,$fourth)=split(/ +/, $infoline);
            if ($wrien eq "notyet")
            {
                $counting=$counting+1;
            }
            elseif ($wrien eq "notyet") && ($fname lt $second) && ($counting>2)
            {print "<b>Error 20C2_1</b>. Please contact your instructor.<br>
            }
            elsif ($wrien eq "notyet") && ($lname lt $first) && ($counting>2)
            {
                $wrien="written";
                select(info);
                $~="outp_info";
                write;
            }
            elsif ($wrien eq "notyet") && ($lname eq $first) && ($fname lt $second) && ($counting>2)
            {
$written="writen";
select(info);
$~="outp_info";
write;
}
if ($first) {print info "$infoline\n";}
}
if ($written eq "notyet")
{ $counting=$counting+1;
$written="writen";
select(info);
$~="outp_info";
write;
}
close(info);
select(STDOUT);
}
else
{print "<b>Error 20C1_2</b>. Please contact your instructor.<br>
}

##########################################
# Write the student's information to the
# log file on the server
##########################################
sub writelogfile
{
if (open(all,$logfile))
{
@logarray=<all>;
close(all);
$wlogfile=">" . $logfile;
if (open(all,$wlogfile))
{
$arraylength=@logarray;
if ($counting>$arraylength)
{
print all @logarray;
select(all);
$~="outp_all";
write;
select(STDOUT);
}
else
{
for($a=1;$a<$arraylength+1;$a++)

```plaintext
{
    if ($a == $counting)
    {
        select(all);
        $~="outp_all";
        write;
        select(STDOUT);
        }
        print all $logarray[$a-1];
    }
    close(all);
} else
    {print "<b>Error 20C5_2</b>. Please contact your instructor.";
    }
else
    {print "<b>Error 30C5_1</b>. Please contact your instructor.";
    }
}

# In file formatting
#
format outp_info_title=
@<<<<<<<<<<<<<<<  @<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
@<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<  @<<<<<<<<<
"Lastname","Firstname","Email Address","ID Number"
.
format outp_info=
@<<<<<<<<<<<<<<<  @<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
@<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<  @<<<<<<<<<
$lname,$fname,$email,$id
.
format outp_all=
@<<<<<<<<<<<<<<<  @<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
@<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<  @<<<<<<<<<
$lname,$fname,$email,$id,$passwd
.
format outp_all_title=
@<<<<<<<<<<<<<<<  @<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
@<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<  @<<<<<<<<<
"Lastname","Firstname","Email Address","ID Number","Password"
.
```
APPENDIX C

SOURCE CODE OF 3X3 MATRIX SOLVER

on enterFrame
    put 0 into member "aa1"
    put 0 into member "aa2"
    put 0 into member "aa3"
    put 0 into member "dd1"
    put 0 into member "bb1"
    put 0 into member "bb2"
    put 0 into member "bb3"
    put 0 into member "dd2"
    put 0 into member "cc1"
    put 0 into member "cc2"
    put 0 into member "cc3"
    put 0 into member "dd3"
    put 0 into member "xx1"
    put 0 into member "xx2"
    put 0 into member "xx3"
end

on keyUp
    global a1,a2,a3,b1,b2,b3,c1,c2,c3,d1,d2,d3,de1,de2,de3,x1,x2,x3
    if the key = ENTER then
        go to the frame
    end if
    set the floatPrecision to 4
    set a1=value(the text of member "aa1")
    set a2=value(the text of member "aa2")
    set a3=value(the text of member "aa3")
    set b1=value(the text of member "bb1")
    set b2=value(the text of member "bb2")
    set b3=value(the text of member "bb3")
    set c1=value(the text of member "cc1")
    set c2=value(the text of member "cc2")
    set c3=value(the text of member "cc3")
    set d1=value(the text of member "dd1")
    set d2=value(the text of member "dd2")
    set d3=value(the text of member "dd3")
    set d1=d1*1.0000
    set d2=d2*1.0000
    set d3=d3*1.0000
    set de1= a1*(b2*c3-b3*c2)+a2*(b3*c1-b1*c3)+a3*(b1*c2-b2*c1)
    if (de1 <> 0) then
        set x1=(d1*(b2*c3-b3*c2)+a2*(b3*d3-d2*c3)+a3*(d2*c2-b2*d3))/de1
set x2=(a1*(d2*c3-b3*d3)+d1*(b3*c1-b1*c3)+a3*(b1*d3-c1*d2))/de1
set x3=(a1*(b2*d3-c2*d2)+a2*(d2*c1-b1*d3)+d1*(b1*c2-b2*c1))/de1

put x1 into member "xx1"
put x2 into member "xx2"
put x3 into member "xx3"
end if
end keyUp

on exitFrame
  go to the frame
end
APPENDIX D

Fall 98: A total of 13 students in the class involved in the survey
(The number in the columns indicate the number of students selected that option)

<table>
<thead>
<tr>
<th>The usefulness of the following items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Web Board discussion group</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2 Lectures on the Web</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2a Lectures on the Web - still pictures</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3 Homework on the web</td>
<td>12</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4 Homework submission on the web</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5 Homework solutions on the web</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 Laptop in class</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7 Laptop during test</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8 CD delivery of theory</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9 CD problem examples(cases)</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10 Course syllabus on the Web</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11 Tests on the Web</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The ease of use for the following items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Web Board discussion group</td>
<td>4</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2 Lectures on the Web</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3 Homework on the web</td>
<td>9</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4 Homework submission on the web</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5 Homework solutions on the web</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 Laptop in class</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7 Laptop during test</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>8 CD delivery of theory</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9 CD problem examples</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>10 Course syllabus on the Web</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>11 Tests on the Web</td>
<td>10</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>12 Web page navigation</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Compare to previous courses with textbooks, the CD-based course content was:

<table>
<thead>
<tr>
<th>Compare to previous courses with textbooks, the CD-based course content was:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 easier to use</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2 incomplete</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3 more enjoyable</td>
<td>7</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>4 more convenient</td>
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<td>5 lacking material</td>
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Overall course with Laptops

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<td>1 Video camera made me uncomfortable during class</td>
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<td>2 The computer projector was easy to see</td>
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<td>3 The computer projector in class helped understand</td>
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<td>4 The laptop in class let me follow the lesson</td>
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<td>5 The laptop was useful for other work in class</td>
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<td>6 The laptop was useful for other work out of class</td>
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<td>7 I would like to take another laptop based course at OU</td>
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<td>8 The video quality on the web was readable</td>
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<td>9 Overall, I learned more in this course due to the laptop</td>
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<td>10 The electronic content was easier to understand than a book</td>
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<td>12 The video on the web was easy to use</td>
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