WEB-BASED INTERACTIVE REVIEW SYSTEM FOR
THE FUNDAMENTALS OF ENGINEERING EXAM

A THESIS
SUBMITTED TO THE GRADUATE COLLEGE
In Partial Fulfillment of the Requirements for the
Degree of
MASTER OF SCIENCE

By
ADRIAN MELVIN NG
Norman, Oklahoma
1999
WEB-BASED INTERACTIVE REVIEW SYSTEM FOR
THE FUNDAMENTALS OF ENGINEERING EXAM

A THESIS APPROVED FOR THE
SCHOOL OF AEROSPACE AND MECHANICAL ENGINEERING

BY

________________________
DR. KURT GRAMOLL (CHAIRPERSON)

___________________
DR. HAROLD STALFORD

___________________
DR. BILLY CRYNES
ACKNOWLEDGEMENT

I would like to express my sincerest appreciation to my advisor Dr. Kurt Gramoll for his guidance, mentoring, support, and assistantship without which this thesis and research project would not have been made possible. His charismatic leadership, management and technical skills continue to astonish me and I'm very blessed to have the opportunity to work under his tutelage. I'm also indebted to Dr. Billy Crynes and Dr. Harold Stalford for their support, encouragement, and time to serve in my thesis committee.

I give praise and thanks to the Lord for His divine grace and mercy that He has showered upon me and for surrounding me with His many blessings. My unending love and appreciation to my parents: Michael Ng Seong Keong and Shirley Wong Yoon, and my sister Audrey Michelle Ng, for their love, ceaseless encouragement, and for giving me this opportunity and experience to a better education. Last but not least, to all the employees at the Engineering Media Lab (EML), I offer my sincerest thanks not only for their assistance and support but most importantly for their friendship. It's has indeed been a wonderful experience.
# TABLE OF CONTENTS

ACKNOWLEDGEMENT  iv  

LIST OF FIGURES  viii  

LIST OF TABLES  xi  

ABSTRACT  xii  

1. CHAPTER 1: INTRODUCTION  1  
   1.1 Fundamentals of Engineering Exam Background  2  
   1.2 Online FE Exam Review Project Background  2  
   1.3 FE Exam Preparation Obstacles  3  
   1.4 Benefits Of Online Review Site  4  
   1.5 Internet Background  7  

2. CHAPTER 2: LITERATURE REVIEW  12  
   2.1 Online Distance Learning  12  
   2.2 Education On The World Wide Web (WWW)  13  
   2.3 Current FE and PE Exam Review Methods  16  
   2.4 FE Online Review System Vs. Current Online Review System  18  
   2.5 Programming Languages On The World Wide Web (WWW)  19  

3. CHAPTER 3: ONLINE REVIEW SITE  23  
   3.1 Site Layout  23  
   3.2 Site Navigation Options  25
4. CHAPTER 4: MODULE PAGES
   4.1 Topic Introduction Page
   4.2 Basics Page
      4.2.1 Graphics and Images
      4.2.2 Movie Animations
      4.2.3 JavaScript and VRML Usage
      4.2.4 Texts And Equations
   4.3 EXAMPLES PAGE
      4.3.1 Interactive Simulations
   4.4 PROBLEMS PAGE

5. CHAPTER 5: SOFTWARE
   5.1 Simulation And Animation Authoring Software
      5.1.1 Flash
      5.1.2 Director
   5.2 Graphics Authoring Software
      5.2.1 Photoshop
      5.2.2 FreeHand
   5.3 Equation Authoring Software
      5.3.1 MathType
   5.4 HTML Authoring Software
      5.4.1 Visual Page
5.4.2 Dreamweaver 92

6. CHAPTER 6: CONTENT AND MODULE PAGE DEVELOPMENT METHODS 94

6.1 Layout And Format 94

  6.1.1 Basics Page 95
  6.1.2 Examples Page 105
  6.1.3 Problems Page 109

6.2 Content Development Difficulties 115

7. CHAPTER 7: ASSESSMENT AND CONCLUSION 117

7.1 Assessment and User Feedback Tools 117

  7.1.1 Web Board 117
  7.1.2 Web Trends 121

7.2 Results From Web Trends 124

7.3 Summary And Conclusion 125

7.4 Recommendations 127

REFERENCES 128

APPENDIX A 131
LIST OF FIGURES

Figure 1: Main Page of FE Online Review Site 26
Figure 2a: HTML Navigation System 29
Figure 2b: Shockwave Navigation System 29
Figure 3: HTML Menu System 30
Figure 4: Shockwave Menu System 31
Figure 5: HTML Main Topics and Modules Listing 33
Figure 6: Shockwave Main Topics and Modules Listing 34
Figure 7: Individual Topic's Main Page (HTML Version) 36
Figure 8: Individual Topic's Main Page (Shockwave Version) 37
Figure 9: Basics Page 39
Figure 10: Movie Animation Window 40
Figure 11: Periodic Table (Shockwave Version) 43
Figure 12: Mollier Diagram (Shockwave Version) 45
Figure 13: Property Chart (Shockwave Version) 46
Figure 14: JavaScript Calculation Tool 48
Figure 15: Chemistry Module Display (VRML) 49
Figure 16: Examples Page 52
Figure 17: Interactive Simulation Window 54
Figure 18: Problems Page 56
Figure 19: Pop-Up Menu Problems 57
## LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1: Editable Parameters of Symbols in Flash</td>
<td>65</td>
</tr>
<tr>
<td>Table 2: Pre-Defined Actions For Keyframes and Buttons</td>
<td>66</td>
</tr>
<tr>
<td>Table 3: Audio Setting Options in Flash</td>
<td>67</td>
</tr>
<tr>
<td>Table 4: Audio Effect Options in Flash</td>
<td>67</td>
</tr>
<tr>
<td>Table 5: Animation and Graphic Export Format Options</td>
<td>69</td>
</tr>
<tr>
<td>Table 6: Director Cast Member Types</td>
<td>72</td>
</tr>
<tr>
<td>Table 7: Types of Lingo Scripts</td>
<td>74</td>
</tr>
<tr>
<td>Table 8: Pop-Up Menu Options in Photoshop</td>
<td>79</td>
</tr>
<tr>
<td>Table 9: FreeHand Export Format Options</td>
<td>84</td>
</tr>
<tr>
<td>Table 10: Custom Made Icons Used In Basics and Examples Page</td>
<td>104</td>
</tr>
<tr>
<td>Table 11: Web Trends Statistical Information Options</td>
<td>124</td>
</tr>
</tbody>
</table>
ABSTRACT

The question of whether engineering graduates possess a certain level of competence upon completion of their academic endeavors in college should be continuously addressed to ensure that the public is served by competent and qualified engineers. Professional certification in the field of engineering is one such safety measure whereby the engineering licensing board of each state in America regulates engineering licenses to individual engineers who have proved that they do indeed possess the required minimum level of competence. Although, in general, it is a good practice for engineers to be registered, engineers working for companies in the field of product design and manufacturing are exempted from this requirement.

In order to obtain professional licensing all candidates are required to undertake two eight-hour exams: the Fundamentals of Engineering (FE) and the Professional Engineering (PE) Exams. These exams are regulated by the National Council of Examiners for Engineering and Surveying (NCEES). In addition to producing these exams, NCEES is also responsible for the distribution and the grading process.

This thesis documents the Fundamentals of Engineering (FE) Exam online review system developed by the Engineering Media Lab (EML) at the University of Oklahoma. Through this project, a complete Web-based review system has been established for the Fundamentals of Engineering (FE) Exam. All basic 12 science and engineering topics covered in the engineering curriculum during the
first four years of college are comprehensively reviewed and presented in a user-friendly manner by facilitating it through the Internet. To assist the reviewing process, each individual topic is broken down into separate subtopics or modules. These modules are then further divided into three main sections: Basics, Examples, and Problems. All relevant textual information and equations pertaining to the individual module are covered in the Basics Page. The Examples Page contains two problems that are worked out in detailed steps, allowing users to understand the application of the theories and equations presented in the Basics Page to problem solving. Finally, the Problems Page presents a set of six questions to the user as practice problems, allowing them to test their understanding on the individual module. This method of topic and module division allows the user to carry out the review process in a sequential and organized manner.

This project also utilizes a multitude of technologies available to the Internet to provide a thorough and detailed review for students as well as professionals in industry who wish to undertake the FE exam. The Online Review site was designed around the idea of implementing multimedia technology into the review syllabus. Hence the use of several different multimedia elements was paramount in ensuring that users are provided with a dynamic and an innovative environment to undertake the review process. Users are presented with the opportunity to work through the review process with multiple kinds of visual and audio aid.
In addition to the extensive use of texts and equations throughout this site, graphics, movie animations, audio narration, and movie clips were also utilized to further reinforce the information provided in each individual module. Use of movie clips, animations, and audio narration allow users to graphically view the concepts and theories covered. Furthermore, interactive simulations are also present to promote user interactivity and enhance user comprehension. The capabilities of the review site were also optimized through the implementation of HyperText Markup Language (HTML), Virtual Reality Modeling Language (VRML), JavaScript, Common Graphics Interface (CGI), and Practical Extraction and Report Language (PERL) scripts.

This online review site is also equipped with WebBoard, providing users with a tool with which feedback can be obtained. Feedback from users is paramount in evaluating and assessing the quality of the content provided as well as for determining improvement parameters.

To supplement the review material, and provide users with additional practice questions and exam sets, an online testing system is currently under development. Every attempt has been made to approximate the actual FE exam in order to provide users with an opportunity to familiarize themselves with the current FE exam format. When fully completed, the entire exam system will have a database of problems that is sufficient to generate complete sets of FE exams with randomly generated problems.
CHAPTER 1
INTRODUCTION

This thesis focuses on the Internet-based Review Syllabus for the Fundamentals of Engineering (FE) Exam that was developed by the Engineering Media Lab (EML) at the University of Oklahoma. In recent years, the number of online distance learning sites has increase tremendously. The computerization of formal education enterprises are increasing to the point where there are around 10,000 distance learning courses available on the World Wide Web (WWW) (Atkins, 1999), a fact which further supports the Web as a critical instrument for information dispersion as well as for technology implementation.

This chapter begins by providing a brief overview of the Fundamentals of Engineering (FE) Exam background and its general characteristics. In the following section, background information of the online review project that was carried out by the Engineering Media Lab (EML) is presented. The next two sections cover the inherent difficulties in preparing for the FE exam and addresses the possible solutions offered by the online review site. As this review site is facilitated through the Internet, an entire section will be devoted to present the development and the background of the Internet.
1.1 FUNDAMENTALS OF ENGINEERING EXAM BACKGROUND

The Fundamentals of Engineering (FE) exam is held twice a year in April and November for students in college as well as engineers in industry who wish to obtain a professional certification in the field of engineering. In some colleges around the country, students may elect to take this exam during the final year of their senior semester or perhaps after graduation. A few colleges even make it mandatory for engineering students to undertake the exam as a requirement prior to graduation. Currently the professional engineering licensing exam format is made up of two, 8-hour exam sessions: Fundamentals of Engineering (FE) and Professional Engineering (PE) Exam. The FE exam is further divided into two, 4-hour exams: morning (AM) and afternoon (PM) sessions. Question formats in the morning (AM) exam session is designed to cover the 12 science and engineering topics that formed the basic curriculum during the first four years of an ABET (Accreditation Board for Engineering and Technology) accredited engineering degree. On the other hand, the afternoon (PM) exam format caters only to a specific engineering major.

1.2 ONLINE FE EXAM REVIEW PROJECT BACKGROUND

This project began in the Spring of 1998 with the intention of providing an interactive, Web-based review system for the Fundamentals of Engineering (FE)
exam. The site makes extensive use of the various multimedia technologies available to the Internet to create a conducive and an interactive environment for users who are preparing for the FE exam. In the process of building this online review site, the problems associated with the preparations for the FE exam were duly noted. One of the major goals that were established during the design stages of this online site was to employ the proper methods and technologies to ensure that it would be able to rectify or at least alleviate some of these problems.

1.3 FE EXAM PREPARATION OBSTACLES

A common problem associated with the preparation for the FE exam is related to cost. Typical review books for the FE exam can cost upwards of $55. Furthermore, newer versions with additional material updates will render previous versions of review books inadequate. Although the updates are minor, these newer editions are still relatively expensive. Another obstacle lies in the printing errors present in review books. Errors such as these are difficult to correct and thus will be a source of confusion to users. In addition, exam questions are limited in quantity. The lack in the number of questions mean that users are no longer challenged upon attempting the given questions for the first time.

In addition, preparation time can also be a constant obstacle for those who are preparing for the FE exam. Engineers in industry may often find it difficult to implement a review session into their busy work schedule. Students in college
also encounter the same problem whereby most of their time is spent in dealing with their classes, assignments, projects and exams. Graduates who have long since left college may have their old textbooks sold. In some cases, the textbooks may be outdated and thus be insufficient in helping them to prepare for the exam.

1.4 BENEFITS OF ONLINE REVIEW SITE

The online FE exam review site allows users to gain access to the review material at any time of the day irrespective of their individual schedules. This means that all users, be it students in college or engineers in industry, are presented with an unlimited amount of flexibility and convenience. With this online review site, users are able to fit the review into their individual schedules instead of having to cater to any pre-scheduled review sessions. In this way, users are given the opportunity to assimilate the material and progress through the review at their own pace.

By having the review material placed online, the information can be constantly monitored for errors and any mistakes present can be corrected instantaneously. In addition, the review material, as well as the layout, can be updated to keep up with current standards. A Web newsgroup or bulletin board known as web board was integrated into the online site to allow users to leave feedback, or to report any broken links or printing errors within the site. In addition to the web board, feedback via e-mail can also be used to further enhance
the quality of the online review material. For engineers in industry who have long since graduated from college, this online site would prove to be invaluable as it solves the problem of them having to revise from their old textbooks which could be outdated, or in some cases, sold.

The integration of multimedia tools such as graphics, movie animations, audio narration, movie clips, and simulation in the online review site serve to provide an innovative and appealing environment for the FE exam revision to take place. In addition, the use of these various multimedia elements function to promote some form of user interactivity, whereby the user can actively participate in the reviewing process. By employing movie animations, movie clips, and audio narration, users are able to approach the review process from a different aspect rather than just reading from textbooks or review manuals. Users are now able to make use of visual representations to help foster a better understanding. Furthermore, the use of simulations in the online review further encourages interactivity from the user, thus making the review process a more enjoyable endeavor.

The material available in the online review site can also be directly linked to the courses offered at the University of Oklahoma. For example, the AM Statics review topic can be related with the course material presented in the online Statics class offered on campus. In this way, users are provided with additional information to supplement the review. This is particularly beneficial since the review material was designed specifically for reviewing purposes. It should also
be noted that since the regular FE exam review literature was used as a guideline, the format of the online review is in accordance with the actual FE review.

This thesis covers the development of the online review system for the Fundamentals of Engineering Exam that was carried out by the Engineering Media Lab at the University of Oklahoma. The following chapter presents the literature review that was carried out in the relevant areas of distance learning. Several examples of ongoing research and projects in the field of distance learning are mentioned and their applications of Internet technology in the field of distance learning are compared with that of the online review system. In Chapter 3, the organization of the online review site is covered. This chapter talks about the presentation method of the review material to the user in the form of the Basics, Examples, and Problems Page. In addition, the 2 versions of the navigation systems used in the review site: HyperText Markup Language (HTML) and Shockwave are also described in detail. Once the organization of the online review site is explained, a module's Basics, Examples, and Problems Page is described in Chapter 4. The elements of multimedia technology used in each page such as movie animations, audio narration, graphics, images, and interactive simulations are also covered in this chapter. Chapter 5 illustrates all the relevant text, equations, graphics, animation and simulation authoring software, used in the online review site. The method in which each software was employed to develop the content and the multimedia elements are also covered. In Chapter 6, the format and layout structure of the text, equations, graphics, animations, and
simulations within the individual Basics, Examples, and Problems Page are presented and described in detail. Finally, Chapter 7 presents the summary, conclusion, and recommendation for improvements and future usage of the online review system.

1.5 INTERNET BACKGROUND

Online media is made accessible by a set of interconnected computers through a foundation set forth by the Internet. It is well recognized that the Internet has had a major impact on publishing, research, and commerce (Newton, 1998). The potential of the Internet for knowledge dispersion will effectively influence nearly all lifestyles and the method in which business is conducted. This trend will continue to become evermore dominant as the new millennium begins.

The Internet began as a cooperative research effort established by the Defense Department under the Advanced Research Project Agency NETwork (ARPAnet) of the United States Federal Government. This 1969 packet-switching network project, funded by the National Science Foundation NETwork (NSFNET), was initially developed as a means of maintaining communication systems within the United States in the event of an atomic war. Through this project, four research facilities: the University of California at Los Angeles (UCLA), the Stanford Research Institute (SRI), the University of California at Santa Barbara (UCSB), and the University of Utah, and their military customers
were given access to time sharing applications using a few supercomputer centers (Brown, 1996).

By mid 1970's the number of government agencies on ARPAnet increased but so did the number of different networks available. Each individual network utilized a unique set of language codes. To enable different networks to effectively communicate with each other, Transmission Control Protocol/Internet Protocol (TCP/IP) was created. Through TCP/IP a standard networking protocol was established by which interconnected networks, computers with diverse hardware setups and various operating systems could communicate with each other (Newton, 1998). The Transmission Control Protocol (TCP) establishes a connection between the two systems that intend to exchange data. Internet Protocol (IP) decodes the address of the receiver and routes the data to the designated destination. TCP then breaks the information into chunks or bits before transmitting the data to avoid monopolizing the network.

Through commercialization of the Internet, its service was made available to anyone and everyone with a personal computer, a modem, a telephone line, and an Internet Service Provider (ISP). Internet Service Providers are companies that offer access to the Internet through dedicated or dial-up lines. The Internet's backbone is made up of several large computer networks which are linked via high-speed data connections such as T-1, T-3, OC-1, OC-3, and 56.6 KBPS lines (Newton, 1998).
Internet users continue to increase rapidly and commercialization is expected to cause a further exponential growth in traffic volume. As of 1996, Network Wizards reports that as many as 60,000 networks, 9.5 million computers, and 35 million users spanning 150 countries were connected to the Internet (Newton, 1998). One of the main reasons why the Internet has had such a major impact in the world around us, in addition to the innovation of electronic mail (e-mail), is due to its graphics-based front end: the World Wide Web (WWW) (Symantec, 1998). The World Wide Web (WWW) or Web, is a global, interactive, dynamic, and cross-platform graphical hypertext information system running over the Internet (Lemay, 1996). Arguably the reason why the Web has become so immensely popular is its ability to display both texts and graphics in full color on the same page (Lemay, 1996). In addition, it provides an environment whereby sound and video can be assimilated with texts. In addition, the development of scripting languages such as Java, JavaScripts, Practical Extraction and Report Language (PERL), and Common Gateway Interface (CGI), as well as multimedia software, plug-ins, and embedded applications further amplify the existing capabilities of the Web to unprecedented levels.

Another unique innovation brought forth by the Web is the concept of hypertext. Before the advent of the Web, navigation using text-links and other typed commands were the norm. Hypertext eliminates the mundane and rigid structure in which textbooks are read but offers a significant capability to users whereby navigation through text and graphical information can be carried out in a
non-linear manner. The Web is made accessible through the use of browsers such as Microsoft's Internet Explorer, and Netscape's Navigator or Communicator. Currently browsers are able to provide any computer platform (UNIX, Macintosh, Windows) with access to the Web. These browsers can be downloaded from the Web at no cost and some even come as part of the software package in new personal computers.

Web pages are files written in a Web-environment authoring language called HyperText Markup Language (HTML). HTML is made up of three components: tags, comments, and text. HTML tags describes the structure of a Web page by specifying the relative position of all elements. Common styles and formats such as font types and sizes, heading, paragraphs, and tables are contained within tags. In addition, tags also allow hyperlinking to be carried out in a Web page. Hyperlinking means that users are able to move in a sequential or nonlinear manner in a certain Web site or surf to an entirely new site altogether. HTML comments are used primarily by the Web page author to keep track of his work and are not displayed on the browser. HTML texts act in the opposite way as comments in that they are the actual texts that are displayed on a browser.

A Web browser extracts the information from the Web server, formats the information according to the structure of the HTML, and displays it. A browser communicates with the Web server using an Internet protocol known as HyperText Transfer Protocol (HTTP) to access other Web sites. Servers are the
means by which Web pages are stored and published on the Web. In addition, it also governs browser interface with programs from other servers.

Web browsers can also read files from other Internet servers such as File Transfer Protocol (FTP), Gopher, Usenet news, Wide Area Information Server (WAIS) databases, Telnet, and e-mail. Every Web site has a unique address or Uniform Resource Locator (URL). URLs are universal and act as pointers to information provided by a Web document, a file on FTP or Gopher, a posting on Usenet, or an e-mail address. A web browser basically moves to a specific location on the Web based on the information within the pointer, retrieves all relevant information from a server, via (HTTP) protocol, as requested by the user and displays it.
2.1 ONLINE DISTANCE LEARNING

"NSFNET Backbone services are provided to support open research and education in and among US research and instructional institutions, plus research arms of for-profit firms when engaged in open scholarly communication and research. Use for other purposes is not acceptable." (Muller, 1995). The statement above is the established Acceptable Use Policy called the "General Principle" created by the National Science Foundation in June of 1992 to develop a policy that would preside over the usage of the Internet's resources (Muller, 1995). Clearly the Internet was envisioned as a tool for providing an environment to support research and instructional institutions. Although the Internet was initially intended for military usage, commercialization together with government agencies and professionals who advocated the immense potential of the Internet as a tool for knowledge dispersion, played a dominant role in paving the way for the public's access to it.
2.2 EDUCATION ON THE WORLD WIDE WEB (WWW)

The Internet has affected the world of education over the last couple of years. Its graphics-based interface, the World Wide Web (WWW), opened the door for multimedia elements such as animations, movies, audio, graphics and images to play a vital role in the learning process. In addition, the implementation of scripting languages such as VB Script, Java, CGI, JavaScript, and PERL into the Web further promotes and improves user interface and interactivity. The Web's hypertext language allows the flow of information to take place across virtually every spectrum of computer platforms while enabling information linking in both linear and nonlinear ways. In addition, the Web's configuration allows information to be passed back and forth to other Internet services such as File Transfer Protocol (FTP), Gopher, Telnet, and Wide Area Information Server (WAIS) database.

Education through the Web, or online distance learning, is an increasingly popular trend and promises to revolutionize the delivery method of knowledge in educational institutions (Atkins, 1999). This concept of delivering education or training courses through extensive use of computer technologies to off-campus locations has been around since the 70's. Regents College, America's First Virtual University, based in Albany, New York, began offering non-traditional degree programs based on assessments at a distance since 1972 (Atkins, 1999). 27 years after its initial conception, Regents College now offers 30 undergraduate degree programs in nursing, liberal arts, business and technology, including a master's
degree program in liberal studies. There are currently 17,000 students enrolled in the various distance learning courses offered by Regents College (Atkins, 1999).

Distance learning sites are spreading rapidly and this trend can be expected to continue for many years to come. As reported by the US Department of Education's National Center for Education Statistics, one-third of the total number of higher education institutions across America offered distance education courses in the Fall of 1995. 25% of that figure offered degree programs while 7% offered certificate programs solely through undertaking distance education courses. The number of students receiving degrees and certificates in 1995 through enrollment in distance education courses exclusively amounted to 3000 and 2000 respectively (Atkins, 1999).

The use of the Web's distance learning technologies are also evident in topic-specific areas such as the project aimed at enhancing undergraduate construction engineering education carried out by the National Science Foundation (NSF) and Western Michigan University (WMU). This project, spanning a period of three years, plans to bridge the gap between the classroom and construction site by assimilating the actual construction engineering curricula through the use of an Internet-based Construction Management Learning System (ICMLS) (Mund, 1999).

Middle Georgia College (MGC) has also established a program offering credits to practicing and potential surveyors to fulfill the educational requirements for registration as a professional surveyor in Georgia. The need arose from a
change in the law that required all individuals who were interested in obtaining a surveying license in Georgia to complete a minimum of 20-quarter hours of college credit in the respective field (Butler, 1999).

Online laboratories are also an emerging trend on the Web, a case in point being the development of a Web-based resource center for engineering laboratories created by the University of Tennessee at Chattanooga. Through this project, a Web site (http://www.engineering-labs.net) is put together to govern the exchange of resources among engineering laboratories around the world. There are currently 15 different stations for control systems, chemical engineering unit operations, and environmental engineering experiments made available on the Web (Henry, 1999).

One related project carried out by the Milwaukee School of Engineering, called Project Specific Web Sites (PSWS), promises to revolutionize the manner in which information such as project data pertaining to any design or construction project is processed and transmitted to the relevant designers, constructors, and owners. Information exchange can include text, graphical and video data covering contracts and meeting minutes, as well as final drawings and construction images. PSWS can also be used to facilitate real-time collaboration work by allowing participants in remote locations to share and edit the data and images (Capano, 1999).
2.3 CURRENT FE AND PE EXAM REVIEW METHODS

Over the last several years, the Web has played an increasingly prominent role in education. One of the main reasons for this is its capability for integrating various multimedia elements such as animations, images, interactive simulations, and 3-D graphics to aid and reinforce the learning process. There are currently a multitude of university-sponsored online sites related to the Fundamentals of Engineering (FE) and Professional Engineering (PE) Exams. These sites function to aid users in registering for review sessions and provide general preparation guidelines for the upcoming exams.

Most review sessions are held over a period spanning several weeks and are generally held in the evenings. The reviews are presented in the form of lectures in a classroom-oriented environment. In general, review sessions such as these are made up of lecture periods, problem set solutions, and question and answer sessions. Review literature is available in the form of FE and PE exam review textbooks and manuals from Great Lakes Press, Professional Publications Inc., and Engineering Press. Apart from classroom-oriented review sessions, the concept of reviewing for the FE and PE exam using other types of presentation media are currently being carried out by several educational organizations. For example, Pennsylvania State University, Northwestern University, the American Society of Mechanical Engineering (ASME), and Professional Publications Inc., are offering review material in the form of videotapes. This method of preparation for the FE and PE exams include a set of several videotaped lectures, allowing
users to carry out the review within the luxury of their own home. Another example is NCEES' complete FE reference handbook which is placed online (http://www3.ncees.org/femenu.htm). This site allows users to download all the relevant references to each section in the FE exam. The online reference comes in the form of an Acrobat PDF file format.

Although these different review types provide a comprehensive and thorough review, there are several deficiencies that should be addressed. Firstly, the current cost associated with these review sessions can be large. The prices of the classroom-oriented review sessions held by many established higher education institutions such as Arizona State University, University of Houston, Georgia Tech, Worcester Polytechnic Institute, and University of Wisconsin Milwaukee ranges between $250 to $450. In addition, the videotaped review lectures offered by Pennsylvania State University, Northwestern University, the American Society of Mechanical Engineering (ASME), and Professional Publications Inc., ranges between $350 to $600.

Classroom-oriented review sessions also requires mandatory attendance. Because these review sessions can last between two to three hours in length, any participant who is unable to attend due to health, personal, or job related reasons will miss a major portion of the review session. In addition, these review sessions are generally held between two to four months before the actual exam, making it difficult for users to begin the actual preparation ahead of time. Furthermore,
given the multitude of handouts and review textbooks, users are subjected to the monotony of reading.

2.4 FE ONLINE REVIEW SYSTEM VS. CURRENT ONLINE REVIEW SYSTEM

The FE online review system offers a unique feature in that it allows users to access the review material at anytime of the day, regardless of individual schedule or preference. This provides all users, be it students in college or working professionals, a level of convenience as it allows them to begin the reviewing process at their own discretion. With access available at any given time of the day, the review process can be carried out depending on the individual user’s studying habits and progress can be made at the user’s own rate. Also, the extensive use of multimedia elements such as movie animations, audio narration, graphics, equations, texts, and interactive simulations create a dynamic and interactive environment in which to prepare for the exam. In addition, elements of user interface and interactivity within the movie animations and interactive simulations provide the means by which user input can be acquired, thus allowing the user to actively participate in the learning and reviewing process. Currently the University of Oklahoma FE online review system does not impose a fee on any user. Users are given access to all review information free of charge. There are no blocked out sites or links that require payment in order to gain access.
2.5 PROGRAMMING LANGUAGES ON THE WORLD WIDE WEB (WWW)

The World Wide Web (WWW) is history's largest single information repository with an estimated 36,739,000 hosts, 4,270,000 sites, and billions of documents (Enright, 1999). Its capacity to present graphical and textual information barely scratches the surface of its full potential. The advent of programming languages such as HyperText Markup Language (HTML), Practical Extraction and Report Language (PERL), Java, JavaScript, and Virtual Reality Modeling Language (VRML) has given birth to a multitude of user interactivity and interface that is both visually and vocally pleasing.

HyperText Markup Language (HTML) is the most common programming language used on the Web. In addition to specifying hyperlinks, it describes the syntax and location of specific directions that governs how contents such as text, images, graphics, and video within a Web page are displayed on a browser. Although HTML is only in its fifth year of implementation, it has already undergone four different versions of alterations (Flanagan, 1997). The World Wide Web Consortium (W3C) based at Massachusetts Institute of Technology (MIT), functions as the governing body for laying out the standards for HTML as well as overseeing the drafting, circulating, modifying, and reviewing of HTML for public use (Flanagan, 1997).

The first version of this language, HTML 1.0, was designed for publishing scientific papers on the Web. Its replacement, HTML 2.0 was created in 1994 and
featured additional upgrades to the existing capabilities of its 1.0 counterpart such as text field, pop-up menus, and buttons. The third version, HTML 3.0, was established in 1995 but had little support and was dropped in favor of HTML 3.2 (Newton, 1998). Currently HTML 4.0 is the standard version used on the Web.

HTML can be created and edited using standard text editors. There are also multiple software available in the market dedicated for HTML development and editing such as Symantec Visual Page, Macromedia Dreamweaver, and Microsoft Front Page.

Another important technical aspect of the Internet is its ability to interact with servers. This is accomplished through the use of Common Gateway Interface (CGI) scripts. CGI scripts or programs are used to perform certain pre-defined tasks when initiated by the user. These scripts normally carry out actions such as searching and executing applications on the server when a client clicks on certain elements or locations on the Web page (Newton, 1998). One of the most popular methods used for writing CGI scripts is Practical Extraction and Report Language (PERL). This language, which was created by Larry Wall in 1986, was initially designed as a tool for program authoring in UNIX systems. PERL offers the power and flexibility of high-level programming languages such as C and is relatively easy to learn (Biedny, 1997).

The Web also supports elements of animated Web pages and user interactivity. These features open up a new dynamic dimension to static Web pages. There are several languages that can be employed to develop such Web
elements, such as Sun Microsystems' Java. Java is a new object-oriented programming language, with elements from C, C++ and other languages, and with libraries for the Internet environment (Harold, 1997). Arguably the most important Java quality is its compatibility to develop the next generation of network applications. It is the first programming language designed from the ground up with networking in mind (Harold, 1997). It offers many qualities that are paramount for keeping up with the dynamic trends of the Internet such as platform-independence and security. Java also allows applications or applets to be created and left on the Web to be downloaded by other users when needed.

In addition to Java, features such as user interactivity and interface, real time response, pop-up menus, and rollover buttons can also be developed using JavaScript. In fact, JavaScript was developed as an easier alternative, object-oriented, programming language to Java for enhancing Web pages and servers (Newton, 1998). Through the use of JavaScripts, stand alone applications can either be embedded into HTML files or Java applets. Furthermore it is also able to respond to user and client system input without the need for server-side programs such as CGI scripts (Ritchey, 1996). JavaScript is a cross platform compatible, interpreted language that must be compiled or interpreted by the browser each time it is executed.

Within the last few years, the Web has also been used as a tool for 3-Dimensional graphics presentation. This feature of the Web is made possible through the use of Virtual Reality Modeling Language (VRML). VRML, which
was developed in 1995, enables dynamic worlds and sensory-rich virtual environments to be created on the Internet. With VRML, a wide variety of entities such as structures, buildings, organic living forms, and vehicles can be created in a three-dimensional virtual world and displayed on the Web. It also allows object animation, audio and movie clips, and user interaction and control to be incorporated through the use of scripts (Ames, 1997).
CHAPTER 3
ONLINE REVIEW SITE

3.1 SITE LAYOUT

This chapter focuses on the layout and organization of the online review site. The manner in which the topics were divided and presented, as well as the navigation options provided in the review site was also explained in detail. Currently, the FE exam format is made up of two 4-hour sections, morning (AM), and afternoon (PM). In the AM section, all 12 engineering and science topics taught during the first four years of an ABET accredited undergraduate engineering curriculum are covered while the PM section focuses only on a specific engineering discipline.

The organization of the FE review material in this online site was divided into both an AM and PM section to mimic the content organization of existing review textbooks and manuals. There are a total of 12 science and engineering topics covered in the AM section, including Chemistry, Computers, Dynamics, Electrical Circuits, Economics, Ethics, Fluid Mechanics, Mathematics, Materials Engineering, Mechanics of Materials, Statics, and Thermodynamics. The PM review portion encompasses branch-specific fields, including Chemical, Civil, Electrical, Industrial, and Mechanical Engineering Exams. To better organize the content in the AM section, each of the 12 topics were divided into subtopics.
called modules. By organizing the content in terms of modules, users are able to select and gain access to individual subtopics during the review process with relative ease. This concept of using modules can also be beneficial to the need for a quick reference arise.

The layout and presentation of the content within each module is designed to allow users to progress in a sequentially organized manner. To achieve this objective, each individual module was further divided into three distinct sections: Basics, Examples, and Problems. The division of each module allows users to begin reviewing the theory in the Basics page, before moving on to the application in the Examples page. Finally, six problems are presented to the user in the Problems page for the testing and application of the user's understanding on the module. Altogether there are a total of 82 separate modules, each with a Basics review, Examples, and Problems section.

To further improve user interaction, the file size limit for each page in a module is set below 100 kilobytes to minimize downloading time for modem users, in particular, users with 56.6 kilobits per second (kbps) modems. Furthermore, the dimensions of each page was tailored to fit a screen size of 800 x 600 pixels. This setting fits the monitor resolution of most computers allowing users to easily access and view the modules without the need to scroll sideways.
3.2 SITE NAVIGATION OPTIONS

The review site is made accessible to users at www.eml.ou.edu/fie. To better serve the users, there are two text links at the main page of the FE online review site (Figure 1) that allow users to select one of two navigation systems available. The online review site features two types of navigation systems: HTML and Shockwave.
Figure 1: Main Page of FE Online Review Site
Upon reaching the main page, users can choose to navigate through the online review site using either the Shockwave pull-down menu or direct HTML menu link simply by clicking on one of the two text links. Because the online review site makes use of several different multimedia plug-ins such as Shockwave, QuickTime, and Cosmo Player, there are three additional links at the main page to aid users in acquiring these plug-ins. These plug-ins are required so users can access the various multimedia elements efficiently and appropriately.

The Shockwave pull-down navigation system was created using a software called Director 7 by Macromedia (Figure 2a). Although this Shockwave menu is more visually appealing and involves some form of user interactivity, download time may become a factor especially for users with modems of 33.6 kbps or lower. On the other hand, the HTML menu link, which comprises only of text links, has essentially no download time (Figure 2b). Regardless of which navigation option is chosen, users will have access to all the FE review material. Once a menu option has been selected, the respective pull-down or text link menu will appear on the left-hand frame of the review site (Figures 3 and 4). All 12 engineering and science topics available in the AM section as well as the discipline-specific review list for the PM section are listed here.

To help prevent user confusion and improve organization, there is an introduction page provided for each topic. These topic-specific introduction pages provide a brief topic summary and are displayed when the particular topic is selected. To allow users the luxury of navigating through the site in a sequential
or nonlinear manner, the individual modules that make up the entire topic are listed in a menu located on the frame above the topic's introduction page.
### Figure 2a: HTML Navigation System

<table>
<thead>
<tr>
<th>Basic Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fundamentals</strong></td>
</tr>
<tr>
<td>Morning Exam</td>
</tr>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Dynamics</td>
</tr>
<tr>
<td>Economics</td>
</tr>
<tr>
<td>Fluids</td>
</tr>
<tr>
<td>Materials</td>
</tr>
<tr>
<td>Statics</td>
</tr>
<tr>
<td>Thermo</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Branch Specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afternoon Exam</td>
</tr>
<tr>
<td>Chemical</td>
</tr>
<tr>
<td>Civil</td>
</tr>
<tr>
<td>Electrical</td>
</tr>
<tr>
<td>Industrial</td>
</tr>
<tr>
<td>Mechanical</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practice Exams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamentals (AM)</td>
</tr>
<tr>
<td>Chemical (PM)</td>
</tr>
<tr>
<td>Civil (PM)</td>
</tr>
<tr>
<td>Electrical (PM)</td>
</tr>
<tr>
<td>Industrial (PM)</td>
</tr>
<tr>
<td>Mechanical (PM)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>User Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Board</td>
</tr>
</tbody>
</table>

### Figure 2b: Shockwave Navigation System

- General Information
- Fundamentals - Morning Exam
  - chemistry
  - computers
  - dynamics
  - electrical circuits
  - engr. economics
  - ethics
  - fluid mechanics
  - mathematics
  - materials eng.
  - mech. of materials
  - statics
  - thermodynamics
- Branch Specific - Afternoon Exam
- Practice Exams
Figure 3: HTML Menu System
Figure 4: Shockwave Pull-Down Menu System
There is a slight difference in the way the HTML and Shockwave menu options display the individual Basics, Examples, and Problems Page. In the HTML navigation system, the respective Basics, Examples, and Problems Page of each module are displayed within this top frame menu (Figure 5). For the Shockwave navigation system, the individual link to each modules' Basics, Examples, and Problems Page appears once the mouse cursor rolls over the particular module (Figure 6). In general, the Basics Page contains all the basic theory and equations relevant to the module. To further improve user understanding, theory and equation application to problem solving is demonstrated in the Examples Page. Finally, to provide users with the opportunity to test out their understanding of the module, a set of six problems are provided in the Problems Page. The simultaneous presentation of all the individual topics in the left frame and a topic's modules on the top frame is accomplished through the use of JavaScript.
Figure 5: HTML Main Topics and Modules Listing
Figure 6: Shockwave Main Topics and Modules Listing
CHAPTER 4

MODULE PAGES

4.1 TOPIC INTRODUCTION PAGE

This chapter talks about the individual Basics, Examples and Problems Page for each individual module. The various multimedia elements used, such as movie animations, graphics, equations, interactive simulations, and 3-D VRML models are also described in detail.

To prevent user confusion, each individual main topic in the FE review has its own introduction page. This introduction page is displayed when the user selects a topic and contains an overview of the selected topic (Figures 7 and 8). To permit the user to identify the scope of coverage for each topic, the introduction page also contains a list of modules that make up the topic. The module listings on each introduction page are text links that can also be used to access the individual modules. In this way, users can gain access to the review modules should the menu containing the list of modules located in the frame above the introduction page malfunction.
FLUID MECHANICS

Topics Reviewed

1. Basics
2. Fluid States
3. Flow
4. Centrally
5. Momentum
6. Dynamics
7. Bernoulli's Theorem

This section deals with some of the fundamental aspects of fluid mechanics and various flow phenomena. A basic understanding of the fundamentals is essential in the study of fluid flow and the equations governing interactions will help you review for the exam in a very effective manner.

The topics above allow you to review directly to any of the three sections for each topic. The sections are:

- Basics
- Fluid States
- Flow
- Centrally
- Momentum
- Dynamics
- Bernoulli's Theorem

Examples: To help you recall the basic principles, examples are given with their solutions. Examples include animations, simulations and videos to help you better understand the topic.

Problems: Typical problems are given with answers. The problems are similar to what you might find on the actual exam.

© 1997 Kurt Grenwell, The University of Oklahoma
All Rights Reserved.
Figure 8: Individual Topic's Main Page (Shockwave Version)
4.2 BASICS PAGE

To organize the review material, each module is divided into three separate sections: Basics, Examples, and Problems. Through this method of module breakdown, users are able to progress through the review process in a sequential and organized fashion.

The Basics page contains all the relevant theory and equations pertaining to a particular module (Figure 9). Here users are presented with the basic information to gain an understanding of the module. In addition to the texts and equations, multimedia elements such as graphics, movie animations, audio narration, and movie clips are included in the Basics Page to further encourage interactivity and enhance comprehension on behalf of the user. The movie animations were designed to provide users with a visual representation of the engineering phenomenon described by the theory in order to promote better user understanding (Figure 10). As stated earlier, the material presented here are specifically tailored for reviewing purposes and not for teaching an entire course. As such, users are expected to have prior knowledge of the material as the theories and equations are presented without their respective detailed derivations. The review material is aimed at providing sufficient information on a particular module to enable users to answer the exam questions successfully.
Figure 9: Basics Page
A TYPICAL VISUALIZATION OF AN ATOM

Nucleus contains both proton and neutrons.

- electron orbit
- electron
- nucleus

NOTE: There is scientific evidence that electrons do not move in orbits.

Figure 10: Movie Animation Window
4.2.1 GRAPHICS AND IMAGES

Graphics and images were used extensively in each Basics Page to convey certain concepts or to aid the user in acquiring a better understanding on how the theory is applied in actual engineering practices. All graphics and images used in the online review site were either obtained from the Web, or created using commercially available graphics software such as Adobe PhotoShop, Macromedia FreeHand, and Flash. Occasionally, an Epson Photo PC digital camera and an Astra 600 S UMAX flatbed scanner was employed to assist in obtaining some of the needed graphics and images.

Images that were obtained from the digital camera and the scanner were edited using PhotoShop to enhance picture quality and to emphasize certain graphical details. Once the editing process was completed, the final version of the image was then exported as a GIF (Graphics Interface Format) or JPEG (Joint Photographic Experts Group) format. Although there are other export formats available such as Bitmap and TIFF (Tag Image File Format), both GIF and JPEG formats offer the best image quality while imposing a minimum file size requirement due to its compression techniques. Furthermore, both GIF and JPEG file formats are standard for displaying images on the Web.
4.2.2 MOVIE ANIMATION

To provide a graphical illustration of certain engineering concepts, movie animations were utilized. Module-specific movie animations were created using Macromedia's Flash and included into each modules' Basics Page (Figure 11). By providing a graphical representation of the information presented in the text, users are able to reinforce their understanding on the material. In addition to movie animations, Flash is also capable of creating vector-based drawings.

In vector-based drawings, graphics are defined mathematically as opposed to raster graphics that are described by individual pixels and thus, have fixed dimensions. The vector-based feature in Flash allows movie animations and graphics to be resized without experiencing the pixelization effects inherent in pixel-based or raster drawing tools. Furthermore compression options within Flash allows file sizes to be kept at a minimum. By default, all movie animation windows are set to open at 320 x 240 pixels.

All animations are accessed by clicking on its screen-captured image (Figure 9). This image is linked to the animation through the use of JavaScript. By having the picture linked directly to the animation, the time required to download the Basics Page is reduced since the movie is downloaded only when initiated by the user. Once the user clicks on the image, JavaScript initiates the movie animation and displays it in a separate window (Figure 10). Through the use of JavaScript, presentation of the Basics Page and the movie animation can be carried out simultaneously, allowing the user to view the material in a neat and
Figure 11: Periodic Table (Shockwave Version)
orderly manner. To promote user interaction, all movie animations are equipped with a play, stop, and rewind button. A timeline is also provided to indicate the actual length of the movie (Figure 10).

Flash's vector-based characteristics are also used in certain modules where large amounts of information have to be displayed in a relatively small area. Within certain topics such as Materials Engineering and Thermodynamics, property charts and tables are included to provide additional information to the user (Figures 11, 12, and 13). Because these property charts and tables are developed using Flash's vector-drawing features, its Shockwave export can be resized without loss of quality and detail.

As with the movie animations, these charts and tables are linked via JavaScript to their respective screen-captured images and can be conveniently accessed. In general all Shockwave files containing charts, graphs, or tables are set to open in a window size larger than 320 x 240 pixels.
Figure 12: Mollier Diagram (Shockwave Version)
Figure 13: Property Chart (Shockwave Version)
4.2.3 JAVASCRIPT AND VRML USAGE

User interface and interactivity can be accomplished using JavaScript. Through the use of JavaScript, real-time responses, rollover images, and calculations can be performed. JavaScript was used to developed calculation tools for certain modules in engineering economics. These calculators can be used to determine values such as capital recovery, and present worth (Figure 14). Text fields were included to allow users to input values manually and the final answer will be displayed once the user presses a particular button to begin the calculation.

Viewing graphical models in 3-D, allow users to make use of the various viewing angles, in addition to zooming in on a particular graphical detail for further observation or analysis. 3-D graphics can be developed in a virtual environment through the use of Virtual Reality Modeling Language (VRML). VRML was used in the Polymer and Organic Chemistry module (Figure 15). The implementation of VRML allows three-dimensional viewing of certain chemical compounds such as acids, alcohol, and hydrocarbons to be accomplished. To enhance user interaction, the navigation bar within VRML can be employed to scale and rotate the 3-D object to obtain a better view within the virtual environment.
Figure 14: JavaScript Calculation Tool
Figure 15: Chemistry Module Display (VRML)
4.2.4 TEXTS AND EQUATIONS

All texts within the Basics, Examples, and Problems page were developed using commercially available HTML authoring software such as Symantec Visual Page and Macromedia's Dreamweaver. Whenever possible equations were also developed and edited within these HTML editing software. After experimenting with several different font types, the Arial font group was chosen because it provided the best visual quality. The Arial font group is made up of three fonts types: Arial, Helvetica, and San Serif. These three font types are grouped together as they closely approximate each other in appearance. By utilizing font groups, a browser that is used to display textual information will switch to the next available font type in the group should it be unable to detect the initial font type. For instance if the Arial group was employed, the browser will seek to use the Helvetica font type if it is unable to utilize the Arial font option. Such flexibility in font types enables the appearance of textual information to remain relatively consistent. The font size for the texts varies according to their individual function. To ease user navigation, each Basics Page contains a custom-made icon that links directly to the Examples Page.
4.3 EXAMPLES PAGE

The Examples Page is the second section of each module. Once the Basics Page has been reviewed, users are able to observe the manner in which the theories and equations are applied to problem solving in the Examples Page to further strengthen their grasp on the relevant concepts (Figure 16). On the other hand, if the user chooses to do so, he may elect to test his own understanding of the material by attempting to solve the given example problems. In most modules, there are two examples that are worked out in detailed steps. There are however, certain modules with more than two examples, depending on the module's level of complexity. Each example is worked out using all the relevant theory and equations given in the Basics Page. All solution steps pertaining to each example is clearly displayed to present users with a comprehensive look on how each equation is utilized. Occasionally, alternative equations are used with the derivation steps clearly outlined and documented.

Each example problem is displayed with the corresponding diagrams and images, together with the application process for the theory and equations. All solution steps are carefully outlined to avoid any confusion. In addition, the solution steps are also carefully planned and laid out to present the clearest possible method for solving the example problems. Finally, each example problems' final answers are designated in red text color.
Figure 16. Examples Page
4.3.1 INTERACTIVE SIMULATIONS

Another multimedia element that was used to promote and enhance user interactivity within the online review site is interactive simulations. These simulations also serve as a tool to help users visualize certain engineering phenomenon as described in the Basics Page. By allowing users to edit certain numerical parameters within the simulation, users are able to observe the effects and establish certain engineering relationships associated with the edited parameters. The development of each simulation was carried out in Macromedia's Director 7 and then exported as a Shockwave movie. The Shockwave movie format allows the file size of each simulation to be minimized while optimizing the quality level. All simulations can be accessed through the use of custom-made icons that can only be found in the Examples Page of certain modules. Once a user clicks upon these icons, the respective simulation will open up in a separate browser window through the use of JavaScript (Figure 17). This setup reduces the download time of the Examples Page as the Shockwave movies are downloaded only when requested by the user.
Figure 17: Interactive Simulation Window
4.4 PROBLEMS PAGE

The Problems Page is the last component of each module. There is a set of six questions presented allowing users to test their understanding of the module. Each of the six questions can be accessed by clicking upon their respective screen-captured images (Figure 18). Once the images are clicked upon, JavaScript will initiate the individual questions and display them in a separate pop-up window (Figure 19).

Each individual question was made in Macromedia's Flash and exported as a Shockwave movie. All questions are accompanied with the corresponding graphics and a list of four answers from which users can select upon (Figure 19). These answers were designed as buttons that refer to different parts of the movie upon the interaction of the user (Figure 20). If the user selects a button leading to the incorrect answer, a "back" button is present to allow the user to return to the main problem page to begin again. All correct answers are displayed with the corresponding graphics and a step-by-step derivation leading to the correct answer (Figure 21).

Although there are six questions in each Problems Page, download time is not a significant factor since the individual questions are downloaded separately only when the user initiates it. The pop-up window is set at 560 x 360 pixels and can be resized by the user without loss of visual quality due to Flash's vector-based graphics capability.
Figure 18. Problems Page
Figure 19: Pop-Up Menu Problem

Problem 4

A autotransformer is used to change a source voltage of 220V to a load voltage of 140V across a 10Ω resistance. Determine the power in winding B assuming this transformer is the ideal.

(a) $P_B = 712.73$ VA
(b) $P_B = 3.2$ kVA
(c) $P_B = 1.3$ kVA
(d) $P_B = 2.5$ kVA

Figure 20: Answer List Buttons
Problem 4

Correct Answer.

The ideal current $I_3$ is determined as:
\[ I_3 = \frac{V_3}{R_L} = \frac{140}{10} = 14 \, \text{A} \]

Solving for $I_1$,
\[ I_1 = \frac{V_2 I_3}{V_1} = \frac{140 \times 14}{220} = 8.909 \, \text{A} \]

Applying Kirchhoff’s current law at the junction:
\[ I_1 = I_2 + I_3 \]

Thus,
\[ I_2 = I_1 - I_3 = 8.909 - 14 = -5.0909 \, \text{A} \]

The power in winding B is:
\[ P_B = (140)(-5.0909) = 712.73 \, \text{VA} \]

Figure 21: Correct Answer Display
CHAPTER 5
SOFTWARE

5.1 SIMULATION AND ANIMATION AUTHORING SOFTWARE

The FE online review site employs several different multimedia elements such as movie animations, graphics, texts, and interactive simulations. These multimedia elements were used to create a dynamic and interactive environment in which users can prepare for the FE exam. This chapter details the different software that were used in developing these multimedia elements. The software outlined in this chapter were divided into four groups: simulation and animation, graphics, equations, and HTML authoring software.

Macromedia Flash and Director were used for the purpose of developing the movie animations and interactive simulations. Graphics creation and modification were accomplished using Adobe PhotoShop and FreeHand from Macromedia. Equations that were used extensively throughout the Basics, Examples, and Problems Page were done in MathType. Finally, the structure and layout of each Basics, Examples, and Problems Page, as well as the text fonts were created and edited using Symantec Visual Page, and Macromedia Dreamweaver.
5.1.1 FLASH

Movie animations that were used in each Basics Page serve to provide a graphical representation of the theories that were covered in a particular module. To develop these movie animations, Macromedia Flash was employed because of its Web-based interactivity and ease of use. Flash is primarily an animation and authoring tool for the Web that can also function as a vector graphics editor. It allows both graphics and animations to be created easily through a user-friendly interface while keeping file sizes to a minimum. In addition, interactive controls and specified actions can be integrated within the animation without the hassle of dealing with scripting languages. These qualities make Flash a suitable tool for developing animation and interactivity for Web pages (Macromedia, 1998). There are four main components to Flash: stage, timeline, command and control panels, and drawing tools (Figure 22).

The stage is where all drawings, imported graphics, and animations are created and edited. By default the stage dimensions are set at 550 x 400 pixels, but this configuration can be modified. The minimum and maximum dimensions that can be set by the user are 18 x 18 and 2880 x 2880 pixels respectively.

The timeline is used to define the individual elements or contents of a movie over a length of time by incorporating frames. By default, 12 frames constitute one second but this setting can be modified according to the user's preferences. To alter the movie contents according to the user's specifications, keyframes are utilized. Alterations can include color, text, motion, or sound
Figure 22: Macromedia Flash Interface
editing. Each frame and keyframe has its own pop-up menu that contains all relevant commands for modifying, creating, and deleting elements.

To better help users organize their work, layers can be employed at the user's discretion. By making use of layers, users are able to separate the different elements of texts, equations, graphics, or drawings. Layers are located as rows in the timeline (Figure 22). As with frames and keyframes, each layer has its individual pop-menu where users can modify the settings and properties of a particular layer.

Images and graphics used in movie animations can be created within Flash. In addition, graphics can also be imported from other graphics software such as PhotoShop, and FreeHand. All the basic drawing tools for creating lines, curves, rectangles, circles and texts are made available in the drawing toolbar. In addition, all relevant editors and modifiers such as color, resizing, scaling, line thickness, brush size, curve smoothness, font types and sizes can also be accessed from the same toolbar.

Flash can also be used to develop vector-based shapes and lines. Vector-based graphics are defined using mathematical equations and are therefore resolution-independent. Because vector-based graphics are resolution-independent, it can be stretched or viewed up close without losing its crisp and smooth features. On the other hand, pixel-based graphics that are resolution-dependent, will experience a pixelization effect when it is resized.
Among Flash's greatest attribute is its capability to create animations. In general, there are two types of animations: frame-by-frame and tweened. In a frame-by-frame animation, each frame is set up as a keyframe. This type of animation is particularly useful for creating animations involving images that change with time and frame (Macromedia, 1998). In contrast, if an animation involves images that translates, rotates, or scales, then the tweening animation method is better suited for the job.

Tweened animations involve defining keyframes within a particular time frame and then allowing Flash to interpolate the contents of the frames in between. There are two types of tweened animations available in Flash: motion and shape.

In motion tweening, the movements of a group of elements or symbols are dictated by Flash. The user positions the object's initial and final position in the first and the last keyframes respectively, and all movements in between the two keyframes are defined by Flash. Motion tweening only deals with rotating, scaling, and orienting groups of elements or symbols.

To modify the actual shape of objects, shape tweening is required. The user defines the initial and final shape of the object and Flash proceeds to morph the shape of the object as defined by the two keyframes.

Flash can also generate orient-to-path-tweening animations whereby objects follow a predefined path. Here the user creates a motion path for the desired object to follow. Once this is done, the initial and final location of the
object on the path is specified using keyframes and Flash animates the object's motion from the start to the end points as defined by the path.

Another important element in Flash is symbols. Symbols are reusable objects that are stored in the library. In general there are three different types of symbols: graphic, button, and movie clip. A graphic symbol is the best choice for graphics, images or animations that will be repeatedly used. The button attribute incurs upon a symbol a timeline with only four frames. These four frames define the actions of mouse-up (mouse button is not hit), mouse over (mouse pointer is over), mouse-down (mouse button is pressed), and mouse hit (area which will respond to the actions of the mouse). A movie clip symbol is liken to a graphic symbol with the exception that it contains all the functionality and interactivity of a movie. This movie is self-contained and is independent of the main timeline. The characteristics of each symbol are listed in Table 1. These parameters can be modified at the user's discretion.
<table>
<thead>
<tr>
<th>Symbol Attribute:</th>
<th>Editable Parameters:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphic Symbol</td>
<td>Frame Properties:</td>
</tr>
<tr>
<td></td>
<td>▪ Loop</td>
</tr>
<tr>
<td></td>
<td>▪ Play Once</td>
</tr>
<tr>
<td></td>
<td>▪ Single Frame</td>
</tr>
<tr>
<td></td>
<td>▪ First Frame</td>
</tr>
<tr>
<td>Button Symbol</td>
<td>▪ Mouse Action</td>
</tr>
<tr>
<td></td>
<td>▪ Mouse Up</td>
</tr>
<tr>
<td></td>
<td>▪ Mouse Down</td>
</tr>
<tr>
<td></td>
<td>▪ Mouse Over</td>
</tr>
<tr>
<td></td>
<td>▪ Mouse Hit</td>
</tr>
<tr>
<td>Movie Symbol</td>
<td>▪ Links</td>
</tr>
<tr>
<td></td>
<td>▪ Target</td>
</tr>
</tbody>
</table>

Table 1: Editable Parameters of Symbols in Flash

The button attribute of symbols is an important element in creating interactivity. Buttons can be used to play movies, skip to new frames, or even for transporting to a Web site. There are four frames in the timeline defined by Up, Over, Down, and Hit to help simplify the process of creating button animations and actions. The texts, graphics, or movie animations used to represent each of the four frames can be created and edited as the need arises. In addition, audio elements can also be added to further improve the functionality of the button.

Both keyframes and buttons can be designated with specified actions. This allows buttons to carry out a pre-defined task upon the input of the user or enables certain keyframes to perform an assignment in the movie once it reaches a
particular frame. The user specified actions available to keyframes and buttons are presented in Table 2.

<table>
<thead>
<tr>
<th>Keyframe and Button Actions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go To</td>
</tr>
<tr>
<td>Play</td>
</tr>
<tr>
<td>Stop</td>
</tr>
<tr>
<td>Toggle High Quality</td>
</tr>
<tr>
<td>Stop All Sounds</td>
</tr>
<tr>
<td>Get URL</td>
</tr>
</tbody>
</table>

Table 2: Pre-Defined Actions For Keyframes and Buttons

Flash also allows the implementation of sound within movies. Sound files can be imported into Flash in the form of AIFF or WAV file formats. Sound elements can be set to play independently of or synchronized with the timeline. In general there are two types of sound elements available in Flash: event and stream.

An event sound element can only begin playing once the entire sound file has been completely downloaded. Event sound plays independently of the animation timeline. Once it has begun playing, it will continue to do so even if the animation has ended, and will persist until it has been given specific orders to stop.

Streaming sound begins playing once a certain amount of sound data has been downloaded. When the streaming sound element begins to play, the
remaining sound data continues to be downloaded until complete. Unlike its event counterpart, Flash synchronizes the streaming sound with the movie animation timeline. If the movie animation is stopped, the streaming sound will cease to play as well.

Because sound elements can contribute significantly to the file size of the movie animation, Flash offers a variety of compression settings to optimized sound quality while minimizing the file size. Tables 3 and 4 lists the sound settings and effects options available to users

<table>
<thead>
<tr>
<th>Sampling Rate Options:</th>
<th>Sound Bit Options:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ 5 kHz Mono</td>
<td>▪ 5 kHz Stereo</td>
</tr>
<tr>
<td>▪ 11 kHz Mono</td>
<td>▪ 11 kHz Stereo</td>
</tr>
<tr>
<td>▪ 22 kHz Mono</td>
<td>▪ 22 kHz Stereo</td>
</tr>
<tr>
<td>▪ 44 kHz Mono</td>
<td>▪ 44 kHz Stereo</td>
</tr>
<tr>
<td>▪ 16 Bit</td>
<td>▪ 18 Bit</td>
</tr>
</tbody>
</table>

Table 3: Audio Setting Options in Flash

<table>
<thead>
<tr>
<th>Sound Effects Options:</th>
<th>Sound Synchronization Options:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Event</td>
<td>▪ None</td>
</tr>
<tr>
<td>▪ Start</td>
<td>▪ Left Channel</td>
</tr>
<tr>
<td>▪ Stop</td>
<td>▪ Right Channel</td>
</tr>
<tr>
<td>▪ Stream</td>
<td>▪ Left to Right</td>
</tr>
<tr>
<td>▪ Fade Right to Left</td>
<td>▪ Fade In</td>
</tr>
<tr>
<td>▪ Fade Out</td>
<td>▪ Custom</td>
</tr>
</tbody>
</table>

Table 4: Audio Effect Options in Flash

Sound elements embedded within a Flash movie are housed in a separate layer and can be modified. The modifications are carried out in the Sound pop-up
menu through the use of volume envelope handles. Sound elements can also be integrated within buttons to make it more responsive to user input.

The final product of a Flash animation is commonly exported as a Shockwave Flash file. In general, Shockwave can be played as an individual file or placed in an HTML file to be accessed as a separate Web page. The movie is set to play automatically unless an action is embedded in the keyframes to tell it to do otherwise. Since Flash's graphic is vector rather than pixel-based, the Shockwave files can be resized without any loss of quality or detail. Coupled with Flash's compression options, users can be assured that file sizes can be kept to a minimum while optimizing the audio and visual quality. In addition, bandwidth can also be optimized to ensure that download time will be kept to a minimum.

There are several other options for animation and graphic export formats available in Flash as listed in Table 5. Each export format has its own individual settings where users can decide upon parameters such as compression quality, image quality, dimensions of width and height, resolutions (dpi), color depth (bits), and sound compression and quality.
<table>
<thead>
<tr>
<th>Flash Animation and Graphic Export Formats:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Shockwave (swf)</td>
</tr>
<tr>
<td>• Generator Templates</td>
</tr>
<tr>
<td>• FutureSplash Player (spl)</td>
</tr>
<tr>
<td>• Quick Time (mov)</td>
</tr>
<tr>
<td>• Animated GIF (gif)</td>
</tr>
<tr>
<td>• PICT Sequence (pict)</td>
</tr>
</tbody>
</table>

Table 5: Animation and Graphic Export Format Options

Macromedia Flash was used extensively to develop the movie animations with audio narration in the Basics Page for each module. The vector-based graphics capability combined with the multitude of sound compression options available in Flash enable the exported Shockwave file format to be minimized while allowing the graphics to be resized without loss of quality or detail. Flash's vector-based graphics feature was also used to develop several property charts and tables for the Materials Engineering and Thermodynamic review topics. These resizable charts and tables allow users to gain valuable technical information without cluttering up the computer screen. Flash was also used to develop the set of six problems presented in the Problems Page. In each problem the individual answer list were made using button attributes, allowing users to actively participate in the problem solving process.
5.1.2 DIRECTOR

Interactive simulations provide users with an opportunity to experiment and explore the different engineering and science relationships. There are several different programming languages available that can be used to develop simulations such as Java, Director, and JavaScript. In the FE online review site, the interactive simulations were developed using Macromedia Director because it offered significant programming capabilities through the use of Lingo scripts but without the complicated syntax of other object-oriented programming languages such as Java. Director is the leading multimedia-authoring tool and is a powerful instrument for creating interactive simulations for the Internet and interactive CD-ROMs.

There are several components to Director: movie, cast, member, score, stage, frame, channel, and sprite (Figure 23). These components provide the tools to create animations and graphics in Director. To employ Director's capabilities to create complex and interactive simulations, a programming language, known as Lingo is built into the Director program.

All elements of graphics, vector shapes, texts, sounds, or movies that are used in a Director movie are known as cast members. Cast members can be created and modified within Director or imported from an external source. Director accepts cast members from a multitude of different graphics, audio or video formats as listed in Table 6. Every cast member is listed in the Cast window and has its own property window to allow for property editing. For cast members
Figure 23: Macromedia Director Interface
that will be reused in several different Director movies, external cast libraries can be utilized for storing purposes.

<table>
<thead>
<tr>
<th>Types of Director Cast Members:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Bitmaps - Graphics or images that can be created within Director or imported from other graphics or 3D software.</td>
</tr>
<tr>
<td>▪ Text - Formatted characters of alphabets and numbers with high quality anti-aliasing options available within Director</td>
</tr>
<tr>
<td>▪ Sounds - Mostly imported from an external source since Director does not have the capability to create or edit sounds</td>
</tr>
<tr>
<td>▪ Shape - Lines, circles, rectangles, curves</td>
</tr>
<tr>
<td>▪ Vectors - Mathematical descriptions of lines that can be bent and curved without losing shape and clarity</td>
</tr>
<tr>
<td>▪ Buttons - Functional buttons that respond to a user's specific input</td>
</tr>
<tr>
<td>▪ Digital Video - In general QuickTime and AVI movie formats. QuickTime VR and MIDI formats are also possible options</td>
</tr>
<tr>
<td>▪ Xtra Members - Additional cast members available Director to improve functionality and appearance.</td>
</tr>
</tbody>
</table>

Table 6: Director Cast Member Types

The stage is the visible area of a movie where the cast members appear. Users can determine the cast member's physical location on the stage. Stage properties such as dimensions of height and width, stage location, background color, and system palette color can be altered according to the user's specifications.
The score is used to determine the movements, presence, timing, and location of each cast member (Macromedia, 1997). Columns representing time, or frames, span across the score while sprite channels occupy the rows of the score. Once a cast member is placed in the score, a corresponding sprite will appear on the score channel. Properties of a cast member such as its location on the stage and position in the score are given in the sprite.

In addition to the sprite channels, there are five other special channels: tempo, palette, transition, sound, and frame script. These channels provide users with additional controls such as movie rate, color palette variations, audio overlaps, and Lingo scripts.

As with Flash, tweened animations can also be created using keyframes on sprites. The user defines the first and the last keyframes, and positions the cast member's corresponding location on the stage. Director then automatically determines the movements of the cast member in between the two defined keyframes. Tweening options are not limited to straight lines. Curved and circular path tweening as well as scaling and rotating individual sprites can also be accomplished.

To create an interactive Director movie, Lingo scripts must be employed. There are several types of scripts used in Director as listed in Table 7.
- Behavior Scripts - Placed on a sprite to enhance user control
- Frame Script - Embedded within a frame or a set of frames
- Movie Script - Functions throughout an entire movie
- Cast Script - Placed in a cast member
- Parent Scripts - An advance script used with object-oriented-programming

<table>
<thead>
<tr>
<th>Table 7: Types of Lingo Scripts</th>
</tr>
</thead>
</table>

Lingo, the scripting language, presents the user with a multitude of flexibility and control over each cast member's actions throughout the entire Director movie. In Director terminology, when an event takes place, a message is sent to any Director object that is related to that particular event. Event handlers tasks with interpreting specified messages then proceed to execute pre-defined commands associated with the message (Macromedia, 1997).

The use of variables and strings or sequence of characters enable Director to perform trivial as well as complicated mathematical computations. Through the use of *if* and *then* statements, loops, nested loops, case statements, and logical operators can be created (Macromedia, 1997). User input can also be included by implementing check boxes, rollovers, radio buttons, drag items, and sliders. In addition, text fields can be used to allow users to manually submit alphanumeric values as input to a Lingo program. By incorporating mathematical equations in Lingo and utilizing the trail property, which is available to all sprites, users have the option of generating graphs or plotting diagrams.
User interface objects such as progress bars, pop-up menus, and dialog boxes can also be created within Director. Progress bars are particularly useful when there are Lingo programs that require some processing time. Pop-up menus allow users to better organize contents that are being viewed.

Like its Flash counterpart, vector-based shapes and lines can be created within Director using Lingo. In actuality, the Flash engine is used to develop the vector-based drawings; therefore properties of Flash members are also made available within Director.

Sound elements can also be imported and embedded within a Director movie. Once an audio element is employed, Lingo can be used to control it. There are three audio types that can be controlled by Lingo: internal cast members, external files, and compressed Shockwave audio. Sound elements are placed in a special audio channel. All aspects of sound in Director such as volume, sample rate, and playback options can be directly controlled through Lingo. Sound elements can be set to play throughout an entire movie, or placed within a cast member in which it is played only when the selected cast member is in action.

The final output or product of a Director movie can take many different forms. A common step is to produce it as a Shockwave movie. Shockwave exports offer compression methods that help reduce the file size of any Director movie. Once a Shockwave movie has been created, it can be placed within an HTML page, or left as a standalone Shockwave movie.
Director was used to develop the Shockwave navigation system as well as all the Shockwave interactive simulations available in certain modules. The use of Lingo scripts provide the elements of user interface and interactivity. Through the implementation of the interactive simulations in the FE online review site, users are able to reinforce their understanding by making use of the editable parameters within the simulations to observe and analyze the associated engineering relationships. In addition, the simulations also permit a visual observation of the different engineering concepts as described in a module's Basics Page.

5.2 GRAPHICS AUTHORING SOFTWARE

The extensive use of graphics in the FE online review site, particularly in the individual module's Basics, and Examples Page is to effectively communicate a concept or an actual engineering example. For the individual questions provided in the Problems Page, the accompanying graphics serve to improve user understanding on the questions posed thereby allowing them to effectively solve the problem. Currently there are several software programs available that specializes in graphics authoring and editing for the Web such as Adobe Illustrator, PhotoShop, and Macromedia Fireworks.
5.2.1 PHOTOSHOP

For the purpose of editing and developing graphics for use throughout the FE online review site, Adobe PhotoShop was selected because of its user friendly interface and the multitude of graphical enhancement styles and effects available. This software is the world-standard image-editing instrument for the Web or print (Peck, 1997). Images and graphics can be created from scratch or imported from other graphics software. PhotoShop accepts a wide variety of file import formats, including graphics and images obtained through the use of video and digital cameras, photo CDs, scanners, and video capturing cards (Peck, 1997). Unlike other existing drawing programs, PhotoShop creates and modifies any image by altering the individual pixels.

The entire process of image creating and editing is carried out in the PhotoShop window (Figure 24). To better aid users in organizing their work, each individual element in an image or text can be placed in a separate layer. Should there be multiple layers utilized in the authoring process, certain layers that are not in current use can be hidden from view to avoid cluttering the work area.
There are three main separate pop-up menus each with three additional control options as listed in Table 8. These menus provide the user with all the relevant tools to create and edit images and texts.

<table>
<thead>
<tr>
<th>Control Menu 1</th>
<th>Control Menu 2</th>
<th>Control Menu 3</th>
<th>Control Menu 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigator</td>
<td>Color</td>
<td>Layers</td>
<td>History</td>
</tr>
<tr>
<td>Info</td>
<td>Swatches</td>
<td>Channels</td>
<td>Actions</td>
</tr>
<tr>
<td>Options</td>
<td>Brushes</td>
<td>Paths</td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Menu Options in Photoshop

There are six additional pull-down menus that contain a wide variety of control options to further enhance user control over the different aspects of the image or text under construction. Among the six menus, the filter pull-down menu contains the tools for creating multiple types of special image effects. By incorporating plug-ins called Kai Power Tools into PhotoShop, users have access to an enormous list of options to enhance their texts and images. Some of the filter options provide a drastic alteration on the image, others merely improvises and improves the quality of the existing image.

PhotoShop offers a wide range of export options for use on the Web, digital video, or multimedia. An important parameter to consider when placing images on the Web is resolution (Peck, 1997). When image resolution increases, the file size increases correspondingly which in turn requires a longer download time. A typical image size is 640 x 480 pixels with a resolution of 72 pixels per...
inch (ppi). The most common export format for use on the Internet is Graphics Interface Format or GIF. GIF’s compression method reduces the number of colors to 256 or less. This reduction in color in turn decreases the file size. It should be noted that GIF is better suited for images with flat colors or images with small amounts of color gradients (Peck, 1997). Another commonly used image format on the Web is Joint Photographic Experts Group or JPEG. JPEG is better suited for images that display color gradients (Peck, 1997). File size is reduced through the subtraction of data from the image. However, in doing so, the image quality degrades in the process. This drawback is countered in the export process whereby the user can specify the quality level desired when the file is used. Quality levels are divided into low, medium, and high. The higher the desired quality, the larger the resulting file size.

Another parameter to consider is the system color palette compatibility between Macintosh and Windows platforms. Because Windows reserves 40 colors for system operations, it only allocates 216 colors for image viewing (Peck, 1997). For images with 256 colors, Windows uses its own palettes. Popular browsers such as Netscape and Internet Explorer also make use of their own color palette of 216 colors.

All images that were obtained through the Web, digital camera, or scanner were brought into PhotoShop for editing. The final version of the graphics and images were exported as GIF or JPEG file formats before being embedded within the respective Web pages. Most of the images were used in the Basics and
Examples Page to help improve user understanding of a particular concept or to provide a graphical illustration of an actual engineering example.

5.2.2 FREEHAND

Macromedia FreeHand was used on several occasions to develop graphics that were used to accompany the example problems presented in the Examples Page and the individual questions posed in the Problems Page. FreeHand is an object-oriented drawing software that allows the user to create a wide variety of drawings such as rectangles, lines, and circles as well as those of vector-based origins. In addition, FreeHand can also be used to create complicated vector-based shapes such as polygons and curves. By manipulating the control points that make up the vector line or shape, users are able to customize objects as desired. Because vector-based graphics are described mathematically, it can be resized without any loss in smoothness and quality (Macromedia, 1998).

Graphics and texts can be created from scratch or imported from an external source. There are several other ways to bring graphics and text from other software into FreeHand: cut and paste, and drag and drop. Cut and paste is a feasible method to transfer graphics from a software that does not have the option of exporting a FreeHand-supported file format. The drag and drop alternative for file transferring, can only be carried out between applications that supports Apple's Drag Manager (Macintosh), and OLE Drag and Drop (Windows). Current
graphics software such as Adobe PhotoShop and Illustrator supports this mode of file transferring.

FreeHand accepts several different types of graphic formats including JPEG, TIFF, BMP, PhotoShop, and 3-D modeling applications. It should be noted that, these imported file formats are not vector-based graphics unless the final edited version carried out in FreeHand is exported as Shockwave.

In addition to graphics, users are also provided with control over texts used such as spell check, word replace, and inserting special characters. FreeHand also possess additional options for editing text, for example, converting and attaching texts to paths, word wrapping around objects, and text effect applications.

To exercise control over each individual graphic and text element in FreeHand, users can make use of several pop-up panels (Figure 25). All aspects of each individual FreeHand element for example, color gradients and transparency can be modified through the use of these pop-up panels.

As listed in Table 9, there is a wide selection of export formats available for each final FreeHand product. Selection of export formats may vary depending on the desired application of the finished product. Although there are a few export formats that are exclusive for Macintosh or Windows platforms, in general, all export formats are cross-platform compatible. Despite the numerous types of export formats available in FreeHand, drawings that are exported as graphics do
Figure 25: Macromedia Freehand Interface
not have vector-based attributes. The vector-based features are available to movie
export formats such as Shockwave.

<table>
<thead>
<tr>
<th>Export Format Options:</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Adobe Illustrator</td>
</tr>
<tr>
<td>▪ ASCII Text</td>
</tr>
<tr>
<td>▪ Bitmap</td>
</tr>
<tr>
<td>▪ Shockwave Flash Movie</td>
</tr>
<tr>
<td>▪ FreeHand</td>
</tr>
<tr>
<td>▪ Encapsulated PostScript (EPS)</td>
</tr>
<tr>
<td>▪ Graphics Interface Format (GIF)</td>
</tr>
<tr>
<td>▪ Joint Photographic Experts Group (JPEG)</td>
</tr>
<tr>
<td>▪ Acrobat PDF</td>
</tr>
<tr>
<td>▪ PICT</td>
</tr>
<tr>
<td>▪ TIFF</td>
</tr>
<tr>
<td>▪ Targa (TGA)</td>
</tr>
<tr>
<td>▪ Portable Network Graphic (PNG)</td>
</tr>
</tbody>
</table>

Table 9: FreeHand Export Format Options

FreeHand was used to develop graphics that were used within the Problems and the Examples Page. This software's capability to operate on many different file formats, make it highly useful for creating and editing effects for graphics and texts. The common export version for graphics edited within FreeHand are JPEG and GIF formats.

5.3 EQUATION AUTHORING SOFTWARE

5.3.1 MATHTYPE

The FE online review system uses equations extensively, particularly in the Basics Page where all the engineering concepts are being reviewed. In
addition, the Examples Page also employs equations to provide users with a
detailed illustration on how the theory is applied to problem solving. Equations
were also used in the individual questions set forth in the Problems Page.

To develop the needed equations, MathType was selected as the primary
equation editor. MathType offers a multitude of mathematical symbols and
abbreviations that are readily accessible from pull-down menus, allowing
equations to be created and edited with relative ease (Figure 26). This software
can also be used in conjunction with other word processing software such as
Microsoft Word and Corel WordPerfect. These word processing software features
MathType as the governing equation editor (Design Science Inc., 1996).

The version of MathType available for Macintosh platforms contains 120
templates of mathematical symbols and abbreviations. To enhance user interface,
there are an additional 150 special symbols made available on-screen. Compared
to the Macintosh, the MathType version available for Windows consist of 175
templates and 214 symbols readily available on-screen.

MathType offers several features to help promote better user interface. For
example, the on-screen mathematical symbols can be added or removed at the
user's discretion. Furthermore, the sizes and appearances of each symbol or font
can be altered
Figure 26: MathType Interface
by the user through a large list of preferences. MathType also has a built-in capability which recognizes commonly used mathematical abbreviations, such trigonometric, log, and calculus terms and pre-defines an appropriate font type and size for them. This allows users to maintain a level of consistency in their work and improve productivity.

There are a variety of file format options available for the finished MathType product. Users can utilize the cut and paste method via Clipboard for bringing in their work into a word processing application or any other programs that supports the format. Macromedia's Flash and FreeHand also accepts MathType equations via cut and paste.

Object Linking and Embedding (OLE) bypasses the cut and paste method by accessing MathType within an application such as a word processor. This method is also referred to as embedding objects. Once the object is double-clicked upon, MathType is accessed and editing can be carried out.

MathType equations can also be exported as PICT, Encapsulated PostScript (EPS), or Graphics Interchange Format (GIF). Because MathType PICT files make use of fonts to define the graphic, it will always display and print with the same quality as the word processor's text. On the other hand, it also requires that if the graphic is moved from one Macintosh platform computer to another, the receiving Macintosh machine should have the same set of fonts that were used to develop the graphic. This option for using PICT files is made available to all Macintosh platform computers.
The equations used within the FE online review site were exported as GIF images. MathType's on-screen menu list allows instant access to the multitude of mathematical symbols and abbreviations, allowing editing to be carried out quickly and easily. In addition, MathType offers several convenient methods to export or transfer equations to other software applications.

5.4 HTML AUTHORING SOFTWARE.

5.4.1 VISUAL PAGE

To organize the content of the review material and the layout of the Basics, Examples, and Problems Page, a HyperText Markup Language (HTML) editor was required. Currently, there are several HTML editors available, such as Symantec Visual Page, Macromedia Dreamweaver, and Microsoft Front Page.

For this online review site, there are two separate HTML editors that were utilized. The first, Visual Page, was used as the primary HTML editor. Macromedia Dreamweaver is the other HTML editor used and will be discussed in the following section. Visual Page is a Web page authoring tool equipped for creating, altering, and displaying documents for use on the Internet. This software allows users to create and edit Web pages quickly and efficiently without the difficulties of dealing with HTML code. Utilizing Visual Page is similar to developing documents in a word processor. Text, graphics, and tables can be inserted and edited without having to deal with the corresponding HTML syntax.
In addition, Visual Page supports a variety of media elements for use on the Web such as Java Applets, JavaScript, QuickTime movies, Flash Shockwave files, and Common Graphics Interface (CGI) (Symantec, 1998). To help maintain a level of consistency and efficiency in working with Visual Page, layer editors, and Cascading Style Sheets (CSS) are available.

The main editing window of Visual Page is made up of three components: toolbars, edit area, and link field (Figure 27). The edit area is where all the documents are created and edited. Web pages can be developed from scratch, modified from an existing Web page, or utilizing several ready-made templates. All text, graphics, and multimedia Web tools are placed in the Web page through the edit area.
Figure 27: Symantec Visual Page Interface
The toolbars display the commonly used features of Visual Page. They provide users with control preferences over all text, graphics, frame sets, tables, and other multimedia elements used. Toolbars can be moved and relocated anywhere within the main editing window. To better improve user interface, there are a variety of preferences that can be customized. Global preferences affect the features in Visual Page as a whole, while Page defaults can be set to take effect on only one particular Web page.

Links are created in Visual Page via the link field. Besides using the link field, Visual Page also has a link toolbar that displays additional link options. Through the use of this toolbar, graphics, images, texts, and equations can be used to create external links to other Internet sites or to individual e-mails. In addition, anchors can also be used to directly access a specific location within a Web page. A status tab within Visual Page allows the user to test out and correct any broken links. All Web pages are cross-platform compatible as the HTML codes are defined in the similar manner in both Macintosh and Windows computers.

Visual Page was used as the primary HTML editing tool for the FE online review site. The on-screen toolbars and menu options allow the relevant tools and features to be accessed quickly and efficiently for editing specific Web pages within the review site. In addition, Visual Page's ability to support various multimedia plug-ins such as QuickTime, Shockwave, and VRML file formats allow for the implementation of multimedia technologies within the Web site.
5.4.2 DREAMWEAVER

As mentioned in the previous section, Macromedia Dreamweaver was another HTML authoring tool that was used in the FE online review site to manage and organize all the relevant Web pages. Macromedia Dreamweaver possessed similar features as that found in Visual Page but it also offers additional options for creating interactivity within Web pages (Figure 28).

Dreamweaver provides user controls through the use of several floating menus. These menus allow the user to manipulate a Web page's styles, layouts, images, graphics, and texts. In addition, there are ready-made functions for inserting applets, Java and VB scripts, plug-ins, ActiveX, Flash and Director Shockwave files, and rollover images. Dreamweaver also employs a timeline whereby users can incorporate Dynamic HyperText Markup Language (DHTML) (Macromedia, 1998). DHTML provides the capability for altering the style layout and location of elements in a Web page with time through the use of scripting languages. However, this timeline function can only be applied to browser versions of 4.0 or later (Macromedia, 1998).
Figure 28: Macromedia Dreamweaver Interface
CHAPTER 6

CONTENT AND MODULE PAGE DEVELOPMENT METHODS

6.1 LAYOUT AND FORMAT

The FE online review project began in the Spring of 1998 by the Engineering Media Lab (EML). Throughout the first one and a half years, the AM section was developed continuously until its completion in the Summer of 1999. During the development of the AM section, a total of 4-5 research students were involved in content and multimedia development for the individual modules that would be included in the AM review. To assist in coordinating the efforts of all the research students, general guidelines were established to standardize the layout, style, and appearance of each individual Basics, Examples, and Problems Page. These guidelines established the physical dimensions of each individual Basics, Examples, and Problems Page. Standards for the dimensions of all graphics and images as well as their location within the module's pages were also specified. Font groups and sizes were also defined for equations and textual information. The appearance and physical dimensions of the multimedia elements used such as movie animations and interactive simulations were also determined.

This chapter covers the details of the guidelines used in developing the individual modules and the Basics, Examples, and Problems Page. Information on
the layout of images, graphics, movie animations, and interactive simulations are also included.

6.1.1 BASICS PAGE

The Basics page contains all the relevant concepts and equations of a particular module. To organize the appearance of the graphics, images, movie animation links, equations and text within the Basics Page, a HTML table set of three columns with multiple rows were utilized. Each of the three columns were dimensioned at 240, 10, and 320 pixels wide respectively (Figure 29). The separation of the graphics and images from the texts and equations were intended to present the review material to the user in a neat and organized format. All graphics and images were placed in the 240-pixels wide column, whereas the content of the theory and equations were located in the column of 320-pixels wide. The middle column, 10-pixels wide, acted as a divider to better organize and separate the texts and equations from the graphics and images. To avoid resizing the width of the table by accident, the width of the table was maintained at 570 pixels while the height was set at "auto" to accommodate the content. To hide the presence of the tables, the border thickness was reduced to zero. All module pages were designated with a white background color to improve visual clarity.

Figures 30, 31, 32, 33, and 34 provide graphical illustrations of the guideline format used to standardize the layout and appearance of the Basics
Page. Whenever possible all texts and equations were created and edited within Symantec's Visual Page or Macromedia's Dreamweaver depending on the individual author's preferences. Should there be a requirement to construct complex mathematical equations, an equation editor such as MathType was employed. Once the equations were developed, they were exported as GIF files and utilized in the Basics Page.
Figure 29: Basics Page Layout 1
Figure 30: Introduction Picture Drop Shadow Settings In PhotoShop
Electrical circuits consist of a combination of passive and active elements. These circuits may be linear or non-linear devices. The simplest and most fundamental non-linear circuit element is the diode.

Single Line Spacing Between Paragraphs

Amplifiers normally operate in the linear active region. Early operation amplifiers (op-amps) were used primarily to perform mathematical operations such as addition, subtraction, integration, and differentiation. Most early devices were constructed with vacuum tubes, and required high voltages. Today's amplifier operation uses relatively low dc supply voltages. They are also reliable and low cost.

Apply Drop Shadow to Intopic, Center Justified

Mac Font Size: 1 or
PC Font Size: X-Small
(-Helvetica Group and Center Justified)

Delta-Connected Load

In a delta-connected load, the phase voltages, \( V \), are separated by 120° phase angle. The phase currents, \( I \), are also separated by the same phase angle.

The phase currents are calculated from the line voltage:

\[
I_a = \frac{V_{ab}}{Z_{\Delta}} \theta = \frac{V_b}{Z_{\Delta}} / -60°
\]

\[
I_b = \frac{V_{bc}}{Z_{\Delta}} \theta = \frac{V_c}{Z_{\Delta}} / -60° - 120°
\]

\[
I_c = \frac{V_{ca}}{Z_{\Delta}} \theta = \frac{V_a}{Z_{\Delta}} / -60° - 240°
\]

The line-to-line current are computed as follows:

\[
I_a = V_{ab} - V_{ca} = \sqrt{3} I_{ab} / -30°
\]

\[
I_b = V_{bc} - V_{ab} = \sqrt{3} I_{bc} / -30°
\]

\[
I_c = V_{ca} - V_{bc} = \sqrt{3} I_{ca} / -30°
\]

Fig. 1: Electronics elements like the op-amp and the diode play a significant role in wireless communication.

Figure 31: Basics Page Layout 2

Sub and Superscripts:
Mac Font Size: 10
PC Font Size: 2
Mac Font Size: 2

Figure 32: Basics Page Layout 3
Diodes HTML Font Color: #0000DD

When a piece of silicon is doped so that half is N-type and the other half is P-type, a PN junction is formed between the two regions. A device formed in this way is called a semiconductor diode. The PN junction is fundamental to the operation of solid-state devices.

A simplistic explanation of the operation at the PN junction is that in each type of material there are many free charges available: holes (P) and electrons (N). Some of the electrons near the junction drift across into the P region and recombine with holes near the junction. For each electron that crosses the junction and recombines with a hole, a pentavalent atom is left with a net positive charge in the N region, making it a positive ion.

240 Pixels Wide, Variable Height, Center Justified

Picture Captions

In the P region, a tetravalent atom acquires a net negative charge, making it a negative ion. Thus, as the ion layers build up, the area on both sides of the junction becomes essentially depleted of any conduction electrons or holes. This is known as the depletion layer. When equilibrium condition is reached, the depletion layer has widened to a point where no more electrons can cross the PN junction.

Forward bias is the condition that permits current across a PN junction. The negative terminal of the battery pushes the conduction band electrons in the N region toward the junction while the positive terminal pushes the holes in the P region toward the same junction. If the diode is reverse biased, the free charges are attracted toward their bias polarities, causing almost no current to flow.

Click to play movie

User Notification of Movie Animation

Icon link to Examples Page

Figure 33: Basics Page Layout 4
At the point of impending motion:

\[
R = \sqrt{N^2 + (\mu \cdot N)^2} = N\sqrt{1 + \mu^2}
\]

\[
\tan \phi_c = \frac{\mu \cdot N}{N} = \mu_c
\]

where \( \phi_c \) is known as the critical angle located between the resultant and the normal to the surface. At the critical angle, the object begins to slide.

In the case where \( \mathbf{F} < \mu_c \cdot N \) occurs, the angle of the resultant will always be less than the critical angle.

\( \theta < \phi_c \)

It should be noted that for a body in equilibrium, the angle of the resultant \( \theta \), cannot be larger than the critical angle \( \phi_c \).
A TYPICAL VISUALIZATION OF AN ATOM

Nucleus contains both proton and neutrons.

- electron orbit
- electron
- nucleus

NOTE: There is scientific evidence that electrons do not move in orbits.

Figure 35: Movie Animation Layout
All texts and equations were set to correspond to the Arial font group. This font group is actually made up of three font types that are almost similar in appearance: Arial, Helvetica, and Sans Serif. The priority of usage for these three font types are organized in descending order beginning with Arial. Should a browser be unable to identify the Arial font type, it will proceed to display the text using the next prioritized font type which is Helvetica.

The size and color of the texts vary according to their individual functions. Main titles and subtitles were designated in the color blue while theory texts, subscripts, superscripts, equations, and captions were set in black. If equations were created within Visual Page or Dreamweaver, an additional font type, symbol, would be used in particular to display Greek letters. Equations used were center justified or aligned using spacers to improve their appearance. Spacers are transparent blocks that can be oriented in the horizontal or vertical axis. Because spacers available within Visual Page may not appear correctly in certain browser versions, a new spacer was created using PhotoShop and exported as a GIF image. The width of the spacer images can be altered if needed.

In all the Basics Pages, the first picture in the top-left corner was designated as the introduction picture. These pictures were originally obtained using one of three different methods: Internet, digital camera, or scanner. Each picture was then brought into Adobe PhotoShop 5.0 to undergo editing. Because the width of the first column in the Basics Page was set at 240 pixels, each picture had to be dimensioned equal or less than 240 pixels wide to avoid resizing the
entire column. The height of the introduction pictures were specified by the individual editor's preference. All introduction pictures were then applied with a shadow effect on the bottom right-hand corner using the Eye Candy plug-in in PhotoShop to enhance its graphical qualities (Figure 31). Once all relevant editing procedures were carried out, the images were then exported as either GIF or JPEG format and included into the HTML pages. All images and graphics used were center-justified together with their corresponding captions.

There were two custom-made icons that were repeatedly used in the Basics, and Examples Page. Table 10 illustrates the appearance and function of the two icons.

<table>
<thead>
<tr>
<th>Commonly Used Icons In Module Pages</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Link to Examples Page" /></td>
<td>Link to Examples Page</td>
</tr>
<tr>
<td><img src="image" alt="Link to Interactive Simulations" /></td>
<td>Link to Interactive Simulations</td>
</tr>
</tbody>
</table>

Table 10: Custom Made Icons Used In Basics and Examples Page

Through the use of JavaScripts, all movie animations and interactive simulations appear in separate windows. Because movie animations and simulations are not downloaded until accessed by the user, download time for the Basics Page can be kept to a minimum for each module. To further reduce
download time, the file size of each module page was restricted to 100 kilobytes (kb).

In general, the movie animation windows were dimensioned at 320 x 240 pixels and can be resized by the user without loss of visual quality due to Flash's vector-based graphics. Each movie animation also contains three buttons essential for user interactivity: rewind, play, and stop. A timeline was also created using Flash's tweening capability to indicate to users, the actual length and the remaining time of the movie animation. Due to content volume, there will be certain movie animations that will be opened in a larger window. For example, topics such as Thermodynamics, Chemistry, and Mechanics of Material contain property charts, property tables, and VRML displays that were set to open in a larger window size.

6.1.2 EXAMPLES PAGE

The Examples Page contains two examples problems that were worked out in detail to allow users to view the application of the theory to problem solving. To organize the layout of the Examples Page, the same HTML table layout that was used in the Basics Page was employed. This table was made up of three-columns with multiple rows. Each of the three columns were dimensioned: 240, 10, and 320 pixels respectively. To present the example problems in a organized method, the questions and solution steps were placed in the right hand column,
while the accompanying images and graphics were positioned in the left hand column. The middle column acts as a divider to provide a clear separation between the example problems and the graphics. To eliminate the visibility of the table, the border thickness was set to zero. The background color of all the Examples Page were set to the color white to improve the clarity of the texts and equations.

Figures 36, 37, and 38 provide graphical illustrations of the layout format for the Examples Page. Texts and equations created within Visual Page and Dreamweaver used the Arial font group while equations developed within MathType were exported as GIF format files and placed in the Examples Page. Graphics and images used in the Examples
Figure 36: Examples Page
Figure 37: Examples Page Layout 1

Calculate the friction force when the block resting on an incline surface is attached to another block through a pulley.

Calculating the weight of the block on the slope:

\[ W = mg \]

\[ = 100.00 \text{ kg} \times 9.81 \text{ m/s}^2 \]

\[ = 981.00 \text{ N} \]

Figure 38: Examples Page Layout 2

Determine the angular acceleration of the bar after it has rotated through an angle \( \theta \).

Calculating the mass moment of inertia about the pivot point:

\[ I + d^2 m = \frac{1}{12} m (2.5m)^2 + (2.5m)^2 m \]

\[ = (6.77 \text{ m}) m^2 \]

\[ \sum M = I \alpha = 2.5mg \sin \theta \]

\[ 2.5mg \sin \theta = \frac{(6.77 \text{ m}) m^2 \alpha}{(6.77 \text{ m}) m^2} \]

\[ \alpha = \frac{2.5mg \sin \theta}{(6.77 \text{ m}) m^2} \]

\[ \alpha = 0.3692 \frac{g \sin \theta}{m^2} \]
Page were obtained either from the Internet, taken from a digital camera, using a scanner, or developed using FreeHand, PhotoShop, or Flash.

Graphics and images placed in the first column were center-justified and constrained within 240 pixels in width. Each Examples Page contains two problems that were solved in detailed steps. The relevant equations and theory texts used, including alternative equations were carefully documented and explained. All final answers pertaining to the example problems were designated in red text color.

For certain modules, custom-made icons in the Examples Page were used to direct users to interactive simulations. These interactive simulations open up in a separate movie window via JavaScript. This method of presenting the simulation in a separate movie window reduces the time required to download the Examples Page as the simulation is accessed only when the user clicks upon the custom-made icons. The size of movie window varies depending on the physical layout of the simulation.

### 6.1.3 PROBLEMS PAGE

The Problems Page contains a set of six problems that allow users to test their own understanding by applying their knowledge of the module to problem solving. To organize the content of the Problems Page, a 7 x 3 HTML table with a constrained width of 160 pixels for each column was used (Figures 39 and 40).
Figure 39: Problems Page Layout 1

Figure 40: Problems Page Layout 2
By restricting the width of each column the total width of the table is set at 480 pixels. This will help maintain the dimension of the entire FE online review site within 800 x 600 pixels. Graphics and images were placed in the cells of rows three and six while the problem number designation of each individual problem was placed in the rows directly beneath the graphics (Figures 39 and 40). Each of the six individual images or graphics are linked to their respective questions and presented in a separate window through the use of JavaScript. Every question was created in Macromedia's Flash 3.0 and exported as a Shockwave movie. The movie window for every question was set to open at 560 x 360 pixels. Users are able to resize the window without fear of quality loss due to Flash's vector-based graphics capability. Furthermore, Flash compression options allow each Shockwave movie size to be kept to a minimum.

Figures 40, 41, 42, 43, 44, and 45 illustrate the graphical appearance and layout format for each individual problem. Every problem contains a question and four answers from which users can select upon, together with all the relevant graphics and images. To improve the appearance of the question set, the answer list was aligned using a grid display in Flash. Frames were used to separate and organize the questions and answer list, the page corresponding to the wrong answers, and the page corresponding to the right answers. To promote user interactivity, each individual answer was developed as a button that links to a particular frame depending on whether the user selects the correct or incorrect answer.
Treating air as an ideal gas, find the change in enthalpy between states 1 and 2 if the air is heated from 400 K to 1000 K. Compare with the ideal gas table.

(a) 530.11 kJ/kg
(b) 478.84 kJ/kg
(c) 602.82 kJ/kg
(d) 947.95 kJ/kg
Problem 4

Treating air as an ideal gas, find the change in enthalpy between states 1 and 2 if the air is heated from 400 K to 1000 K. Compare with the ideal gas table.

(a) 530.11 kJ/kg
(b) 478.84 kJ/kg
(c) 602.82 kJ/kg
(d) 947.05 kJ/kg

Figure 43: Shockwave Problems Layout 3

Figure 44: Shockwave Problems Layout 4
**Correct answer**

From the ideal gas table we get:

\[
\begin{align*}
    h_2 - h_1 &= 1046.04 - 400.98 \\
    h_2 - h_1 &= 646.04 \text{ kJ/kg}
\end{align*}
\]

Assuming that the specific heats are constant:

\[
\begin{align*}
    h_2 - h_1 &= C_p(T_2 - T_1) \\
    &= 1.0047 \frac{\text{kJ}}{\text{kg} \cdot \text{K}} (1000 - 400) \\
    h_2 - h_1 &= 602.82 \text{ kJ/kg}
\end{align*}
\]

**Wrong answer**

Check your notes again
To improve user responsiveness for each button, the individual answers change in appearance whenever the user positions the mouse cursor over a particular answer or clicks on it. A "back" button was also implemented in each question to enhance user navigation while working through the problems.

The problems were then exported as Flash Shockwave movies and placed in their individual HTML files. A second exporting process was carried out to obtain the graphics that would be placed in the cells of the Problems Page. These graphics were exported as GIF files.

Although there are six problems available to the user in the Problems page, the download time for the Problems Page is not significant because the individual set of problems are not downloaded until accessed by the user by clicking on the graphics or the problem number designations.

6.2 CONTENT DEVELOPMENT DIFFICULTIES

One of the major problems encountered during the course of content development was font size incompatibility when viewed from different computer platforms. Font sizes for texts and equations developed within a Macintosh platform appear smaller when viewed on a Windows platform computer. This problem was rectified to a certain extent through trial and error, and by reconfiguring the font size preferences of the text and equation editing software within the Macintosh computers. The resulting font size configuration appears to
match that of its Windows counterpart but it is by no means a perfect match. After much deliberation and careful research on this matter, it was collectively agreed upon that the combination of font sizes implemented in this online review site will be optimized for Windows playback.

The guidelines established for each of the modules' Basics, Examples, and Problems Page were designed to maintain a level of consistency in the layout and appearance of each module page. In addition to the use of multimedia elements to enhance the reviewing process, the organization of the review material was designed to provide the users with a sequential and organized review process.
CHAPTER 7
ASSESSMENT AND CONCLUSION

7.1 ASSESSMENT AND USER FEEDBACK TOOLS

7.1.1 WEBBOARD

Feedback is a practical and useful instrument in which to perform the needed functions of assessment and quality control. There are several different types of tools available on the Web for acquiring user feedback such as Web bulletin boards (Web Boards), newsgroups, and chat sites. For the purpose of obtaining user feedback on the effectiveness of the FE online review system, WebBoard was chosen to perform the task because of its multitude of features that allow facilitation of discussion groups and message postings. Through the use of WebBoard 2.0, by O'Reilly & Associates, user feedback can be obtained, and broken or malfunctioning links can be reported.

WebBoard can be used as a site for posting questions and answers regarding specific review topics of interest. In addition, discussion groups can be established among those who are preparing for the FE exam. These discussion groups allow users to review and assist each other should there be any confusion or difficulties during the preparation process. Another unique feature of WebBoard is its capacity to include file attachments. With this feature, engineering diagrams, charts, sketches, and free body diagrams that are essential
in engineering education can be transferred to convey engineering concepts or ideas.

WebBoard was designed for the purpose of fostering communications, globally or locally, among people with common interest whether they are job, civic, or personal. Its browser-based quality means that it can be accessed by any browser at any given time or day regardless of location. Utilizing the WebBoard is merely a matter of obtaining a login identification and a password (Figure 47). One key element of WebBoard is its built-in server that requires no configuration and can be utilized immediately. In addition to supporting the various features of WebBoard such as security modes, file attachments, and JavaScript, the built-in server also offers faster performance compared to external servers. WebBoard's capabilities can be utilized in many different forms such as management meetings, information management, Web conferences, project collaboration, and customer or technical support. In addition, this software provides users with the option of sending and receiving e-mails, post and read messages, and participate in chat sessions (Figure 48).
Figure 47: WebBoard Main Login Page
Welcome to WebBoard 2.0, User!

To view topics within a conference, click a plus symbol (+) next to a conference name (or the conference name itself) in the frame to the left.

You have 8 new message(s).

To use the chat feature you must be using a JavaScript enabled browser such as Netscape Navigator 3.0 (or higher) or Microsoft Internet Explorer 3.0 (or higher).

Thank you for using our board! amm@ou.edu

Stay in touch! For the latest news on product updates, new features, and special offers, enroll your copy of WebBoard 2.0 now at WebBoard Central.

Figure 48: WebBoard Log Analyzer Interface
7.1.2 WEB TRENDS

The ability to monitor and identify the trends and tendencies within a Web site is necessary to keep up with the demands of the users. Currently the FE online review site utilizes Web Trends Log Analyzer to keep tabs on all the activities taking place within the Web site. By identifying the trends of the users such as the common file types requested and downloaded, changes can be made within the Web site to cater to their needs.

Web Trends Log Analyzer is currently being used to monitor and keep track of all activities within the online review site. This software is a comprehensive Web server log file analysis and reporting tool (WebTrends Corporation, 1997). All aspects of activities taking place within a Web site can be monitored, logged, displayed statistically as HTML, Microsoft Word and Excel, Comma-Delimited, and ASCII text documents. Reports can be generated in real-time or only when requested by the user. Web Trends also provide the user with control over which statistical graph or table to include as well as how it will appear in the HTML file. Filters found within Web Trends allow users to effectively target a specific set of information for analysis and display. In addition, each HTML file generated has a hyperlinking table of content from which users can access a particular data portion of interest.

Web Trends' analysis is carried out on the actual Web server log files itself, thereby reducing the time required to process the log data. Currently, Web Trends Log Analyzer is compatible with Windows Operating System 95, 98, and
NT. The main console of Web Trends contains all icons and menus needed to carry out program functions and activities (Figure 49). All management tools such as deleting and adding logs, scheduling a statistical report, and report generation and preferences are made available to the user within the main console. This software currently offers over 300 elements and calculations, 60 tables and graphs, and 32 pre-defined reports. Output reports can be stored within a personal computer, network, or sent through a File Transfer Protocol (FTP) server or Simple Mail Transfer Protocol (SMTP) mail. Through the use of style editors reports generated can be further configured to meet the appearance specifications of the user.
Figure 49: Web Trends Log Analyzer Interface
Web Trends sorts out the statistical information from the logged files and displays it under several different headings which are documented in Table 11:

- Most Requested Pages
- Least Requested Pages
- Top Entry and Exit Pages
- Single Access Pages
- Top Paths Through Site
- Advertising Views and Clicks
- Advertising Views
- Most Downloaded Files
- Most Active Organizations and Countries
- Activity Level by Day of Week
- Activity Level by Hour of the Day
- Client and Server Errors
- Most Downloaded File Types and Sizes
- Organization Breakdown
- North American States and Provinces
- Most Active Cities
- Bandwidth
- Most Accessed Directories
- Top Referring Sites and URLs
- Top Searched Engines and Keywords
- Most Used Browsers and Platforms

Table 11: Web Trends Statistical Information Options

7.2 RESULTS FROM WEBTRENDS

The results presented here are taken within a time frame of four months: from July to October of 1999. Although Web Trends have been keeping track of the number of hits on the Engineering Media Lab Web site, little or no hits were made on the online review site. One possible reason could be that there was no prior advertising carried out for the online review site as the AM Review session was only completed in the summer of 1999. Prior to this the existence and location of this review site was announced through the word of mouth.
Based on the statistical output from Web Trends, the number of pages viewed in the online review site increased although the rise wasn't consistent. Page viewing normally took place around the daytime, in particular during the afternoon. In addition, weekdays appeared to be the most popular time in which the site was accessed. During the weekends, visitor activity was virtually nonexistent. There were also numerous file downloading activities carried out with the most popular file formats being Graphics Interface Formats (GIF), Flash, and HyperText Markup Language (HTML) files. These three file types represented about 80% of all files that were downloaded from the online review site. Web Trends also indicated that the majority of visitors were using Netscape's Navigator to browse the site. Microsoft's Internet Explorer came in second. In terms of computer platforms, the large chunk of visitors were using Window's NT operating system, followed by Windows 95, and finally Macintosh.

7.3 SUMMARY AND CONCLUSION

The World Wide Web (WWW) is indeed a potent tool for distance learning and information dispersion. This Online Fundamentals of Engineering Review Site is just one such example of the immense potential of distance learning applications brought forth by the Web. With the AM Review session fully completed, all 12 engineering and science topics are now accessible for public use at no cost. The division of each major topic into modules and
subsequently into three individual Basics, Example, and Problems page allow users to practice a sequential and ordered approach toward the review process.

The FE online review site provides access to the review material at any given time or day, allowing working professionals and students in college to perform the review at their convenience. In addition, users are also able to advance through the review at their own rate. The implementation of multimedia tools such as movie animations, interactive simulations, JavaScript, and VRML, not only provide users with an innovative and interactive environment to review for the FE exam, but it also encourages user input and participation. Current review textbooks and manuals contain only static text, equations, and graphics, but the use of multimedia opens up a new dynamic dimension in the reviewing process. Users are no longer confined to just reading off review textbooks or manuals but are able to make use of the multimedia elements to enliven the review method.

Extensive work has also been carried out to ensure all relevant text, graphical, and image links function as promised. For example, periodic review schedules were held during the Summer of 1999 to check for content authenticity. It is further hoped that the implementation of the WebBoard will further encourage users to provide the much needed feedback to assist in evaluating and assessing the material and content presented in the online review site. With the AM Review section completed, efforts are now focused on completing the PM Review session, which has been targeted for completion in the Summer of 2000.
7.4 RECOMMENDATIONS

Since user feedback is a practical and useful tool in which to perform the needed functions of benchmarking and quality control, there are several methods that can be implemented towards achieving this objective. Test and control groups can be used to evaluate and verify the contribution of multimedia elements and the utilization of the World Wide Web (WWW) in the learning and reviewing process. Furthermore, a collaboration between engineering departments here in the University of Oklahoma can be established whereby engineering students who are intending or are required to undertake the FE exam can be encouraged to utilize the resources provided by the online review site. Electronic questionnaires can then be used to obtain their opinion on the contents provided and ideas on how to further improve the review material as well as the user interface.

In the future, the FE online review site can be used as an instrument to verify the engineering curriculum offered by the University of Oklahoma by having a mandatory FE exam as a requirement for graduation for all undergraduates. Through this method, engineering courses in which students are having difficulties in can be identified. Steps can then be taken to analyze the sources of these difficulties and the appropriate measures can be established to rectify them. For this purpose, the FE online review site can be used as the primary source for reviewing and preparation for the actual FE exam.
REFERENCES


24. Bacon, Jonathan, Martin, Robert, and Nyquist, John R., "Director 7 and Lingo Bible", 1999


27. Ritchey, Tim, and Shobe, Matt, "JavaScript For Macintosh", 1996


APPENDIX A

JAVASCRIPT CODE FOR SEPARATE POP-UP WINDOW
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 3.2//EN">

<!--[if IE]>

<script Language="Javascript">
<!--
--- Hide from Old Browsers

function f1a() {
    newwin = window.open("media/f1a.htm","Friction","resizable=yes,width=330,height=240");
}
function f2a() {
    newwin = window.open("media/f2a.htm","Friction","resizable=yes,width=330,height=240");
}
function f3a() {
    newwin = window.open("media/f3a.htm","Friction","resizable=yes,width=330,height=240");

//-->

</script>

</head>