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WEB-BASED DISTANCE LEARNING ENVIRONMENT
FOR
COMPUTER AIDED ENGINEERING DESIGN AND ANALYSIS TOOLS

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COMPUTER AIDED ENGINEERING DESIGN AND ANALYSIS TOOLS

A THESIS APPROVED FOR
THE SCHOOL OF AEROSPACE AND MECHANICAL ENGINEERING

BY

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ABSTRACT

Computer aided engineering design and analysis technologies have become very important in engineering development. They increase product reliability and decrease development time and cost. In the mean time, the Internet is evolving as the most intriguing medium for delivering distance education. This thesis describes a web-based distance learning initiative at the Engineering Media Lab, University of Oklahoma, which helps in teaching and training engineering students about computer-aided design (CAD) and analysis technologies.

The learning environment was designed to have two major advantages. First, it accommodates multiple learning styles that assist users in learning about commonly used engineering software tools. The learning styles include traditional text- and diagram-based teaching, interactive multimedia training, and scope-broadening case studies. Second, it supports learning both by individuals and in a class structure. This feature was realized by integrating a backbone database into the site structure, which enables users to register as a regular user or a student of a specific class. Furthermore, a user forum was embedded into the learning environment to enhance collaboration among users as an online community. Other features, such as user progress and tracking, nonlinear learning, customized web pages, etc. were also employed on the website.

There were various kinds of technologies available for developing the course contents and features of the learning site. Therefore, it was important to understand their advantages and disadvantages and choose the optimum combination of the
technologies and their corresponding development tools. Detailed discussions in selecting technologies and development software are presented in the thesis from the viewpoint of distance education site developers.

It was concluded that the research activities presented in this thesis would help engineering students acquire certain computer-based skills to improve their research and coursework. Educators as well would be able to better explore different issues involved in web-based education.

This research project was supported by the Hitachi Foundation.
CHAPTER 1. INTRODUCTION

1.1 The Internet

Information technologies have played a vital role in education for decades. The most recent surge of interests has taken place in the Internet, especially the World Wide Web (WWW), which has created a tremendous amount of new opportunities for teaching and learning.

The Internet is a worldwide communication network system that connects thousands of smaller computer networks. As of February 2002, according to Nua.com, an online source for information on Internet demographics and trends, there are approximately 544.2 million Internet users worldwide, and the number has been steadily and rapidly growing [1]. The Internet is cross-platform, i.e., Internet-connected computers with different operating systems can exchange information conveniently. The WWW, the newest and most prominent part of the Internet, has made the Internet a more user-friendly environment. The integration of graphics, text, audio and video into a single tool enables novice users to easily navigate through information they need and eases their struggle with the learning curve. The pervasiveness and flexibility of the Internet makes it a highly suitable medium for distance education.
1.2 Distance Education

The term “distance education”, alternatively called “remote education”, suggests that it is a means of education that allows its students to collapse time and/or space differences. It enables people with physical and/or time constraints to be educated at their own convenient time and place. The earliest form of distance education was correspondence education, which was based on post office technology and emerged in North America in the 1720s [2]. Since then, there has been a proliferation of different methods of distance education due to the developments in communication technologies, especially telecommunications. Different types of distance education that are popularly used today include: correspondence education, video/radio education, and web-based education.

Among those types of distance education mentioned above, web-based distance education is growing most rapidly and becoming the most popular along with the popularization and commercialization of the Internet as a global medium of communication and research. For example, in the year 2000, more than 13,000 students enrolled in online courses at the University of Maryland University College alone [3]; it was projected that the web-based training market in the USA would reach $6 billion by 2002, and that the number of college students enrolled in distance-learning courses would reach 2.2 million in 2002 [4].

The existing web-based educational institutions may be classified into three categories [5].
First, some traditional institutions, such as Duke University, Stanford University, Pennsylvania State University, and University of Maryland, have created new programs or schools for online distance learning. One important advantage of programs in this category is their well-established institutional reputation and dependable academic credentials of the faculty.

Second, some rather new ones have arisen as particular distance learning institutions, such as the Open University and the University of Phoenix. Institutions in this category have the advantage that their programs are usually more flexible and more skills-oriented because their entire structures are specifically designed and operated for distance education, in which most students seek the goal of professional developments.

The Open University was founded in the United Kingdom in 1969. More than 2 million students have studied at the university through the means of mailed textbooks and audio/video tapes, radio and TV programs, and the Internet. The number of its current students is over 200,000 with about 75% being enrolled online. It offers more than 360 undergraduate and graduate courses in arts, modern languages, social sciences, health and social welfare, science, mathematics and computing, engineering and technology, business and management, education and law. About 80% of undergraduate students at the Open University are in paid employment while studying, therefore most students are enrolled part time and the
average time towards a BA/BS degree is 6 years. The average cost for a degree is £4,100 [6].

The University of Phoenix is probably the most successful example of a university dedicated to web-based teaching [7]. Founded in 1976, it is now one of the leading providers of online education in the US with 37,600 out of its total 116,300 degree-seeking students being enrolled online. More than 151,200 students have earned their degrees from the University of Phoenix. The university has been able to attract many faculty members worldwide, all 9,758 of whom hold master’s or doctoral degrees. Undergraduate and graduate programs in art, business, education, health care and information technology are currently offered. In 1989, the University of Phoenix became one of the first accredited colleges to offer online degree programs, accredited by The Higher Learning Commission and a member of the North Central Association of the Commission [8]. The majority of the programs offered by the university are focused on business and education, and no engineering courses are being offered today.

Third, there have been a variety of commercial, or for-profit, distance training websites, such as Knowledge Universe and Smart Force. Many of these commercial education companies are relatively new ventures with diverse perspectives. For example, the range of products and services provided by the Knowledge Universe Learning Group (KULG) includes interactive education
products; early childhood education; and interactive learning websites for children, their parents, grandparents and teachers [9].

1.3 Websities and Software Dedicated to Distance Education of Engineering

As mentioned in the preceding section, the Internet, especially the WWW, has significantly affected education in many subjects or majors. Engineering is no exception. A large number of programs that utilize web-based technologies to deliver engineering educational contents have evolved. Some of them are full-scale degree programs, and others are designed for specific topics/courses. For example, the University of Wisconsin – Madison now offers an online degree Master of Engineering in Professional Practice (MEPP) [10]. The MEPP program uses WebCT, a commercial software package for building a web-based learning environment, as the main course delivery tool. Other tools, such as teleconference, textbooks and CD-ROMs are used to supplement information delivered on the web.

Another successful example of practicing online engineering education is the “eCourses in Engineering” web portal, developed and maintained by the Engineering Media Lab at the University of Oklahoma, Norman, Oklahoma. The website (http://www.ecourses.ou.edu/) was initially designed to teach two online engineering courses, Statics and Dynamics, offered at the University of Oklahoma by Dr. Kurt Gramoll. Enrolled students are able to use the website to view lectures, access textbooks, submit homework assignments, get class announcements, and
obtain help from teaching assistants and the instructor during virtual office hours through a message board. The website is a self-contained multifunctional environment for teaching and learning of basic engineering courses. Features of the web portal include eBook, database of homework/quiz/test problems, solutions to all problems, lectures in Flash format, computer grading, and utilities. In short, all instructional materials required to conduct a course are integrated into the website, free of charge to both students and instructors. This engineering education website

Figure 1.1 Snapshot of an eBook page in the eCourses in Engineering website
extensively explores the advantages of using the web to teach, employing various
learning methods, a wide array of multimedia elements and high interactivity.
Currently, instructors from a number of institutions including the University of
Oklahoma, the University of Illinois – Urbana Champaign, Alabama A&M
University, etc. are using this web portal to offer courses in engineering mechanics.
Figure 1.1 shows a page on the website for a statics course.

Other examples of websites for the purpose of teaching engineering online
include: SmartPros Engineering (http://engineering.smartpros.com/), The Stanford
Center for Professional Development (SCPD) (http://scpd.stanford.edu/),
International Engineering Consortium (IEC) Online Education
(http://www.iec.org/online/), etc. Among the mentioned above, SmartPros mainly
specialize in offering online courses for PE exam\(^1\) preparation, civil engineering
techniques, and engineering-business management. SCPD is a program developed
by the School of Engineering and affiliated departments at Stanford University to
deliver degree and non-degree academic courses over distance education. The web-
based portion of SCPD courses takes the format of streaming recorded videos of
actual lectures. Also taking the streaming video format, IEC Online Education
offers a variety of courses in information technology. In contrast to the previously
mentioned eCourses web portal, which is free to the public, all three of the above

\(^1\) The Principles and Practice of Engineering (PE) exam is a standard exam administered by the
National Council of Examiners for Engineering and Surveying (NCEES) to test the examinee’s
knowledge in engineering gained through academics and practice.
web education programs charges a fee to register as a student. Sometimes the fee can be as high as several thousands of US dollars for a single course.

Non-Internet media, such as textbooks, audio and video tapes, TV programs and CD-ROMs have also been widely used in remote engineering education. Practices in using CD-ROMs to teach how to use certain engineering software tools have been made by many corporations and individuals. One successful example is the CD-ROM “Exploring MSC/Patran” produced by the MacNeal-Schwendler Corporation (MSC, the developer and trademark owner of Patran) and Engineered Multimedia Incorporation [11].

This CD-ROM was produced for a training course offered by MSC to teach new Patran users how to use this finite element analysis (FEA) software package to perform mechanical simulations. It was integrated with highly nonlinear interactivity and a variety of multimedia elements including text, pictures, audio narration, animation and video. The CD-ROM-based training materials could be used to support both synchronous and asynchronous modes of learning (see Section 1.4 for more information). In the synchronous mode, the CD-ROM had the course notes embedded for the users’ reference. The users could also take advantage of the built-in interactivity to follow what was being taught real-time in class. In the asynchronous mode, the large volume of information stored in the CD-ROM and the vivid multimedia presentation developed using advanced simulation and
authoring technologies made this software training tool suitable for self-teaching.

Figure 1.2 shows the main menu of the “Exploring MSC/Patran” CD-ROM.

1.4 EMET and EMET-Engineering

Electronic Media Education for Teachers (EMET) is a three-year project that started in January 2000. Funded by the Hitachi Foundation, it is a collaboration between the Colleges of Engineering and Education at the University of Oklahoma. EMET was developed at the Engineering Media Lab as an online learning environment for teaching multimedia tools to K-12, vocational teachers and
students in the College of Education. It was later extended to EMET-Engineering, which serves as an online tool for engineering students and practicing engineers, who may not be able to get access to a CAD course, to learn computer-aided design (CAD) and analysis programs.

Both EMET and EMET-Engineering are dedicated to the asynchronous mode of distance learning. The term “asynchronous” describes the situation in which the teacher and the students are separated in time, i.e., the classes do not meet in real-time. The main advantages of computer-aided asynchronous learning are that the learning of students is self-paced and interactive [12]. Therefore, it gives the students more controllability and flexibility over the course content.

Aside from facilitating asynchronous learning, the EMET websites also have the potential to build learning communities that would encourage peer-to-peer learning and interaction.

The realization of the asynchronous learning mode was by means of integrating the content and user interaction with a server-based database, or sometimes referred to as a “back-end” database. The database contains registered users’ information and privileges, academic progress and a record of user clicks on the learning material. Data logged into the database build a data history for future analysis of online learners’ behavior patterns and effectiveness of the EMET online education system [13].
1.5 Overview of Thesis

As the background for the development of EMET-Engineering, the design of the EMET multimedia site will be reviewed in detail in Chapter 2. Chapter 3 discusses the purpose of expanding EMET with engineering content. Various aspects involved in the design of EMET-Engineering with emphases on website layout and database structure are presented in Chapter 4. Issues in the realization of the EMET-Engineering site design will be reported in Chapter 5 with detailed descriptions on technologies in the categories of server, database, scripting and integrated development software packages. In the end, Chapter 6 gives assessment of the research project and summary of the thesis, as well as recommendations for future research.
CHAPTER 2. REVIEW OF EMET

Since EMET-Engineering is an extension of the EMET-Multimedia site, general introduction to the multimedia is given in this chapter. EMET was made possible by a grant awarded by the Hitachi Foundation on February 28, 2000 [14].

2.1 Design Purpose

As mentioned in Section 1.3, EMET was designed as an online distance learning program to teach K-12 and vocational teachers how to use multimedia software tools to develop interactive instructional materials. In the mean time, it was also developed as an online learners’ community to enhance interaction between the learners and thus improve the learning environment for them.

2.2 Major Features

2.2.1 User Login and Logout

In order to take full advantage of the EMET education site, one must register an account on the first visit before he/she can log in and start learning. The user registration form is shown in Figure 2.1. Various pieces of information are needed in the registration to ensure that the identity, privileges and progress of the user will be able to be conveniently confirmed and tracked. Once registration is completed, the user can log into the EMET site using the username and password selected by him/her. The logged-out page is depicted in Figure 2.2. Both the login
and logout processes are straightforward, similar to those commonly used to access a web email account.

Figure 2.1 User registration
2.2.2 User Progress and Tracking

It is important for a user to know what content he/she has completed during online learning. The feature of user progress was designed for this purpose. Figure 2.3 shows the user progress page for the topic of “Premier Basics” in the Tutorials section. The objectives that the user has gone through are marked on the progress page. All user progress is stored in and retrieved from the server-based database.

User tracking is a feature that can be accessed only by website administrators and course moderators. This feature enables data from the hyperlink clicks on the EMET pages to be logged for future reviewing and analysis on user behavior. Currently the data being collected include the username, time of last visit, and total time spent on the site. Additional information such as the user’s IP and
which pages the user is visiting can also be readily collected if necessary. The user tracking information is logged into the “userAccount” table in the EMET database.

2.2.3 Concepts Section

The design of EMET and EMET-Engineering took advantage of a controllable development environment without direct intervention from third-party software. Three major features, namely Concepts, Case Studies and Tutorials, were incorporated into the design of the EMET multimedia site. The Concepts feature
introduces theoretical multimedia ideas. Figure 2.4 shows a screenshot of a sample concept page for the topic area of data visualization.

Figure 2.4 A sample concept page

The concept pages only involve a basic level of interactivity, although the user has flexible choices of navigating through different pages by means of clicking hyperlinks on the left-side navigation bar. Therefore, only a minimum amount of multimedia elements (graphics, animations, sound and movie clips) that are critical
to the understanding of the concepts were used to illustrate the descriptions by the
text elements. This remarkably reduces the total download time.

2.2.4 Tutorials Section

The Tutorials section teaches the user how to use different multimedia tools
step by step in a simulated environment. This section is the core of the courseware
presented on the EMET website. It offers the user a much higher level of
interactivity than the Concepts section.

The tutorials were created using the software package Macromedia
Director, which will be discussed in detail in Chapter 5. To correctly display the
tutorials in a web browser, the user must have the Shockwave plug-in installed. To
achieve the goal of making the user’s learning process as smooth as possible, the
interface of the tool being taught was simulated by integrating captured screenshots
into the tutorials. When studying the tutorials, the user is guided to make
appropriate actions in the simulated environment, which accurately duplicates the
use of the real software tool.

In each of several objectives of a tutorial, there are a few goals that the user
should achieve, such as adding text to a picture as shown in Figure 2.5. Upon
completion of the objective, a short quiz is administered to test the level of the
user’s understanding of the objective, and to give the user feedback, as shown in
Figure 2.6.
Figure 2.5 Simulated environment in the Tutorials section

Figure 2.6 Screenshot of a quiz
2.2.5 Case Studies Section

The Case Studies section presents examples created using the multimedia tools introduced in the Tutorials section. This section was designed to provide the user an opportunity to explore possible applications of a certain topic area, such as “2D animation using Flash” depicted in Figure 2.7.

Case studies can help the users, mostly K-12 and vocational teachers, in getting better understandings about the course contents presented in the sections of Concepts and Tutorials and in developing skills in the design of course-supporting materials.

Figure 2.7 A case study page
2.3 Design Environment

The different technologies used in the design environment of EMET included Microsoft Windows NT technology, database technology, and scripting technology. These technologies were used to successfully realize client-server interaction, which is the fundamental network interaction and the principal working mechanism of EMET.

The EMET server plays the roles of file server, database server and web server. First, Microsoft Windows NT Server technology, including Internet Information Server (IIS), Open Database Connectivity (ODBC), ActiveX Data Objects (ADO), and Active Server Pages (ASP), was used as the central control unit on the network of EMET. Second, database technology, such as Relational Database Management System (RDBMS) and Structured Query Language (SQL), was used extensively in the development of EMET to ensure easy access and modification of the database. Third, scripting technology including VBScript and JavaScript was utilized to provide additional functions, capabilities and interactivity to web pages.

The detailed discussion of design environment for EMET-Engineering will be presented in Chapter 5.
2.4 Course Contents

As an online distance learning program to teach K-12 and vocational teachers on how to use multimedia software tools to develop interactive instructional materials, EMET is able to offer the user basic and advanced knowledge in the following topic areas: web pages, drawing, graphics processing, sound, video, 2-D animation, data visualization, simulation, and scripts. The different software tools that can be used to create the multimedia elements from the areas mentioned above are taught in simulated interfaces. The software tools include DreamWeaver, FreeHand, Photoshop, Sound Forge, Sound Studio, Premiere, Flash, Excel, Director, Carrara, JavaScript, Perl, and ASP.

2.5 Development Strategy

The 3-year project of EMET was originally planned to have three development phases, as shown in Table 2.1 [13].

<table>
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<tr>
<th>Phase</th>
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| 1     | • Develop prototype online courseware  
      | • Investigate learning methods for online learning  
      | • Conduct design reviews  
      | • Start development on course content |
| 2     | • Develop courseware content  
      | • Review and evaluate content usefulness (through focus group)  
      | • Deliver courseware by Internet to select test sites |
| 3     | • Deliver courseware  
      | • Elementary, middle and high school, vocational education and University of Oklahoma evaluation  
      | • Formal assessment, review and modification |

Table 2.1 Development phases of EMET
At the time of the composition of the thesis, the design and layout of the website has been finalized, content incorporated, and courseware released. Studies on user feedbacks and assessment are being conducted.

During the development and delivery of the original EMET site, it was decided that a sub-site, which is dedicated to online training of engineering design and analysis tools, would be designed in the framework of the multimedia site, with the purpose to demonstrate and investigate how web-based distance education programs can help in the learning of engineering topics. In the development of the engineering site, tasks that are required in the design of an online training site but are the same as those already completed in the construction of the multimedia site would not have to be repeated. Only those particularly pertinent to engineering site design would be handled. The development strategy of EMET-Engineering will be discussed in detail in Chapter 3.
CHAPTER 3. INITIATION OF EMET-ENGINEERING

This chapter addresses issues involved in projecting to expand the EMET program with engineering contents. EMET-Engineering is an expansion site of the original EMET project. It takes advantage of the successful approaches by the EMET multimedia site in online teaching and combines them with appropriate adjustments for engineering contents.

3.1 Purpose of Launching the Engineering Site

EMET, as its name denotes, was built to facilitate teaching educators how to use multimedia elements and multimedia development tools to create interactive contents for use in their classes. The EMET site has been successful in teaching twelve widely used multimedia tools corresponding to the most important media types to educators. During the period of developing and deploying the multimedia site, the developer of this project, the Engineering Media Lab at the University of Oklahoma, has noticed an increasing amount of demand by engineering students and practicing engineers to learn about engineering topics online. In order to meet the need by these user groups and to enlarge the area in which EMET can teach using the similar framework, the EMET project decided to branch out to accommodate online courses in the topic areas of computer aided design (CAD) and analysis tools. Such topic areas were chosen because computer aided design and analysis technologies have become more and more important in engineering
development. They increase product reliabilities and decrease product development
time and cost. Engineering students desire to learn and use these tools in their
academic projects and future careers. Practicing engineers want to work with these
tools to improve their design quality and work efficiency. Employing an
asynchronous learning mode, the EMET engineering site would provide them a
web-based environment to learn fundamentals of engineering design and analysis,
basic operations of relevant software programs, and applications on how to make
use of the software tools.

3.2 Advantages of Teaching Engineering on EMET

First of all, similar to the multimedia site, the EMET engineering site is
dedicated to supporting asynchronous access. In this learning mode provided by the
site, students can access course contents any time of the day or night, thus can
determine their own schedule. This makes the site ideally suited to meet the needs
of nontraditional students, for example, those who work full-time. Moreover,
students are not limited to a linear progression through the topics step by step.
Instead, they can focus on the specific areas they need.

Second, the author’s educational experience indicates that because of limits
on time and one person’s ability to tend to many others’ requests, it is often
difficult for a teacher to give sufficient help to every student’s specific problems
when teaching how to use engineering software tools in a traditional classroom,
whether it is equipped with computers or not. The EMET engineering site gives students an opportunity to be guided through learning how to use these tools without the time limit imposed by traditional classes. The easy-to-follow step-by-step teaching style employed on the site maximally eliminates chances for the students to make unexpected errors during use.

Finally, in order to make the teaching of engineering topics extensive and to keep a uniform style of EMET’s structure, three different teaching methods were chosen. They are: a) concept pages, b) tutorial simulations, and c) case studies. Each method emphasizes different course contents and accordingly offers a different degree of interactivity to effectively suit the user’s needs.

3.3 Choice of Software Tools Taught on EMET

EMET multimedia site teaches twelve multimedia development tools. Those tools were chosen to ensure that all major media types are covered using a selection of the most widely used software available. In the area of computer-aided engineering, EMET engineering site chose to teach solid modeling, finite element analysis (FEA), and motion analysis. These analysis features were selected as the most mature and accessible CAD techniques for the initial efforts with the engineering site. The corresponding software tools (SolidWorks¹, Pro/ENGINEER

¹ SolidWorks is a registered trademark of SolidWorks Corporation.
and Pro/MECHANICA\(^2\) are among the most effective and popular ones currently available. For future development, EMET-Engineering is expected to include more engineering topics, such as computational fluid dynamics (CFD) and thermodynamics, and more software tools corresponding to the current and new topics, of which ANSYS\(^1\), Working Model\(^2\) and FLUENT\(^3\) are possible choices.

Table 3.1 shows the topic areas and tools covered on EMET-Engineering.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Tools</th>
<th>Descriptions</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Pro/ENGINEER</td>
<td>• Solid modeling</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td>SolidWorks</td>
<td>• Design analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Modification and regeneration</td>
<td></td>
</tr>
<tr>
<td>Second</td>
<td>Pro/MECHANICA</td>
<td>• FEA</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Motion analysis</td>
<td></td>
</tr>
<tr>
<td>Third</td>
<td>ANSYS</td>
<td>• FEA</td>
<td>Projected</td>
</tr>
<tr>
<td>Fourth</td>
<td>Working Model</td>
<td>• 2-D modeling</td>
<td>Projected</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Motion analysis</td>
<td></td>
</tr>
<tr>
<td>Fifth</td>
<td>FLUENT</td>
<td>• CFD</td>
<td>Projected</td>
</tr>
</tbody>
</table>

Table 3.1 Topic areas on EMET-Engineering

\(^2\) Pro/MECHANICA and Pro/ENGINEER are registered trademarks of Parametric Technology Corporation (PTC).

\(^1\) ANSYS is an FEA software package. It is a registered trademark of SAS IP Inc.

\(^2\) Working Model is a motion simulation software package. It is a registered trademark of MSC.Software Corporation.

\(^3\) FLUENT is a CFD software package. It is a registered trademark of Fluent Inc.
CHAPTER 4. DESIGN OF EMET-ENGINEERING

This chapter presents the various aspects involved in the design of the EMET engineering site.

As mentioned in Section 3.2, three different learning methods (concept pages, tutorials and case studies) employed by the online courses on the EMET-Engineering site represent the user-visible dimension of the distance-learning site. These methods will be discussed in Section 4.1. Another dimension of interest to developers and educators lies in the variety of web technologies employed in the design of the site, which will be discussed in Chapter 5.

The user interface design of the different features of EMET-Engineering, which includes the learning methods mentioned above and other features, such as log on/off and progress tracking, will be presented in Section 4.2.

Another important aspect of the site design lies in the database design, which will be presented in Section 4.3.

4.1 Learning Methods

The design of EMET-Engineering, similar to the EMET multimedia site, makes use of three different learning methods in teaching engineering topics online. They are: (a) concept pages, (b) tutorial simulations, and (c) case studies. During the deployment of the multimedia site, it was concluded that these methods were effective and straightforward for EMET online education [15]. In addition,
employing these methods keeps the similar structure and website layout between the multimedia site and engineering site.

4.1.1 Concept Pages

Concept pages describe the basic knowledge involved in a specific computer aided engineering design and analysis technology. They can serve as fundamental background information before the user accesses the interactive software simulations in the tutorials section, although the user is not required to work through this section. These pages provide the user with a general overview of technical background information, design and implementation considerations, and ideas or useful tips about an individual topic area. Information in this section is generally not suitable for inclusion in tutorials and case studies. Although the concept pages may include supplemental information needed to extend what would be learned in the tutorials, they also provide theoretical information, which may not lend itself to simulations, or may not be a realistic, suitable topic for a case study. Thus, the concept pages are used to complement and supplement the interactivity of the tutorials and diversity and versatility of the case studies without duplicating them.

4.1.2 Tutorials

The purpose of the tutorials is to teach the user how to use specific computer aided engineering design and analysis tools. Therefore, the tutorials were designed to closely mimic the interfaces of the software tools taught on the site.
This learning method places the most demand upon students in terms of interactivity, especially as compared to the concept pages. To the user, it appears as if he/she is working in the actual software environment, with the added benefit of interactive instructions and message cues. However, the actual software is not, nor is it required to be, loaded on the user’s computer in order for the user to follow the step-by-step procedures. Having learned the material, the user may then create computer models of mechanical structures and perform analysis upon the models in a computer lab on campus or, if desired, purchase the actual software for installation on his/her personal computer.

In order to provide the user with flexibility during teaching, the tutorial for each topic area consists of about ten objectives, with each objective being further divided into several smaller goals for the user to accomplish. For example, a CAD goal might be how to create a default coordinate system or a cut feature in a solid model in Pro/ENGINEER. Upon completion of one objective, a brief quiz is then administered for the user to self-test his/her comprehension on the material and to collect information about how well he/she understood the objective.

4.1.3 Case Studies

The other learning method is presented to the user in the form of case studies. Case studies provide actual examples of what can be created or analyzed once the engineering topics presented in the previous two sections have been completed. EMET staff developed the initial case studies available on the site. As
the program matures, these case studies will be supplemented or replaced by those submitted by online course students. This learning method will deepen the user’s understanding of topics taught in the previous sections, serve as an exchange and inspiration of ideas, and enhance cooperation among different users. The intent of incorporating this learning method into the EMET engineering site is to illustrate how particular computer aided engineering design and analysis tools can be used to improve engineering students’ homework design or research projects. For example, in teaching the user how to capture a designer’s “design intent” using SolidWorks, it would be helpful to show the user how design intent will decide if the design works.

4.2 User Interface Design

Generally, a style similar to that of the user interface for the previous EMET multimedia site was used for the engineering site, with proper changes to accommodate engineering contents.

4.2.1 User Login and Logout

In addition to the text input fields required by the login process, the login page (see Figure 4.1) provides a variety of information suitable for presentation to a visitor of the site when he/she is not logged in or has not registered to be a user. The information includes, for example, a common “about” section, site overview,
plug-in information, a link for new user registration, and links to other sites that might be of interest to the visitor.

First-time visitors are required to register before they can start using the online courses offered on the site. There is no charge to register. In order to accommodate the future expansion of this project to a multifunctional online learning community, registration for a special user type, teacher registration, was provided in addition to the standard user registration. The standard user registration
sets up an account for any user or student who wish to use the online course contents provided by EMET. During the registration process, the user’s biographical data, as well as other information, are collected, as shown in Figure 4.2. Not all the items listed in the registration form are required, but a few are

![New user registration for the engineering site](image)

Figure 4.2 New user registration for the engineering site
necessary, such as name, occupation and email address, to ensure a complete registration. In the mean time, the user has to choose a username and password he/she would like to use.

The only difference between the registration process for a teacher and that of a standard user is that prior to registering as a teacher, one must request a teacher identification number from the EMET administrator. This number will be requested during registration. As projected, a teacher will have more administrative and access privileges than a standard user. This will make it convenient for a teacher to manage, supervise, and assist students in a class, add or deduct course contents, and administer course-related activities.

Once the registration process is completed, the user can use the chosen username and password to log into EMET engineering site from the main login page.

4.2.2 Concept Pages

The section of concept pages is the most static among the three sections designed for different learning methods discussed in Section 4.1. A sample concept page is shown in Figure 4.3. This section offers concepts and theories in detail through textual references, and is comparable to the information found in a traditional textbook in many respects. Unlike a traditional textbook, however, the concept pages may include a modest amount of interactive illustrations of the concepts presented.
4.2.3 Tutorials

One of the web’s most important advantages in delivering distance education programs is that it is well suited for presenting dynamic displays. Traditional media, such as textbooks, which are capable of presenting only static visual displays, don’t match the human perceptual capabilities very well. Human beings are highly efficient movement detectors, and sensitive to subtle changes in the visual field [16]. The Tutorials section was designed to take advantage of the web’s
capability to display dynamic contents so that the efficiency of the learning would be improved.

This section is made up of a number of learning objectives, with each one consisting of a simulation module that closely mimics the actual interface of the software tool being taught, and a quiz following the simulation. The close resemblance of the simulation to the actual tool was realized using Macromedia Shockwave technology in the software package of Macromedia Director.

The user enters the Tutorials section by clicking on the items under “Tutorial” on the navigation bar, which is located on the left of the screen at all times for the user’s convenience (discussed in Section 4.2.5). The ASP script on the web server detects the username and accesses the database to check the user’s learning schedule, then generates a welcome page with a red check displayed next to every objective the user has completed, as shown in Figure 4.4.

On the welcome page, the user can click on either the START button to go to the first uncompleted objective, or the blue numbered button that represents the particular objective he/she prefers to learn. This design gives the user an opportunity to choose between linear and nonlinear learning styles. It also allows users who are revisiting the site to have a choice of revising the completed objectives according to their preference.
Once the user begins working on an objective, the corresponding simulation module will be downloaded, and the work environment will be displayed. In addition, instructions will appear in a floating dialog box. The user is then asked to follow the instructions and move on step by step. A pink elliptical circle prompts the user’s next action. Figure 4.5 shows the dialog box and the prompting circle working collaboratively in the simulated work environment to guide the user’s
learning activities. Although the user is able to know what to do next just by looking for the prompting circle, the dialog box is not redundant. It gives explanations of the actions the user is taking. This makes the user understand how the software functions, rather than just following the given steps blindly. It also benefits the users in that they will be able to figure out how other similar software applications function.

Figure 4.5 Instructions and prompting circle in the simulated environment
The module tracks the user’s actions. Whenever a wrong move is made due to a misunderstanding of the instructions or by accident, a message box will pop up to alert the user and guide the user to take the right action, as shown in Figure 4.6. This helps the user realize and understand the mistake better, rather than simply giving no reactions to the wrong move.

![Figure 4.6 Pop-up alerting message box](image)

After reaching the end of an objective, the user is given a chance to take the quiz that tests the user’s understanding about this objective or to go back to the
beginning of the objective to review the lesson. A sample of the dialog box displaying the choices is depicted in Figure 4.7.

![Figure 4.7 Dialog box at the end of an objective](image)

If the user clicks on “Quiz”, a set of questions will appear to test his/her newly acquired knowledge. The user will get an immediate response after answering each question by checking the box in front of a choice and pressing “Next”. Figure 4.8(A) shows the interface of the quiz. If the answer is right, the system will congratulate the user and prompt to proceed to the next question, as displayed in Figure 4.8(B). If the user provides a wrong answer or clicks “Next” without selecting an answer, the system will generate an explanation of the answer to the question, as shown in Figure 4.8(C). The scores are sent to the database and recorded. One set of scores will be retained for the user under each objective. Older scores are overwritten by the user’s latest attempt. The purpose of keeping score is to help the user keep track of difficult areas. Having completed a set of questions, the user is allowed to move on to the next objective. If all the objectives under one topic area are completed, the system will go back to the welcome page.
4.2.4 Case Studies

After reading the concept pages and training in the tutorial simulations, users would understand the topics better if they were provided with actual examples of what can be done using the software tools taught on the EMET engineering site. The section of case studies was designed for this purpose. The examples demonstrated in this section make use of a variety of the functions and/or features of the software tools, which are introduced to the user in the Tutorials section. For instance, after presenting how to create extrude, revolve, cut and loft features in SolidWorks, the site may offer a case study on how to design a rather
complex solid model using a combination of the features mentioned above. A sample case study is depicted in Figure 4.9.

![Snapshot of a page in a case study](image)

Figure 4.9 Snapshot of a page in a case study

### 4.2.5. Navigation Bar

Several factors led to the decision to keep the navigation bar on the left of the screen permanently viewable. First, it was designed to avoid the “lost in hyperspace” syndrome. User disorientation was one of the earliest identified effects of hypertext navigation, and it is strongly related to the learner’s cognitive skills; however, increasing the site’s interface apparenty by, for example, mapping the site structures, giving a clear title for each page, and placing a navigation bar on
each page, could aid the learner in efficient wayfinding [17, 18]. The placement of a permanent navigation bar can facilitate the students to easily navigate of the structure of EMET presentations. Second, the navigation bar was designed to accommodate the nonlinear style of learning. According to Lam and Cheung [19], the provision of hyperlinks in web pages allows users to navigate through the same document in more than one way, and is especially advantageous for learners to acquire concepts that are highly related to one another. It also benefits users who prefer to selectively learn certain contents on the site. As depicted in Figures 4.3 through 4.6, the navigation bar enables the user, while learning in one topic area, to jump between different pages in the Concept, Tutorial, and Case Study sections, as well as links to the home page, the member pages, and the user forum. The navigation bar also features a pull-down menu called “Topic Links”, which provides links that connect to the home page of other topic areas. The navigation bar is shown once more with the expanded pull-down menu in Figure 4.10.

![Figure 4.10 Permanent navigation bar with expanded pull-down menu](image)
4.2.6 User Forum

The EMET educational sites were designed to be web-based learning environments where users can share information as an online community. This purpose brought up the need for an online conferencing feature. The user forum was designed to fulfill the role of the online conferencing feature. Users can post, reply, edit, and delete messages, and perform full-text searches on forums designated for different topics.

Aside from exchanging ideas and discoveries between common users, the user forum can also be used for teachers to hold virtual office hours and for web administrators to set up a helpdesk to provide technical support.

At the beginning of the multimedia site, a commercial software package called O’Reilly WebBoard (now known as Akiva WebBoard) was attached to the EMET site to build and hold the forum. For various reasons, such as controllability and speed, the user forum feature for the EMET-Engineering site (as well as the updated multimedia site) was redesigned using ASP scripts (see Section 5.2.2 for more information).

The interface of the newly designed user forum is shown in Figure 4.11. Compared with the original version of the forum administered through O’Reilly WebBoard, the current user forum has the following advantages:

1) It is more controllable and tunable by the development team of the research project than was the third party software package.
2) It was designed to be simple, yet easy to use, and satisfactorily functional. WebBoard is a commercial software package for comprehensive online conferencing. It has many features that provide no or little substantial benefit to the EMET educational sites. The redesigned user forum included only necessary features, thus significantly improved the functioning speed.

3) It has a near-zero financial cost, in contrast to the expensive commercial software. According to the online store of its developer, a single-license WebBoard 6 Premium Edition currently sells for $4,995. The cost for the EMET-Engineering user forum was essentially in the form of programming time. Also, the programming itself was fairly basic. The finalized module for the user forum involved only 15 ASP files and the total size of the files did not exceed 50 kilobytes.

4) The user forum feature programmed using ASP scripts is not an individual server component attached to the server platform. It was seamlessly embedded into the site. Therefore, compatibility did not become an issue.

5) Most importantly, it only requires a single login process for the user to use the new online forum in association with the other features offered by the EMET-Engineering site. In contrast, WebBoard had its own login
system and database, thus brought certain inconvenience to the user and extra complexity to the site maintenance.

4.3 Database Design

The front-end website presents a graphical user interface (GUI) for the EMET-Engineering learning environment. However, the behind-the-scene database is the backbone of this online education project, and serves as the central control mechanism of the site. Similar to the EMET multimedia site, the database design
for the engineering site needs to satisfy the following requirements [13]: first, the
database has to be robust and able to handle a large volume of users; second, it has
to be able to handle anomalies to keep its integrity; third, it has to be able to be
scaled up to accommodate expanded research studies in the future.

The database used on both sites of the EMET project were created using
Microsoft Access. This tool was chosen based on wide availability, ease of use, and

It is generally accepted that an effective education is a learner-centered
education [20]. This focus on the learner is reflected in the database design.
Various pieces of information, such as the learning progress and viewing period,
are logged into the database based exclusively on the username. The username is
appointed as the unique identifier for a user’s activities on the website. Therefore,
the table “userAccount”, which contains information on different categories of a
user’s profile, can be seen as the central unit of all the tables in the EMET-
Engineering database. The other tables are directly or indirectly linked to the
“userAccount” table using relationships, as shown in Figure 4.12. The defined
relationships essentially prevent anomalies that could arise from different entries
for the same attribute.

Other aspects of the website are also registered in the database. These
aspects include the three sections (Concepts, Tutorials and Case Studies), user
bookmarks and progress, etc. Altogether, 16 tables were created for the EMET-Engineering database, as shown in Figure 4.13.

Figure 4.12 Relationships between the tables in the EMET-Engineering database

Figure 4.13 Tables in the EMET-Engineering database
Once the database was created, the web pages were designed to interface with the database. The pages on the EMET sites were mainly written in ASP scripts and use technologies including ADO, ODBC and SQL to access the database.

Detailed discussions about ASP, ADO, ODBC and SQL are presented in Chapter 5.
An important dimension of interest to distance-learning site developers lies in the variety of web technologies employed to realize the design intents. Among these technologies are the Relational Database Systems (RDBMS), Open Database Connectivity (ODBC), Internet Information System (IIS), ActiveX Data Objects (ADO), Active Server Pages (ASP), and Structured Query Language (SQL). Additional technologies that are less intensively employed include client-side scripting languages such as JavaScript, as well as interactive streaming media, such as Macromedia Shockwave.

The technologies listed above were selected from a variety of those currently available for a number of reasons. First, this suite of technologies enables the client/server model to work quickly and seamlessly across the Internet interface. The database on the EMET-Engineering server was assigned the central role as the repository for storing information. The client, i.e. the user’s web browser, requests data from the database on the server. Second, most of the technologies mentioned above originated from one company (Microsoft Corporation). In other words, the chosen technologies were easily integrated and are considered mature and less problematic. They are also understood to be stable and well documented.

This chapter presents an in-depth exploration as to why and how different technologies were used in the development of EMET-Engineering. First, a brief introduction to the basic principles of network interaction is provided as a basis for
understanding the rest of this chapter. In the following sections, server technologies, database technologies, and scripting technologies used on the site will be summarized. In the end, the software environments for the development of the site will be discussed.

5.1 Basic Principles of Network Interaction

Currently, the most common network interaction takes place in the form of client-server interaction between two computers. In this interaction, one computer takes the role of server, and the other client. The client requests information from the server. Usually, communications in this interaction are enabled by Transmission Control Protocol / Internet Protocol, usually known as TCP/IP, which is a suite of networking protocols that have been used to construct the Internet. TCP/IP defines the methodology for sending data packets between computers on a network.

Servers can assume the role(s) of file server, database server, email server, and/or web server. The EMET server functions as a file server, database server and web server.

The EMET server acts as a file server only in the phases of site development and maintenance, not during the process of providing services to general users. As a file server, it can be accessed and its storage ("files") modified by development staff through a connection in the local area network (LAN).
Certain configurations on both the server and clients were made to ensure that only client machines of the development team could be granted access to the file server.

As a database server, the EMET server functions as a bridge between the database queries and the database. It guarantees the integrity of the database by keeping track of the location and permission levels of the database.

The most important role of the EMET server is as a web server. It enables the delivery of the site contents through the WWW. Rather complicated interactions can occur between the web pages and the database and file management on the EMET server as the user click through the web pages.

5.2 Microsoft Server Technologies

The EMET-Engineering project was constructed on the platform of Microsoft Windows 2000 Server. This server platform was chosen for several reasons including stability, security, user-friendliness, and variety of compatible technologies that were used by the project.

Windows 2000 Server, which was developed as the successor to Windows NT 4.0 Server, is the newest version of Microsoft’s best-selling server operating system. According to its manufacturer, Windows 2000 Server is “the multipurpose network operating system for business of all sizes.” It allows users to “share files and printers reliably and securely, choose from thousands of business applications
compatible to run today on Windows 2000 Server, and build web applications and connect to the Internet” [21].

Windows 2000 Server is integrated with many software technologies that enable it to function as a central control unit to provide services and share resources with computers on a network. These technologies, for example, include Internet Information Services (IIS), Active Server Pages (ASP), ActiveX Data Objects (ADO), and Open Database Connectivity (ODBC).

5.2.1 Internet Information Services (IIS)

Fully integrated at the level operating system, Microsoft Internet Information Services (IIS) is a built-in web server that enables users to do the following: host and manage websites to share information, create web-based business applications, and extend file, media, print and communication services to the web.

The research project of EMET-Engineering chose IIS as the web server because it has the following features:

a) It shares information efficiently using the web. Integrated Windows 2000 Server technologies make it as easy to carry out standard file operations on a web share as on a network file share.

b) It enables its users to create web-based business applications that integrate well with traditional business applications. The course content on EMET educational sites could be developed and delivered
conveniently through traditional media such as CD-ROMs, but applications that suit for such media might not be readily delivered through web pages. Now Windows 2000 Server overcomes this burden by sharing Internet-aware application development tools with IIS, an efficiency that extends applications to the web.

c) It brings server operating system functionality to the web. In addition to allowing organizations to extend basic file and print services to the web, Windows 2000 Server supports applications, media, and communications and networking services from a common server platform. This feature is critical to the EMET project because the online education program consists of a great deal of services in the forms of media, communications and applications [21].

As of providing services of communications as mentioned in part c) above, one important feature of IIS that was used by the EMET project is the SMTP service. SMTP stands for Simple Mail Transfer Protocol. It was defined by the IETF (Internet Engineering Task Force) in 1982 in order to transfer mail reliably and efficiently [22]. An SMTP server component is installed with IIS 4.0 or up.

The initial development of the EMET multimedia site used a third party program from Persits Software Inc. called ASPEmail. This program did not function as a mail server itself and sent out emails using an external mail server such as the one at the University of Oklahoma, smtp.ou.edu. The IIS-integrated
SMTP service runs as a virtual mail server; this means that messages from the webmaster can be directly sent to designated users without being relayed to an external mail server. Therefore, the EMET-Engineering site (and the upgraded multimedia site) switched to the integrated SMTP service for enhanced reliability and compatibility.

Once installed and running, the SMTP service can be easily invoked using ASP scripts (see Section 5.2.2) through an interface with another server component called Collaboration Data Objects for Windows NT Server (CDO for NTS) by Microsoft. A sample ASP script that can send an email using the SMTP service is shown below:

```vbscript
Set objMail = CreateObject("CDONTS.Newmail")
objMail.From = "emetsupport@ou.edu"
objMail.To = "johndoe@domain1.com; joandoe@domain2.com"
objMail.Subject = "Welcome to EMET-Engineering!"
objMail.Body = "Start learning and have fun!"
objMail.Send
Set objMail = Nothing
```

This code is easy to read and debug. Since there is no logon authentication, the “From” field can be set to anything the developer wants or even emptied. This example shows how the SMTP service on the Windows 2000 Server can be used to send a plain text email. In addition, HTML messages and attachments as well as other email-related functions are supported, although this paper will not cover the technical details here.
The interface for setting up the properties of the SMTP mail server is shown in Figure 5.1.

Figure 5.1 SMTP server properties

In addition, IIS is tightly integrated with support for accessing databases, for example, ODBC and ADO (discussed in Sections 5.2.3 and 5.2.4). For a database-driven project like EMET-Engineering, IIS would be an optimum choice for web service platform.
5.2.2 Active Server Pages (ASP)

Microsoft Active Server Pages (ASP) is a server-side scripting environment that can be used to create dynamic web pages and build powerful web applications. When the server receives a request for an ASP file, it processes server-side scripts contained in the file to build the web page that is sent to the browser. Since the output of this dynamic processing is in the form of a static web page (as a normal HTML page), the performance of ASP is browser- and operating system-independent. Since the EMET project assumes that its users might use different types of browsers (Netscape Navigator, Microsoft Internet Explorer) on different types of computers (PC, Macintosh), it is strongly beneficial that ASP was chosen as the environment for developing web contents.

A component of the IIS technology, ASP technology is very powerful and has few restrictions on developers [23]. It allows developers to embed any scripting language, such as VBScript or JavaScript, or ActiveX Data Objects (ADOs) into their HTML pages. ASP pages provide standards-based database connectivity and the ability to customize content for different browsers. ASP also provides error-handling capabilities for web-based applications.

Another benefit of using ASP is security. Since ASP scripts are processed on the server side, users on the client side cannot view them. This makes it more difficult to compromise the server as well as makes it easier to protect copyrights.
Among many competing technologies to create dynamic web contents, such as PHP (Hypertext Preprocessor), CGI (Common Gateway Interface), and JSP (Java Server Pages), ASP shows some distinctive advantages such as high running efficiencies on the web server due to good reusability of server threads, and the quality of being easy to learn.

On the EMET learning sites, ASP was extensively used in a combination with ODBC and ADO to access the database and build customized web pages for specific users, as well as serving as the control program for the user forum (see Section 4.2.6 for more details).

5.2.3 ActiveX Data Objects (ADO)

Microsoft ActiveX Data Objects (ADO) is an application program interface that allows Windows applications to gain access to a database. It is Microsoft’s strategic, high-level interface to all kinds of data [24].

ADO is implemented with a small footprint, minimal network traffic in key Internet scenarios, and a minimal number of layers between the front-end and data source—all to provide a lightweight, high-performance interface. Choosing ADO, the EMET sites were able to take advantage of this easy-to-use application level interface to Microsoft’s most powerful data access paradigm, OLE DB, which provides high-performance access to any data source, including databases, email and file systems, text and graphics, custom business objects, etc.
An ADO command is implemented whenever there is a need to access data from the EMET database. The command is usually positioned at the beginning of an ASP file to establish a connection to the database. After the demanded data are acquired, the connection will be closed.

5.2.4 Open Database Connectivity (ODBC)

Open Database Connectivity (ODBC) is an open standard application programming interface (API) for accessing a database. ODBC was created by the SQL Access Group and first released in September 1992. Now its main proponent and supplier is Microsoft [25].

By using ODBC, database files in a number of different formats, including Access, dBase, Excel and Oracle, can be accessed without activating corresponding database programs. ODBC is closely aligned with the Structured Query Language (SQL) standard. It handles the SQL requests from programs trying to access a certain database and translates them into requests that the individual database system understands.

In the EMET project, the web pages written in ASP format contain instructions for requesting data from the EMET database through ODBC. Therefore, ODBC is used to bridge the database and the customized web pages. The Microsoft ODBC used in EMET has a feature called “connection pooling”. It was enabled in developing the project to allow an application requesting to access a
database to reuse an open connection within a certain timeout period in order to improve the usability of server resources.

5.3 Database Technologies

Since both the multimedia site and the engineering site of the EMET project were built around a central database, database technologies saw a large amount of use in the development and deployment of the project. Almost every phase of a user’s visiting experience on the two EMET sites has something to do with databases, for example, login and logout, access of tutorials, review of personal progress and scores, etc.

A database is an organized collection of data that can be accessed and modified. There are a number of ways to organize a database, but relational databases are the most prevalent. This type of database organization, which is a set of formally described tables, enables data to be accessed and reassembled in many different ways without having to reorganize the tables. In this way, it provides good accessibility and reliable security. In addition to being relatively easy to create and access, a relational database has the important advantage of being easy to extend. After the original database creation, a new data category can be added without requiring that all existing applications be modified. This feature meets the need of the EMET sites to be expandable.
The standard user and application program interface (API) to a relational database is the Structured Query Language (SQL). SQL statements were used to read and write data in the database of EMET.

This section covers the database technologies employed on EMET-Engineering, i.e. Relational Database Management System (RDBMS) and SQL.

5.3.1 Relational Database Management System (RDBMS)

A Relational Database Management System (RDBMS) is a program that allows its users to create, update and administer a relational database using SQL statements. Some of the best-known RDBMS’s are as follows: Access (Microsoft), Oracle9i (Oracle), DB2 (IBM), and CA-OpenIngres (Computer Associates).

Microsoft Access was used for database manipulations on EMET since it is in the Microsoft product line thus has the best compatibility with the other technologies used in the project.

A relational database is a set of tables containing data fitted into predefined categories. Each table (which is sometimes called a relation) contains one or more data categories in columns. Each row contains a unique instance of data for the categories defined by the columns. Figure 5.2 shows the table “userAccount” of the EMET-Engineering database in the Access environment. As can be seen from the table, the columns specify the data categories (username, password, user type, last name, first name, etc.), and every row provides the data values of one user for the data categories.
A relational database may have more than one table. For example, the database of EMET-Engineering has sixteen tables, as shown in Figure 5.3 (replicated from Figure 4.13).

In order for the multiple tables in one database to be coordinated so that all the data fields can be correctly accessed and modified, relationships have to be defined among the tables. A relationship works by matching data in key fields (a key field is usually a field with the same name in both tables). In most cases, these
Matching fields are the primary key from one table and a foreign key in the other table. A primary key is a field or set of fields that uniquely identifies each record stored in the table. A foreign key is one or more fields that refer to the primary key field(s) in another table. For example, in a database for a commercial organization, employees can be associated with orders they're responsible for by creating a relationship between the Employees table and the Orders table using the EmployeeID fields.

The relationships defined among the different tables in the EMET-Engineering database are depicted in Figure 5.4 (replicated from Figure 4.12), with primary key fields shown in bold.

![Figure 5.4 Relationships in the EMET-Engineering database](image)
For the initial design, development and deployment of the EMET sites, Access, which is a packaged program of the Microsoft Office suite, performs satisfactorily as an RDBMS program with its easy-to-use interface and popular availability. However, since it is mainly a personal database management tool, it has some limitations that may compromise its performance for larger databases in future EMET development. For example, the largest number of objects in an Access database is 32,768. The most important limitation might be the maximum number of concurrent users allowed, which is only 255 [26]. In addition, it has few tools to help with the optimization of the database. Therefore, it was planned that the databases for the EMET sites would be upgraded to SQL Server databases at an appropriate time.

Microsoft SQL Server is a fully web-enabled database and data analysis package. It has many powerful features that Access does not. SQL Server can integrate, consolidate and summarize data information through large, central data stores where information is collected. It has an Online Analytical Processing (OLAP) service that can perform rapid, sophisticated and web-enabled analysis on large and complex data sets. Such analysis would not only reveal patterns and trends in the collected data, but also provide predictions for future activities. Therefore, SQL Server would be very helpful in future studies on website performance and user behaviors.
Databases must be tuned in order to achieve optimal end-user performance. SQL Server performs several operations to keep itself tuned. The dynamic algorithms in SQL Server 2000 are able to optimize disk space usage and memory allocation dynamically to have the fastest database performance. SQL Server 2000 also provides tools to monitor the circumstances under which automated management tasks are occurring, such as changes in data files and log files. Developers, in turn, can troubleshoot problems by capturing these events on a production system and replaying them on a test system. SQL Server also provides the highest level of security available in the industry, taking advantage of the integrated security of Windows 2000.

The current Access database of EMET and EMET-Engineering can be conveniently upgraded to SQL Server database using the built-in Upsizing Wizard.

5.3.2 Structured Query Language (SQL)

Structured Query Language (SQL) is a standard interactive and programming language for getting information from and updating a database. SQL queries take the form of a command language that lets the user select, insert, update, find the location of data, and so forth. Most commercial database products, such as Microsoft Access, Microsoft SQL Server and IBM DB2, support SQL.

SQL statements querying a database take several forms including commands such as SELECT, INSERT, UPDATE and DELETE, and clauses such as WHERE and ORDER BY. SQL can be divided into two main sub-languages:
DDL and DML [27]. The Data Definition Language (DDL) contains the commands used to create and destroy databases and database objects. After the database structure is defined with DDL, database administrators and users can utilize the Data Manipulation Language (DML) to insert, retrieve and modify the data contained within it.

In the EMET sites, SQL commands were embedded into ASP files (see Section 5.2.2) to access the databases through ODBC (see Section 5.2.4).

5.4 Scripting Technologies

A script is a program or sequence of instructions that is interpreted or carried out by another program rather than by the computer processor, as a compiler program [28]. Among well-known script languages are Perl (Practical Extraction and Reporting Language), JavaScript and VBScript.

In general, script languages are easier and faster to code than compiled languages such as C and C++. However, a script usually takes a longer time to run than a compiled program since each instruction is being handled by another program first. This requires additional instructions, rather than direct handling by the basic instruction processor.

On the WWW, script languages are often used to provide enhancements to the capabilities and interactivity of web pages, such as handling forms or displaying animated contents.
There are two types of scripts: server-side scripts and client-side scripts. Server-side scripts, such as those written in Perl, are processed on the web server as the name indicates. Client-side scripts, such as JavaScript scripts, run on the user’s web browser.

The EMET-Engineering site used VBScript and JavaScript as its script languages.

5.4.1 VBScript

VBScript is a script language developed by Microsoft for interpretation by web browsers. According to its developer, VBScript is able to serve as both server-side and client-side scripting [29]. As a client-side script language, it can be recognized and interpreted by Microsoft Internet Explorer. As a server-side script language, it works in the environment of Microsoft Internet Information Services (IIS) (see Section 5.2.1).

VBScript is generally thought to be easier and faster to learn than other script languages. A shortcoming of VBScript is that Microsoft Internet Explorer and Mosaic ³ are the only commercial browsers that support it. Other currently available Internet browsers, Netscape being the most popular, do not provide interpretation for VBScript. Therefore, the EMET-Engineering web developers used VBScript solely as server-side script to avoid causing browser incompatibility problems or forcing the users to use certain browsers.

³ Mosaic is an Internet browser developed and copyrighted by the National Center for Supercomputing Applications (NCSA) at the University of Illinois, Urbana-Champaign.
Paragraphs of VBScript can be embedded into HTML and ASP files conveniently with the use of paired <SCRIPT> tags. Below is an HTML file with a script written in VBScript that responds to a button click:

```html
<HTML>
<HEAD>
<TITLE>Test Button Events</TITLE>
</HEAD>
<BODY>
<INPUT TYPE="Button" NAME="Button1" VALUE="Click">
<SCRIPT FOR="Button1" EVENT="onClick" LANGUAGE="VBScript">
MsgBox "Button Pressed!"
</SCRIPT>
</BODY>
</HTML>
```

The running result would be a pop-up message box that reads “Button Pressed!” after clicking the button “Click”, as shown in Figure 5.5.

Figure 5.5 VBScript message in response to a button click
5.4.2 JavaScript

JavaScript was developed by Netscape as an interpreted programming language to enhance web pages’ performance. Although it can also be used as server-side script, in the EMET-Engineering project, JavaScript is mainly used in static web pages as client-side script to follow directions as open a pop-up window and display mouse-rollover effects on text and graphics.

Like VBScript, JavaScript can be conveniently embedded into an HTML file using paired <SCRIPT> tags. One advantage of JavaScript over VBScript is that all popular commercial web browsers, including Internet Explorer, Netscape, Mosaic and Opera, support web pages containing JavaScript codes. To accomplish the same goal of displaying a message box in response to a button click as in the preceding section about VBScript, the JavaScript code may look like the following:

```html
<HTML>
<HEAD>
<TITLE>Test Button Events</TITLE>
</HEAD>
<BODY>
<INPUT TYPE = "BUTTON" VALUE = "Click" NAME = "Button1"
     OnClick="press()">
<SCRIPT LANGUAGE="JavaScript">
   function press() {
     alert("Button pressed!");
   }
</SCRIPT>
</BODY>
</HTML>
```
The running result of the above code is similar to that of the VBScript code in the preceding section. The screen capture is shown in Figure 5.6.

![Figure 5.6 JavaScript message in response to a button click](image)

**5.5 Shockwave Technology**

Shockwave, developed by Macromedia, is a family of multimedia players. It is a current standard for web multimedia playback. Web users with Windows and Mac platforms can download the Shockwave players for free from the Macromedia site (http://www.macromedia.com) and use them to display and hear Shockwave files. Shockwave files are authored with Director or Flash, both multimedia development tools by Macromedia.

Shockwave technology has the following advantages:
1) By using Director or Flash, multimedia contents including animation, sound, video, etc. and advanced interactivity can be conveniently integrated into a Shockwave file for distribution over the Internet.

2) It has excellent security protection against tampering with the source file. Once packed, the Shockwave file can only be used for playback, but not disassembling. This feature makes it easier to protect the copyright.

3) Shockwave files have compact file sizes because vector animation is used to draw the frames on the local computer, in contrast to pixel-based frames being downloaded and replayed. For example, the size of a Shockwave file can be less than one hundredth of the file size in other popular formats of multimedia playback, such as QuickTime and AVI. Shockwave files can be “streamed”\(^1\) during distribution, which means little bandwidth requirement and fast distribution over the Internet.

4) Shockwave players (Flash Player and Shockwave Player) are free, cross-platform, easily accessible and widely distributed. It has been estimated that more than 300 million web users have had Shockwave players installed on their PC’s or Mac’s with Internet Explorer, Netscape or AOL being the browser [30].

\(^1\) Streaming means a multimedia file can be viewed while partially downloaded. It reduces the waiting time before the presentation begins.
As can be concluded from the above, Shockwave technology was an ideal choice for the development of the tutorials for the EMET project, which contain large volumes of multimedia elements and complicated interactivity.

5.6 Software Environments for Site Development

In the previous sections of this chapter, various technologies employed in the EMET-Engineering project were discussed. Any of the designed features in the project would not be able to be realized in the absence of certain technology. Nevertheless, without the help of software design tools, technology itself, which means manual coding, cannot provide website developers with satisfactory efficiency.

In this section, brief introductions to the software tools chosen for the EMET-Engineering site development will be presented as well as reasons for using these tools.

5.6.1 Macromedia Dreamweaver

Macromedia Dreamweaver is a WYSIWYG1 software environment for efficiently creating and managing websites and Internet applications. It has a powerful integrated environment that supports the development of contents using most popular web technologies including HTML, ASP, JSP, PHP and XML.

---

1 WYSIWYG is an acronym for “what-you-see-is-what-you-get”. A WYSIWYG program is one that allows the developer designing a user interface to see what the end result will look like while the interface is being created.
Since the EMET sites contain a large volume of static web pages, which are mainly located in the sections of Concepts and Case Studies, Dreamweaver was selected as the major tool for the creation of those static web pages because it has the following advantages:

1) It is easy to use, even for beginners in web design. Like other successful WYSIWYG programs, Dreamweaver’s user interface (see Figure 5.7) is friendly and intuitive to understand.

![Figure 5.7 User interface of Macromedia Dreamweaver (the page in editing is the homepage of EMET-Engineering)](image)
2) It enables fast design and production. A variety of features, such as pre-built site structures, forms, accessible templates, JavaScript functions for client-side interactivity, code hints, tag editors, and code validation, significantly alleviate the burden of hand coding.

3) It is integrated with drag-and-drop visual tools and robust code-editing assistance. Popular web plug-ins, such as Shockwave, QuickTime and Real Media, are supported.

Apart from the above, Dreamweaver is excellent in generating “clean” HTML tags, which makes occasional manual modifications easy to perform, and is academically priced.

5.6.2 Macromedia Director

The core contents of the EMET educational sites are the interactive tutorials. They were created within the environment of Macromedia Director with Shockwave technology (see Section 5.5).

Macromedia Director is currently the most powerful software tool for authoring multimedia contents with rich interactivity. It integrates a comprehensive array of multimedia elements to create fast-rendering, high-performance, media-rich applications. Multimedia elements such as animation, Real Media, MP3, QuickTime, pixel- and vector-based graphics, text, etc. can be combined in the development environment to create streaming interactive multi-user content.
A new Version 8.5 of Director has a feature, 3D vector-based graphics, that is critical to the tutorial development for EMET-Engineering. As discussed in Chapter 3, EMET-Engineering was designed to teach solid modeling, FEA and motion analysis online. All of the above three topics require display and maneuvering of 3D graphics. The currently newest release of Director, Version 8.5, provides an easy way for developers to deliver scalable, bandwidth-friendly 3D content over the Internet for the first time. The 3D feature of Director was realized by integrating Intel’s Internet 3D Graphics Software [31]. It offers a flexible, extensible and robust 3D content creation solution. The produced movie of Director containing 3D contents can still be played using browsers with Shockwave plug-in.

The working environment of Director uses a theater metaphor, as shown in Figure 5.8. The Stage is the area that in the produced movie will be displayed on the user’s screen. Cast Members can be placed on the Stage as players of the movie. The properties of the Stage and Cast Members can be obtained and modified using the Property Inspector. The Score defines the frame sequence of the movie as if animating a cartoon. The frames are lined in time but can have nonlinear playback effects if settings of certain frames are defined using Lingo. Lingo, a script language, can also be used to describe behaviors of Cast Members.

As of the date of this thesis, there is still no direct competition with the power and functionality of Macromedia Director in developing interactive multimedia applications.
Figure 5.8 User interface of Macromedia Director (the movie in editing is the tutorial for creating a 3D block in Pro/ENGINEER)
5.6.3 Microsoft Access

Microsoft Access is one of the popular RDBMS programs. It was used to design, create and manage the database of EMET-Engineering. For more details, see Section 5.3.

5.6.4 ModelWorks SitePad Pro

SitePad Pro is an ASCII text editor developed by ModelWorks Software. It saw extensive use in the development of EMET sites, especially manual coding of ASP files and minor modifications of Dreamweaver-generated HTML files.

Although ASCII text editors are among the most primitive software applications, and Windows 2000 comes with a built-in editor called Notepad, SitePad Pro has a lot of advanced features that provide useful assistance to the development of EMET sites. These features include coloring and indenting for reserved keywords or tags, numbering of lines, conversion from spaces to tabs, immediate preview of HTML files in a browser window, powerful find and replace, etc.

A snapshot of an ASP file being edited in the environment of SitePad Pro is shown in Figure 5.9. It can be clearly seen that compared with simpler text editors such as Notepad, SitePad Pro provides the developer with a friendlier, more powerful and more convenient environment of editing text files.
5.6.5 TechSmith SnagIt

TechSmith Corporation’s SnagIt is an advanced screen capture utility working with the Windows system.

Since the tutorials on the EMET educational sites were designed to exactly mimic the actual user interfaces of certain software tools, a large collection of screen captures made from the working spaces of those tools would be a necessity.
Furthermore, sometimes captures needed to be made from specific regions rather than the whole screen or an active window. This requires assistance from a better screen capture utility than the simple “Print Screen” function provided by the Windows operating system.

SnagIt qualified for this requirement of EMET site development with the following major features:

1) The multiple input modes make the capture of a snapshot flexible. The user can select from a total of nine input modes for image capture, such as Screen, Window, Active Window, Region, and Clipboard. In addition, it can be switched between whether or not to include the mouse cursor in the captured image.

2) The output procedure is fast and easy. A picture captured by using the “PrintScreen” key on the Windows keyboard needs to be first pasted into a graphics program, such as Photoshop or MS Paint, before it can be saved onto the hard disk. SnagIt can directly save the snapshot as a file, or send it to the printer, the clipboard, an FTP server or an email address.

3) It supports many image formats including BMP, JPEG, GIF, etc. The user can always choose the format to save a capture in order to best suit the needs. For example, if a picture consisting of just a few solid color
blocks, lines and dots, the user may choose GIF over BMP and JPEG as the file format to reduce the file size and facilitate web use.

The interface of SnagIt on startup is shown in Figure 5.10, and the capture preview window with a picture captured from the EMET-Engineering homepage with cursor is shown in Figure 5.11.

![Image](image1.png)

Figure 5.10 Main interface of TechSmith SnagIt

![Image](image2.png)

Figure 5.11 Capture preview window of SnagIt
Other similar screen capture utilities include LEAD Screen Capture (LEAD Technologies, Inc.), Capture By George (Svet-Soft), Quick Screen Capture (ETru Software, Inc.) and CaptureWizPro (PixelMetrics).
CHAPTER 6. CONCLUSIONS

Because of its popularity, flexibility, interactivity, richness of multimedia, geographic and temporal independency, and support for learner-centered education, the web has been considered an ideal medium for distance education.

Reported in this thesis is the research initiative at the Engineering Media Lab, University of Oklahoma, to build an educational website dedicated to teaching its users how to use certain engineering software tools. Issues involved in the design and development of this website were discussed.

Accomplishments achieved during the research and development of the reported project include the following: the current status of distance education, especially distance education for engineering, was reviewed; different learning methods employed by the original EMET site were examined and evaluated; then they were adapted to constitute the user-visible layer of the EMET-Engineering site; initiations of using multimedia applications to teach engineering topics online were made through the construction of the EMET-Engineering site; issues involved in selecting the appropriate technologies and tools to accommodate the development of such a website were discussed, and a selection suitable for this project was formed; some features proposed in the design of the website were created, others were adapted from the EMET multimedia site with proper adjustment to achieve improvements in performance; work that could be done on the research project in the future was suggested.
The research website named EMET-Engineering was an extension to the original site of EMET, a distance learning site for multimedia contents development. It was designed to be a self-contained environment that is used to teach college students in mechanical engineering how to use CAD and FEA software tools. By the date of this thesis, the CAD section, which features two software packages (Pro/ENGINEER and SolidWorks), has been completed and deployed to the public; the FEA section is still under development.

The research site presented in this thesis accommodates the asynchronous mode of learning, which gives the users more flexibility and makes the site management easy to perform. Three learning methods, i.e. static presentations of basic concepts, interactive simulations of tutorials, and scope-extending case studies, were integrated into the learning site to fully explore the advantages of the web in distance education and to offer different learning styles. Various considerations were given to the design of the site in order to make it a user-friendly, self-paced nonlinear learning environment. In addition, the site can be used not only for individual study, but also to facilitate users in a class structure, or in an online learning community.

Technologies employed to realize the site design were also discussed in order to forge the dimension of interest to developers of distance education sites. The backbone of this learning site is a database, which manages the course contents, monitors user activities, records user progresses, generates customized
user interfaces, and so on. Other technologies and corresponding development tools were introduced as well. The emphasis on presenting the technologies was in discussing their advantages in engineering distance education, i.e. why certain technologies were selected by the EMET-Engineering developers.

In the future, a variety of research activities could be performed on the site. First, the engineering site will be completed to include the FEA section as projected and possibly extended to a wider scope. Second, user feedback should be collected and reviewed as references for future site update and maintenance. Third, user behaviors on the site could be analyzed, which could also contribute to the assessment of the learning site and further exploration in the area of online distance education.
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APPENDIX A. A SAMPLE LINGO SCRIPT

Global AnswerList, QuestionList
Global currentsprite, Correct
Global Gpoint, GScore, GTScore
Global Completed

on Submittodatabase
  dbloc = externalParamValue(1)
  databaselocation = string(dbloc)
  infolist = ["moduleID": "2","LessonID": "1","ObjID": "3","Score":GTScore]
  answerlist.deleteall()
  GTScore = 0
  PostNetText(databaselocation,infolist)
  put infolist
end

On CalculateScore
  if sprite(currentsprite).member.hilite = true then
    if Correct = True then
      Gpoint = Gpoint + 1
    else
      Gpoint = Gpoint - 1
    end if
  else if sprite(currentsprite).member.hilite = false then
    if Correct = True then
      Gpoint = Gpoint - 1
    else
      Gpoint = Gpoint + 1
    end if
  end if
  put Gpoint
end
APPENDIX B. A SAMPLE ASP SCRIPT – REGISTER.ASP

<!-- #include file="../includes/header.asp" -->
<%
'DESCRIPTION

'Purpose: User registration
'This ASP file is used for user registration on EMET.
'Date: 11/12/2001

'Variables from the Form

Dim str_first, str_last, str_occupation, str_address, str_city, str_zip
Dim str_state, str_country, str_email, str_speed, str_location
Dim str_gender, str_public, str_username, str_password, str_passwordc, str_class,
str_userType
Dim str_school, str_phone
Dim str_teacher 'global variable to identify the teacher, if has one
str_teacher = ""
str_first = Request.Form("fname")
str_last = Request.Form("lname")
str_occupation = Request.Form("occupation")
str_address = Request.Form("address")
str_city = Request.Form("city")
str_zip = Request.Form("zipcode")
str_state = Request.Form("state")
str_country = Request.Form("country")
str_email = Trim(Request.Form("email"))
str_speed = Request.Form("connspd")
str_location = Request.Form("connvenue")
str_gender = Request.Form("gender")
str_username = Request.Form("id")
str_password = Request.Form("password")
str_passwordc = Request.Form("passwordc")
str_class = Request.Form("myclass")
str_userType = Request.Form("type")
str_school = Request.Form("school")
str_phone = Request.Form("phone")
str_public = Request.Form("public") 'possible values ("" or "on")

If str_public = "on" Then
    str_public = "1"
Else
    str_public = "0"
End If
'Additional values need to be inserted
'-------------------------------------
Dim str_today
str_today = Date
%

<html>
<head><title>Create My EMET Account</title></head>
<body bgcolor="#FFFFFF">
<table border="0" width="600" cellpadding="2" cellspacing="0" vspace="0"
hspace="0">
<tbody>
<tr>
<td width=85 bgcolor="#000000">
  <div align=center>
    <p><a href="http://emet.ou.edu/" target="_parent"><IMG align=bottom
border="0" height="28"
src="../common/images/emetlogo.gif" width="84"></a> </P>
  </div>
</td>
<td colSpan="2" bgcolor="#000000" width="482">
  <div align=center><font color="#CCCCCC" face="Arial, Helvetica, sans-serif"
size="2">"Integrating the world of education through e-technology"</font>
</div>
</td>
</tr>
<tr bgcolor="#FFFFFF">
<td colspan="3"><font face="Arial, Helvetica, sans-serif" size="2">
  %>
  Variables for the database
  '--------------------------
Dim obj_connect
Set obj_connect = Server.CreateObject("ADODB.Connection")
obj_connect.Open "DSN=" & Application("emetengidsn")

If Not isCorrect() Then
  printError()
Else
  If str_userType = "teacher" Then '-------------------for teacher----------------------
    If Not checkTeacher() Then
      printErrorTeacher()
    ElseIf Not existClass() Then
      printErrorTeacherClass()
    Else
      doUpdate()
      doUpdateForTeacher()
  Else
    End If
Else
  End If
</font></td>
</tr>
</tbody>
</table>
</body>
</html>
Function checkTeacher()
    checkTeacher = False
    'check two conditions: username exists and not yet registered
    Dim str_SQL, obj_retrieve
    str_SQL = "SELECT username FROM userAccount WHERE username = " & str_username & " AND usertype = 'teacher' AND registration = ","
    Set obj_retrieve = obj_connect.Execute(str_SQL)
    If obj_retrieve.EOF = False Then
        checkTeacher = True
End Function
End If
End Function

**********************************************************************
Function existUser()
existUser = False
Dim str_SQL, obj_retrieve
str_SQL = "SELECT username FROM userAccount WHERE username = " & str_username & ";"
Set obj_retrieve = obj_connect.Execute(str_SQL)
If obj_retrieve.EOF = False Then
    existUser = True
End If
End Function

**********************************************************************
Function existClass()
existClass = False
If str_class = "" Then
    existClass = True
    Exit Function
End If
Dim str_SQL, obj_retrieve
str_SQL = "SELECT username FROM teacherAccount WHERE classroom = " & str_class & ";"
Set obj_retrieve = obj_connect.Execute(str_SQL)
If obj_retrieve.EOF = False Then
    existClass = True
    str_teacher = obj_retrieve("username")
    If str_userType = "teacher" AND str_username <> str_teacher Then
        existClass = False
    End If
End If
End Function

**********************************************************************
Sub doInsert()
    Dim str_SQL
    obj_connect.Execute(str_SQL)
End Sub
Sub doUpdate()
    Dim obj_retrieve, str_SQL, str_today
    str_today = CStr(Date)
    Set obj_retrieve = Server.CreateObject("ADODB.Recordset")
    str_SQL = "SELECT * FROM userAccount WHERE username = " & str_username & ";"
    obj_retrieve.Open str_SQL, obj_connect, adOpenKeyset, adLockPessimistic, adCmdText
    'Update the database
    obj_retrieve("lastname") = str_last
    obj_retrieve("firstname") = str_first
    obj_retrieve("occupation") = str_occupation
    obj_retrieve("email") = str_email
    obj_retrieve("address") = str_address
    obj_retrieve("city") = str_city
    obj_retrieve("zipcode") = str_zip
    obj_retrieve("state") = str_state
    obj_retrieve("country") = str_country
    obj_retrieve("gender") = str_gender
    obj_retrieve("connectspeed") = str_speed
    obj_retrieve("connectlocation") = str_location
    obj_retrieve("public") = str_public
    obj_retrieve("registration") = str_today
    obj_retrieve("lastvisit") = str_today
    obj_retrieve("password") = str_password
    obj_retrieve.Update
    obj_retrieve.Close
End Sub

Sub doInsertForClass()
    Dim str_SQL, obj_retrieve
    str_SQL = "INSERT INTO teaches VALUES(" & str_teacher & "," & str_username & ");"
    obj_connect.Execute(str_SQL)
    'Get the teacher name
    str_SQL = "SELECT lastname, firstname FROM userAccount WHERE username = " & str_teacher & ";"
    Set obj_retrieve = obj_connect.Execute(str_SQL)
    str_teacher = obj_retrieve("firstname") & " " & obj_retrieve("lastname")
End Sub
Sub doUpdateForTeacher()
    Dim str_SQL
    str_SQL = "UPDATE teacherAccount SET highschool = " & str_school & ",
    phone = " & _ str_phone & ", classroom = " & str_class & " WHERE username = " &
    str_username & ";"
    obj_connect.Execute(str_SQL)
End Sub

Sub sendEmail()
    Dim str_message
    str_message = constructMessage()
    Dim obj_sendMail
    Set obj_sendMail = CreateObject("CDONTS.NewMail")
    With obj_sendMail
        .From = Application("email")
        .To = str_email
        .Subject = "Registration Information"
        .Body = str_message
        .Send
    End With
    Set obj_sendMail = Nothing
    Response.Write("<br><b>An e-mail has been sent to <i>" & str_email &
"</i><br></b>"
End Sub

Function constructMessage()
    Dim str_temp
    If str_userType = "teacher" Then
        str_temp = "Dear " & str_first & ", " & str_last & "," & chr(13) & chr(10) & _"Thank you for registering with EMET. At EMET, we are
        committed to ensuring your privacy and are continually " & _"improving our web site
to fit your needs. Therefore, your participation and feedback is important to us. " &
        chr(13) & chr(10) & _"Here is your username and password to login to EMET," &
        chr(13) & chr(10) & _"username: " & str_username & "," & chr(13) & chr(10) & _"Password: " & str_password & "," & chr(13) & chr(10) & _"Class number:"
        & str_class & "," & chr(13) & chr(10) & _"Please store this information in a safe place." & chr(13) & chr(10) & _"Your
        registration is now active. You can login to EMET at http://emet.ou.edu/" & chr(13) & chr(10) & _"Regards," & chr(13) & chr(10) & _"EMET
        Webmaster" & chr(13) & chr(10) & _"- Integrating the world of education through e-
technology"
    End If
If str_userType = "user" Then
    str_temp = "Dear " & str_first & " " & str_last & "," & chr(13) & chr(10) & "]" & chr(13) & chr(10) & "]Thank you for registering with EMET. At EMET, we are committed to ensuring your privacy and are continually } & ]"improving our web site to fit your needs. Therefore, your participation and feedback is important to us. " & chr(13) & chr(10) & "]"Here is your username and password to login to EMET." & chr(13) & chr(10) & "]"Username: " & str_username & "]" & chr(13) & chr(10) & "]"Password: " & str_password & "]" & chr(13) & chr(10) & "]"Please store this information in a safe place." & chr(13) & chr(10) & "]"Your registration is now active. You can login to EMET at http://emet.ou.edu/" & chr(13) & chr(10) & "]"Regards," & chr(13) & chr(10) & "]"EMET Webmaster" & chr(13) & chr(10) & "]"- Integrating the world of education through e-technology"
    End If
    constructMessage = str_temp
End Function

Function isCorrect()
    isCorrect = True
    If str_first = "" Then
        Response.Write("Please provide a <font color=#FF0000><b>first name</b></font><br>
        isCorrect = False
        End If
    If str_last = "" Then
        Response.Write("Please provide a <font color=#FF0000><b>last name</b></font><br>
        isCorrect = False
        End If
    If str_occupation = "" Then
        Response.Write("Please select an <font color=#FF0000><b>occupation</b></font><br>
        isCorrect = False
        End If
    If str_email = "" Then
        Response.Write("Please provide a valid <font color=#FF0000><b>email address</b></font><br>
        isCorrect = False
        End If
    If str_username = "" Then
        Response.Write("Please provide a <font color=#FF0000><b$username</b></font><br>
        isCorrect = False
        End If
    If str_password = "" Then
        Response.Write("Please provide a <font color=#FF0000><b>password</b></font><br>
        isCorrect = False
        End If
End Function
Response.Write("Please provide a unique <font color=#FF0000><b>password</b></font>.<br>")
isCorrect = False
End If
If str_password <> str_passwordc Then
    Response.Write("Please verify your <font color=#FF0000><b>password</b></font>.<br>")
isCorrect = False
End If
If str_userType = "teacher" And str_class = "" Then
    Response.Write("Please provide a <font color=#FF0000><b>class number</b></font>.<br>")
isCorrect = False
End If
End Function
'**********************************************************************
'**********************************************************************
Sub printError()
    Response.Write("<b>There were errors with the information provided.</b><br>")
    Response.Write("An account was not created for you on the server.<br>")
    Response.Write("Please make sure to provide all necessary information.<br>")
    Response.Write("<a href="javascript:history.back()"">Please try again.</a>"
End Sub
'**********************************************************************
'**********************************************************************
Sub printFeedback()
    Response.Write("The following is the registration information you provided.<br>")
    Response.Write("Your user account is: <b>" & str_username & "<br></b>"
    If str_teacher <> "" Then
        Response.Write("Your teacher is: <b>" & str_teacher & "<br></b>"
    End If
    Response.Write("Your first name is: <b>" & str_first & "<br></b>"
    Response.Write("Your last name is: <b>" & str_last & "<br></b>"
    Response.Write("Your e-mail address is: <b>" & str_email & "<br></b>"
    Response.Write("Your occupation is: <b>" & str_occupation & "<br></b>"
    If str_userType = "teacher" Then
        Response.Write("Your class number is: <b>" & str_class & "<br></b>"
        Response.Write("Your school is: <b>" & str_school & "<br></b>"
        Response.Write("Your phone is: <b>" & str_phone & "<br></b>"
    End If
    Response.Write("Your address is: <b>" & str_address & "<br></b>"
    Response.Write("Your city is: <b>" & str_city & "<br></b>"
    Response.Write("Your state is: <b>" & str_state & "<br></b>"
End Sub
Response.Write("Your zipcode is: <b>" & str_zip & "</b><br>")
Response.Write("Your country is: <b>" & str_country & "</b><br>")
Response.Write("Your gender is: <b>" & str_gender & "</b><br>")
Response.Write("Your internet connection speed is: <b>" & str_speed & "</b><br>")
Response.Write("Your internet connection location is: <b>" & str_location & "</b><br>")
Response.Write("The above information has been saved on the EMET database.<br>")
Response.Write("<a href="../home.htm">Your account has been activated.</a><br>")
End Sub

Sub printErrorUser()
    Response.Write("There was an error with the registration.<br>")
    Response.Write("Another member is already using the username <b>" & str_username & "</b><br>")
    Response.Write("<a href="javascript:history.back()">Please try again.</a>"
End Sub

Sub printErrorTeacher()
    Response.Write("There was an error with the registration.<br>")
    Response.Write("Please provide a <b>valid username</b>.<br>")
    Response.Write("<a href="javascript:history.back()">Please try again.</a>"
End Sub

Sub printErrorClass()
    Response.Write("There was an error with the registration.<br>")
    Response.Write("No class number <b>" & str_class & "</b> exists.<br>")
    Response.Write("<a href="javascript:history.back()">Please try again.</a>"
End Sub

Sub printErrorTeacherClass()
    Response.Write("There was an error with the registration.<br>")
    Response.Write("Class number <b>" & str_class & "</b> is invalid.<br>")
    Response.Write("<a href="javascript:history.back()">Please re-enter the class number.</a>"
End Sub

%>