Design and Implementation of an Internet Portal for Basic Statics and Dynamics Courses

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Abstract

The Internet has revolutionized the way information and knowledge is shared and used. It is nowhere more evident than in e-based education systems. Online courses and web-based learning management systems are important breakthroughs for students and cost-conscious instructors and education institutions. With rapid technological changes and shifts in educational practices, the education system is challenged with providing increased educational opportunities and providing for lifelong learning. However the implementation of such systems has been difficult due in part to the lack of proper organization and administration by education institutions and student access to the useful programs. Web based learning essentially uses special capabilities of the Internet to deliver methods for learning to improve the way that engineering students can understand engineering principals. This paper discusses an innovative use of delivering course content for Static's and Dynamics over the Internet so that other instructors have access to the material and can be used in their own courses.

The project involved in developing a long term scalable system and a strong backbone which connects different kinds of resources and has an integrated system wherein any instructor can set up his own class, manage his own set of students and administer testing and evaluation methods. But unlike similar systems like WebCT or Blackboard, this system includes content so that the instructor does not have to develop problems and it is freely available to all institutions. The system has been used at University of Oklahoma (OU) where selected Dynamics and Static's engineering courses are taught using laptop computers (required at OU with wireless network connection), CD-ROMs, and the Internet. This project involves giving all instructors the opportunity to set up their own Internet class where students can go and view the lectures online, learn the course material and take home works and tests. Each class is independent of another class thereby giving different instructors at different places opportunity to use the system and manage their classes. All information related to instructors and students are stored in a database and are retrieved upon request of the user and dynamic web pages are created based upon such requests. Instructors use a common pool of questions in a database library to set up their home works and tests. The system then records and stores the information sent by users and grades the responses. Each instructor has administrative control over his class wherein he can add/delete students, manage student information, manage home works, quizzes and tests, set up points and view score reports and e-mail students. The system has security features where instructor can

access certain administrative pages while access to students is denied. The system is scalable and can handle a large number of students, instructors and courses.

Some of the benefits are instant access to all course material, quick feedback of homework and quizzes, access to course lectures, customized content pages and a viable alternative to traditional training. The idea is to develop tools that can be used most effectively to leverage the instructor's time and energy so that he can spend time doing things that add value to the learning process.

I. Introduction

The most promising feature of multimedia and network-based media is its ability to interactively display complex information or concepts in an accessible and easy-to-understand animated graphical form. One of the more difficult issues to deal within the engineering curriculum, especially at the introductory levels, is the process of abstraction of real and practical situations into mathematical models. The engineering curriculum is filled with analysis courses where the focus is invariably on the analysis of completely determined homework problems that represent some implied abstraction from reality (and for which a "unique" answer is available in the back of the book). Given the rapid development of technology, the curriculum is under continual compaction as new topics are added and older material is edged out to maintain a nominal 4-year program. One of the earliest casualties in this process has been the application of engineering principles to practical problems through the mechanism of realistic homework problems, homework and tutorial sessions, project labs, and the like. The result is having engineering graduates with impressive analytical skills, but with little or no understanding of how to apply these skills in an effective manner to solve problems. Multimedia and network based media technologies have the potential of providing a mean for dealing with these issues in a dynamic, provocative and likely cost-effective manner that not only will increase the effectiveness of the educational program but will also increase the quality of the resulting students [1, 2].

The main thrust of this work is to create a portal that will give instructors an opportunity to present engineering curriculum in an effective manner using multimedia and network-based technologies. However, electronic media has it own set of problems and difficulties. In addition to security issues, the design and implementation of such portal should be made in such a way that it gives the best results and is cost and time efficient as well as scalable and reliable. First, the structure and technology used to build the system needs to be considered. For example, if server-based CGI-Perl scripting is to be used, then the programming of the problem database, and online homework management will need to be developed. Second, a database system must be implemented to store all the instructor and student information and keep track of all data and user request. A system is required such that the Perl scripts, database information and the web pages can interact and web pages are be dynamically created based on user request. Foremost is the time and effort needed to develop and implement such electronic media system. Similar to authoring a textbook, the core material will take 1-2 years to develop. This involves conceptualizing and designing, constructing and coding, testing and implementing such system. The work should be divided into two phases, wherein the first phase involved developing the portal to work for a single instructor for a single course. Only one professor can use the portal and he can set up his class and assign homework's and quizzes and manage a single class. The

second phase involves creating architecture that is scalable and can work for multiple professors and multiple classes, so that each instructor can setup and manage the content for his or her class.

In order to create dynamic web pages based on user request, HTML pages can be created dynamically using coding and scripting. All information and data required is then stored and retrieved from a database. Next the weekly material, such as homework and quizzes is added to web pages in electronic form. This is not just simply scanning problems from existing notes or old tests, but constructing them from scratch using a drawing program. Other types of media can also be added to the web site, such as lectures and discussion groups. The lectures are digitized video of the actual class lecture and this process is not as simple as running them through a computer. A number of important factors must be met in order for a high quality video with useful content to be produced, which is outlined in later sections. Also, discussion groups using electronic bulletin boards are used to allow students, teaching assistants and instructors to post and answer questions during normal working hours and in the evenings. Finally, there is the need to have online quizzes and tests.

The primary purpose of this paper will focus on examining the design and implementation of the Internet portal and all the different types of electronic media used in the Static's and Dynamics course. All of the electronic media was accessed through the main course web page (Fig. 1), except the basic course theory and examples that were made available separately on the course CD-ROM. This paper will give the reader an overview of a typical online course used for students on and off the campus, without the option of a classroom, and traditional teaching methods.

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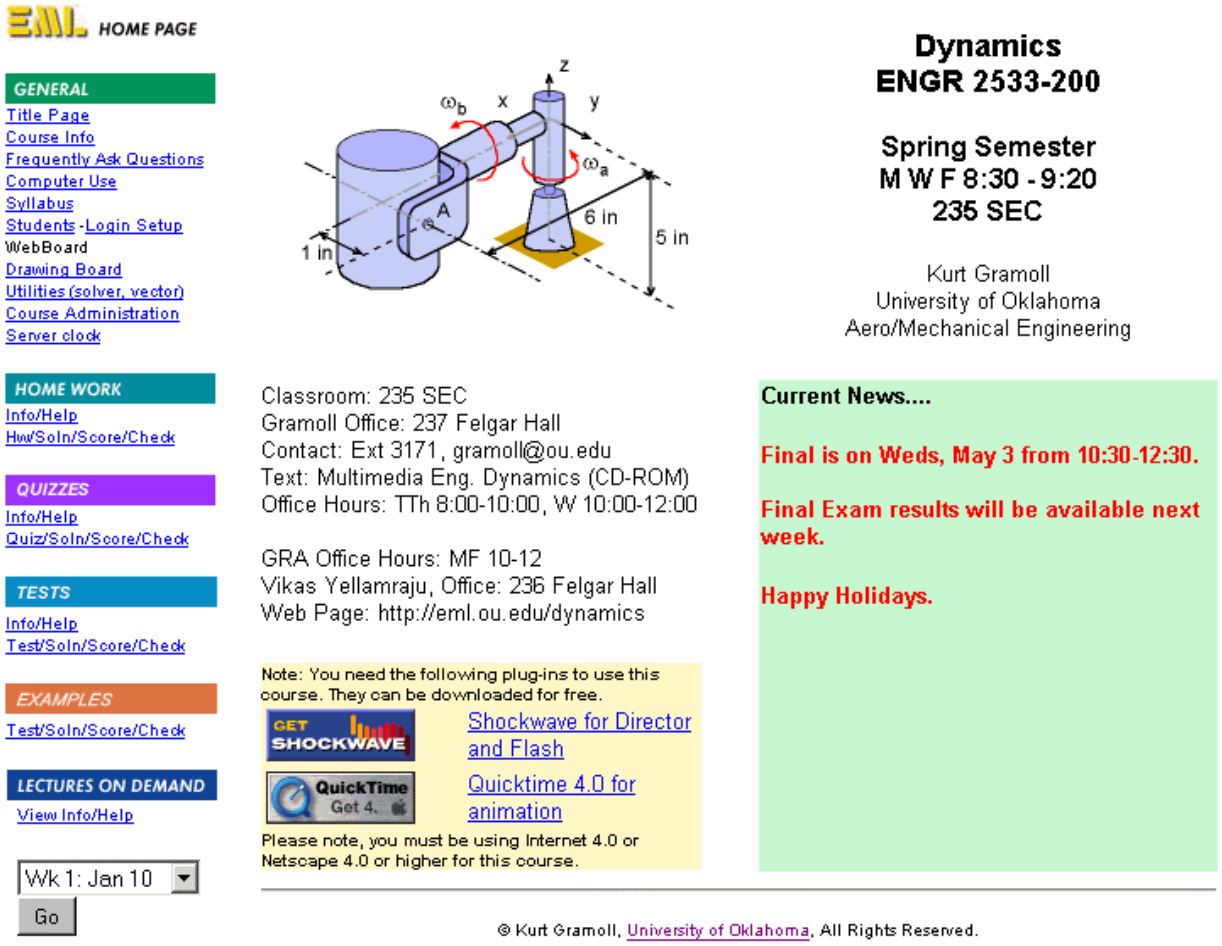

Fig. 1 Web Site main page

II Design of the Basic Portal Website

The basic design of the portal was designed so that any instructor can setup his own class for the courses in Statics and Dynamics. This portal has no installation requirements; no setup costs and required no problem generation. It is similar to a portal like e-mail service at Yahoo where one sets up an account through the Internet and then starts using it. The students of that particular instructor can then click on their instructor's link and be directed to the correct course web page. Each instructor can have his/her own students view the lectures online, access homework/quizzes at the designated time and submit the work through the Internet. In order for students to access the designated assignments they are required to enter their login name and password and only students of that particular class can access the assignments.

In order to create these web pages based on user request, Perl (Program Extraction and Report Language) was extensively used to deliver the web pages. HTML (Hyper Text Markup Language) code is the basic code for building web pages and this was embedded into Perl for creating the web pages. All data required to be displayed and processed is stored in a database. A

discussion regarding Perl, Access, SQL, Perl-DBI (database interface) is given below and is explained to give an overview of the server-based support system in developing this architecture.

CGI-Perl Scripting

In a complicated Internet-based framework, not only client-side interactivity is required, but also server-side programs are needed to allow the user to exchange data with the server. The entire on-line system took advantage of CGI (Common Gateway Interface) scripting which is a server-based means of transferring data between a server and a client. In this system, Perl programming language is used for the CGI scripts. Perl is an interpreted language mainly used for managing specified text files, taking information from the text files, and printing reports. Perl scripts allow the user to submit data via a homework, quiz, or test page to be processed on the server. The processed results are then posted through Perl scripts back to the client.

A complex backbone of Perl scripts allows the system to interact with the user and the system database. Perl can obtain data from HTML form pages, process the data, and then sends the results back to the user. The scripts are responsible for taking the information from HTML forms, store information into the database, retrieve information from the database using SQL commands and process it at the server and then display the new web pages back to the user. Perl scripts are responsible for the entire management of the database homework system from which the instructor chooses which problems to assign. For the portal, Perl scripts "dynamically" create the respective web pages. That is, Perl scripts actually construct and display the respective web pages through code rather than through links to existing HTML documents. This is valuable not only to ensure grade confidentiality, but also to protect the security of the upcoming homework and quizzes, as well as the integrity of the system as a whole.

Perl-DBI

DBI is the standard database interface for the Perl programming language. It is database independent and works with any database such as Oracle, Sybase, Informix, and Access etc. It provides a unified interface for accessing data stored within database systems and allows writing Perl code that accesses data without needing to worry about database or platform specific issues. Since Perl processes textual information, which is handled well by databases, Perl-DBI forms a good choice for database programming and accessing information.

SQL

Structure Query Language (SQL) allows users to access data in relational database management systems, such as Oracle, Sybase, Informix, Microsoft SQL Server, Microsoft Access. SQL statements are used to perform tasks such as add or update data on a database, retrieve data from a database, allow users to define the data and manipulate it.

ODBC

Open Data Base Connectivity (ODBC) is an Application Programming Interface (API) that allows abstracting a program from a database. When writing code to interact with a database, one usually has to add code that talks to a particular database using a proprietary language. If one wants a program to talk to an Access or Oracle databases one has to code the program with different database languages. This can be a daunting task. ODBC relieves this problem by connecting the code with the database. The ODBC Manager figures out how to contend with the

type of database that is being targeted. Regardless of the database type being used, all of the calls are to the ODBC API. Since the portal uses a Microsoft Access database, Perl extension module Win32::ODBC is used to access the ODBC API in this portal.

As described previously, each instructor has a unique link that enables their students to view their class. As shown in Fig. 2 and Fig. 3, students select the course they are enrolled and click onto the instructor's name to go to their class page. In order for a professor to create his own class, he is required to sign up and setup his class. Using the setup form as shown in Fig. 4, the instructor enters all relevant information and creates a class of his own. In order to have security and disallow anybody to setup, the instructor enters a key number provided by the system administrator. Proper security features are implemented to check the validity of the key number and people with invalid key numbers are disallowed to set up courses. The key number is actually stored in the database and is verified by the scripts when the new instructor enters information. This method prohibits students setting up their own class and viewing the problem database.

Fig. 2 Web page to select a particular course

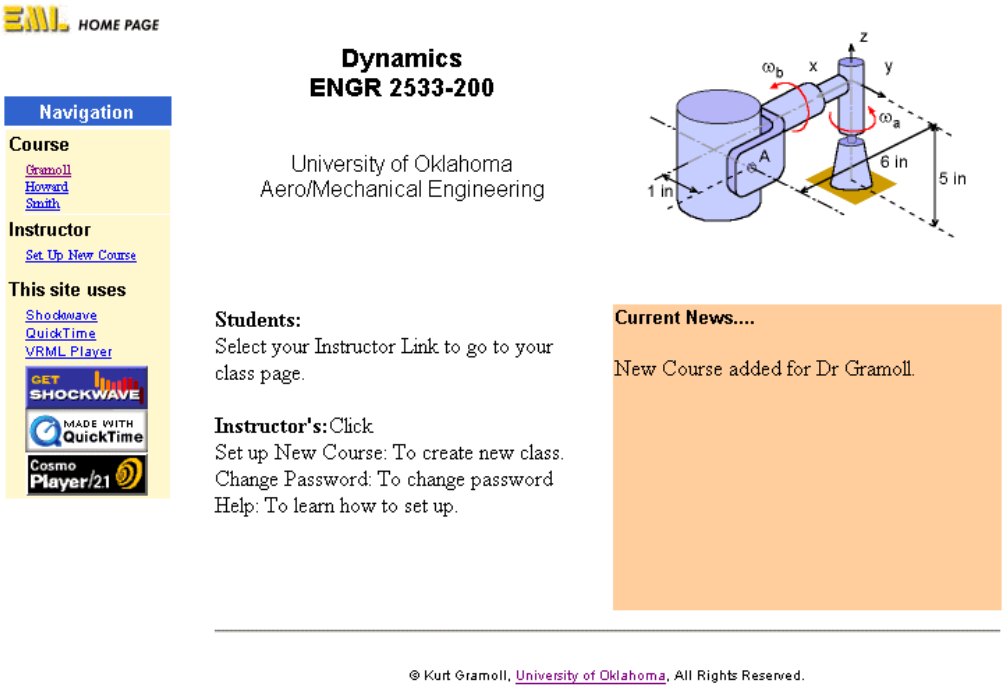

Fig. 3 Web page showing links to instructor's pages

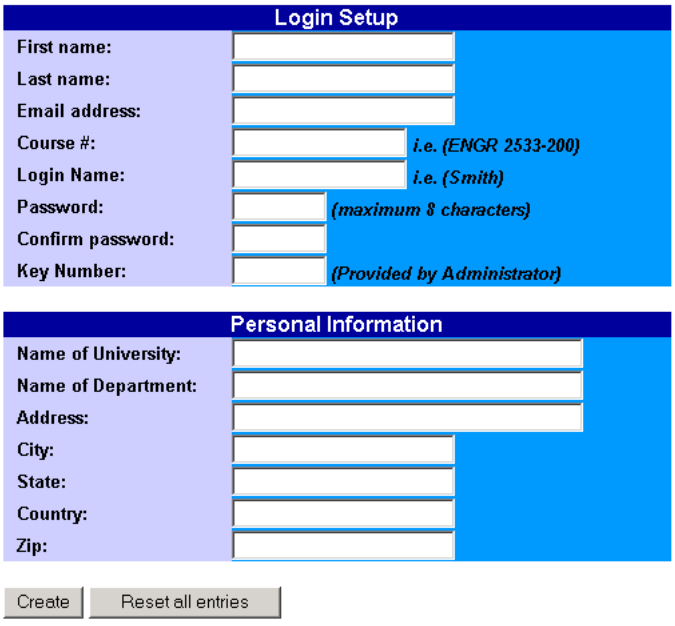

Fig. 4 Instructor Course Set-up page

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The portal system assigns a unique web number for each course to allow the system to track all the activities. The course name and the course web number form the key data for navigating through the web pages for the students. Based on the course name and web number all information related to only that class is retrieved from the database. Since each instructor has a unique web number, multiple courses for the same instructor can also be created and managed in the system. Since the web number and course name are passed as variables, proper security features have been implemented so that system cannot be hacked and improper use of these variables is denied. Scripts were written to deny access to pages when certain combinations of variables are entered. In order to avoid people accessing pages and information, the web numbers are randomly generated and security features implemented to deny access to pages when these parameters are entered at the URL prompt.

Once the students are at their class web page, they have access to homework's/quizzes/tests, online lectures, online web discussion and various utility tools. Since each class is independent of other classes, the students have problems assigned by their instructor for homework and tests. All courses have access to the same online lectures that are QuickTime based. A detailed discussion about online lectures and discussion groups is explained later in the paper.

III. CD-Based Courseware

Although the web site has homework's, quizzes, tests, syllabus, utilities, and lectures-on-demand, the students still need core theory and examples. For this course, the theory, examples and simulations are delivered to the student on a CD-ROM that was developed previously by the author [3, 4]. The CD-ROM, which is presented in a case study approach, contains all relevant theory for Statics and Dynamics courses. Each major topic is introduced through the use of a typical engineering problem. Each case is fully worked out and supported by the appropriate theory. Case-based learning has a number of benefits, such as the ability to hold a student's attention and provide an application for abstract fundamental concepts [5].

The CD-ROM contains topics in the form of cases, each illustrating a specific concept that is required to be conveyed to the student. Each case or example is presented in four parts: Introduction, Theory, Solution, and Simulation. Each part incorporates graphics, audio components, animations, videos, and hypertext. The first part introduces a problem to the user. The second part presents specific concepts that are required to solve the problem (Fig. 5). The third part actually walks through the solution. The fourth part allows the student to experiment with a computer-generated simulation that explores the parameters of the problem. Reference materials for engineering courses are also accessible through the appendices.

Due to the large amount of material on the CD-ROM, it was not possible to place it on the web because the download times for the animations are too large. However, by making the main course content available on the CD, the students are able to access the course material even if they were not connected to the Internet. The CD served the same purpose in the course as a textbook in a traditional classroom oriented course in that it presented the main source of theory and examples. The purpose of the course lectures was not to simply show CD content, but to explain the concepts from a different viewpoint. This allowed the students to have another perspective on the theory and problem solving process.

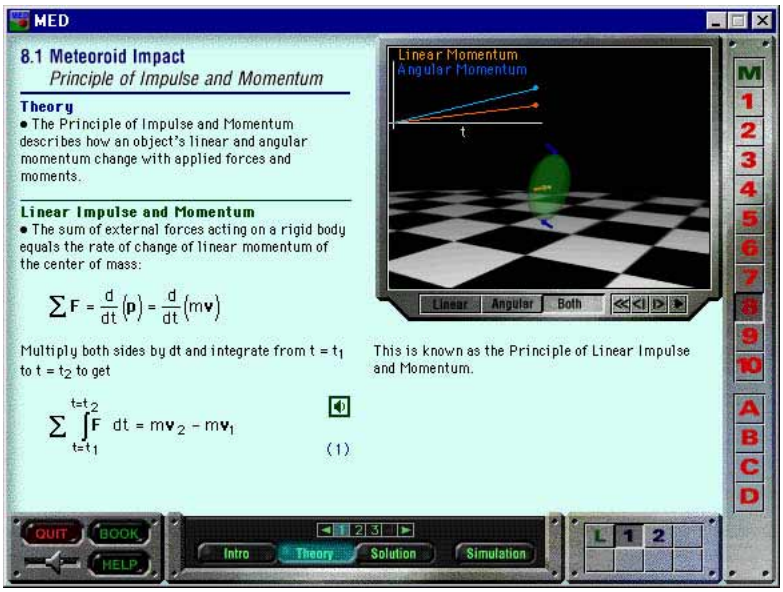

Fig. 5 Typical theory page from the Dynamics CD-ROM

IV. Online Course Management

An important benefit in the use of electronic media for a course is convenient access to course materials from a CD and to problems and solutions over the Internet. The instructors can select questions from a database of questions and assign them over the web, which reduces the time to setup a class and quickens the access to material to an unlimited number of students. The portal allows both the instructor and teaching assistants to have virtual office hours to monitor student questions. In addition to the course content being delivered electronically via a CD-ROM, the homework and quizzes were designed and delivered in an electronic format over the Internet. The web-based testing system was implemented wherein all the answers submitted by students are automatically graded and results are immediately available.

In order to make questions available in electronic format the system required all questions to be either 'fill-in-the-blank' or multiple-choice. Traditionally, partial credit is given to students in engineering courses due to the difficulty in solving problems and frequency of simple errors such as algebra and sign errors. Even though partial credit is not possible with fill-in-the-blank or multiple-choice questions, an instructor can minimize the effects of its absence by asking more questions and directing each question to deal with only a single concept or step. In order to do so, the instructor is then burdened to develop new homework, quizzes and tests that fit such a style. However, this process does allow for better monitoring of problems developed using multiple-choice questions. The system developed still allowed giving partial credit by deducting partial points even if the student answered the question wrong. This model also correlates with the various testing methods used outside the university, such as the professional engineering exams.

Problem Generation

To allow the instructor to assign problems to students over the web, a database of web-based questions pertaining to that course was required. These problems needed to be generated in the form of GIF images in order for them to be easily loaded onto the web page. Each problem had to be developed and constructed in electronic form. This involved a regimented process of deriving a question, creating diagrams, transferring the problem and solution to HTML format, and adding various system manipulations. The problem also had to be original in order to avoid copyright infringements with current textbooks. The respective problem and solution were then developed in electronic form so that it could be posted on the web after the test or assignment was completed.

Initially, all problems were fill-in the blank but this required manual grading which eliminated some of the advantages of an online course since the students could not get immediate feedback and increased the instructor's time devoted to the course. The decision to use only multiple-choice increased the initial developing time for the problems, but made grading easier. It also paved the way for automated problem generation and grading. Wrong solutions were developed to closely match possible mistakes that the students would make. However, the correct answer was always one of the choices listed, so that the student had the opportunity to work toward the correct answer. Over the course of three semesters, over 400 problems were electronically developed with the intent of being web-based.

For developing the problems, all diagrams were drawn using Macromedia Freehand and then saved as GIF files for posting to the web site. The graphics were generally simplified when compared to typical textbook graphics due to the reduced 'dots-per-inch' resolution of the computer screen as compared to print media. However, the difference had little effect on the understanding of the problem.

Course Administrator Management

In order for the Instructor to manage his class, add students, manage their scores and assign homework's and quizzes, an additional framework of web pages was created. Access to those pages is restricted to the instructor only. Once inside the administration section of the web site (Fig 6) the instructor has the ability to add students to the course, edit their information, manage their scores and delete students. Other features incorporated are a score report in spreadsheet-form of the class performance of all assignments and log information on all students that give details of student's access to various pages of homework's/quizzes/tests.

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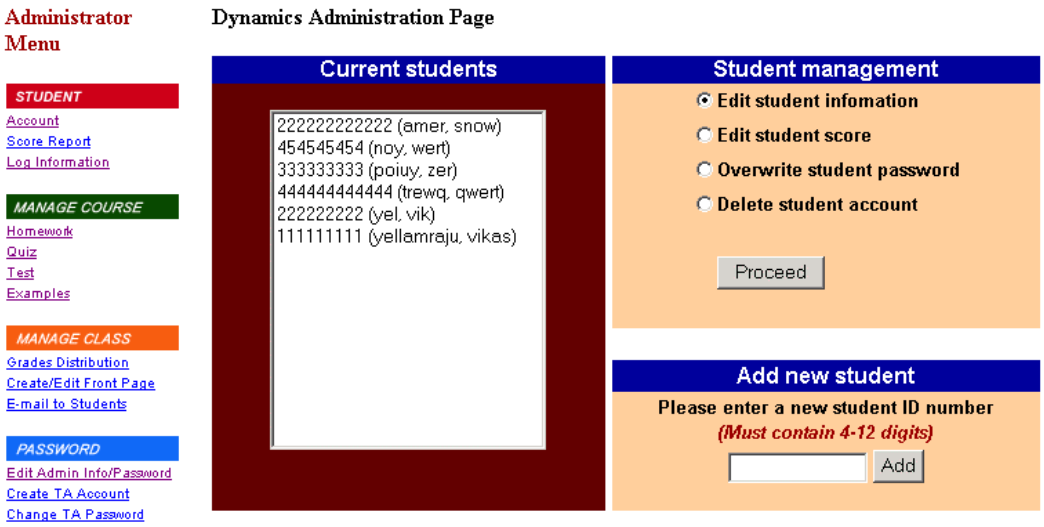

Fig. 6 Course Instructor's Administration page

A key feature to this portal is the homework management system. This feature allows instructor to choose problems from a database of questions through a web page. The instructor can choose from a database of over 400 problems for homework sets (Fig. 7). All the information related to assigning the problem, choosing problems, locations of the problem are stored in the database. Once a particular problem is chosen for an assignment, the system remembers the allocation of the problem to a particular set of homework and it cannot be re-used again for that class by the same instructor. Another useful feature is the ability to set the date and time for a particular homework to be released. Based on these times, the homework problems, solutions, grades and submission details are released. Other features of homework management system include homework set editing, viewing of homework solutions, score distributions, editing homework schedules, renaming specific homework sets, viewing the entire homework database and deleting homework sets. The same features are applicable and useable while setting up quizzes, tests and examples.

Other features of the course instructor's management site include the ability to view and edit instructor's information, assign/edit teaching assistant's login and password and edit instructor's login and password too. The instructor can also set grade percentages and percentage distribution weight for homework's, quizzes and tests. Also it gives a choice to drop the lowest scored homework's and quizzes for the students. Finally the site gives a facility to e-mail all the students in the class. All e-mails entered by students of the particular class are retrieved from the database and are displayed on the web page and the instructor can then add the text and send all the students an e-mail.

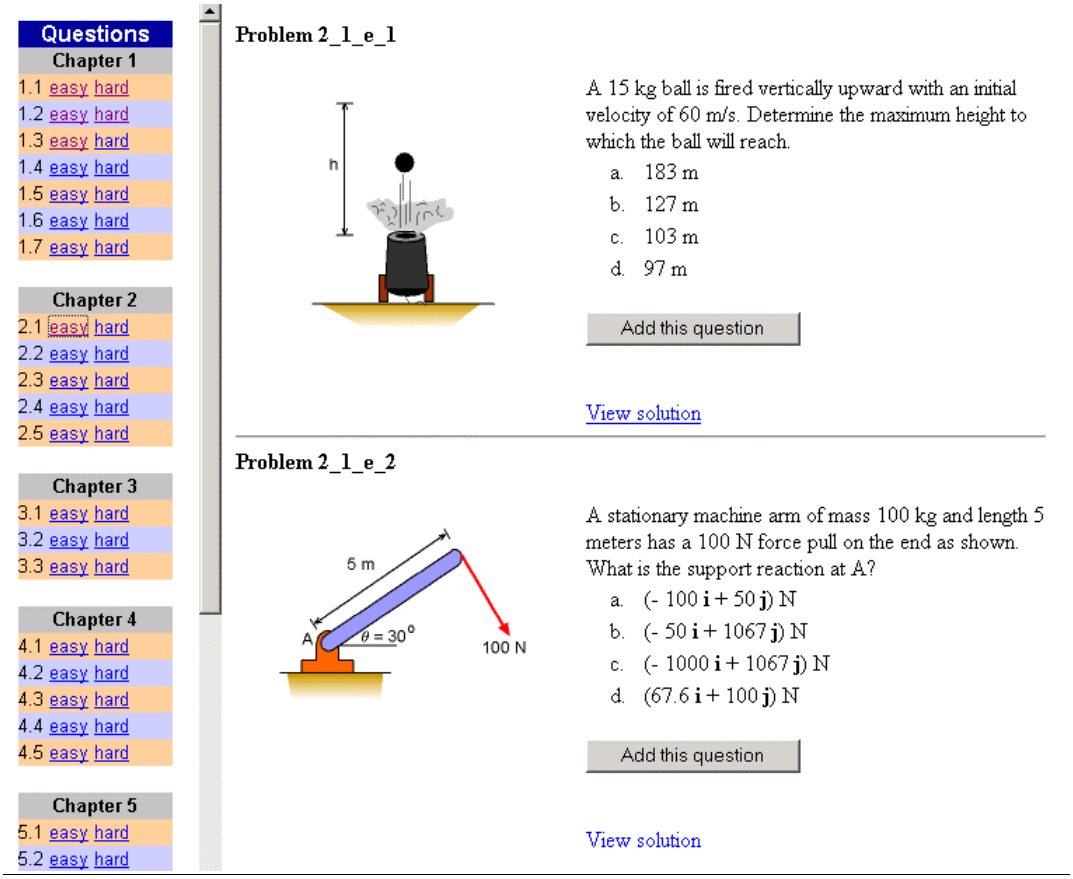

Fig. 7 Web page for selecting problems from the database

Homework/Quizzes/Tests Management

All homework's/quizzes/tests are assigned, completed, turned-in, graded, and returned through the Internet. Since everything is web based, students receive access to the assignments through the Internet and they submit all the questions online. This system enables students to take the homework's and tests from any location. For students to be able to access the web pages, they must be enrolled or registered for the class. Unless the instructor has given permission (by adding the student to the class), the student doesn't have the authority to enter his information to the system. Once the student receives permission to login in, they need to enter their names, email address and password (Fig.8). The students can later change their passwords and view their overall scores in all assignments and tests.

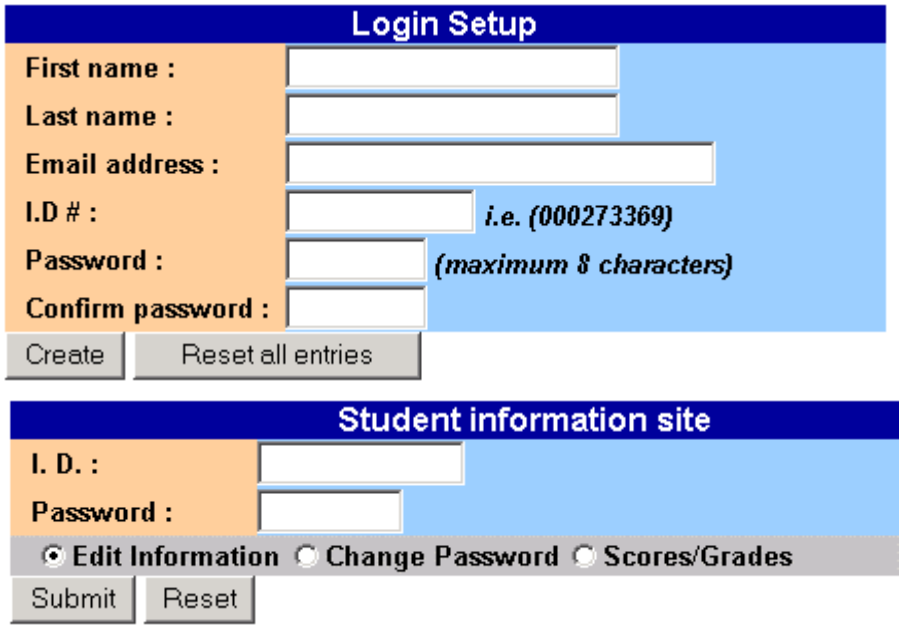

Fig. 8 Student's login and edit information pages

In order for a student to view a particular assignment, they enter their I.D number and password. Based on the assignment number and the release dates of these assignments, web pages for that particular assignment are released. In order to provide maximum security regarding the directory paths for the GIF image used in the problems, duplicate copies of the original images from the database are copied into a folder created for each instructor. The GIF images are copied from one folder to another and are renamed such that the actual name of the GIF images is not released for general viewing. Since the names of the images are randomly generated and the actual name and path of the actual images are never revealed, it is difficult for anyone to actually get direct access to original set of questions in the database. All information related to the name of the actual images including the encrypted images name is stored in the Access database.

Each problem includes a picture, problem statement, and four multiple-choice answers. Only one set of GIF images is copied into instructor's folder to avoid duplication of images. When the homework is completed and the student submits the answers through the Internet, the time and date of the submission are also recorded. All choices entered by students are stored in the database and if the student desires to resubmit after an earlier submission, then the system brings back their old choices and gives them an opportunity to re-submit. Through the use of scripts, the students can check their submission and grades. The choices entered by students are compared with actual right choices and based on the points to be deducted per question for wrong answers, the students are graded for the particular assignment.

The system automatically grades and posts the results of the assignment. The student can then view the results of completed assignment after the due date. The solution posted on the web has the problem information, a solution graphic, and the solution procedure with the answer. The system also performs an analysis of performance of all students for a particular assignment and automatically creates a histogram of student scores for that assignment. Figure 9 gives a view of

a particular student scores for an assignment and the histogram of all the students' scores for that assignment.

Submission for Homework 7

The graded homework:
ID no = 111111111

1 : c
2 : b
3 : a
4 : a
5 : a
6 : b
7 : b
8 : a
9 : c -8 Correct answer is a.
10 : d

Homework submitted on 10/15/2000 at 9:48pm.

Notes:
The total score for this Homework is 92.

Class Score Distribution For Homework 7

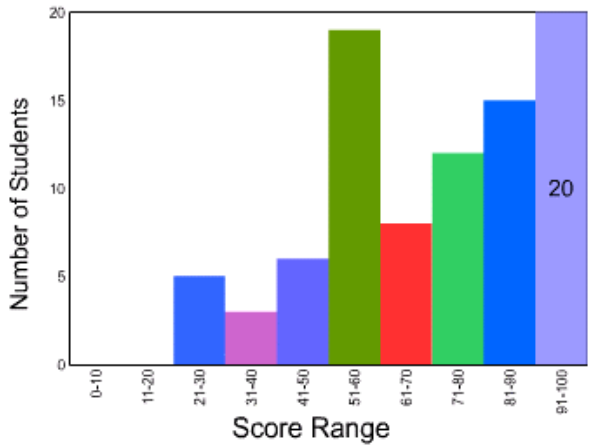

Fig. 9 A typical students grade page

The students generally appreciated the web-based homework solution because it allowed them to view older homework's and study for tests and quizzes without having to contact the instructor or visit a physical bulletin board for posted answers.

V. Discussions Online

Since most students were not in the physical classroom for an online course, it is important to have an online discussion method where students can ask questions and get a response. Several solutions have been considered, such as email, Internet news groups or web server-based bulletin boards. The email option had a deficiency similar to normal office hours, in that the same

question would probably be answered numerous times. With news groups or bulletin boards, the question is answered once and then all others can view it, thus saving time for both the students and professor. For this system, a commercial program called Web Board (distributed by O'Reilly Publ.) was used for the discussion groups for a number of reasons.

One of the main reasons for using Web Board is its ability to upload and view graphics. This allowed each student to modify a problem diagram (obtained from the web homework) and then post it with his or her question. The web board concept, while not new, is an extremely important component to the online courses. With the web board, questions and discussions can be done similar to the interaction that takes place in a normal classroom. In some respects, the web board discussions allowed more students to participate in asking questions since there is no time limit or peer pressure not to ask questions. It also allows students to ask questions when the questions arose, irrespective of time. Over the course of many semesters, it was found that the time saved from students not coming to the office during hours (there were still official office hours) was offset by the time spent on the web board answering questions. However, less time was spent answering the same question numerous times since others could view the questions and answers. The end result was three to four times as many questions were answered.

VI. On-Demand-Lectures

One of the disadvantages of online teaching is the lack of participation in the classroom. This can be partially overcome with the use of streaming video over the Internet of all class lectures and with online discussion groups that was discussed previously. This gives all students the same information that was discussed and presented in the classroom, including student questions and answers. Furthermore, online students can still interact through the use of email questions that can be answered and discussed in the next classroom meeting [6].

Convenience is probably the most important reason for allowing students to view the lectures online. Internet-based streaming video is delivered directly to the students' laptop computers at any time or location. The student can repeat the lecture if there is concept that they did not understand. This feature is more important than originally thought, because the freedom to repeat a lecture became the main reason why students like the online course.

Video Streaming

The ability to view video over the Internet has improved tremendously over the last couple of years through the concept of streaming video. Basically, the user can view the first minutes of the video while the latter parts are still downloading which saves the student time. Various video recording and video compression techniques were tested and developed for this course, including QuickTime, NetShow (now ActiveMovie), Vivo and Real Player. It was determined that QuickTime retained most of the desired advantages, and also allowed user control of the play back location and allowed post-compression editing. QuickTime also streamlined the processing steps for compression.

Teaching Style for Online Lectures

It is wrong to assume that any course can be simply video taped and then converted to streaming video. There are a number of critical issues that need to be addressed in the teaching style to maximize the benefit of the Internet-based video. First, students need to have concepts introduced, taught and summarized into 10 to 15 min. segments. To maximize the compression, it is important to minimize the change in motion on the screen, thus the instructor should minimize walking around and learn to write within a preset area of the chalk or white board. Finally, the writing style needs to be neat and clear. The video will be able to record normal size writing but sloppy diagrams, text on top of other text, and cursive text will not be readable on the video.

VII. Student Response

The student responded favorably to the online course. Throughout the semester, the students took surveys for both the learning experience and the use of technology in teaching. In general, the students felt that they had a good educational experience. However, they did not feel that they had learned more material as compared to a traditionally taught course. They strongly agreed that the technology allowed then to maintain the course based on their own schedules and convenience. They enjoyed the element of flexibility, which was derived from the freedom to attend the class anywhere on campus that was added to their schedules.

The tests and homework were judged to be lengthy and hard, which is consistent to classroom type class. The class size of each course per semester allowed the author to quickly solve any problems that developed due to the use of technology. Some of the early problems included, installation problems of the CD-ROMs (correct version of QuickTime needed), wireless network connection, and variations of Internet browsers.

The students also gave high marks in the survey for taking advantage of technology in the classroom. Since all the students had laptop computers, they were eager and even appreciative to have the chance to finally use them for a complete course. The students did make several useful comments about the technology, such as suggesting sliders on the videos and requesting simple web-based utilities. Both of these comments were implemented for later classes.

VIII. Summary

Over a number of semesters, both Statics and Dynamics was taught using only electronic media by the author at the University of Oklahoma in the School of Aerospace and Mechanical Engineering. The electronic media included a courseware CD-ROM for the main content, lectures over the Internet, homework assigned and submitted online, web boards for group discussions, online quizzes and a general web site for course information. Multiple professors for multiple classes can use the web portal developed for the courses. Each class is independent of each other. All information is stored in an Access database. Based on user request, Perl scripts process information between the user and the server and dynamically create web pages. Security features are implemented in the system to prohibit students accessing the problem database. Although a printed textbook is not required for the course, students were able to learn the material as effectively as compared with traditional teaching method using print media. The

student comments consistently praised the new teaching method and enjoyed the elements of freedom and flexibility. The main complaint from students was the testing method of multiple-choice questions and the pressure to complete the test in set time period.

Since the course was delivered over the Internet at the University of Oklahoma, all students had laptop computers and were connected to the network through wireless network cards that attached to their computers. The wireless connections allowed all lectures to be broadcast over the Internet and minimized the need for the student to attend the actual class. Through experimentation it was found that QuickTime delivered the best quality video, for streaming video lectures with the smallest bandwidth. The system has been case tested only at the University of Oklahoma but the use and application of multiple professors still hasn't been implemented.

From the administrator's point of view, the portal took a large amount of time to develop the electronic homework problems and quizzes. In addition, a server-based grading system and online testing routines involved a substantial time commitment over the last several years. However the benefits of the online homework management system can be experienced from the start of the course. For just one or two classes, the time spent cannot be justified, but the time and effort can be justified if the system is implemented for multiple courses over a number of years. The end goal was to create an e-course curriculum with a set of multiple electronic courses that can offer online or in-class to help address the scheduling and learning needs of the student.

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Biography

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