AN INTERNET PORTAL FOR STATICS AND DYNAMICS ENGINEERING COURSES

Kurt Gramoll[1]

Abstract - A scalable Internet portal to assist teaching statics and dynamics is presented (www.ecourses.ou.edu). Each instructor can set up their own Internet class where students can view lectures, review course material, complete homework, access examples, post questions and complete tests. Each class is independent of other classes so that instructors can use the system and manage multiple classes. All information related to instructors and students are stored in a database on a web server. Instructors use a common pool of questions in a web-based database library to set up homework 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/his can add/delete students, manage student information, manage home works, quizzes and tests, set up points and view score reports and email students. Benefits include instant access to all course materials, quick feedback of homework and quizzes, access to course lectures, customized content pages and usable with large classes. The system has been successful used at University of Oklahoma for over three years.

Index Terms – Dynamics, Internet, Portal, Statics, Web

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. 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. Second, a database system must be implemented to store all the instructor and student information and keep track of all data and user request. Third, course content and problems need to be developed for web access. Fourth, the system's database information and web pages need to interact so web pages are be dynamically created based on user request. Finally, the system architecture needs to be scalable so that multiple professors can use the system and manage only their classes without interfering with other classes.

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.

WEBSITE AND INTERNET TECHNOLOGY

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

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[1] Kurt Gramoll, University of Oklahoma, Aerospace and Mechanical Engineering, Norman, OK 73019 gramoll@ou.edu

sets up an account through the Internet and then starts using it. A typical student or instructor would first go to the main page (Fig. 1) and choose the type of course they wish to set up or participate in. Within the course type, the instructor can set up a class or a student can click on their class to begin the class (Fig. 2). 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.

Fig. 1 Web page to select a particular course

In order to create dynamic web pages based on user requests, various Internet technologies were used including Perl (Program Extraction and Report Language) HTML, Access, SQL, Perl-DBI (database interface), Macromedia Multi-user Server, Director Shockwave, QuickTime, and multimedia software tools.

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 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.
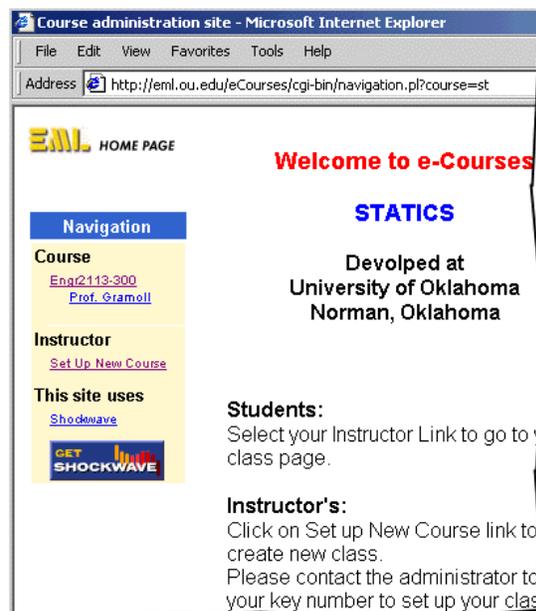

Fig. 2 Web page showing links to instructor's pages

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.

SETTING UP CLASSES OVER THE WEB

It is not practical to install the course system at each institution that would like to use the courseware. Thus, the system has been designed so that any instructor can set up a class over the web through a browser. The instructor is required to obtain a unique registration key from the author before the class can be set up. This is so that students cannot set up classes themselves and view the database of problems. There is no cost in obtaining a registration key number. Using the setup form as shown in Fig. 3, the instructor enters all relevant information and creates a class of his own. After the class is setup, each instructor will have a unique link that enables their students to view their class (Fig. 2).

Fig. 3 Instructor Course Set-up page

The portal system assigns a unique web number for each class so that the system can track all 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.

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 classes 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.

ONLINE COURSE MATERIAL

Not only does the web site portal have homework sets, quizzes, tests, syllabus, utilities, and lectures-on-demand, but all course material is also web based. The content is similar in scope to a textbook, but uses multimedia to help explain concepts. The material is presented in a case study approach and 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].

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. 4). 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. The web-based course material served the same purpose in the course as a textbook in a traditional classroom oriented course and was the main source of theory and examples.
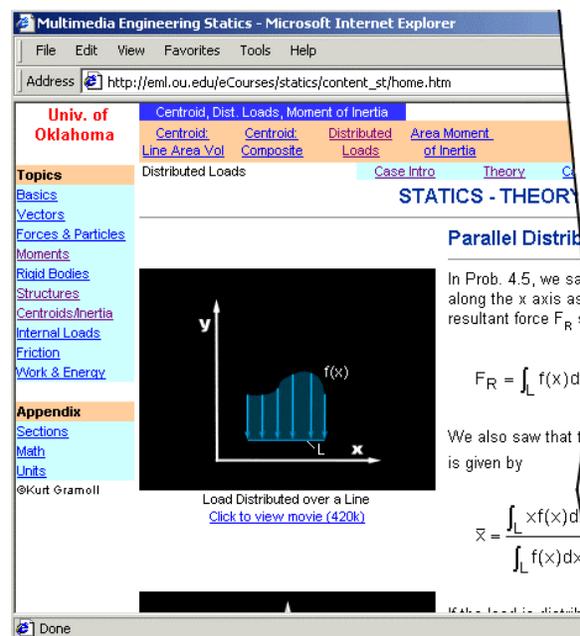

Fig. 4 Typical theory page from the statics content

ONLINE COURSE MANAGEMENT

An important benefit of electronic media for a course is convenient access to course materials over the Internet for both the student and the instructor. 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, 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 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 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. 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 the course was required. The problem questions were based on HTML code, but the figures were stored as GIF images. The solution graphics were also developed as GIF images. 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. In the course of three semesters, over 400 problems have been electronically developed for both the statics and dynamics courses.

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. 5) 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.
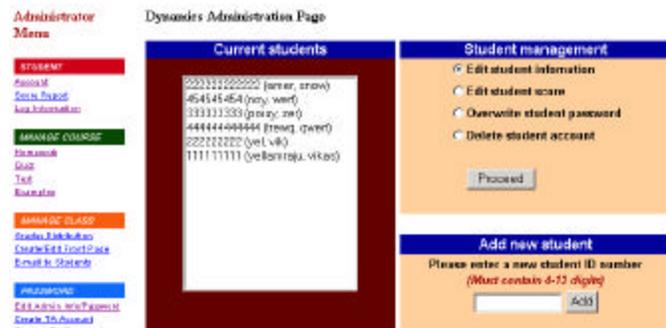

Fig. 5 Course Instructor's Administration page

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. 6). 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. The date and time for a particular homework to be released can also be set. 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.
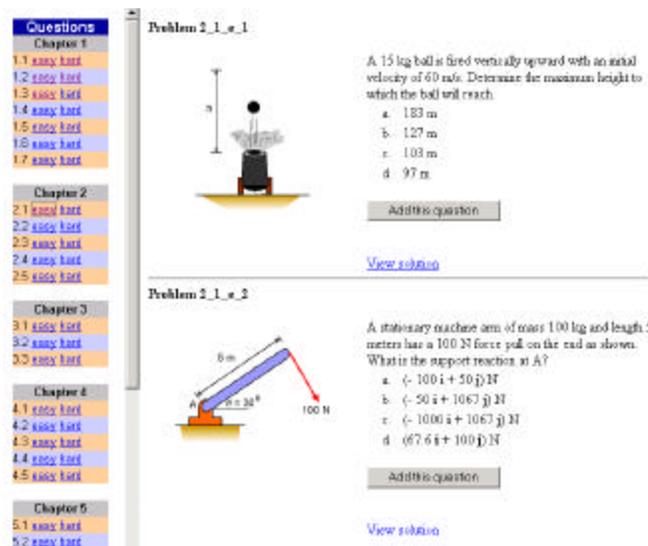

Fig. 6 Web page for selecting problems from the database

Other features of the management system 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.

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. The students can later change their passwords and view their overall scores in all assignments and tests.

For a student to view a particular assignment, they enter their ID number and password. Based on the assignment number and the release dates of these assignments, web pages for that particular assignment are released. 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 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. 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.

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 irrespective of time. It was determined that less time was spent answering the same question numerous times since others could view the questions and answers.

ON-DEMAND-LECTURES

To further assist students that cannot attend class, all classroom lectures have been indexed and placed on the Internet. 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.

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.

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.

STUDENT RESPONSE

The student responded favorably to the online course. Throughout all semesters, 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 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.

SUMMARY

Over last four 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 course 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.

The system has now been opened for other instructors to use regardless of their location. All class management is done through the Internet and each class is independent of each other. Security features have been implemented in the system to prohibit students accessing the problem database. Although a printed textbook is not required for the course, students are 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.

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