

Design and Implementation of Web-based Multimedia Techniques for Construction Education*

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This paper describes the development of a novel tool for the enhancement of undergraduate technology-oriented education. This tool takes the form of an interactive, animated, multimedia web-based textbook, which provides the primary source of reference for an undergraduate senior-level construction course. The intent is to integrate emerging computer technologies such as CD-ROM-based knowledge management, computer visualization, web technology and computer simulation/gaming, to provide a rich learning environment. The multimedia web-based textbook facilitates self-study (for distance learning) at a location, time and pace suited to the user. The tools and utilities provided will, however, also be applicable to, and enhance learning in a traditional classroom environment.

INTRODUCTION

THE CONSTRUCTION INDUSTRY, as with other branches of manufacturing, is becoming increasingly complex and technologically sophisticated. The change has been dramatic in recent years and is likely to continue to increase due to rapid developments in, for example, the information technologies, materials science, and computer-based modeling tools. The problem has been made even more critical by increased performance expectations (such as lower maintenance costs and reduced environmental impact) from both the sponsors of construction and society.

To remain competitive, engineering students need to assimilate an ever broader and deeper base of knowledge about the industry. In response to this need, there has been an expansion in the curricula of engineering programs to meet ABET 2000 criteria [1]. Corresponding to this increase in the volume and technological complexity of information, there is a growing need to attract and retain students of high academic standards in all engineering disciplines [2, 3].

This paper describes the design, development and implementation of a multimedia web-based textbook for a senior-level construction course. It describes the course selected as a proof of concept to utilizing multimedia web-based technology in civil engineering education. Then it presents an overview of the developed multimedia web-based textbook and its main features. Next, it demonstrates the implementation and evaluation steps that are followed to ensure both the quality of the knowledge base and the flexibility of the user

interface. Finally, it concludes by highlighting the key contributions of this research to enhancing students' motivation, understanding and learning skills, and future extensions.

APPLICATION AREA

For students of architectural and engineering design (including structural, mechanical and electrical systems design), courses in construction focus on the configuration of the components that comprise a building. That is, a building is viewed as an essentially static entity, with limited consideration given to understanding the dynamic processes involved in its assembly. As a consequence, architectural and engineering design students often fail to understand the impact of their decisions on the *constructibility* of the project (the ease with which it can be built). Many of their decisions require the adoption of inefficient construction methods that protract construction time and incur excessive costs.

On the other hand, construction students, unlike those of architecture, often demonstrate a poor 3-dimensional spatial understanding of a building and its elements. All too often they are unable to visualize the form of a completed building and its components from a set of drawing and other design information. Their construction education focuses more on developing an understanding of the sequence of assembly (the temporal aspect of construction) through courses in construction methods and construction scheduling. Development of a spatial understanding of a building and its components is left largely to post-educational field experience. As a result, construction students

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are poorly prepared when it comes to solving problems such as:

- identifying interference or conflict in the space demand of components during assembly;
- designing construction systems (jigs, formwork, assembly tools, etc.) necessary for the manufacture and assembly of intricate components;
- planning construction processes that make efficient use of limited site space.

Due to its large knowledge base, and the intrinsically dynamic and graphic nature of much of the information to be conveyed, an interdisciplinary course on construction methods was selected for the proof of concept of a multimedia-based textbook. Such an interdisciplinary course is common to architecture, construction, and engineering students, and integrates understanding of both the process (temporal) and product (spatial) aspects of building construction. An ability to both visualize a built facility (including its components) and understand its method of assembly, are fundamental to design and construction. Consequently, the resulting multimedia textbook provides a base for understanding dependent junior and senior level courses such as construction scheduling, cost analysis, productivity improvement and safety. It should embrace these additional topics in as far as they impact, and/or are impacted by, the construction process and building design. The end product would provide a model for the development of future multimedia applications emphasizing both design and technology to enhance engineering education [2].

The contents and materials from a Concrete Construction and Technology course (CE437), a senior undergraduate course in civil engineering, were selected to be converted into a web course. In this course, its organization is based on the construction project's lifecycle. Its design resembles the actual construction process to simplify the navigational process for the students. The course outline and objectives are as follows:

Advantages and limitations of concrete, types of cements and admixtures, batching equipment, types of mixers, ready-mixed concrete, pumping equipment, finishing concrete, hot weather concreting, formwork design, methods of curing, strength of concrete, destructive and nondestructive testing of concrete, durability, repair and maintenance of concrete.

There are many reasons for selecting this particular course for conversion into the web. Construction engineering involves physical resources of space, labor, and materials. Also construction projects consist of many elements and different documents. This course depends heavily on graphical examples and site visits. Most of the time, sites visits are not convenient to both students and teachers due to other commitments. Also, real site applications, including certain construction activities that are rarely carried out, might not be available during the time of the lectured materials. Adequate project research collaboration in construction

requires the interaction of students, the teacher, and the actual project staff through meetings and exchanged discussions. If such meetings were possible, then it would be few due to different time schedules of the involved parties. The use of multimedia and web tools could overcome the mentioned difficulties as follows:

- provides different media for the course materials mainly in graphical outputs;
- creates a discussion space (chat room) for meetings and exchange of views at more convenient time and location to the parties involved in the project;
- links the construction project elements and documents in a single database source;
- allows for repetitive access to class lectures, notes, and examples anytime and at different locations.

MULTIMEDIA WEB-BASED TEXTBOOK—OVERVIEW

Recent advances in computing technology have provided convenient and powerful tools for the interaction and visualization of information from large data sources [4, 5]. Through an appropriate CD-ROM or web-based technology it has been possible to provide a rich environment for the retrieval, visualization, interpretation, and querying of the knowledge base that comprises any technological discipline [6, 7]. Course instructors and students can use the system at home, in the office, and in the classroom/laboratory. Access is made available on instructor's and student's personal computers, and in the computer laboratory. Such a facility provides a much richer tool for instruction and reference than conventional textbooks and traditional classroom presentational media. Key features of the facility are as follows:

1. Presentation of animated diagrams and charts, audio, and video information, with related information viewed in concurrent windows.
2. Interaction between the user and the knowledge base—a user could control and direct the sequence of presentation of information, as well as ask questions.
3. Guided walkthroughs of user-selected topics, acting as a *Virtual Tutor* that takes the user through subject matter in a structured manner, but also answering questions and anticipating user questions and misunderstandings. The walkthrough may be formatted as a lecture, case study, or a tutorial session for solving any problem from a set of in-built examples. The user could progress at whatever pace desired, backtrack, and make lateral explorations of the knowledge base.
4. Random walkabouts exploring the knowledge base. This is analogous to flicking through the pages of a textbook but is supported by sophisticated query/keyword search

and cross-reference tools, as well as backtracking capabilities.

5. Interfacing to the Internet with distance learning and conferencing capabilities, allowing the establishment of a virtual classroom in which students and instructors can interact from remote locations, submit class assignments, and return graded material. Also, interfacing with the Internet allows direct reference to external supplementary sources of information through the World Wide Web, as well as greatly facilitates the education of people with physical disabilities [8].
6. A choice between in-depth, intermediate, and abridged presentations of information.
7. Assisted exam/test/assignment compilation for instructors, using pre-written (though customizable) questions a la carte, with automated production of model answers.
8. Assisted course and lecture compilation for instructors, with preassembled a la carte (though customizable) course structures and lectures.
9. Report generation facilities to enable a student to compile and output reports for class assignments, etc., calling on information generated during a session with the system.
10. Automated note taking, whereby the user could search information and demonstrations provided in the system, and collate the points of interest into a notebook for future reference or hardcopy output.
11. Student self-examination through interactive tests/examinations.
12. Simulation facilities allowing users to monitor and control the behavior of various processes operating under different conditions.
13. Gaming (role-playing) facilities operating in single and multiple-user environments. This allows users to interact with each other within simulated environments, and could be used as the basis for class exercises and/or class assignments.

Although virtual reality tools have computational demands beyond the capabilities of most current personal computers, the proposed system is structured to permit future inclusion of this technology. Virtual reality techniques would greatly enhance the simulation and gaming components of the system, enabling, for example, walkthroughs of buildings at various stages of construction.

IMPLEMENTATION AND EVALUATION

Software requirements

A plan was developed that would outline the technology requirements for the web-based course system. Technological resources are chosen to fit the curriculum, not vice-versa [9]. The identified requirements of the web-course determine the type of media to be included in the web system [10]. As

for determining the software requirements, certain issues were considered including: web-course objectives, training's cost and ease, and total development and maintenance cost. The software requirements might include:

- website development (e.g. *MS FrontPage*),
- graphics (e.g. *Adobe PhotoShop*),
- animation (e.g. *Animator Shop*),
- questionnaire and test design (e.g. *Infopoll Designer*),
- video (e.g. *Platypus Animator*), and
- optical character recognition (e.g. *Omini Page*).

Table 1 lists the software that was selected in developing the multimedia web-based course.

Designing multimedia web-based course

The design and development of a website for any course should include all necessary educational materials that the instructor intends to give to the students as well as those materials that the students should retrieve on their own from the library or external references. Having access to such materials on-line is not only a matter of convenience to students but also a matter of saving much of their effort and time. Such a web-based course provides an on-line interactive environment for students to obtain homework assignments and submit their solutions and for professors to grade homework and send results along with feedback to students. Several on-line course components and tools are considered in designing the course home page [10, 11]. The course website structure is demonstrated in Table 2, and is described in detail later.

Testing, operation and assessment







The end product is then tested for technical functionality on the website and simplicity of use to students. Whenever the system failed to carry out any of its functions, it was taken back to the design stage for further technical reviews and modifications.

The web-based course is incorporated into the teaching process and it has been evaluated by both teachers and students. Learner performance is assessed through quantitative indicators such as: grade scores (of exams, homework, projects) and

Table 1. Software requirements

Website development	<i>Microsoft FrontPage2000</i>
Graphics	<i>Adobe PhotoShop,</i> <i>Macromedia Fireworks,</i> <i>MS image composer</i>
Animation	<i>Animation Shop,</i> <i>Microsoft Gif Animator</i>
Questionnaire and test design	<i>Infopoll Designer</i>
Video	<i>Platypus Animator</i>
Optical character recognition (OCR)	<i>Omni Page</i>
Also Microsoft Word 2000 was used for: equation editing, scanning, and some graphic drawings.	

Table 2. Course website structure

Course Lectures: 	<ul style="list-style-type: none"> ▪ Text. ▪ Animation. ▪ Still pictures and graphs. ▪ Audio. ▪ Video.
Communication Tools: 	<ul style="list-style-type: none"> ▪ E-mail. ▪ Message board \ discussion (news) groups. ▪ Chat room. ▪ Comment and feedback forms. ▪ Announcements.
Administrative Tools: 	<ul style="list-style-type: none"> ▪ Course & lab syllabus. ▪ Class & lab schedules. ▪ Faculty information. ▪ FAQ. ▪ Exam scores.
Testing Tools: 	<ul style="list-style-type: none"> ▪ Quizzes and tests on-line. ▪ Student self-evaluation test. ▪ Questionnaires. ▪ Assignments.
References: 	<ul style="list-style-type: none"> ▪ Previous exams & assignments. ▪ University phone directory. ▪ Extra reading. ▪ Course glossary. ▪ Useful links. ▪ Files and software downloads.
Helping Tools: 	<ul style="list-style-type: none"> ▪ Search the course homepage. ▪ Search the WWW. ▪ Calculators. ▪ Plotting tools. ▪ Class mail list.

time of student engagement with the web-based course materials. Qualitative assessment is also carried out through a questionnaire (a sample questionnaire is provided in Table 3) on the website use in the learning process to students and teachers at the end of the course work. This qualitative assessment is also part of evaluating the learning environment for future improvements. Quantitative and qualitative indicators of students in the study program are then compared to similar indicators of students who did not take part in the program. Conclusions and recommendations are drawn based on the completion of the evaluation process.

Another type of evaluation is associated with web authoring and design. Considering the enormous amount of information available on-line, web users need some criteria to evaluate the reliability of web information. In this stage, this

kind of evaluation can be considered as designing criteria in website authoring, as provided in Table 4.

In this project, the evaluation process is still in progress. Initial evaluation results of 35 students are encouraging indicating that more than 88% of the students responded with agree or strongly agree to the general evaluation questions in Table 3, i.e. the website is very helpful to the course instruction, and the concept of WBI (web-based instruction) is a very effective instruction tool. Students reported convenience of accessing all course materials anytime and anywhere. Extra time and effort were devoted at the beginning of the semester getting acquainted with such a new environment of teaching for the first time compared to other traditionally taught courses. Once getting used to the web-based application, the students appreciate the time saving and the

excitement of receiving educational and practical knowledge in a variety of multimedia tools at their finger tips.

Currently, we are conducting further improvement and expansion of the course website mainly to make it more interesting, attractive and useful to the students. For example:

- animation and visualization of construction operations demonstrating the safe movement of construction equipment and labor on site;
- alternative efficient site layout options for a given project;
- simulation programs of earthmoving operations;
- walkthrough programs for site inspection and final testing;
- increasing the number of self-evaluation quizzes and assignments;
- expanding the knowledge base of the course material and enhancing the user interface allowing faster information access.

COURSE WEBSITE STRUCTURE

This section describes in detail the web course contents as listed earlier in Table 2.

Course notes

Perhaps the most important and difficult part of developing a web-based course is creating the on-line content which begins with translating the basic lecture materials to the web and integrating media such as sound, images and even video.

The lecture homepage (see Fig. 1) is divided into:

1. *Title*: Lecture number, chapter number, and subject.
2. *Lesson*: The main part of the page, which uses multimedia for illustration.
3. *Example*: Links for any examples illustrating the lesson (problem statement, given data, required items, solution steps).
4. *Pages references*: List of all information resources used to construct the lecture.
5. *Assignments*: Link for the lesson assignment and due date.
6. *Related Links and Extra Readings*.
7. *Help tools*: Link to calculator, unit converter, and list of tables needed for solving the example.

Communication tools

Computer-mediated communication (CMC) is communication accomplished through the use of computer and networking technologies among faculty and students. It can be person-to-person (such as e-mail) or among a group (for example, a 'listserv' or newsgroup). Although the quantity of interaction may not be as great as it is in a standard classroom, users of CMC often find that the quality of the correspondence is better and the rate of learning is higher [12].

CMC uses include:

- Students use e-mail to ask questions of faculty or teaching assistants at times other than class periods or office hours and even when faculty is away at professional meetings. Answers to frequently asked questions (FAQ) might be posted to a shared location.
- Faculty asks a critical question prior to class so students are better prepared for in-class discussion.
- Students share their papers, outlines, homework problems and project plans to receive feedback from other students.
- Posting important announcements.
- Creating groups and having group discussions on a specific topic.
- Posting lecture notes, sample exam questions, or study tips.
- Requiring discussion questions or homework to be turned in electronically.
- Having an on-line help desk supervised by the professor or teaching assistant.

Computer-mediated communication can be synchronous or asynchronous [13]. Synchronous communication is the exchange of messages among correspondents who are on-line at the same time. One form of synchronous communication is on-line text-based chat and conferencing. Educational uses include virtual office hours and small group meetings. On the other hand, asynchronous communication is the exchange of messages among correspondents who are not on-line at the same time. The most common forms include e-mail, newsgroups (Usenet), mailing list servers, group project collaboration and course discussion groups.

Whether the type of communication is synchronous or asynchronous, it can be on a whole range of levels [14]. These different levels were implemented in the developed web-based courses.

- *One-alone*: e.g. one person accesses on-line resources such as on-line databases or journals, remotely executes software programs stored on a remote computer, or downloads application software via Internet File Transfer Protocol (FTP).
- *One-to-one*: e.g. two people send messages back and forth via e-mail such as a student corresponding with a teacher or two students communicating.
- *One-to-many*: e.g. learning materials can be posted to a website by a teacher, forming an electronic lecture which any number of students can view.
- *Many-to-many*: e.g. any number of participants (students or teachers) interacts via chatting, a computer conferencing system. Debates, discussion groups and brainstorming can take place.

Table 3. Website feedback questionnaire

Section 1 (General Information)

1.1 Personal information:

Your name:

Title:

Organization:

E-mail:

1.2 What is your age?

- 18 or under
 19–24
 25–34
 35–44
 45–54
 55–64
 65 or more

1.3 For how many years have you been using the Internet?

- Less than one year
 1–2 years
 3–5 years
 more than 5 years

Section 2 (website evaluation questions)

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
<i>2.1 Speed</i>					
The home page downloads efficiently.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>2.2 First impression—general appearance</i>					
You can tell where you are immediately.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The home page is attractive, has strong eye appeal.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The home page makes you want to continue exploring the site.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>2.3 Ease of site navigation</i>					
You can move from page to page, link to link, item to item with ease, without getting lost or confused.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
All links are clearly labeled and serve an easily identified purpose.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Navigation buttons and bars are easy to understand and use.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The site map makes navigation easier.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Links provided to other pages and sites operate efficiently.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
<i>2.4 Use of graphics/sound/video</i>					
The graphics/sounds/video make a significant contribution to the site.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The graphics/sounds/videos are clearly labeled, clearly identified.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The graphics/sounds/videos serve a clear purpose appropriate for the intended audience.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The graphics/sounds/videos will aid my students in reaching the desired objectives for using this site.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>2.5 Content/information</i>					
This site offers a wealth of information related to its objectives.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information is clearly labeled and organized, and will be easily understood by students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The content of linked sites is worthwhile and appropriate for the intended audience.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The content of linked sites adds to the value of this site for achieving the instructional goals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The information providers are clearly identified.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The information providers are reliable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The content is free of bias, or the bias will be clearly recognized by the students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
This site provides interactivity which increases its instructional value.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.6 General

This website is very helpful to the course instruction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The Concept of WBI (web-based instruction) is a very effective instruction tool.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.7 If you found some of the information to be unsatisfactory, select the reason(s):

- too detailed not detailed enough
 too scientific/technical not scientific/technical enough
 old/out of date unclear/inaccurate
 biased lacked confidence in source
 other (please specify): _____

Section 3

3.1 Is there anything else you would like to add?

Course website communication components

The following communication components were implemented in the developed web courses:

- **E-mail:** e-mail between faculty and students can be integrated into the web environment. The web page allows e-mail to be sent to faculty and classmates, and a pop mail system can be integrated for reading e-mail messages. In both cases, e-mail can include attachments of any binary file (e.g. word processing files, spreadsheets, graphic images, and even sound and video files). The mailing services included in the course website were provided from Zap Zone Network (www.zzn.com). Students can access the mail login page, create a new account at login@kuniv.zzn.com. With this service, an instructor can monitor his or her students, send e-mail to all of them at the same time informing them about any changes in the course, or reminding them of any important dates.
- **Message board/discussion group:** a message board for communication among all course participants is a wonderful resource allowing for course discussions, questions regarding course material and assignments, and course announcements. Its advantages are tremendous including greatly enhanced student inclusion and participation in the course. Another communication facility is the discussion group that sets up a forum for site visitors to communicate with each other. A discussion group allows site visitors to post articles and reply to them. The easiest way to create a discussion group with FrontPage 2000 is by using the Discussion Web Wizard, as shown in Fig. 2. The wizard asks for the desired features, then creates a web and sets up the pages for you. After the web is created, you can open the pages and customize them. Another way to create a message board is by using on-line free board services like inside the web service (www.insidetheweb.com).
- **Real-time chat facility:** allows for the holding of real-time typed conversations. Office hours can take place this way without the need for instructor, students or teaching assistants (TAs) to travel to campus. A multichat service (www.multichat.com) was used in the course web page. MultiChat is a Java chat client applet service that enables you to place a chat room on your own site.
- **Feedback form:** provides the instructor with the student's response and comments. The user should first choose the comment kind from the following: Complaint, problem, suggestion, or praise. Then he should use the pull-down menu to select the item he wants to comment about (website, class, lab, instructor, TA, technical help, or other). The last step is to write the comment in the provided field and his contact information.
- **Announcements:** effective announcements need to be read; for that to happen the students need to know when a new announcement has been posted. Alert boxes or running footers (using JavaScript) or a blinking link added to a page can let students know of new announcements. Such announcements are implemented in the

Table 4. Website evaluation criteria

A) Content:	
1 Accuracy	<ul style="list-style-type: none"> The information source should be accurate and reliable (compare with other sources, logical information, check author background information).
2 Authority	<ul style="list-style-type: none"> The name of the individual or group creating the site should be clearly stated. The creator should give a source for information in the site where necessary. The website author or manager should provide a way for users to make comments or ask questions. The website author or manager should be responsive to any questions regarding copyright, trademark, or ownership of all material on the site. Sites that knowingly violate copyright statutes or other laws should not be linked, listed, or recommended.
3 Up-to-date	<ul style="list-style-type: none"> The information should be updated when needed. Dates of last up-date should be stated. Links should be updated when needed.
4 Interaction and student engagement	<ul style="list-style-type: none"> The content should encourage students to think and interact. Evaluation ways for student's knowledge acquisition should be provided (on-line testing, self-evaluation testing, drill exercises). Ways for students collaboration should be facilitated (shared projects and assignments, student's communication tools). Students should be encouraged to continue research by providing additional hyper links. Provide communication channels with Experts.
5 Nature of the content	<ul style="list-style-type: none"> There should be enough information to make visiting the site worthwhile. Content should be appropriate for student level and background. Content should be unique (information and images from more than one source, adding animation, sound, links, or any other web features).
6 Quality of writing	<ul style="list-style-type: none"> Well-written text. The title of a site should be appropriate to its purpose. Site content should be easy to read and understand by the intended audience. Spelling and grammar always should be correct.
7 References	<ul style="list-style-type: none"> Appropriate references and copyright statement should be included when needed.
B) Navigation:	
1 Links	<ul style="list-style-type: none"> Moving around the website should be easy. Sufficient shortcut or hot buttons should be provided. Links should be clearly and accurately described. Navigation links should be visually obvious. Links are logically grouped.
2 Site organization	<ul style="list-style-type: none"> Homepage should contain a well-labeled table of content. Site map should be provided.
3 Consistency	<ul style="list-style-type: none"> Navigation buttons should be consistent throughout the website. The type styles and background make the page clear and readable. The layout is consistent from page to page.
4 Ease of browsing	<ul style="list-style-type: none"> You can tell from the first page how the site is organized and what options are available. There is a link back to the home page on each supporting page. The links are relevant to the subject. The icons clearly represent what is intended.
C) Workability:	
1 User Friendly	<ul style="list-style-type: none"> Easy to use web interface. Help information should be provided when needed.
2 Required computing environment	<ul style="list-style-type: none"> Best-view web browser software should be stated. Required 'plug-ins' or other helper applications should be clearly identified. Links to web browser and plug-in download sites should be provided. Text only versions should be provided. Printer friendly version should be provided. Easy to switch between (Frame- Non-frame) versions if needed.
3 Searching	<ul style="list-style-type: none"> In case of file transfer (file name, type, size, and required time to download should be provided). Website search engine should be included. WWW search engines should be included to assist further research (yahoo, altavista, Excite, etc.). Search engine interface should be intuitive and easy to use.
D) Website Design:	
1 Visual appeal	<ul style="list-style-type: none"> The site design and style enhance information delivery. The site design should be appealing to its intended audience.
2 Thematic design	<ul style="list-style-type: none"> The design should be related to the site topic. The design should be consistent for each web page within the website.
3 Clarity of presentation	<ul style="list-style-type: none"> Add appealing web design features like tables and graphs. Pages should be uncluttered and cleanly designed.
4 Flexibility	<ul style="list-style-type: none"> Website should be viewed and tested by different text browsers (Lynx) and graphics browsers (Netscape Navigator and MS-Explorer).
5 Stimulation	<ul style="list-style-type: none"> The web design layout should get the students' attention and maintain their attention.
6 Appropriateness	<ul style="list-style-type: none"> Make appropriate use of graphics in the design layout. The site's design should be appropriate for the intended audience.

E) Performance:

- | | |
|--------------------------------|--|
| 1 Page acquisition time | <ul style="list-style-type: none"> • Try to minimize the time needed to load web pages with the type of connection you are using in your classroom. • Offer a text-only option. |
| 2 Connectivity | <ul style="list-style-type: none"> • Offer a thumbnail version of large graphics. • Check the site accessibility (Is the site usually accessible or is it difficult to connect into?). • You can connect quickly to the page. • Site URL should be short and easy to memorize. |
| 3 Hardware speed | <ul style="list-style-type: none"> • The page is available through search engines. • Consider your connection speed when you access a website. |

F) Multimedia Issues:

- | | |
|------------------------------------|---|
| 1 Problems of size | <ul style="list-style-type: none"> • Compress large multimedia files to minimize downloading time. • Provide download information (file name, type, size, and required time to download). • Multimedia files such as videos, sounds, and animations are usually very large files and can take a very long time to download. It is recommended to download these types of files ahead of time and have students access them locally from a hard drive or mass-storage device. |
| 2 Required applications | <ul style="list-style-type: none"> • Many multimedia objects on the WWW require a helper application or plug-in. Some helper applications such as Shockwave require an excessive amount of memory and time to load and run multimedia animation. Make sure you have the appropriate helper application or plug-in loaded ahead of time before using these files with students. |
| 3 Purpose of the multimedia | <ul style="list-style-type: none"> • Sounds, graphics or video enhance the site's message. |

G) Communication Issues:

- | | |
|------------------|--|
| 1 General | <ul style="list-style-type: none"> • Provide communication channels with instructor (e-mail, chat room, discussion groups, etc.). • Provide communication channels with students (e-mail list for all students in the class). • Provide communication channels with experts (e-mail, invite to chat room, specialized news groups, etc.). • Encourage collaborative projects and assignments (provide chat room, e-mail, discussion groups, etc.). • Provide feedback and comments forms. • Use announcements to get students attention to important dates and issues. • Provide help and supporting material to enhance student performance (e.g. how to use e-mail, chat room). |
|------------------|--|

H) Objective and Scope:

- | | |
|------------------|--|
| 1 General | <ul style="list-style-type: none"> • State the purpose of the website. • State kind of intended users. • Specify the scope of the site. |
|------------------|--|

web course site to remind students of exam dates, assignments due date, etc. Announcements are created with FrontPage 2000 using Marquee option from the Insert menu.

- *Yellow Shared Board*: a tool to assist chatting sessions. It lets the instructor illustrate his or her ideas to students as in the same way as with pen and paper. Meanwhile the student could participate in the illustration. NetWriter, a free shared Yellow Pad on-line service provided by ParaGraph/Vademto, was used in the course website to implement the yellow-shared board. With NetWriter the instructor can reserve the session ahead of time and send e-mails to students to inform them with the session time and number.

COURSE ADMINISTRATIVE TOOLS

On-line syllabus

An on-line course syllabus provides the instructor with a way to change course material easily, and inform the student with a complete and up-to-date picture of the course requirements. The format

need not (and probably should not) duplicate the print version. Hypertext links to sample relevant disciplinary websites may be helpful in giving students (and prospective students) a sense of the disciplinary context for the course.

The Syllabus (see Fig. 3) should include the following:

- course name, number, and prerequisites
- class time and location
- instructor
- instructor contact information
- teaching assistance
- teaching assistance contact information
- course description
- course objectives
- required course materials
- assessment methods course schedule
- grading
- late policy.

Class schedule

Class schedule provides students with a clear idea of the course timetable so they know the specific lesson for each given date. Class schedule

Lecture # 9
Chapter # 5
Slab Formwork Design

SLAB FORM DESIGN

Method of Analysis

Deck Span Design (Joint Spacing)

The procedure for applying the equations of Table 3 to the design of a deck or slab form is to first consider a strip of sheathing of the specified thickness and 1 ft wide (see Figures 1-a). Determine in turn the maximum allowable span based on the allowable values of bending stress, shear stress, and deflection. The lower of these values will, of course, determine the maximum spacing of the supports (joists). For simplicity and economy of design, this maximum span value is usually rounded down to the next lower integer or modular value when selecting post spacing.

Example 1

Page References:
Construction Methods and Management, S. W. Hunsally, Prentice Hall, Third edition.

Assignments:
Homework 2 Due 16 / Oct / 1999.

Formwork Related Links

- [Concrete Formwork](#)
- [Formwork III Sliding Presentation](#)
- [Formwork Litings](#)
- [Formwork](#)

Tables List

- [Table 1 - Recommended Minimum Lateral Design Load for wall form.](#)
- [Table 2 - Maximum Bending, Shear, and Deflection in Uniformly Loaded Beam.](#)
- [Table 3 - Concrete Form Design Equations.](#)
- [Table 4 - Properties of Plyform.](#)
- [Table 5 - Section Properties of Lumber and Timber.](#)
- [Table 6 - Typical values of allowable stress for Lumber.](#)

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Fig. 1.



Fig. 2.

**Concrete Construction & Technology
(CE-437)
Syllabus**

1. Objectives, Prerequisites and Prerequisites
2. Class Time and Location
3. Instructor
4. Instructor Contact Information
5. Teaching Assistants
6. Teaching Assistant Contact Information
7. Course Description
8. Course Objectives
9. Required Course Materials
10. Assessment Methods
11. Course Schedule
12. Grading
13. Late Policy

Fig. 3.

Classes Schedule

Day	Date	Lecture #	Chapter #	Lecture Title
Saturday	Sep-11	1	-	Overview the course - Syllabus
Monday	Sep-13	2	1	Concrete [Def-Time Line-Composition]
Saturday	Sep-18	3	1	Concrete [advantages-Limitation- Properties]
Monday	Sep-20	4	1	Concrete [Concrete Properties]
Saturday	Sep-25	5	2	Concrete Testing

Fig. 4.

- Concrete FAQ**
1. What is the difference between cement and concrete?
 2. How is Portland cement made?
 3. What does it mean to "cure" concrete?
 4. Can it be too hot or too cold to place new concrete?
 5. What is air-entrained concrete?
 6. What are recommended mix proportions for good concrete?
 7. Why does concrete crack?
 8. Why test concrete?
 9. What are the most common tests for fresh concrete?
 10. How can you tell if you've ordered the amount of concrete you need?

Fig. 5.

3. Oppium is ground with hot rollers to control the setting time of the produced Portland cement.

True
 False

4. The Joint:

Carry on the load from sheathing
 Made of lumber or steel
 Prevent any bending in the sheathing
 All the above

5. What does the vertical framework consists of?

Fig. 6.

consists of (day, date, lecture #, chapter # and lecture title) as shown in Fig. 4.

Frequently asked questions (FAQs)

A FAQ is a list of commonly asked questions and their answers. Posting FAQs provides ready answers to the student. FAQs also reduce the amount of time spent in answering questions piecemeal. Some of the items that may be posted are:

- FAQ concerning course content (see Fig. 5).
- FAQ concerning technical help (computer support, internet, how to use the website).
- FAQ concerning the course in general (registration, important dates, instructor, TA).

Student access to grades

It is common practice at many universities for teachers to post grades, sorted by student ID, in a common area, e.g. on an office door. It would be easier, faster and more convenient to post the entire list in the course website.

TESTING TOOLS AND OTHER RESOURCES

On-line exams, quizzes and assignments

Exams, quizzes and assignments can be delivered to the students via the WWW, as shown in Fig. 6. The student answers are sent privately to the instructor or TA through e-mail and the results are returned privately to the student.

Self-evaluation testing

On-line drill and practice or testing can be used to reinforce material even if not used as part of a grade. Reading comprehension questions, for example, in short answer or multiple choice formats can provide students with self-assessment of their level of understanding of the text. The test shown in Fig. 7 was created using on-line Quiz Creator service provided from Builder.com. When the quiz is submitted the quiz score and correct

answers appear in the box below the (get score) button.

Questionnaire

A questionnaire or a survey is a rapid means of collecting opinion on a wide variety of questions. Most educators will be familiar with end-of-term student questionnaires where students will rate the course they have attended.

In our project, three kinds of questionnaires were constructed, the first questionnaire aimed to measure student's computer skills to determine what type of training they will need for handling web-based education. The second and third questionnaires are dealing with website feedback, evaluation and assessment by students and site visitors (Tables 3 and 4).

To construct questionnaires that are submitted and stored via the web, you can create quizzes which allow users to record the results of an evaluation, or you can use a specific survey creation tool such as Infopoll Designer. FrontPage 2000 provides a simple way to create forms (for quizzes, exams, feedback forms, or questionnaires) with the form wizard utility.

Resources

In this section, the instructor provides any information resources that will help students, support their understanding and broaden their knowledge in the course material. Such resources include:

- old exams, quizzes and assignments;
- related links extra readings;
- file and software download;
- university phone directory and civil engineering department staff information;
- guides to the Internet and its components;
- glossary containing terms defined for the course and is searchable via prefix string, which are also linked directly from the notes to the glossary, so a student reading the notes can click on a term to access the definition for that term.

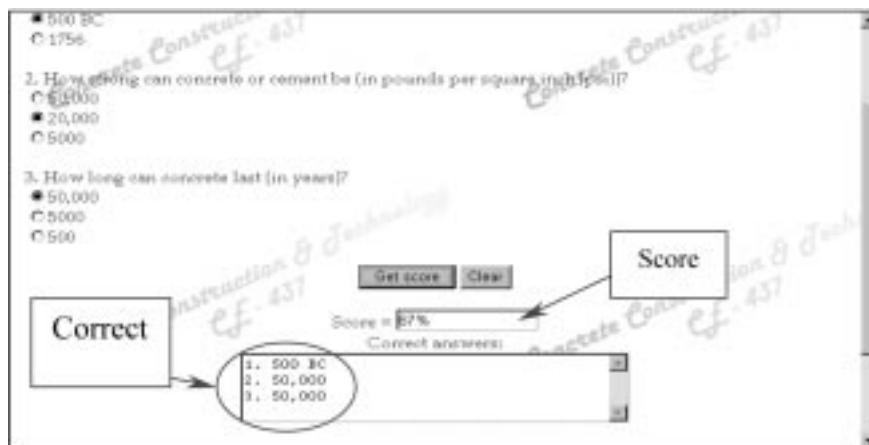


Fig. 7.



Fig. 8.

Help tools

Finding information on the web can be challenging with the number of web servers and web pages growing rapidly. A search engine is the solution for this problem: the search engine is a program that looks for pages relevant to the keywords the user enters into the engine and displays the results as hyperlinks.

You can add a www search engine to your course website very easily using Java scripts and Java applet. In our course website, a Java script search engine was designed (Fig. 8) allowing the user to search the net using 1 to 12 of the most popular search engines at the same time, and the results of each engine is displayed in a different window.

Calculators and plotting tools are provide the students with some help in understanding and solving problems. They are mainly designed using Java or Java scripts, as shown in Fig. 9 and Fig. 10.

SUMMARY AND CONCLUSIONS

While many texts have been developed around the basis of the CD-ROM and web-based media, and while many more are currently under development, the application to technology education has been less developed, and the construction industry is quite lacking in this utilization. Originality of the research is largely derived from the topic that is investigated (construction education) and from the simultaneous development of shell and content. These items are not original per se; rather it is their combination which warrants such designation. Thus originality must be viewed from the perspective of applicability to setting and appropriateness to user within the increasingly complex and technologically sophisticated construction industry.

This paper demonstrated how to:

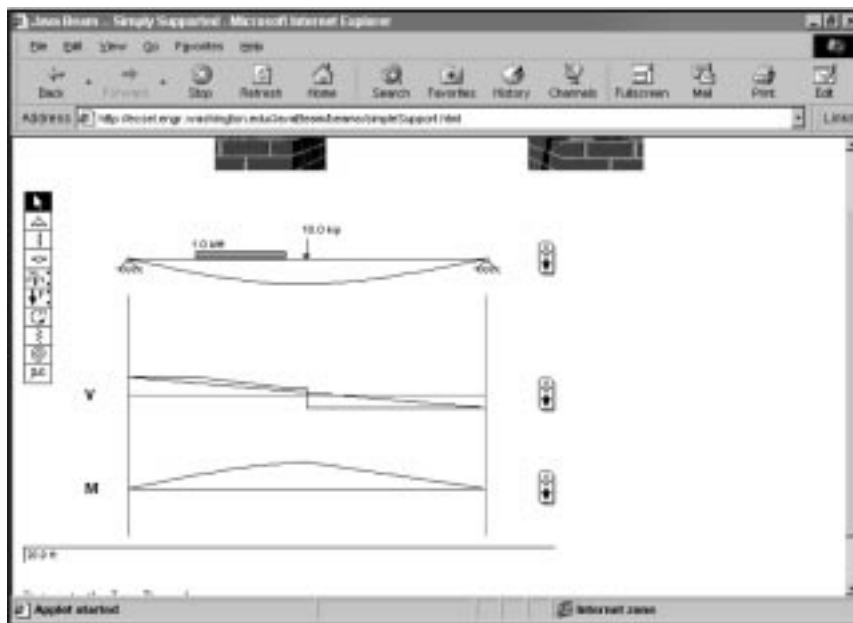


Fig. 9.

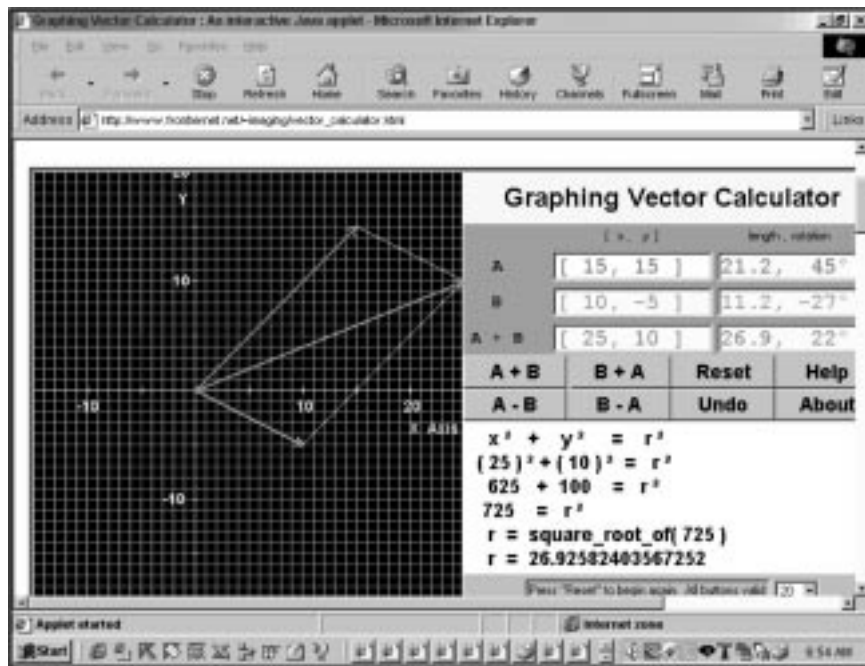


Fig. 10.

- identify the most effective organization and information content for a multimedia-based textbook;
- design a shell for the management of the information content including managing remote communication between instructors and students;
- establish an appropriate framework for the implementation and utilization of a multimedia-based textbook in construction engineering courses;
- assess the extent of the advantages derived from the use of such a facility.

Future research by the authors will focus on:

- continuous expansion of the knowledge base of the multimedia textbook to cover other

- construction methods and constructibility improvement techniques;
- updating the user interface taking advantage of new advancements in the rapidly changing multimedia and web-based technology;
- further evaluation and assessment of this new teaching method both as a complete distance-education tool and as a complementary-educational assistant to a formal university course;
- utilizing the developed *shell* as a model for future multimedia web-based textbooks for technology-oriented disciplines.

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