Development of a Multimedia Structural Mechanics Teaching Tool on the World Wide Web

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Abstract

The HyperText Markup Language (HTML) is used for the development of a multimedia teaching tool for an Aerospace Structural Analysis course at Mississippi State University. This tool is tailored specifically for the World Wide Web, and can be accessed by typing the following address: http://www.ae.msstate.edu/-masoud/Teaching/SA2/Course.html. This paper discusses the objectives of this effort, the tool content and development procedure, and the potential of this approach in improving the way engineering courses are taught. The first and most important phase of this three-phase project has been implemented with the remaining two phases to be implemented in the future. The results of a written survey of students who used this tool for an entire semester are extremely positive, with all students expressing satisfaction with the way this tool has enhanced their learning of the concepts taught in the course.

Introduction

The traditional method of instruction in the form of classroom lectures is still the most prevalent method at institutions of higher learning. While classroom lectures are an important component of teaching, their effectiveness, as far as student's comprehension of the subject is concerned, may be less than desirable. Of particular concern is the way engineering courses are typically taught — based primarily on lectures. In-depth understanding of the physical concepts and methods of analysis discussed in an engineering course, especially at the senior-level and beyond, requires an enhanced method of instruction that gives full consideration to variation in students' learning styles and thinking preferences. [1] However, tailoring of classroom lectures alone, toward this objective, would undoubtedly be a formidable and perhaps even an unrealistic task. Therefore, educational tools that complement standard curricular activities in order to improve student's understanding of the subject need to be considered.

A source that a student heavily relies on when doing homework assignments and preparing for tests is his or her class notes. An incomplete or inaccurate set of notes may hamper as opposed to help a student's efforts in these activities. To alleviate this problem and improve student's understanding of the course contents some instructors offer handouts summarizing or supplementing classroom lectures with perhaps one or more example problems. While this practice is generally helpful to students, it is limited in the way it can present the information and enhance learning. A notable alternative to this approach would be to store the information related to the topics covered in the course, with discussion of key issues, illustrative example problems, and stimulating exercises in an organized and visually attractive multimedia format on a computer that is accessible by students from virtually any where at any time.

With the eagerness students show in using computers, attempts should be made to channel that interest in a way that is educationally most beneficial to them. Various methods to enhance engineering education by the use of multimedia-based programs have been explored in the past. Unfortunately, the practice is still not wide spread in the higher-education community. Some of the most recent efforts in the use of multimedia and computers in engineering education are cited here. Cobourn and Lindauer[2] created multimedia software for the instruction of an introductory course in Thermodynamics. Mosterman *et al.*[3] have utilized the concepts derived from virtual reality in creation of a virtual laboratory. Daily and Daily[4] have conducted a study on the use of televised interactive multimedia distance education with a focus on engineering. Numerous projects have been carried out over the past decade or more to integrate computers with instruction in engineering education. While the approaches taken are somewhat different, the ultimate goal remains the same — to improve the quality of higher education in engineering.

Although not yet fully utilized, the technology exists today that allows the dissemination of information through the network of computers (i.e., the Internet) in a multimedia format with the aid of the World Wide Web ("the Web" for short) and related software. The Internet and the Web are gaining more audience every day in those seeking to use these technologies to access information on just about any subject. The versatility of the Web in allowing the presentation of information in a multimedia (i.e., text, image, and sound) format makes it an ideal tool for access and utilization of an educational software or tool that students can use to gain better understanding of the concepts introduced in a course, at their own pace. This approach also has the potential to greatly enhance the distant-learning courses (i.e., TV courses) offered to off-campus students.

With the availability of such a tool the student would be less compelled to take unnecessary notes in class, more encouraged to be actively involved in each lecture, and more confident of his or her learning of the subject. This approach would also allow the instructor to spend more time in class discussing the underlying theory, and involve students in thought-provoking discussions. The overall outcome would be a more motivated class and better educated engineers.

This paper discusses the details of a project to create a multimedia teaching tool on the World Wide Web to be used by students in a senior-level aerospace structural analysis course. The project tasks are divided into three phases as follows:

Phase 1. Develop a multimedia teaching tool capturing the essence of all the topics covered in the Aerospace Structural Analysis II course (taught in the Department of Aerospace Engineering at Mississippi State University) with easy-to-follow discussions, mathematical descriptions, illustrative diagrams, and detailed example problems, and tailor it specifically for the World Wide Web.

Phase 2. Develop and incorporate short video clips, either through animation or digitized video of actual laboratory experiments, demonstrating and clarifying the concepts covered in the course.

Phase 3. Develop and incorporate a solution software that students can use to solve the types of aircraft structures problems discussed in this course, and enable them to answer the "what if" questions in each problem by varying the input parameters.

The first phase of the project began in the Summer of 1995, and the students taking the course in the Fall 1995 semester began to make use of the beta version of the tool. The work on the first phase has been completed. The remaining two phases are planned to be carried out in the future. Summary of the course and details of phase 1 are discussed next.

Course Description

The Aerospace Structural Analysis II is a course students in the Department of Aerospace Engineering at Mississippi State University take in the first semester of their senior year with the first author as the instructor. It is the second in a sequence of three aerospace structural analysis and design courses students have to take in the last two years of their undergraduate studies. The first two courses are mostly analysis oriented whereas the third one is focused mainly on design. The Aerospace Structural Analysis II course deals primarily with topics related to advanced mechanics of materials with a focus on metallic aircraft structures. Special emphasis is given to the stress analysis of simple and complex built-up structures under the action of pure torsion, pure bending, transverse shear, internal pressure, and combined loads. The major topics discussed in this course are categorized according to the loading condition, and are described in Figure 1.

The textbook used for the course is Analysis and Desire of Flight Vehicle Structures by Bruhn[5]. Five chapters of this book, related to the topics outlined in Figure 1, are covered in this course. Supplemental information is taken from available literature in this area, Students are required to submit approximately eight homework assignments, take three in-class tests and a comprehensive final exam.

1. Pure Torsion

Shear Flow, Shear Stress, and Angle of Twist:

a. Circular Bars
- Elastic & Homogeneous
- Inelastic & Homogeneous
- Elastic & Non-homogeneous
- Inelastic & Non-homogeneous

b. Noncircular Bars
- Elastic & Homogeneous

c. Thin-walled Open Sections
- Elastic & Homogeneous

d. Thin-walled Closed Sections
- Elastic & Homogeneous
- Single and Multiple Cells

2. Pure Bending

Bending Stress, Neutral Axis Location, and Deflection:

a. Elastic & Homogeneous Straight Beams
- Symmetric Loading
- Unsymmetric Loading
- Open and Closed Symmetric Cross Sections
- Open and Closed Unsymmetric Cross Sections

b. Elastic & Non-homogeneous Straight Beams
- Symmetric Loading
- Open and Closed Symmetric Cross Sections

c. Inelastic &Homogeneous Straight Beams
- Symmetric Loading
- Open Symmetric Cross Sections

d. Elastic & Homogeneous Curved Beams
- Symmetric Loading
- Open and Solid Symmetric Cross Sections

3. Transverse Shear

Shear Center, Shear Flow, Shear and Bending Stresses:

a. Elastic & Homogeneous Straight Uniform Beams
- Symmetric Cross Sections
- Unsymmetric Cross Sections
- Load Passing Through the Shear Center
- Load Not Passing Through the Shear Center
- Thick-walled Open and Closed Sections
- Single and Multiple Cells

b. Elastic & Homogeneous Straight Tapered Beams
- Symmetric Cross Sections
- Load Passing Through the Shear Center
- Load Not Passing Through the Shear Center
- Thin-walled Open and Closed Sections

4. Internal Pressure

Membrane Stresses:

a. Spherical Pressure Vessels
- Elastic & Homogeneous
- Unstiffened Shell

b. Cylindrical Pressure Vessels
- Elastic & Homogeneous
- Unstiffened & Stiffened Shells
- Circular & Generally Axi-symmetric Cross Sections

5. Combined Loading

Shear and Normal Stresses:

Elastic, Homogeneous, Straight & Uniform Beams
- Thin-walled Open and Closed
- Symmetric Cross Sections
- Unsymmetric Cross Sections

Figure 1. Outline of the major topics and related concepts introduced in the Aerospace Structural Analysis II course and described in the multimedia teaching tool.

An Overview of the World Wide Web

The World Wide Web is a multimedia information access and retrieval tool available on the Internet. Users of the Web can access and retrieve documents from various sources such as universities, government agencies, industry, etc. What separates the Web from other tools on the Internet is its capability to transfer and display documents in the form of still or movie images, sound, mathematical formulae as well as ordinary text.

A Glimpse at the Web History

The idea of a world wide database was first conceived in the 1940's, but it was not explored further until the 1960's. It was thought that a universal database would revolutionize the way humans interact with information, particularly in the education field. Only recently was the technology 'able to live up to these dreams. Tim Berners-Lee, a member of CERN (European Laboratory for Particle Physics) located in

Switzerland, proposed the Web project in March of 1989 as a means of transporting research findings and ideas throughout the organization. Since CERN members were located all over the globe, there was a need for effective communication. After the original proposal, the National Center for Supercomputing Applications (NCSA) at the University of Illinois at Urbana-Champaign began a project to interface the World Wide Web. They-wanted to aid the scientific research community by producing widely available, non-commercial software. Another goal of NCSA was to perform research in new technologies with the hope that commercial interest will be able to profit from them. The Software Design Group at NCSA began to work on Mosaic, a multi-platform interface used as a Web browser. Mosaic and other browsers, such as Netscape, are used every day by millions of people to retrieve information through the Internet from all over the world on everything from scientific documents on the state-of-the-art in a particular technology to rudimentary gardening tips.

This Is How It Works

Communication in the Web works through a client-server interaction. The client is the seeker and the server is the provider of information. The client, through a browser (e.g., Mosaic or Netscape) connected to the Internet, types in the address of the server where the desired document resides. The browser then searches for the document in the server, and if found, displays it on the client's computer monitor. A multimedia document may contain mathematical and/or ordinary text as well as video and sound recordings.

A document on the Web may contain hyperlinks to other documents. A hyperlink is usually identified by an underlined word or phrase, or a bordered icon in a document. A hyperlink word or phrase also has a different color from the rest of the document text, usually blue. When a hyperlink is activated (i.e., clicked on with a mouse), the browser goes to the location where the document resides. There can be more than one hyperlink in a single document leading to additional documents that themselves may also have hyperlinks to even more documents — creating a complex "virtual web" of connections among a multitude of documents. The difference between a hypertext and a hypermedia document is that the latter contains not only hyperlinks to text, but also to images and/or sound recordings and perhaps even digital video clips. Movement through the Web is primarily accommodated by point-and-click actions of the mouse, which account for its ease of use and to some extent its growing popularity.

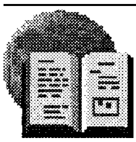
Each document on the Web is identified by a Uniform Resource Locator (URL) that includes information regarding the document's name as well as the directory and server in which it is stored. A URL also specifies the method of information transfer between the client and the server computers. Common types of transfer are: HTTP, FILE, FTP, GOPHER, NEWS, and TELNET. Because these types of transfers can be done with a Web browser, it means that they are also full-featured FTP, GOPHER, etc. clients. Here is an example of a URL: http: //www.ae.msstate. edu, identifying the Web site of the Department of Aerospace Engineering at Mississippi State University.

The standard language used for creating a multimedia document on the Web is the HyperText Markup Language (HTML). Hypertext is simply an ASCII text accompanied by specific commands, similar to those found in computerized typesetting systems such as TEX created by Donald Knuth, that tells the browser how and what to display in terms of font style, color, images, hyperlinks, etc. An HTML document is identified by a filename ending with ".html". A simple example of a multimedia document on the Web with multiple hyperlinks is shown in Figure 2-a, with its hypertext source file shown in Figure 2-b. A Web site, identified by a URL, is also referred to as a "Home Page". To make information available on the Web, a home page needs to be created. The best way to create a home page is to examine an existing one or use on-line guides available on the Web. The HTML code for a specific home page can be viewed by clicking on the **Source** under the **View** icon in the top ribbon.

Development Procedure of the Multimedia Structural Mechanics Teaching Tool

Important issues that needed to be addressed at the outset included software architecture and system compatibility. It was immediately recognized that in order to make this a useful tool, it has to be compatible with any computer platform the student has access to (e.g., a personal computer, a workstation, or a mainframe), regardless of its operating system. Obviously, this constraint posed a challenge that we were not too eager to face — as it would have required a very complex software architecture. Then we realized that if this tool were to be developed using the HTML language, then it could be easily accessed through the World Wide Web by any student with a computer network connection to the Internet. With that in mind we proceeded with deciding on the outline of topics and the format by which the information related to each topic was to be presented. The scope of information that we wanted to make available to students required the creation of what could be considered as a "home page complex" — a collection of different home pages with each devoted to a particular major topic discussed in the course. With the greater popularity enjoyed by Netscape among available Web browsers, it was decided to set up the Web site to be primarily compatible with the Netscape.

As it was mentioned in the introduction, the development project of the multimedia teaching tool was divided into three phases. For the first phase we decided to get most of the information from the lecture notes developed by the first author over the past four years, and supplement it with informative discussions, attractive illustrations, example problems, and sample tests — all in an organized and easy-to-follow format. The first phase was to lay the foundation upon which the home page complex could evolve in the future. The difficult part of this tool development was deciding on its organization and content. In contrast the learning and use of HTML language were fairly simple.



Sample of Libraries on the Internet

- LC - Library of Congress
- VL - The WWW Virtual Library
    - o ASE - Aerospace Engineering

Figure 2-a. An example of a very simple hypermedia document with multiple hyperlinks.

```
<hr><p><IMG ALIGN=left SRC="Icons/Virtual_Library.gif' '><br><br><p><h3 >Sample of Libraries on the Internet</h3><p>
<ul><li><a href="gopher://marvel.loc.gov:70/11/>LC</a> - Library of Congress</li>
<li><a  href=''http://www.  w3  .org/hypertext/DataSources/bySubject/Overview.htm1>  VL</a> - The WWW Virtual Library </li><ul>
<li><a href="http://macwww.db.erau.edu/www_virtual_lib/aerospace.html>ASE</a> - Aerospace Engineering</li></ul></ul><hr>
```

Figure 2-b. The HTML source code of the document shown in Figure 2-a.

Description of the Home Page Complex

The home page complex contains five sections with each devoted to a major topic discussed in the course as outlined in Figure 1. Directory of the major topics, with information as to which chapters in the textbook[5] they correspond to, are shown at the beginning so the student can easily identify and hyperlink to any particular topic he or she wishes to study. Upon the selection of a major topic, the list of available information under that topic would appear next. Each specific item on the list also has markers, next to the title, identifying the corresponding chapter and section in the textbook; this provides the student with an opportunity to study the book along side the multimedia teaching tool. Subsequent hyperlinks direct the student to discussions on specific concepts and problems addressed in the course.

Organization of the home page complex is similar to a "tree" structure with detailed information available to the student as he or she further explores an individual topic or "branch". Each discussion usually begins with an introduction of the underlying theory, followed by a step-by-step description of restrictions and assumptions. Wherever appropriate, the necessary mathematical analysis and example problems along with sketched drawings and diagrams are provided. The extent of explanation, mathematical derivation, example problems and associated figures depend on the concept being discussed. For example, some mathematical formulae are introduced with a detailed derivation whereas others are given without any derivation. The same is true with regard to example problems — some are solved with every equation and analysis step explicitly shown while others contain less detailed solutions.

The use of color was emphasized in drawings and diagrams to make them more visually attractive and easy-to-understand to the student. The figures are either directly included with the text or are displayed via hyperlinks. These figures are created using a drawing software and are stored in Graphics Interchange Format (GIF). The mathematical equations used in specific analysis involve many Greek symbols and are typically fairly revolved. To allow easy display of these equations, they were also saved as GIF files. The equations were written on Word Perfect 6.1 'M in its equation editor, and XV (a UNIX-based graphics editor) was used to take a snapshot of each and save it as a GIF file. Figure 3 shows the home page for the second major topic (i.e., Pure Bending) discussed in the tool. Figure 4 shows the listing of example 3 in section Al 3.5. Underlined text in each figure indicates a hyperlink which once activated would take the user to the corresponding document.

Calling procedure

This multimedia teaching tool can be accessed by a Web browser by typing the following address or URL: http: //www.ae.msstate.edu/~masoud/Teaching/SA2/Course.html. The upper and lower case letters must be carefully considered. In order to clearly view all the text, symbols, and graphics in the home page complex, the 1. 1N or higher version of Netscape software is recommended.

PURE BENDING

THEORY:

The problems of beam bending considered here are based on the Euler-Bernoulli Beam Theory. In addition, the beam section(s) considered here are in the state of **"Pure Bending".** This implies that transverse shear forces are zero along the beam.

- **A13.1** Location of Neutral Axis
  - Review
    - o **A3.8** Rectangular Moments of Inertia and Product of Inertia
    - o A3.1O Parallel Axis Theorem
- **A13.2** Elastic and Homogeneous Beam Bending for Symmetric Loading
  - Neutral Axis Location
  - Normal Stress Distribution (Eq. 13. 13)
  - Symmetric Cross Sections
- **A13.5** Elastic and Homogeneous Beam Bending for Symmetric and Unsymmetric Loading
  - Neutral Axis Location
  - Normal Stress Distribution (Eq. 13. 13)
  - Symmetric and Unsymmetric Cross Sections
- **A13.9** Elastic and Non-homogeneous Beam Bending for Symmetric Loading
  - Neutral Axis Location
  - Normal Stress Distribution
  - Symmetric Cross Sections
- **A13.1O** Inelastic and Homogeneous Beam Bending for Symmetric Loading
  - Neutral Axis Location
  - Normal Stress Distribution
  - Symmetric and Unsymmetric Cross Sections
- **A13.11** Curved Beams: Stresses Within the Elastic Range for Symmetric Loading
  - Neutral Axis Location
  - Normal Stress Distribution
  - Symmetric and Unsymmetric Cross Sections

Test Your Knowledge!

- **Sample Test**

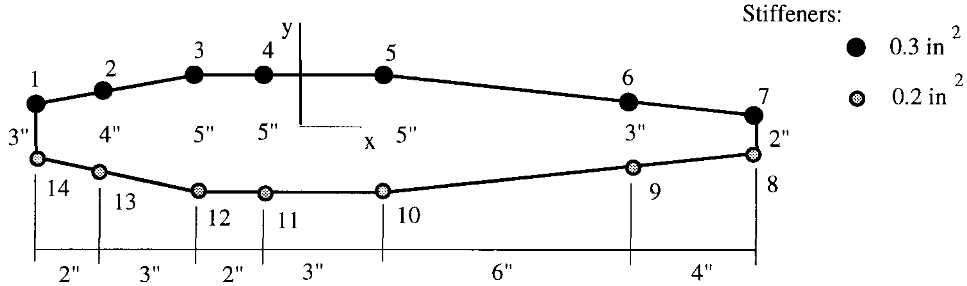
To Course Outline

Figure 3. The home page of Pure Bending and Chapter A13 menu.

SECTION A13.5 EXAMPLE 3

The skin-stringer wing section shown is subjected to a bending moment MO which acts in the vertical plane putting the top surface in compression. Determine:

- (a) the location of the neutral axis (NA) and its orientation;
- (b) the largest permissible value of MO if the maximum elastic stress in the wing is not to exceed 12 ksi;
- (c) the stress normal to the plane of the cross section in all stiffeners.



EQUATIONS USED: EQ. A13.13 AND EQ. A13.15

$$\sigma_z = -\frac{(M_y I_x - M_x I_{xy})}{(I_x I_y - I_{xy}^2)} x - \frac{(M_x I_y - M_y I_{xy})}{(I_x I_y - I_{xy}^2)} y \qquad \tan\phi = -\frac{(M_y I_x - M_x I_{xy})}{(M_x I_y - M_y I_{xy})}$$

SOLUTION:

Since the cross section is not symmetric, the product of inertia will not be zero. With the reference point at stiffener 14, the centroid of the cross section is obtained first. Then the rectangular moments of inertia and product of inertia are determined.

$$\bar{x} = \frac{\sum Ax}{\sum A} = 8.5714\, in \qquad \bar{y} = \frac{\sum Ay}{\sum A} = 1.8857\, in$$

$$I_x = \sum A(\Delta y)^2 = 13.604\ in^4 \qquad I_y = \sum A(\Delta x)^2 = 159.85\, in^4 \qquad I_{xy} = \sum A(\Delta x \Delta y) = -1.2714\, in^4$$

(a) Since the wing section is elastic, the NA passes through the centroid. Equation Al 3.15 gives ϕ = -.45”. Note that M_X = MO and My = O in this problem.

(b)The simplest way to find the largest permissible MO is to pick out a few candidate stiffeners that appear the farthest from the NA. Then use equation A 13.13 to solve for MO by fixing the stress at 12,000 psi. The lowest moment will be the answer as it will not induce a bending stress at any point above the allowable value of 12,000 psi.

Based on stiffener 5, MO = 76,743.7 in-lb; based on stiffener 6, MO = 139,027.1 in-lb; based on stiffener 12, MO = 55,979.2 in-lb; and based on stiffener 13, M_o = 113,443.9 in-lb

In this case, stiffener 12 will have the maximum stress because it is the farthest from the NA. Therefore, the largest permissible moment is MO_{max} = 55,979.2 in-lb such that $|\sigma_{max}|$ = 12,000 psi.

(c)Use MO_{max} for M_X in Eq. A13. 13 to solve for stress at each stiffener location.
σ_1 = -4,307 psi, σ_2 = -6,431 psi, σ_3 = -8,588 psi, σ_4 = -8,645 psi, σ_5 = -8,752 psi, σ_6 = -4,830 psi, σ_7 = -2,902 psi, σ_8 = 5,334 psi, σ_9 = 7,523 psi, σ_{10} = 11,840 psi, σ_{11} = 11,940 psi, σ_{12} = 12,000 psi, σ_{13} = 10,040 psi, σ_{14} = 8,046 psi.

To Section A13.5

To Chapter A13 Menu

Figure 4. An example of an elastic wing section under pure bending discussed in section A13.5.

Evaluation of the Multimedia Structural Mechanics Teaching Tool

The following questionnaire was developed to gather some feedback from students to determine whether or not the desired objectives have been achieved, and also to receive suggestions for improving the tool for the next time the course is taught. The Fall 1995 Aerospace Structural Analysis II class consisted of ten students with nine responding to the survey. The survey questions and answers are given below:

Q1. How user friendly is the teaching tool in its current format?
Al. a. extremely user friendly 4, b. fairly user friendly 5, c. not user friendly 0.

Q2. Do you find the information contained in this tool adequate? This considering that the tool was created with the intent to supplement and not replace the class notes and the textbook. If not, what additions do you recommend?
A2. a. adequate 9, b. not adequate 0.

Q3. What do you like the most and the least about this tool?
A3. a. the most: example problems, sample tests. figures, and round-the-clock availability.
b. the least: typos in the beta version. non-availability of a hard copy.

Q4. How helpful was the tool to you in doing the homework assignments?
A4. a. extremely helpful 7, b. somewhat helpful 2, c. not helpful at all 0.

Q5. How helpful was the tool to you in preparing for the tests?
A5. a. extremely helpful 5, b. somewhat helpful 4, c. not helpful at all 0.

Q6. Do you feel that your knowledge and understanding of the concepts discussed in this course have been improved because of this tool? If O means not at all, and 10 means you couldn't pass the course without it, what number would describe your response the best?
A6. a. 10 0, b. 9 0, c. 8 3, d. 7 0, e. 6 4, f. 5 1, g. 4 1, h. 3 0, i. 2 0, j. 1 0, k. O 0.

Q7. Did you feel less pressured to take notes in class because of this tool?
A7. a. a lot less 1, b. somewhat less 7, c. no pressure relief 1.

Q8. Did you find yourself less interested in attending class because of this tool?
As. a. less interested 0, b. more interested 0, c. no difference 9.

Q9. Do you think that a similar tool should be developed for other Aerospace Engineering courses? If yes, name two in particular.
A9. a. no 0, b. yes Gas Dynamics, Incompressible and Compressible Aerodynamics, Astrodynamics, Flight Mechanics III, and other Structures courses.

Q1O. Do you think that a similar tool should be developed for other engineering courses in general? If yes, name two in particular.
AlO. a. no 0, b. yes Strength of Materials, Fluid Mechanics, Statics, Dynamics, Heat Transfer. and Vibration courses.

Q11. Would you recommend the use of this tool to students who are taking a similar course at other institutions?
A11. a. no 0, b. yes 9.

Q12. Would you like to contribute to the development of a similar tool in another course if it would not interfere with your studies?
A12. a. no 6, b. yes 3.

Q13. What is your overall impression of the multimedia teaching tool?
A13. a. excellent 7, b. good 2, c. fair 0, d. bad 0.

Assessment of Answers to the Questions in the Survey

The answers to question one indicate that the tool is fairly easy to use and its format is acceptable to the students. The answers to question two indicate that there is no need to expand the amount of information contained in the tool. The positive responses to the third question were due to the clarity of information and the availability of the tool to suit students' schedules. The negative responses, however, were partly because when students first began to use the tool, it was still in its beta version and not all of the typographical errors had been corrected. Some of the students were also disappointed whenever they were instructed not to print a hard copy of everything they see in the tool. This difficulty should be alleviated in the near future with the greater availability of personal computers and network connections at students' place of residence.

The answers to questions four and five were very gratifying as they indicate the achievement of one of the main objectives of the tool development, helping students to do their best in homework assignments and the tests. The answers to question six were rather unexpected as approximately 78% of students indicated that their knowledge and understanding of the concepts discussed in the course were improved so much that they would have had less than a 50% chance of passing the course without the help of the teaching tool. It is possible, however, to attribute this response to the lack of students' self confidence in passing this rather difficult course in the Aerospace Engineering curriculum.

Another goal of the tool development was to relieve the students from the pressure of taking notes in class. The responses to question seven indicate that this goal was not fully achieved. This is because students did not necessarily examine the tool ahead of time before coming to class. As a result, they did not have a firm idea as to how much of the information being discussed in class would be available in the tool even though the instructor would give some indications in the class lectures. The answers to question eight relinquished the doubt about one of the anticipated side effects of this tool. Fortunately, students did not lose their desire to come to class and listen to the lectures and participate in the ensuing discussions.

Questions nine and ten were designed to know students' opinions about the need for developing similar teaching tools for other aerospace and general engineering courses. None of the students thought that a similar tool should not be created for any other course. The opinions varied as to which courses would benefit from a similar tool. The underlined courses are those mentioned by the students.

Question eleven goes to the heart of this activity, creating a tool that can be used by students beyond Mississippi State University. Every student indicated that they would recommend the use of this tool to students who are taking a similar course at other institutions.

Since the creation of such a multimedia teaching tool is rather time consuming, students' help is crucial. However, the majority of students would prefer to use such a tool as opposed to help creating one as the answers to question twelve indicate.

Question thirteen was asked so we would know if all the effort that was put into creating this multimedia teaching tool was worth it. The responses were highly satisfactory. The counter placed in the web site indicated that there were more than 200 visits to this tool during the period of September 25 to December 5, 1995 alone.

Students' Performance in the Course

The effect of the multimedia teaching tool was noticeable in students' performance in the assignments and the tests in the Aerospace Structural Analysis II course. However, it is difficult to judge the exact amount of improvement. This is because the questions in the assignments and tests are usually different from year to year this course is taught, making an exact scientific comparison among students in different years almost impossible. The overall performance of students in the Fall 1995 semester was not significantly better than those in previous years with grades in the course ranging from two A's, four B's, two C's, and two D's. It is worth mentioning, however, that for the first time in four years there were no F's in this course.

Conclusions

With the success in the first development phase of the multimedia teaching tool for structural mechanics, the next two phases of development should enhance its quality with addition of such features as video clips of actual laboratory experiments highlighting the important concepts discussed in the course and the aircraft structures solution software. It should be clear that the proposed approach is not confined only to the instruction of structural mechanics, and is applicable to other courses as well. By examining the concepts discussed in a course through a multimedia tool, student would have an easier time comprehending the material, and ultimately this would put the student in control of learning at his or her own pace.

Although the burden of learning rests primarily with the student, it is the educators' responsibilities to provide the student with proper tools to help him or her learn as much and as best as possible. The interactive learning source is not meant to be a substitute teacher, rather a round-the-clock tutor. The student cannot skip class and hope to find the entire lecture and ensuing discussions available on the Web. This tool is meant to help the learning process, and at best, provide the student with greater, if not total understanding of the subjects discussed in the course.

The idea makers of the 60's dreamt of the ways humans could interact with information, particularly in the education field. The World Wide Web is an excellent medium for the type of teaching and interactive learning discussed in this paper. The Web is expanding every day, and improving the way information is processed, displayed, and shared. The use of the Web in higher education applications is an idea worth further exploring.

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