Session 1658

A Paperless (almost) Statics Course

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ABSTRACT

An on-line statics course will be described. This course has evolved over time to be run from the Internet using Web browsers and standard software. The course Web site (www.eod.gvsu.edu) contains a complete set of course notes, student pages, additional materials and references. Problem solutions are available here in electronic form (for Mathcad and Working Model). Students submit all their work during the term and post results to their Web pages. Homework is marked and returned electronically. The only activity still using paper is examinations. Special attention is given to how a beginner would develop and run a new or existing Web based course.

1.0 INTRODUCTION

At Grand Valley State University we teach a course in statics and solid mechanics (EGR 209) in the sophomore year. Originally this course was taught using traditional techniques. The recent emergence of the World Wide Web (Web) as a popular standard presented new possibilities for teaching options. In the fall of 1996 I taught the course for the first time making limited use of the Internet as a presentation and communication tool [5]. Based on the success of the results, I expanded the use to eliminate paper-based assignments and distribute problem solutions. The specific objectives of the developments were i) find useful new techniques for teaching statics, ii) encourage the students to learn and use the Web, iii) expose the students to modern engineering support tools (symbolic algebra and simulations) to reduce trivial work and prepare them for senior level courses.

2. THE COURSE

2.1 THE INCOMING STUDENTS

At the beginning of the course, I informally assessed the students to determine the range of computer experience. In general the level of student knowledge was dispersed. I estimated that most of the students were proficient computer users. Four of the students (less than 10% of the class) had inadequate computer knowledge - they were all mature/transfer students. About 3/4 of the students had used a Web browser, but only about 1/4 had generated their own Web pages. About 3/4 of the students had used Mathcad in a previous course in probability (EGR 103) the only deficiencies were for transfer students who had taken an equivalent course at another school. None of the students had used the required software called Working Model (www.krev.com) before.

For students that had no computer experience various options were encouraged including some personal assistance, direction to resources and extra help for some steps. In-class demonstration of all software was given to help familiarize students. To assist students who had not created their own home page, a description was distributed with the course notes, and special instruction was given through extra help sessions in the computer laboratory. Tutorial guides were distributed to the few students that had not used Mathcad previously, and many of these were taking EGR 103 simultaneously. In addition, the textbook was accompanied by a guide to solving statics problems using Mathcad. Introductory tutorials for Working Model were distributed to all students.

2.2 THE NOTES

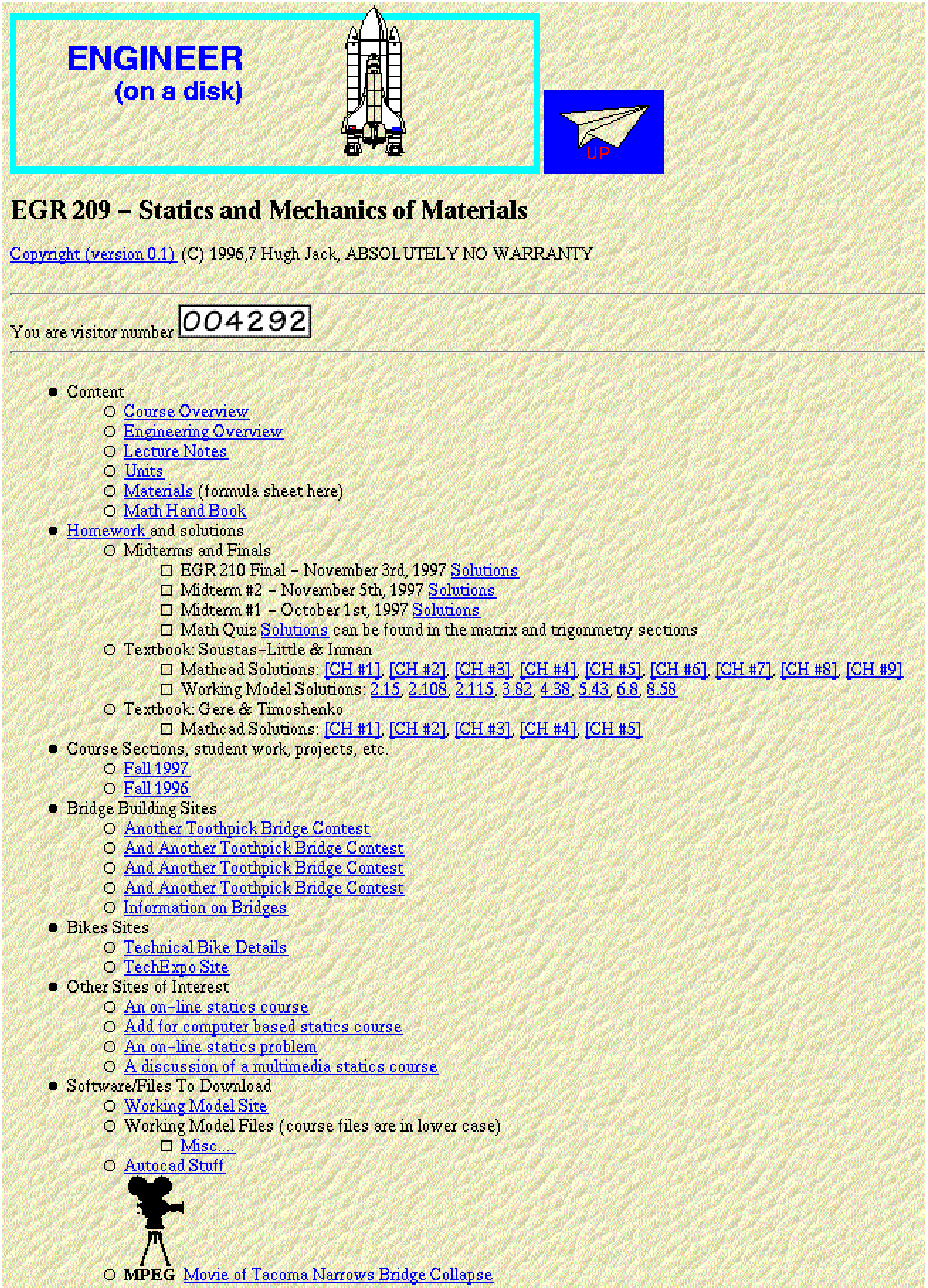
The statics and mechanics of materials course (EGR 209) was offered in the previous year using Web based presentation in lectures [4]. And, the notes were improved based on student feed-back[5] from the previous year. The revised notes were distributed to students, and they brought these to class with them. All assignments and published solutions were done on paper and the students did not publish any pages on the Web. The original course notes were previously developed for a statics course at another university using the Hibbeler [3] textbook. These were then updated and expanded to include mechanics of materials using a textbook by Beer and Johnson [1]. Both of these books use problem approaches that are not well suited to computer algebra solutions. We adopted an innovative book by Soustas-Little and Inman [6]. The book addresses formulation of problem solutions using vectors, matrices and graphing. The text also includes supplemental guides for Mathcad (and other computer programs). For mechanics of materials material we used Gere and Timoshenko [2]. This book also came with some problems suited to computer algebra systems.

2.3 THE LECTURES

The lectures were held in two different rooms. One of the rooms was fully equipped with a permanent computer and ceiling mounted data projector. To prepare to lecture in this room I only had to load some software at the start of the term. It was not necessary to take any materials to the lecture hall. The second lecture room had a single video projector on the ceiling. It was necessary to take at least a portable data projector and computer on a daily basis. The use of a shared projector lead to many conflicts and required additional time before and after class. Both of the rooms had adequate lighting, although the fully equipped room was better. A good rule of thumb is the darker the room the faster the students fall asleep. As a result, turning on the lights to do problems is necessary and helps maintain attention. But this is not as important when the room is brighter when presenting data.

2.4 THE SEQUENCE OF THE TERM

In general the preparation for the course began about two months before. The course notes from the previous year were updated and proofread to eliminate as many mistakes as possible (correct-ing mistakes during the term is harder). About one month before the


ENGINEER
(on a disk)

UP

EGR 209 – Statics and Mechanics of Materials

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You are visitor number 004292

- Content
  - Course Overview
  - Engineering Overview
  - Lecture Notes
  - Units
  - Materials (formula sheet here)
  - Math Hand Book
- Homework and solutions
  - Midterms and Finals
    - EGR 210 Final – November 3rd, 1997 Solutions
    - Midterm #2 – November 5th, 1997 Solutions
    - Midterm #1 – October 1st, 1997 Solutions
    - Math Quiz Solutions can be found in the matrix and trigonmetry sections
  - Textbook: Soustas-Little & Inman
    - Mathcad Solutions: [CH #1], [CH #2], [CH #3], [CH #4], [CH #5], [CH #6], [CH #7], [CH #8], [CH #9]
    - Working Model Solutions: 2.15, 2.108, 2.115, 3.82, 4.38, 5.43, 6.8, 8.58
  - Textbook: Gere & Timoshenko
    - Mathcad Solutions: [CH #1], [CH #2], [CH #3], [CH #4], [CH #5]
- Course Sections, student work, projects, etc.
  - Fall 1997
  - Fall 1996
- Bridge Building Sites
  - Another Toothpick Bridge Contest
  - And Another Toothpick Bridge Contest
  - And Another Toothpick Bridge Contest
  - And Another Toothpick Bridge Contest
  - Information on Bridges
- Bikes Sites
  - Technical Bike Details
  - TechExpo Site
- Other Sites of Interest
  - An on-line statics course
  - Add for computer based statics course
  - An on-line statics problem
  - A discussion of a multimedia statics course
- Software/Files To Download
  - Working Model Site
  - Working Model Files (course files are in lower case)
    - Misc....
  - Autocad Stuff
  - **MPEG** Movie of Tacoma Narrows Bridge Collapse

Figure 1 - The Main Web Page for EGR 209

course began the notes were sent to the book store for reproduction, including a tutorial guide for Working Model. After this, the course Website was updated with a more recent version of the notes (www.eod.gvsu.edu). Figures 1 and 2 show screen captures of the main course page and an example of a note page. During the lectures the course material is presented directly from the Web pages.

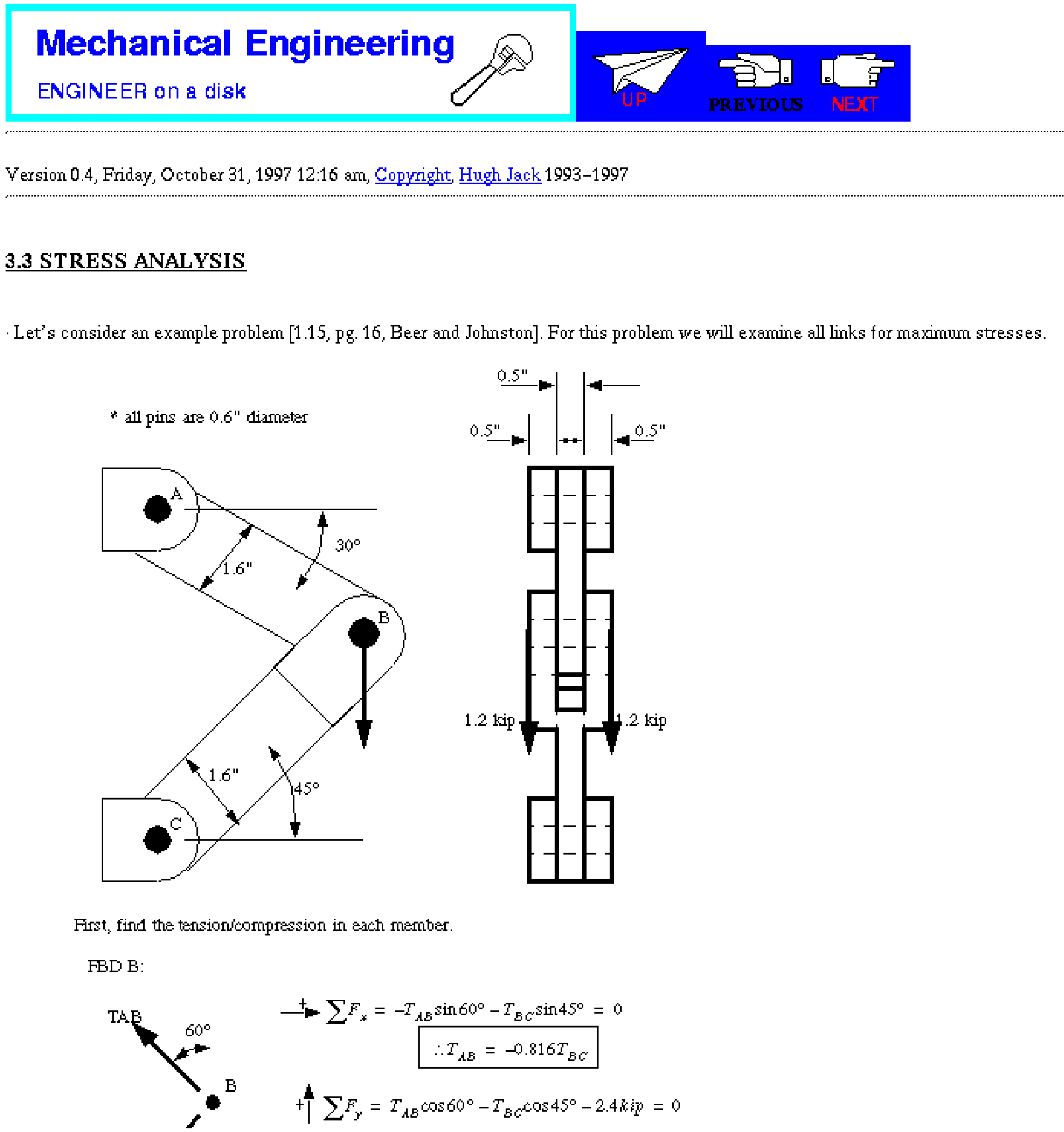

Figure 2 - A Web Based Page from the Course Notes

In addition to normal first day activities, students were asked to buy and bring the course notes to each lecture. In addition, the need for software and Web usage was described and students were asked to drop my office to obtain an account on the course server. In the second lecture an assignment was given that required the student to use Mathcad and post the results on the Web.

In the first week, most of the student accounts were issued. And, about a quarter of the students used previous knowledge and materials in the course notes to modify their Web pages. Over the first two weeks questions were entertained in class (sometimes with demonstrations) about how to modify Web pages. Scheduled and ad-hoc help sessions were also held in the lab. By the end of the second week, about half of the students had been able to modify their home pages, and some had posted assignment solutions. A typical example of a student page can be seen in Figure 3.

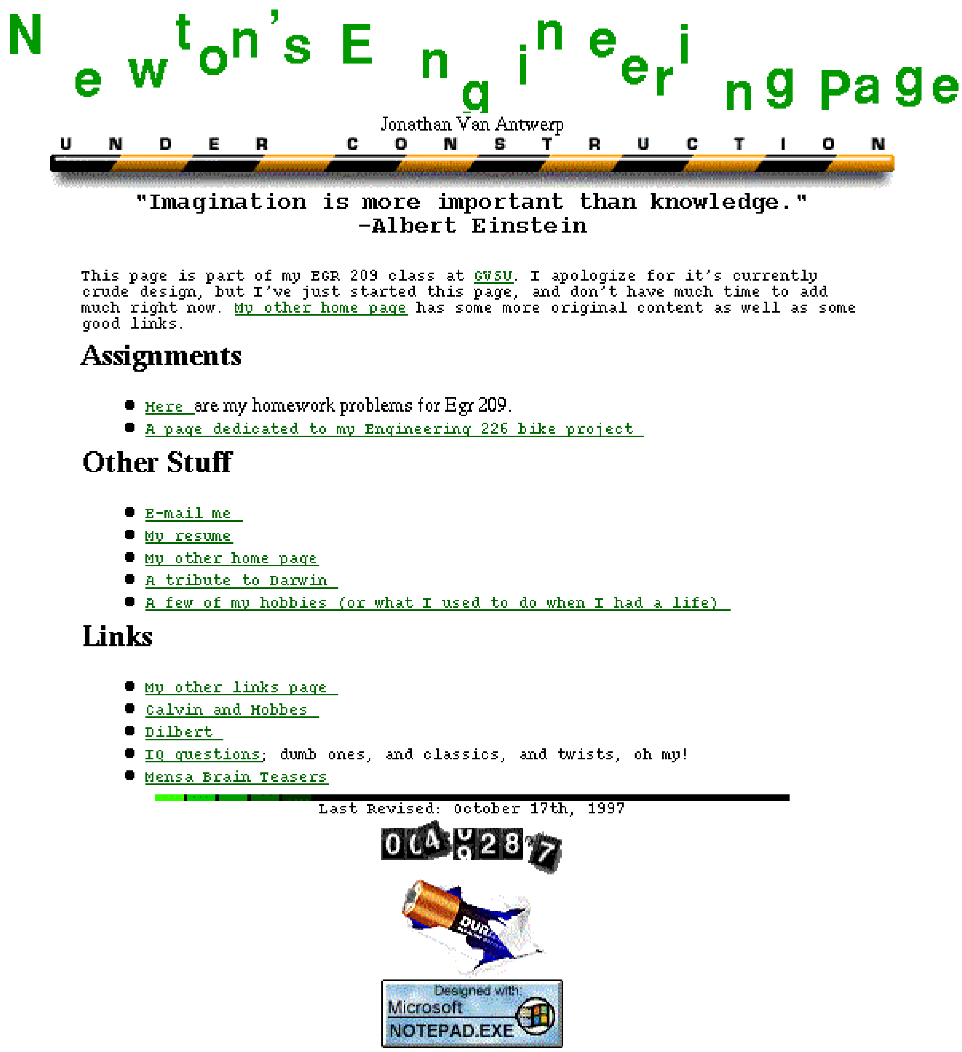

Figure 3 - Typical Example of Student Page

By the third week, the assignments were due and by this time about 37/43 had successfully changed their home pages, 20/43 had linked separate files successfully, about 23/43 had done the Mathcad assignment successfully, and 31/43 had problems with the Working Model solutions. I made it clear to the students that the submission policy would be liberal at the beginning of the term, but become more strict as the term progressed. This helped reduce the stress level surrounding technical problems. After additional help sessions and direct contact, many pages had been changed, 38/43 had done the Mathcad problem, 34/43 had done the Working Model solution, and 39/43 pages were linked correctly to files. After this I individually approached students and discussed problems. By the end of the term, all students were fully proficient with both software packages and posting to the Web.

Solutions to recommended homework problems were posted on the Web server early in the term (in Mathcad and Working Model files). An example of a solution to a problem is shown in Figures 4 and 5. Posted solutions give students easy access (even from home), and if they have made different assumptions, they may modify the posted solution to check for accuracy. Solutions were also posted for assignments and examinations after they were written.

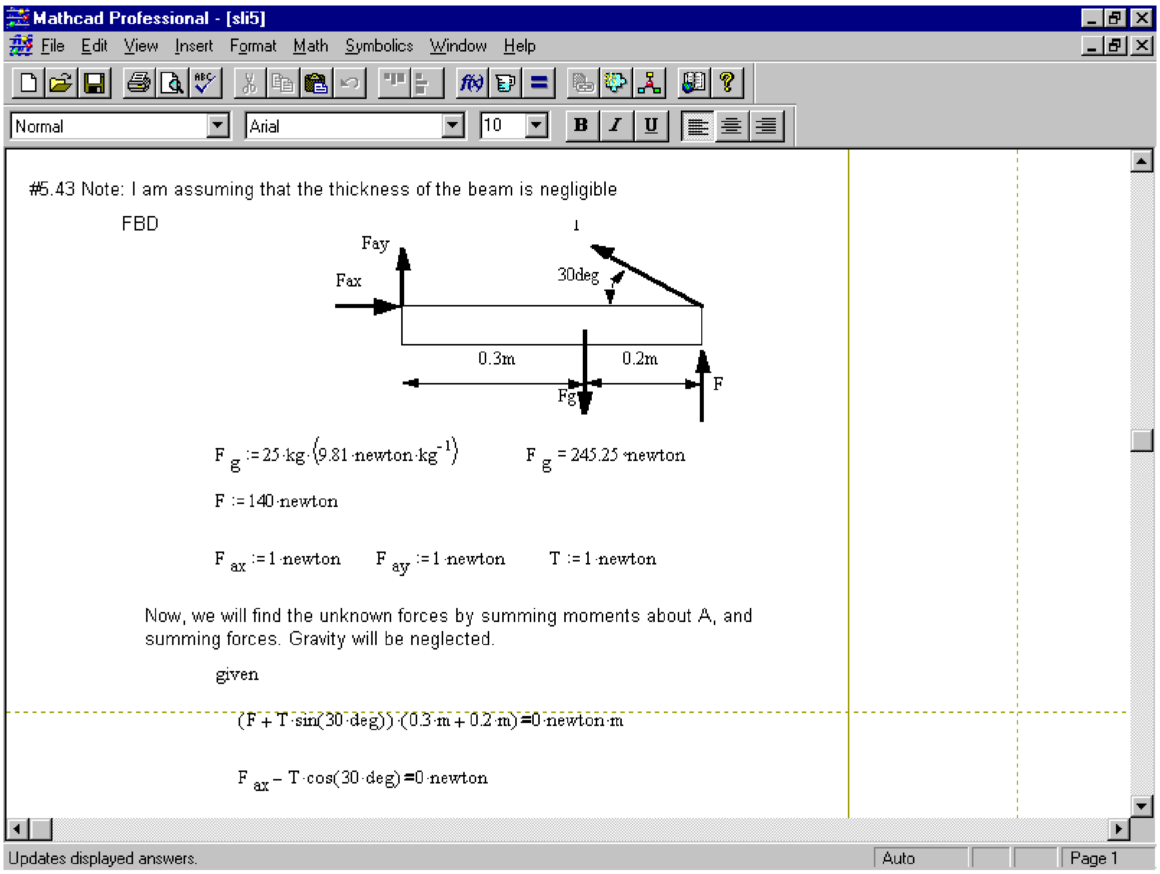

Figure 4 - A Textbook Problem Solved in Mathcad

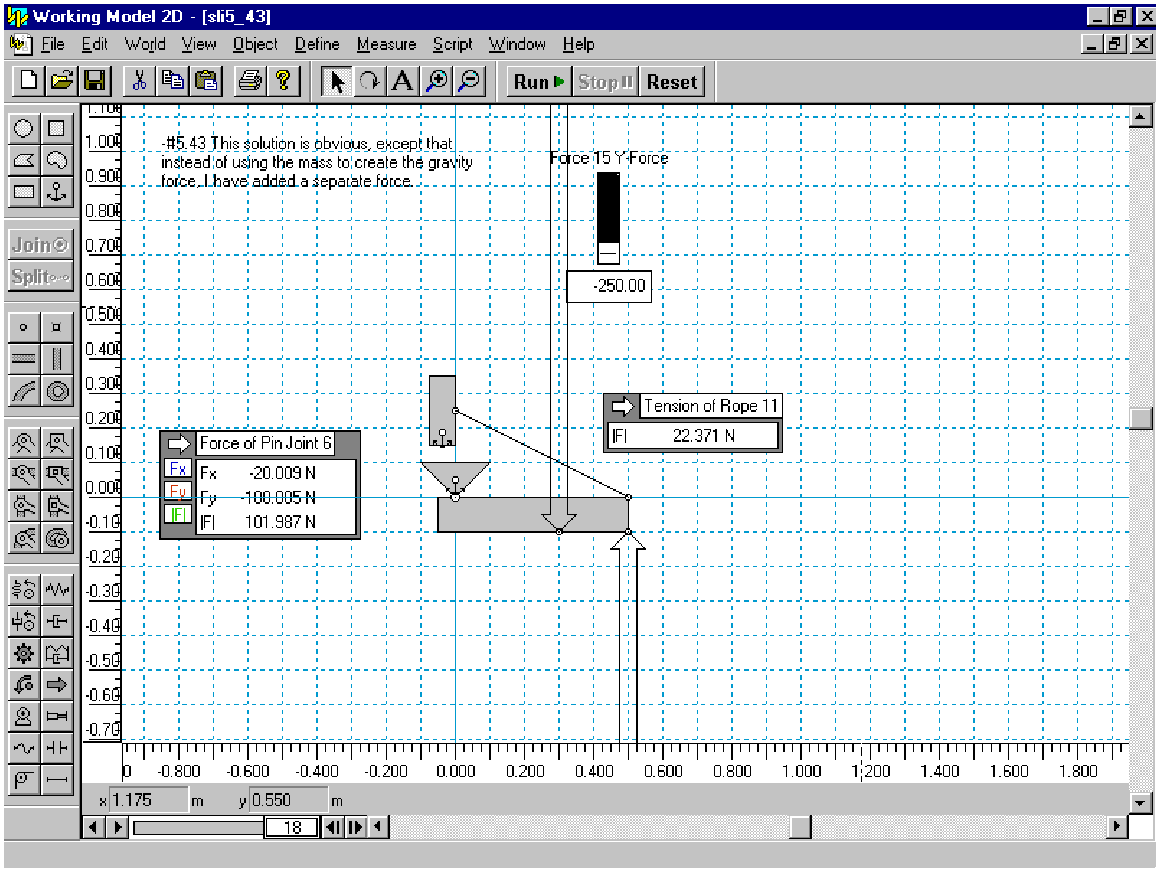

Figure 5 – A Textbook Problem Solved in Working Model

Grading was all done electronically. The basic process involved going to the students Web page (using Netscape) and opening the assignment file. In Working Model or Mathcad I would add comments to the files and enter grades into a grade spreadsheet, and then put (with ftp) the marked files in private directory for the students to retrieve. The directory for marked work must be protected so that only the student and instructor can access the results.

Throughout the year, I ran an analysis project for a bicycle frame. A sequence of assigned problems first approximated the tension/compressions in the rear members. The analysis then proceeded to look at material properties, factors of safety, etc. This project proceeded during the term by having them add to their original Mathcad analysis file (their previous work acted as a basis for future work). The analysis was done in stages and feedback was given so that students would correct problems with calculations done in earlier parts. Students worked in pairs and the files were kept in one of the students accounts and the other student would add links from their home page. At the end of the term, the complete analysis was in one large file.

Later in the term a bridge building competition was held. In addition to designing and building the bridge, students were required to estimate failure loads. Many students were able to estimate the failure loads using Working Model within a couple of hours. And Working Model allowed students to do trial and error design techniques.

2.5 PROBLEMS

As with most new technologies, there were some problems that arose. One of the most significant was that computer laboratories were overwhelmed by the exploding computer usage on campus. Another problem was that we had two main versions of Mathcad in use, and the files were not backward compatible. The older version 5.0 was in use in most labs, although version 7.0 was available elsewhere and for sale in the book store. As a result, all problem solutions had to be posted in version 5.0, and when marking I had to have access to both versions of the software. In addition, the Mathcad software is well suited to equations and calculations, but figures are not supported directly in the package. This means that a separate software program was required to create free body diagrams. As a result, a number of students used ‘Microsoft paint’ which is inadequate for technical drawing. We are planning to get a site license for a technical sketching program.

Throughout the term, there were some corrections/modifications made to the notes. These were posted to the Web pages. In a couple of cases, I distributed paper copies to replace pages in their notes - without these there would have been a run on lab printer paper.

2.6 ADVANTAGES

The computer tools and Web increased student access. Assignments were submitted by posting to a students personal home page. This allowed students to submit any time, from anywhere, and there is a record of submission. In addition, files don’t need to be kept on floppy disks and files larger than 1.44 Mbytes are easier to work with. Both increase student and instructor access. Using email, students had expanded access to me; and, using the network, I could mark assignments and check progress in my office or from home. The students also learned to master important tools, often going beyond the basic requirements to add graphics and structure to their home pages.

At the beginning of the term most students were using Mathcad as a mathematical word processor. They would do work by hand and enter it into the computer. By the end of the term, most students were more familiar with Mathcad capabilities, and as a result would do their first draft on the computer. This approach also shaped thought processes away from numerically oriented solutions to algebraic equations. Working Model was primarily designed for dynamics, but it works for statics also and gives students a more intuitive understanding of the statics principles.

Concerns were expressed about copying assignments when one student posts it on the network, and it is visible to others. But only one incident was encountered in the entire term, and this was easily fixed. (It is also easier to check for coping when assignments are in electronic form) Another concern expressed was possibly reduced lecture attendance; the philosophy for the course was that the students should have enough high quality material to be able to learn without the lecture. But, by treating lectures as a value added activity the lecture attendance rate was typically 80-100%.

3. CONCLUSSIONS

Methods were described for offering a course using the Web. The techniques presented reduce most of the paper used during the term with the exception of written examinations. This course can now be used by faculty members teaching a similar course elsewhere (please warn me first) or could be “fit” to special needs by picking and choosing.

The computer exposure in the class prepared students for more senior courses and contemporary professional computer usage. Specific tools allowed students to solve or simulate much more complex problems than would be possible by hand. The Internet usage fostered an open environment where student presented their work publicly and with high quality results.

3.1 FUTURE

As time goes on, computers will become as common as calculators are now. I anticipate that students will eventually carry laptops with high density permanent media storage, such as rewritable CD drives. This would allow students to get a single CD that has a copy all of their course notes, as well software such as Mathcad and Working Model. In class they could try new and previously prepared problems using the actual tools. They could add their own notations to the course notes in a permanent format. It would also become feasible to run examinations in a paperless format. Not only is this solution more compact overall, but it has the potential to become much less expensive and more current than large printed volumes.

REFERENCES

[1] Beer, F.P., Johnston, E.R., Statics & Mechanics of Materials, McGraw-Hill, 1992.
[2] Gere, J.M., Timoshenko, S.P., Mechanics of Materials, fourth edition, PWS Publishing, 1997.
[3] Hibbeler, R.C., Engineering Mechanics: Statics and Dynamics, 6th edition, MacMillan Publishing Co., New York, USA, 1992.
[4] Jack, H., “Developing Multimedia Courseware for the Web”, ASEE North Central Section Conference Proceedings, Dayton Ohio, April 1997.
[5] Jack, H., “Use of Computer Technology in the Classroom”, ASEE National Conference Proceedings, Milwaukee, June 1997.
[6] Sousta-Little, R.W., Inman, D.J., Engineering Mechanics; Statics, Prentice-Hall, 1998.

BIOGRAPHICAL INFORMATION

Hugh Jack is an assistant professor in the Padnos School of Engineering at Grand Valley State University. He is teaching courses in mechanical, electrical and manufacturing engineering. His research interests include computer aided process planning and robotics.