USING THE INTRANET IN ChE INSTRUCTION

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Reflecting an overall information revolution, communication across the Internet has evolved rapidly in the past few years, from primarily text-based (e-mail) information to graphically oriented material. This has been due to the amazing growth of the World Wide Web (WWW) and the development of web browsers, beginning with NCSA Mosaic but now including Microsoft's Internet Explorer (based on Mosaic) and the current market-dominating Netscape.[1] The academic community has, for a number of years, been fervent in its use of the Internet (how long could we survive without e-mail?) and has expanded its use as the Internet has grown. The desire to remain at the forefront of information technology has led to significant academic discussion concerning the use of the WWW and the Internet in undergraduate and graduate education.[2-4]

Much of the discussion about using the Internet has concerned incorporation of the vast amount of information available across the Web into the curriculum. Given a Universal Resource Locator (URL—basically a web address), one can immediately travel throughout the world and obtain information (text, images, files, programs, etc.) that have been posted on the Internet. The tools that have been developed for browsing through the Internet are not only capable of surfing the net but also of distributing information within a corporation, a university, or even within the classroom in a similarly convenient fashion. In the same manner that these browsers and the Internet have made accessing information across the world nearly instantaneous and interesting, the *intranet* can be used to assist instruction and information distribution within the classroom.

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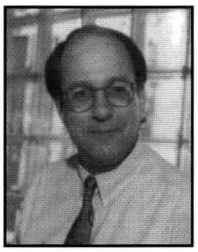

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Wouldn't it be nice to

- *Improve your undergraduate courses with your existing campus network?*
- *Improve communication with your students and colleagues?*
- *Save resources (such as paper) by publishing assignments, solutions, course syllabi, exams, and quizzes on the WWW?*
- *Publish grades and scores on the intranet while protecting students' security?*
- *Provide assistance to students outside of the classroom or office hours?*
- *Provide student access to course materials twenty-four hours a day (and thereby eliminate a host of common excuses)?*
- *Obtain truly anonymous feedback from students?*
- *Advertise your course to a broader audience both on campus and outside your school?*

The goal of this article is to describe our efforts to incorporate the intranet into the instruction of an undergraduate chemical engineering course and to relay those aspects of the incorporation that appeared to be most useful. We will also give some tips for developing Web-based materials, including a discussion of the current status of Web standard development and the various tools available to aid in Web

page construction. In our own experience, some of the things we have attempted have worked quite well, while others have been less successful. We hope that those who attempt to duplicate our efforts in their own department at some time in the future can benefit from this discussion.

COMPUTER INTEGRATION AT COLORADO SCHOOL OF MINES

At the Colorado School of Mines (CSM), we are well poised for incorporating the Web into undergraduate chemical engineering instruction. This is due to a large donation and the construction of the Bernard Coady computer laboratory incorporating 22 IBM RS/6000 workstations in a classroom environment. These workstations are used throughout the undergraduate chemical engineering curriculum,[5] primarily as a tool for using the ASPEN and Provision simulators[6,7] in courses ranging from the initial mass/energy balances course all the way through the senior design course. This workstation classroom is also used in teaching organic chemistry with Spartan molecular modeling and visualization software.[8]

Because of the required and heavy use of networked workstations in their other coursework, students have ready access to the Internet. In addition, many students also have access to the Web from their home or dorm via dial-up access to the CSM network or other external networks (such as Compuserve and America On-Line) and are able to readily obtain classroom information. In fact, a recent survey of heat transfer undergraduates showed that every single student in the class knew how to access the WWW and that fully two-thirds of them could access the Web from their home/dorm.

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WHY USE THE INTRANET?

Academicians are not noted for having a lot of free time, so the first question one of them usually asks is, "What do I get in return for the time investment required to incorporate the Web into classroom instruction?" It is a difficult question to answer because the Web is always evolving—probably at a rate proportional to the rise in the use of the Internet itself. As the number of uses for the Internet increases, so do the conceivable applications of having such a resource available.

Our approach in this initial use of Web-based materials has been focused on the ability to rapidly disseminate information in a convenient manner. There are, however, a number of other possible advantages in using the Web to aid in the instruction of an undergraduate course. They include the ability to incorporate supplemental course materials such as pictures, diagrams, videos, and even links to other information sources across the Internet. Having the course home page also provides a ready means of communicating with the class outside of the lecture, thereby giving the instructor some flexibility in the course outline. In general, though, and especially in this initial incorporation of the Web into our course, we hoped that making class materials readily accessible to students outside of the classroom would aid in their assimilation of the subject matter.

WHAT IS HTML?

In order to use standard Web browsers in displaying classroom materials, the documents and graphics must be formatted in the language of the Internet. This requires converting documents prepared by other means (LaTeX, Word, Excel, etc.) into Hypertext Markup Language (HTML). Once they have been converted to HTML, any browser software can be used to preview the documents before they are added to the course Web site.

Hypertext Markup Language is a relatively simple means of preparing documents in a manner that various browsers can use to display information in a formatted manner. Preparing documents in HTML, particularly simple text-based materials, can be quite easy. The HTML "language" is text-based and can therefore be created and read with a large number of applications and word processors. Various tools for converting files such as those produced by Word, Excel, and LaTeX to HTML are available on the Internet. For those who are interested in preparing their own documents directly, or in optimizing files created using converters, a number of excellent tutorials are available on the Internet. They include:

- A Beginner's guide to HTML
  http://www.ncsa.uiuc.edu/General/Internet/WWW/HTMLPrimer.html
- A Bare Bones Guide to HTML
  http://werbach.com/barebones/barebone_html.html
- The Web Designer
  http://web.canlink.com/webdesign *(This site has a great list of the converters currently available on the Internet for the various computer programs and platforms.)*

In addition to the above, Java is the latest development in incorporating new capabilities into Internet browsing software. Developed at Sun Microsystems, Java is a true pro-

gramming language for the Internet that, in its simplest form, allows incorporation of animation into Web pages.[9] If your browser is Java-capable (most current browsers are—Netscape has such versions available for UNIX workstations, PCs, and Macs), a great site for exploring its capabilities is

http://www.javasoft.com/applets

Also, for a glimpse of the educational possibilities of Java, see

http://www.gamelan.com/

We did not attempt to include Java into the class home pages; in fact, Netscape browsers including Java were not available until the middle of the spring semester in 1996. Certainly though, Java has potential for aiding in instruction and providing demos that would be more readily assimilated by the 'Nintendo' generation.

EXAMPLES FROM UNDERGRADUATE HEAT TRANSFER

The authors have each taught a section of a semester-long junior-level heat transfer class with a total enrollment of 75 students. In general, most of the features we placed on the class home page were well received by the students in the course. To keep track of general usage, we used a counter similar to an automobile odometer (see

http://www.digits.com

for a nice counter that runs externally and can keep track of such things). The number of times the class home page was accessed during the semester was about fifty times (hits) per week, totaling around 850. Specific usage statistics, however, were not compiled, so the number of times students were accessing homework solutions versus course grades, for example, were not kept. (Some usage information was obtained directly from the students during class evaluations, however, the results of which are shown graphically in Figure 4, which will be discussed in detail later.)

GENERAL INFORMATION

The class home page (see Figure 1) includes:

Urgent Messages • These were placed at the beginning of the course page and blinked if they were particularly urgent. Example messages included reminders of upcoming exams or changes in scheduled class quizzes. This feature also proved extremely useful when sudden changes in office hours were necessary—placing an announcement on the page prevented many students from showing up at the door and finding us unavailable.

Course Syllabus • A description of our policies on grading, homework, and exams so that students would always have access to the information.

Course Outline • A description of where we expected to be throughout the course.

Course Objectives • Outlines of what we intend for the students to learn throughout the course.

Office Hours • Office hours are given.

Schedules • Our weekly schedules are displayed so students will know when we are available. This also makes it convenient for other professors or secretaries who are trying to put together meetings (such as committee meetings). When we receive e-mail asking about

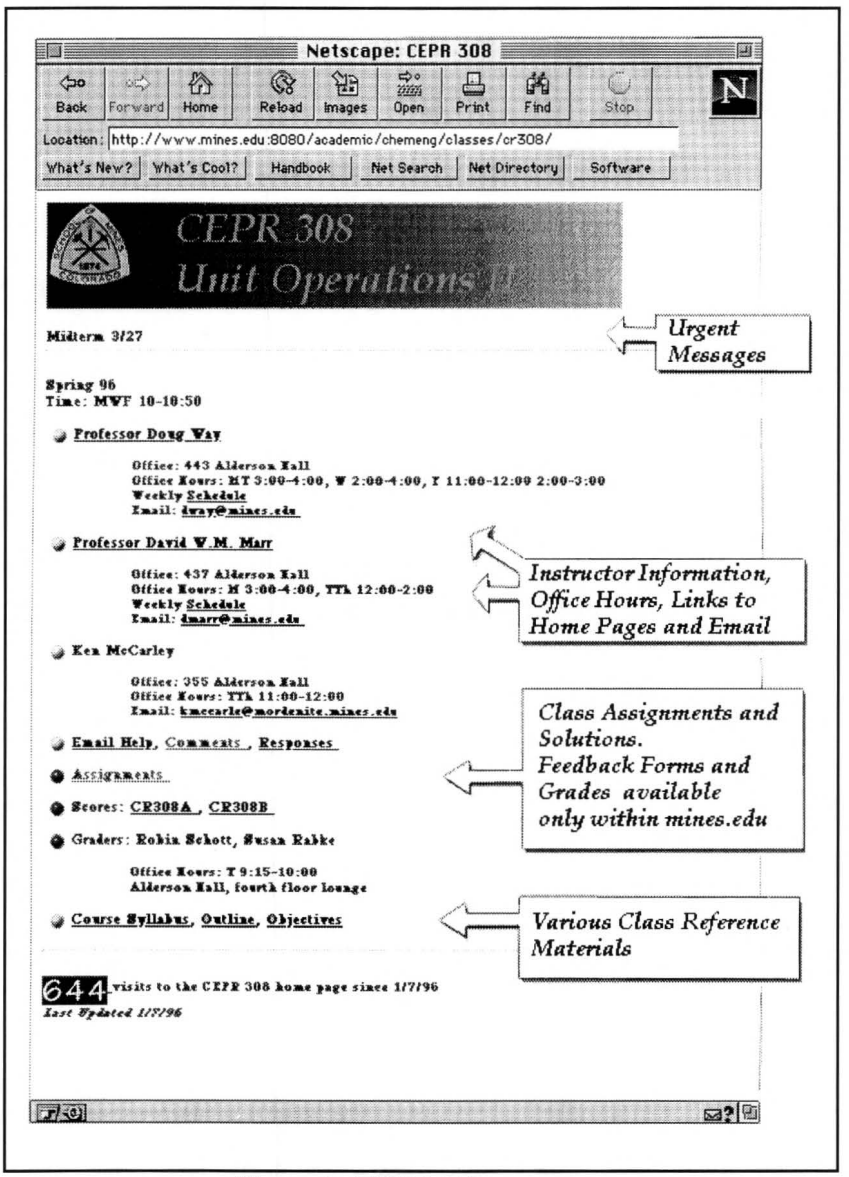

Figure 1. *CEPR 308 home page.*
http://www.mines.edu/academic/chemeng/classes/cr308.s96

availability, we give out our URLs. This also turns out to be useful information for other researchers that we collaborate with across the country—by having such a guide available, they know the best times to try to contact us directly.

Practical Issues • As discussed above, translators from software we typically use to prepare course materials are extremely useful. Examples include TextToHTML (freeware for the Macintosh) that can convert Microsoft Word documents (or any word-processing software that can save files in rich text, or RTF, format) to HTML. The major drawback of these translators is that embedded graphics are not dealt with in a simple manner. One typically needs to deal with them separately (converting them from their original format to gif or jpeg) and then either embedding them or including links to them from the converted HTML file. Currently, however, large strides are being made to address this problem. For example, Microsoft has made available tools that work directly with Microsoft Office—for example, "Internet Assistant," available at

http://www.microsoft.com/word/work.htm

HOMEWORK, QUIZZES, AND EXAMS

Weekly homework assignments were distributed both in class and on the Web. When students would ask if we had an extra copy of the homework, we would tell them it could be downloaded from the Web at their leisure—about half-way through the semester they stopped asking. Solutions to the homework problems were also available on the Web, as an aid in solving the assigned problems. Having the solutions available on the Web meant that students could access them when they were most needed—the night before the homework was due and after the library had closed.

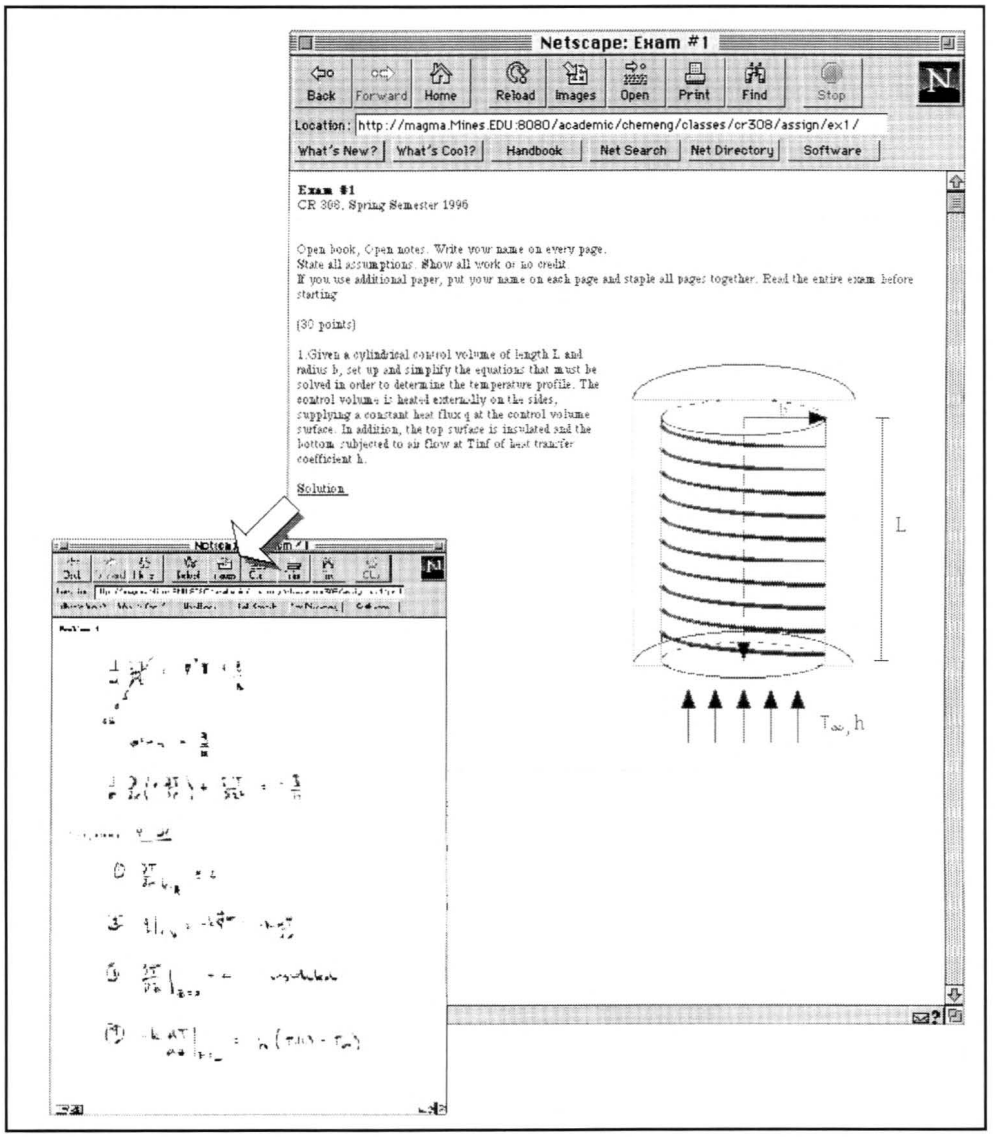

Figure 2. *Clicking on the solution link displays scanned image of problem solution.*

Quizzes were typically given biweekly, and if a quiz were delayed, an announcement to that effect would be placed on the class home page. Quiz solutions were also posted on the Web, just as the homework solutions were.

As far as midterm exams were concerned, the exam and its solutions were posted on the Web after the test had been given (see Figure 2). From the usage statistics, however, it is clear that many students still preferred to obtain solutions by photocopying them from the library, as opposed to getting them off the Web. The motivation for this is unclear—whether it is just a habit that will change over time or if it is simply easier to go to the library and photocopy as opposed to logging onto a computer.

Practical Issues • There is presently no real standard for Internet browsing software or the computers that run them. Currently, Netscape controls about 85% of the market, so the pages we have written are designed for it.[1] For text-based solutions there is no problem since text typically comes across clear and easy to read on any browser capable of accessing the class home pages. Many of the solutions for the un-

dergraduate heat transfer course, however, are equations or mathematical derivations, and there is currently no HTML standard for marking up equations (although this should change when HTML 3.0 becomes available). Subscripts and superscripts are supported with the <sub> and <sup> commands, respectively, but a comprehensive math environment has yet to be incorporated. Current plans call for equation commands in a flavor similar to LaTeX to be incorporated into this environments (in fact, there is a converter available called math2html that will convert equations typeset in LaTeX to HTML 3.0). Until the full math environment is incorporated into the most popular browsers, however, writing equations in HTML 3.0 will make little sense. Currently, therefore, the process involves writing out the solutions and then scanning them into the computer as an image file for display on the Web (gif and jpeg are the most common formats). These images can appear quite different on different computers with different browsers and different monitors of differing resolutions. This makes displaying solutions for all users in a readable and printable fashion extremely difficult. Our final solution was a compromise arrived at through an iterative process involving feedback from students with widely differing setups. For those who prepare their documents using LaTeX, another solution is available—the LaTeX2HTML converter found at

http://cbl.leeds.ac.uk/nikos/tex2html/doc/latex2html/latex2html.html

This application will convert the entire document to HTML, including equations, not through the markup expected to be available in HTML 3.0, but by converting them into graphic files that can be directly incorporated. Most of us, however, do not prepare our homework assignments and solutions in LaTeX, so we eagerly await the full incorporation of the new standard into Netscape and the other popular browsers.

A side note about the full implementation of HTML 3.0 is that the only browser that includes this is Arena, available at

http://www.w3.org

This browser, however, is not intended as commercial software and is currently used only for development of future standards.

GRADES

Grades, including homework, quiz, and exam scores, are posted on the Web. This allows students to check and keep track of their grades throughout the semester so there will be no surprises when the course is over. Other incorporated amenities include test grade distributions and graphs.

Practical Issues • Students may not want their grades posted in a public place. At CSM, student scores at the end of the semester are posted outside professor's doors via their student numbers. It doesn't seem prudent to use these to post their grades to the Internet, so grade numbers were randomly generated instead. Also, to further make grades inaccessible to those who have no particular need to peruse them, access to this part of the class home page was limited to our local domain,

mines.edu

For httpd servers, the process can be a relatively simple one. One need only create a particular file within the UNIX directory in which access for Internet users at large is to be prevented (see Figure 3). Preventing access in this manner, however, has a disadvantage in that students accessing the class home page from home using an outside vendor (Compuserve, etc.) will be unable to see their grades.

In regards to grade preparation, spreadsheets are a convenient way to keep track of scores, and there are tools available for translating such documents into Web-based files. Specifically, translators from Microsoft Excel to HTML are available—two examples include XTML (shareware) and CSV-to-HTML (freeware), both available on the net at

http://www.shareware.com

FEEDBACK

One of the interesting things that can be done with the latest browsers is the incorporation of forms into Web pages. Properly designed, this capability can be used to solicit anonymous feedback from the students (see Figure 4). The opportunity to deliver anonymous feedback to an instructor can be taken advantage of, however, particularly in an undergraduate course. For the most part though, feedback was quite positive and was typically directed at getting us to do more demos in class. Having such feedback during the course, as opposed to the end of the course, allows incorporating suggestions in a timely fashion. If an anonymous feedback form is used, we suggest that a response section also be included to allow for replies to the concerns submitted as feedback.

To limit access to a specific unix directory within domain *mines.edu* create a file named ".htaccess" which contains:

```
AuthUserFile /dev/null
AuthGroupFile /dev/null
AuthName Example
AuthType Basic

<Limit GET>
order deny,allow
deny from all
allow from .mines.edu
</Limit>
```

Figure 3. *Limiting access.*

Practical Issues • Setting up a form for the course home page is a little more difficult than standard HTML markup. It requires not only preparing an HTML document that can handle the entering of data, but also a script (which can be written in perl, for example) that knows what to do with the data once it is entered (such as forwarding it as mail). Details of this procedure are beyond the scope of this article, but are covered in many newly available references on Web publishing.[10] Using a template

available from these references, one can design a feedback form that readily sends the anonymous information. One word of warning, however, is that such scripts can be vulnerable to attack and must be carefully written before being published on the Web. Additionally, and as with the course grades, access to the feedback form was limited to the local domain to prevent anonymous feedback from non-CSM students.

STUDENT USE

Figure 5 shows the results of a survey given to the students

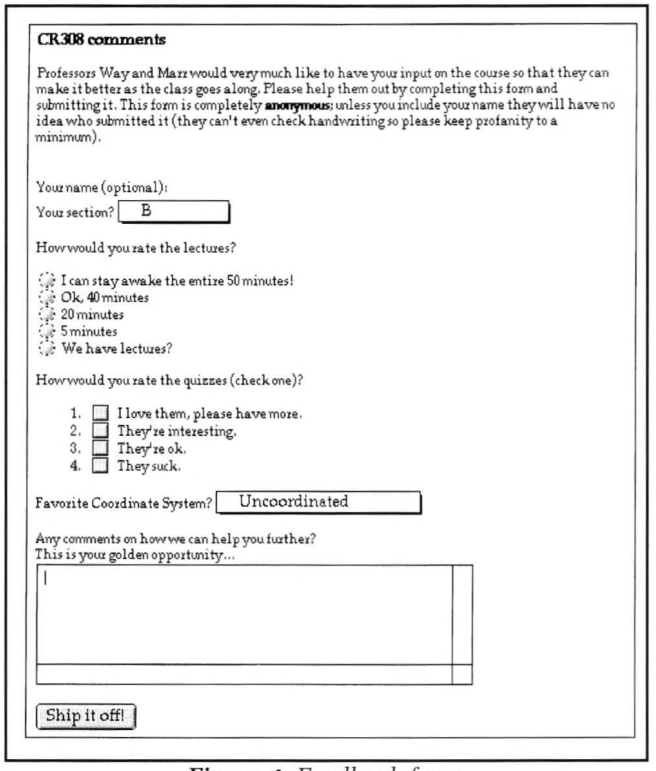

Figure 4. *Feedback form.*

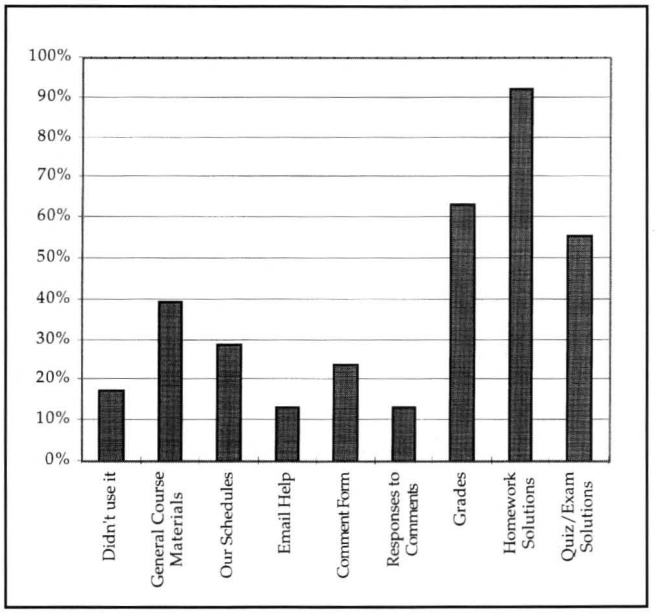

Figure 5. *Student-use statistics.*

concerning how they actually used the class information published on the Web. Of the students in the class, about 20% did not use any of the Web features; of the other 80%, the three most popular features were access to homework solutions, access to grades, and quiz/exam solutions. Other features were clearly less frequently used by the students, e-mail help being a notable example. It may just be too difficult to formulate a cogent question concerning a homework problem via e-mail.

SUMMARY AND CONCLUSIONS

We have described both the methods necessary to use the intranet and the available Web browsers to disseminate information to students in an undergraduate chemical engineering course. Many freeware or shareware conversion utilities are available on the Internet to convert course materials prepared using standard word processing and spreadsheet software to the necessary HTML format. These tools greatly simplify construction of a course home page, making a highly detailed knowledge of HTML unnecessary.

It appears that many students were eager to take advantage of the course home page features, possibly due to the current public interest in the Internet. Although students in the course were not required to use the Web, many of them did so. Exposing the students to the latest technology and introducing them to such a massive resource as the Web should also prove useful to them in their future coursework. Making students comfortable in understanding and using the computer's capabilities is one of the goals that we, as educators, have to better prepare our students for future employment.

This article and the associated hypertext links are available on-line at

http://www.mines.edu/academic/chemeng/faculty/dmarr/pubs.html

or via links from the CEPR department home page at

http://www.mines.edu/academic/chemeng/

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