

## Developing Web-Based Courses Using an Online Development Guide and Templates

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### Abstract

The impact of the web on engineering and engineering technology education is difficult to predict, but it is safe to say that instructional delivery will change as a result of Internet technology. This paper describes how a traditional engineering technology course can be converted to web delivery using fourteen prepared HTML templates. Seven of the templates use standard HTML scripts, and seven use some advanced scripting techniques, including Dynamic HTML (DHTML) and Cascading Style Sheets (CSS). In addition, various techniques used to deliver course content are discussed, and links to many examples of online courses are provided. A web-based version of this paper with active links to all information can be viewed at <http://cac.psu.edu/~jar14/web/temp.html>. The many active links provided in the online version of this paper offer a much richer resource base for web-course development, and readers are encouraged to use that document if possible.

### Introduction

John Naisbitt's 1982 best selling book<sup>1,2</sup>, *Megatrends*, used a method called *content analysis* to study society and to identify major new trends entering the marketplace. This technique, developed during World War II in order to analyze the conditions in Axis countries, uses the frequency with which a topic is referenced in the media to identify marketplace undercurrents that drive change. If that technique were applied today, the Internet and its associated technologies would be identified as a *gigatrend*. The impact on engineering and engineering technology education is hard to predict, but it is safe to say that the delivery of instruction will change as a result of the World Wide Web (WWW). This paper describes a minimal HTML scripting process that any faculty member could use to move instructional content from a traditional lecture course to the web, using a set of course templates. In addition, the paper compares technologies used to deliver content over the web and discusses the resources<sup>3</sup> available to the web course developer. A web-based version of this paper with active links to all information can be viewed at <http://cac.psu.edu/~jar14/web/temp.html>. The many active links provided in the on-line version of this paper offer a much richer resource base for web-course development, and readers are encouraged to use that document if possible.

### Web-Based Instruction - Advantages

The issue with any new instructional delivery mode is improved levels of learning for the students. Clearly, web-based courses offer advantages in access to course information, in

providing links to a wider resource base, in providing an asynchronous delivery mode, and in handling administrative tasks. While these advantages do not guarantee increased knowledge, they do remove impediments from the learning process. However, for some courses, access to information from across the world enhances the content. Also, the opportunity for a greater understanding of concepts is present in situations where the WWW provides access to learning resources beyond that possible from a classroom or single-campus site. In addition, detaching course information from a rigid lecture schedule provides the opportunity for students to work at their own rates and time schedules.

The ability to deliver course material to a wide range of operating systems, like UNIX, Windows, and Macintosh, from a single source is a major advantage that the web offers. In addition, the software or browser to view the course material is free and supports the display of multiple file formats without the need for the software that created the original document.

One of the two major disadvantages of web delivery is the static nature of HTML scripted pages. Instructors familiar with instructional technology software, such as ToolBook, Authorware, and Hypercard, would find the basic scripting languages for the web limiting. To overcome this shortcoming, the developers of the major technology software systems are making provisions to migrate their material to the web, and current web developments, like Dynamic HTML (DHTML) and Cascading Style Sheets (CSS), will give web pages dynamic characteristics. A second major disadvantage to delivery of course material in the non-traditional mode is the development time required. While the templates provided in this paper will not remove that impediment, they will reduce significantly the time required to migrate basic course material to the web.

## **Publishing on the Web**

Web publishing starts with the identification of the course. While moving some courses to the web makes good pedagogical sense, not all courses are suited to web delivery. Educators often ask if courses suitable for web delivery have common characteristics. Courses that require the use of computers and software in the learning process are good candidates for web-delivery because the students use the computer as a natural course interface. Another characteristic that supports a shift to the web is the level of information delivered. After the course is identified, the following five activities are required:

1. Organize the course material to maximize the impact on learning when the material is ported to the web.
2. Create a course script in the HyperText Markup Language (HTML).
3. Locate a server on the WWW.
4. Move the document up to the server and test.
5. Maintain and update the course.

Much of the work associated with step one is completed if the course is currently taught in the traditional lecture mode. Materials used in the current course, like lecture notes, printed material,

audio tapes, graphics, and still and video images, can be used in web delivery because the web offers the opportunity to integrate text, still graphics, animation, sound, and full motion video into instruction. The quality of web-delivery of these five types of instructional content is quite varied. The delivery of text information is excellent, still graphics and animation are good, sound is possible, but the practical delivery of full motion video for teaching is not yet present.

Another critical organizational issue is the strategy used for movement through the course material. In the traditional delivery mode, it is easy for the teacher to maintain full control of the pace and direction of movement through the course content. However, web courses become non-linear, and student movement through the course must be carefully planned and controlled with sufficient and effective navigational aids. The ability of students to move along different instructional paths as they navigate the material makes it difficult to verify that every topic was covered. In addition, the course designer must make sure that the learner does not get lost in a jungle of hypertext links among related materials.

The work associated with step two, creating a course script in the HyperText Markup Language, is the most demanding because it is not uncommon for a course to have hundreds of HTML pages. Links to fourteen course templates in HTML are provided in this paper to reduce the level of scripting required. Seven of the templates use basic HTML scripts to support delivery of basic course information, and seven have JavaScript, Dynamic HTML (DHTML), and Cascading Style Sheets (CCS) added to enhance the delivery of the course material. The links for the templates are provided below, with additional links to examples of course material. The empty course templates include prompts for the location of the course information. An introduction to engineering technology course, developed at Penn State Altoona with these templates, is identified through page links, and a second set of links points to good HTML page examples at other universities.

- Course title page
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/indexp.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/aindexp.html>
  - ◆ Course example <http://cac.psu.edu/~jar14/et002/home.html>
- Announcements
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/news.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/anews.html>
  - ◆ Course example <http://cac.psu.edu/~jar14/et002/lbnews.html>
- General course information
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/syllabus.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/asyllabu.html>
  - ◆ Course example <http://cac.psu.edu/~jar14/et002/syllabus.html>
- Course schedule
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/topics.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/atopics.html>

- ◆ Course example <http://cac.psu.edu/~jar14/et002/topics.html>
  
- Course units
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/tutorial/u1notes.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/tutorial/au1notes.html>
  - ◆ Course example <http://cac.psu.edu/~jar14/et002/units/u1notes.html>
  
- Course exercises
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/exercise/u1exe1.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/exercise/au1exe1.html>
  - ◆ Course example <http://cac.psu.edu/~jar14/et002/units/u1exe1.html>
  
- Grades
  - ◆ Regular template <http://cac.psu.edu/~jar14/web/htemp/exercise/u1exe1.html>
  - ◆ Enhanced template <http://cac.psu.edu/~jar14/web/htemp/exercise/au1exe1.html>
  - ◆ Course example <http://cac.psu.edu/~jar14/et002/units/u1exe1.html>

When loaded with course information, these page templates replace many of the traditional course functions. For example, the *Course Title Page* provides an entry point to the course and represents the classroom. Another requirement in every course is a mechanism to support a dialog between the teacher and students for announcements, questions, and general information. The *Announcement Page* supports that requirement. The *General Course Information* page is similar to a traditional course syllabus. The *Course Topics, Units, and Exercises* pages include the course content, and the *Grades* page is an on-line grade book with a final grade projection feature. The grade sheet starts with the highest possible grade applied to every assignment and test. As assignments and tests are completed, the maximum grade, illustrated in red, is replaced with the actual grade earned, illustrated in black. Therefore, at all times students can see what work is recorded and the theoretical maximum grade achievable in the course.

The last three activities in establishing a web-based course include: *locating a server, moving the course to the server and testing the course, and maintaining the course*. Many schools have a web-server that is available for course pages. If that is not available then it is not difficult to install a departmental server for the support of web-based courses. The cost of a computer configured to serving up pages on the web is not much greater than the cost of a good desktop system. Moving the course pages to the server and maintaining the course material requires that the author have file transfer protocol (ftp) capability to the server where the course resides. A situation in which all web pages are delivered on disk to the webmaster for placement on the server should be avoided. If one does not have direct access to course pages for updates and changes, the time required to launch a functioning course will be extensive.

## Publishing Other Course Elements

The course elements covered in the previous section include the minimum information required for the delivery of a course. However, in most engineering and engineering technology courses additional learning activities are present, including:

- Delivery of problem sets and example problems
- Analysis of case studies
- Development of problem solving skills through exercises
- Development of team building skills
- Performance of laboratory experiments

Each of these additional course elements will be addressed, along with suggestions and examples illustrating how these various activities might be moved to a web-based course.

***Delivery of problem sets and example problems:*** Technical courses usually require solution of design and analysis problems. The most direct solution for web delivery of problem sets is to reference end-of-chapter problems and sample solutions in the course text or in other reference texts. An example of this approach is found at <http://cac.psu.edu/~jar14/et002/exercise/u5exer1.html>.

Another approach is to place links in the web course to documents stored on the server. Browsers can download most application files and launch the local application to display the document. For example, a problem set developed in MS Word can be downloaded by students and viewed with their local Word application software. If the file is a text file it can be viewed by any text editor. To see an example of this technique visit the assignments section at <http://www.eas.asu.edu/~roedel/ece300s97/index.html>.

***Analysis of case studies:*** Case studies can be delivered with the same techniques that are used for problem sets. In addition, Adobe Acrobat software provides an excellent solution for delivery of course content. The course author uses the Acrobat software to convert most application documents into an Adobe format that can be viewed by the students' browsers, using a free Adobe Acrobat reader. Before viewing the case studies, students must download this Adobe Acrobat reader, available without charge at <http://www.adobe.com/prodindex/acrobat/main.html>. Examples of this type of course delivery are available at:

- PowerPoint transparencies <http://cac.psu.edu/~jar14/web/chapter4.pdf>
- MS Word document <http://cac.psu.edu/~jar14/web/eudoradoc.pdf>
- MS Excel spreadsheet <http://cac.psu.edu/~jar14/web/comgrade.pdf>

The advantage of the Acrobat format is that file size is reduced by compression during the transfer to the .pdf format. For example, the file size for the Acrobat version of the MS Word document was 79k bytes, while the original document was 794k in size. This smaller file size translates into faster downloads over the web and reduced need for fast modems. In addition, the Acrobat format compresses the documents into a single file. For example, when the PowerPoint

transparencies were saved in HTML format for use on the web, they produced twelve separate files that had to be transferred to the server. In contrast, the Acrobat conversion produced a single file that was significantly smaller and displayed the foils with all of their original styles, graphics, and colors.

***Development of problem solving skills through exercises:*** Since teaching students to be good problem solvers in the traditional classroom is always difficult, delivering that same instruction over the web is a real challenge. Many of the techniques used in the previous sections can be used here. In addition, interactive problem solving exercises can be developed with scripting languages like JavaScript and VBScript. A University of Tennessee - Chattanooga example of a web-based process control course is found at <http://chem.engr.utc.edu/Documents/Web-course.html>.

***Development of team skills:*** Building team skills is as difficult as teaching problem solving in a web-based application. Several approaches can be used, including teams linked by Internet mail working on common problems; *progress design exercises* in which each team member works on a portion of the design before passing it electronically to the next team member; and use of chat software technology to permit group interaction on a problem.

***Performance of laboratory experiments:*** The most difficult aspect of teaching engineering/engineering technology courses online is delivering the laboratory experience. The creation of a virtual laboratory online that delivers equal or better experiences than a physical laboratory is difficult to achieve. A second example from the University of Tennessee - Chattanooga, illustrating a web-based process control laboratory, can be found at <http://chem.engr.utc.edu>.

## **Other Course Requirements**

In addition to the course elements addressed earlier, three operational areas need to be examined:

- Collecting student feedback
- Providing for student and instructor interaction
- Satisfying the social needs provided by the traditional classroom

Courses taught in the traditional mode do provide these important student communication needs, and a web-based course must also contribute these elements. The use of forms on the web offers a good opportunity for collecting student feedback. The student information form and the course evaluation form in the following links illustrate how to collect student feedback online:

- Student information <http://cac.psu.edu/~jar14/et002/exercise/ulexer1.html>
- Course evaluation <http://cac.psu.edu/~jar14/et002/lbnews2.html>

E-mail is used frequently in web-based courses for interaction between individual students and the instructor. Another web application, the list serve, is used for interaction between student

groups and the instructor. In a list serve the input from anyone on the list can be broadcast to the entire group, in the same manner that e-mail is sent to group of recipients. Both techniques are easy to use and to set up. Replicating the social aspect of the lecture room is not possible when students are separated by fiber optics and copper. However, the use of chat sessions does permit the exchange of dialog in real time, similar to a classroom situation.

Moving the basic elements of the traditional engineering/engineering technology course to the WWW is not difficult if page templates are used. However, transferring the other course elements and requirements, which were described earlier, to the online mode requires the use of additional resources.

### **Web Development Resources**

A unique aspect of the web is that the resources necessary to generate an online course are available online. Viewing these resources is far better than describing them; therefore, a link to a web page with an extensive resource index is the best place to start. For links to a wide variety of web development resources, visit <http://cac.psu.edu/~jar14/web/resources.html>.

### **Conclusions**

The movement of learning from the lecture hall to the World Wide Web has begun to intensify. To participate in this pedagogy, the instructor starts with the migration of the basic course elements to a web server. This process becomes easier when the templates identified in this paper are used. The development of the web-based course then becomes an evolutionary process, through regular enhancements to the course pages, using techniques like JavaScript, ActiveX controls, and applets that are packaged for specific effects. As the web continues to develop, resources and tools will become available to add additional functionality to the web-based course. Some of these tools have begun to emerge in the HTML 4 specifications, in the form of Dynamic HTML and Cascading Style Sheets. The web is leading the way to the virtual classroom.

### **References**

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## **Biography**

JAMES A. REHG – James Rehg received B. S. and M. S. degrees in Electrical Engineering from St. Louis University and has completed additional graduate work at the University of South Carolina and Clemson University. Since August 1995 Jim has been working as an assistant professor of engineering and the Program Coordinator of the B. S. program in Electro-mechanical Engineering Technology at Penn State Altoona. He is the author of five textbooks, including the following books published by Prentice Hall: *Introduction to Robotics in CIM Systems* and *Computer Integrated Manufacturing*.