Development of a Web-Based Environmental Impact, Monitoring and Assessment Course

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The information revolution has had a dramatic effect on engineering education in the 1990's. Educators and students alike have witnessed a dramatic shift from traditional teaching methods and tools to a new, innovative, interactive approach. What began as the simple use of computers and information technology for student projects has developed into the large scale use of computer software demonstrations, multimedia lecture presentations, World Wide Web and on-line course materials, and educational materials placed on CD-ROM.

This paper addresses one ongoing effort to develop World Wide Web and multimedia educational materials for courses in Civil and Environmental Engineering at the Georgia Institute of Technology. This specific project reported here is the development of a Web-based environmental impact assessment course. Many different types of educational materials for the course are being provided to students via the World Wide Web. These materials include: course readings, on-line government regulations and documents, public domain computer models and hands-on modeling assignments, case studies, research paper assignments, and midterm and final examinations. Additionally, lecture overheads and instructor's notes, prepared in Microsoft PowerPoint, are provided over the Web for use as speaking notes in the classroom. This paper outlines the integration of computer technology in the classroom and the development of the electronic version of the syllabus and course readings.

Introduction

Over the past ten years, university and professional extension engineering education programs have increasingly offered environmental education. Scores of Civil Engineering programs throughout the nation have expanded their curriculum focus to become Civil and Environmental Engineering programs during this period. When the University of California at Davis changed the name of their program to Civil and Environmental Engineering, more than 100 change-of-major applications were received, even though the program requirements and course content did not change at that time.

The increased demand for environmental education in all engineering disciplines is not surprising. Environmental law, regulation, and policy drive many of the engineering tasks associated with civil infrastructure projects. The tremendous knowledge base associated with environmental law and regulations cuts across all engineering disciplines. The ability to understand these complex environmental issues and regulatory requirements, and to identify associated environmental resources provides a distinct advantage to practicing engineers.

However, there is a staggering amount of information associated with environmental regulations that must be understood when proposing and building projects.

Undergraduate university programs in civil engineering and city planning typically do not provide enough opportunity for students to gain practical knowledge in environmental regulation and policy. New concepts in environmental planning are introduced every year, but these undergraduate programs are under pressure not to add additional content beyond their current four year programs. Hence, this material is usually learned by graduates under the tutelage of supervisors once they have their first professional job. This gap in environmental knowledge provides a unique opportunity for educators to explore the use of evolving technologies as a basis for introducing students and professionals to necessary knowledge in the environmental impact assessment arena. In response to this opportunity, this paper describes the World Wide Web multimedia course being developed at the Georgia Institute of Technology to focus on environmental impact assessment. Innovative education technologies can support university and lifelong learning initiatives in both the public and private sectors. This paper describes the technologies brought to bear in delivering this new course over the Internet.

The Environmental Impact Assessment Course

The Environmental Impact Assessment course explores the key policy, planning, and methodological issues in the environmental impact assessment of engineering systems. The course covers a wide variety of topics, including an overview of environmental law, the National Environmental Policy Act (NEPA) and the EIS process, wetlands and wetland regulations procedures and mitigation practices, noise impact assessment, air quality regulations and modeling, Federal Highway Administration (FHWA) Section 4f regulations and analysis, Endangered Species Act requirements, and socioeconomic, historical, and cultural impacts. The course emphasizes both the regulatory aspects of environmental analysis as well as the analytical techniques employed in environmental impact assessment. Successful civil engineering in today's world depends to a large extent on addressing environmental considerations. Thus, the course emphasizes the incorporation of environmental considerations into the engineering design process. Student performance is evaluated based upon a midterm, a number of computer modeling assignments, a research paper (submitted electronically), and a final examination.

The course is an undergraduate civil engineering service course, open to all civil engineering students (as well as students outside of engineering). The course is an elective, so undergraduates are not required to take the course. Under the current quarter system, approximately 75 students take the environmental impact assessment course each year. Of these students, approximately 20% are juniors, 40% are seniors, and 40% are graduate students. Roughly 30% of the students taking the course are from outside of civil engineering.

Web Delivery of the Course

Hypertext Markup Language (HTML) provides the capability to integrate text, graphics, and multimedia files into a single visual framework (Levine and Baroudi, 1994). Course lectures, readings, graphics, and links to external Internet reference sites can all be integrated into a hypertext document (or series of linked documents) that can be viewed using a Web Browser

software package such as NETSCAPE. In general, a home page (or basic page from which all other pages can be accessed) contains a text/graphic display of the topics that are available on the host computer (Guensler and Bernstein, 1996). By pointing and clicking with a mouse, users are allowed to jump from document to document, and even from computer to computer.

Any existing text document can readily be converted into hypertext markup language. There are a wide variety of commercial computer software packages available at the local computer superstore that can be used to accommodate the conversion. However, individuals interested in developing Web materials really should become familiar with the actual hypertext formatting codes. Lemay's (1995) "Teach Yourself Web Publishing with HTML in 14 Days," provides a clear and concise primer on how to prepare Web pages.

The environmental impact assessment course home page is an icon matrix, where each icon is linked to separate pages for: 1) the course syllabus, 2) online lectures, 3) course reader, 4) course assignments and examples, 5) current grades, and 6) World Wide Web resource links. The separate pages provide information predominantly in a bullet or unnumbered list format, or links to viewable files. The index page is the default file accessed by viewers visiting the course Web site and this file links to all other directories and files provided for the course. Yet, the course syllabus file serves as the primary interface document for students. Almost all of the Web pages for the course can be accessed directly from the syllabus page. To provide a clear and logical organization for the students, the syllabus is organized around course week number and lecture topic.

Course Syllabus

The course syllabus on the Web contains all of the standard course information such as: the course introduction, administrative details (course location, instructor, office hours, etc.), assignments, and other miscellaneous information. The syllabus also provides direct links to all of the course materials, including: the course reader, hands-on impact modeling assignments, research paper assignments, and course resources. The syllabus contains a detailed week-by-week breakdown of class topics and assigned readings. Links to all of the course files are therefore provided on a topic by topic basis. To conveniently organize the material on the server hard drive, separate subdirectories are employed for each topic. This way, the course administrator can readily find specific files that may need to be modified. The example below shows how three weeks of the class are organized on the syllabus. Bold text indicates a hypertext link to the appropriate lecture materials and assigned readings that can be viewed by pointing and clicking on the highlighted text.

> **Course Introduction and Introduction to Environmental Law**
> Week 1, Lecture 1
>
> **The National Environmental Policy Act**
> Week 1, Lecture 2; Week 2, Lecture 1
> *Reading:* Bass and Herson (1993); Mastering NEPA, Chapters 1&2
> **National Env. Policy Act; 42 USCA 55; §§ 4321 to 4370d**
> **Council on Env. Quality Regulations; 40 CFR 1500-1517**

Council on Environmental Quality ; 40 Questions

Environmental Impact Statements
Week 2, Lecture 2; Week 3, Lecture 1
Reading: Bass and Herson (1993); Mastering NEPA; Chapters 3-6
Sculley; A Basic Strategy for EIR Preparation

The Role of Environmental Analysis in Transportation Projects
Week 3, Lecture 2
Reading: **FHWA, Environmental Flow Charts**
FHWA; Summary of Selected Environmental Legislation
FHWA; Environmental Policy Statement Memo

The course textbook is not online, due to copyright restrictions. Students still purchase a paper copy of the textbook from the publisher. Federal and state public domain guidance documents are provided directly by the course Web server. That is, the instructors have already downloaded the appropriate documents to the server computer so that and the students can access them locally (the rate of data transfer is faster on the local network, so students save time in downloading information to their own computers). However, these documents could have been provided simply by providing a hypertext link to the existing government sites and requiring the students to download the documents directly from these sites to their own computers.

Course Reader

The vast majority of the environmental impact assessment course reader is composed of government documents. A wide variety of these documents provide regulatory guidance. The course reader index page consists of an unnumbered reference list for all course readings. Each of these reference list entries is hyper-linked to the actual document if it is available online. These documents are provided by the course web site either in hypertext, Microsoft Word for Windows, or Portable Document Format (Adobe Acrobat). Adobe Acrobat Reader software (the software to read, but not to write, portable document format) is pubic domain and available direct from the Adobe home page (http://www.adobe.com). Students are instructed to download and install the Acrobat reader. Students using Windows 95 will find that MS Word or Adobe Acrobat will launch automatically when the linked document name in the reference list is clicked with the mouse. This is because the files ending in "*.pdf" and "*.doc" are "associated" with the Acrobat and Word programs respectively.

While public domain government documents can readily be provided online, copyright law requires course administrators to identify the copyright owners and obtain written releases to reproduce and use privately developed material in any course (electronic or otherwise). To obtain a copyright release, a letter is usually sent to the publisher indicating the class and number of students and requesting permission to use the material. Often a separate release must be obtained from the author(s) every quarter that the course is offered. Some publishers require the payment of fees for the permission to reproduce materials, even in an academic environment. Copyright laws clearly apply to all Web-based material. Permission must be obtained and the name of the copyright owner and copyright date must be clearly indicated on any material

presented on the Web. More information on copyright law can be obtained on the Web (http://fatty.law.cornell.edu/topics/copyright.html).

There is still a great deal of hesitancy on the part of publishers and authors to provide copyright releases for material that is to appear on Web sites, perhaps in part because copyright owners fear they will more easily lose control over electronic versions of their material. Hence, government documents are generally preferred when available. For the course described in this paper, case studies are currently being developed in-house to supplement the existing public domain course resources.

Because individual student access to the Internet can be limited by services or connection speeds, the reference material for the environmental impact assessment course will also be made available on CD-ROM in the Fall. This additional method will allow large files to be viewed on any computer without time-consuming data transfer procedures. The authors are currently in the process of scanning additional lengthy government guidance documents (such as the Army Corps' Wet 2.0 Wetlands Delineation Manual), various permit application forms and procedures, and detailed case studies that supplement the existing electronic material into a format appropriate for CD-ROM.

Lecture Delivery

Lecture overheads are prepared in Microsoft PowerPoint for Windows 95 and then converted into Hypertext format using the Microsoft Internet Assistant for PowerPoint. The Internet Assistant package converts the series of lecture slides into a linked set of images, complete with hypertext links forward and backward between slides (Figure 1). The Internet Assistant for PowerPoint can be downloaded from a Microsoft Web site (http://www.microsoft.com/msoffice/mspowerpoint/internet/ia/).

The lecture overheads serve as the instructor's talking points in the classroom. A portable computer (IBM 760) equipped with an Ethernet PCMCIA card provides an active connection in the classroom to the Internet and the course Web site. The computer is then connected to a projector unit (e.g., Polaroid's Polaview Projector) so that everything received by the computer and displayed on the computer screen is also projected to a classroom screen. Using a web browser (NETSCAPE or Microsoft Internet Explorer), the overheads are presented in class and serve as the outline for the course lecture. When classrooms are not equipped with an Ethernet connection, the PowerPoint files can be used directly. For non-classroom use, the lecture overheads can be augmented with course instructor's notes. In this way, students that miss a lecture can obtain additional information that is normally presented orally in class.

The PowerPoint Internet Assistant allows the files to be exported in black and white or color, in either a JPEG or GIF format. In general, the GIF format is preferred, even though the files are larger, because the JPEG format uses a "lossy" compression algorithm. That is, if the JPEG images are edited repeatedly in a graphics program such as Photoshop, the image quality will degrade slightly each time the image is saved. However, if the material is to be delivered to users over a modem connection to the Internet, and files are not being edited later in a graphics package, a high resolution JPEG format can be used to keep file sizes smaller.

The PowerPoint software exports one hypertext file and one graphic image file for each slide image (plus an index for the set of slides). So, a 20 slide presentation results in 41 files. Because each lecture may contain numerous slides, it is helpful to prepare separate subdirectories for each lecture. Each individual slide is provided a link from the index slide, and each individual slide contains links to the first, next, and previous slide.

The physical size of the images created by Internet Assistant is a function of the monitor's settings at the time the slides are made. Most projector units operate at 640x480 resolution display. The authors have found that 640 x 480 slides display best when they are created on a machine with a display resolution set to either 1024 x 768 (which creates large slides, but puts page forward and page backward toggles below the visible part of the screen, requiring multiple mouse clicks to move forward or backward) or 800 x 600 resolution (which creates a smaller slide display, but does leave the page forward and page backward toggles visible on a 640 x 480 screen). Figure 1 contains an example of a slide created on a machine set to 800 x 600 resolution and displayed at 640 x 480 resolution. Author notes (normally only displayed on a PowerPoint presentation when the slide is viewed in the PowerPoint "notes page view") do appear on the new Web slides. Creating slides at a high resolution helps to keep these notes from appearing on the 640 x 480 screen. When the slide is displayed, the notes can still be viewed by paging down with the mouse.

Internet Links

On-line government regulations and documents, public domain models, and case studies are the primary files that students are encouraged to download from the Internet. The Web sites for all of the federal government agencies that implement the National Environmental Policy Act are hot-linked from the Internet links page. The specific regulations are highlighted in the links, as well as appropriate guidance documents. Emissions impact assessment models and manuals are identified in the links, and where appropriate the software is downloaded for students to access directly.

Electronic Mailing List

This Fall, the course will employ an electronic mailing list to distribute supplemental course materials and will facilitate interactive discussion between students. Mailing lists provide the opportunity to collaborate on work and solve problems with input from others (Guensler and Bernstein, 1996). A mailing list automates message distribution, bouncing all of the e-mail message sent to the server to the mailing list subscribers (students). Majordomo (http://www.inf.utfsm.cl/~marcos/majordomo/) is the software currently used to run local mailing lists for faculty and graduate students in the School of Civil and Environmental Engineering. New course mailing lists are simple to implement. Each student's e-mail address is added to the register of subscribers for the new list. The same course mailing list can be expanded to include students at other universities when the courses are coordinated.

Course Development Support

The development of the site was funded through two internal mechanisms at Georgia Tech. In Fall of 1996, the instructor participated in Georgia Tech's Class of '69 Teaching Fellows Program, where he attended seminars on teaching effectiveness. Georgia Tech's Center for the Enhancement of Teaching and Learning (CETL) provided funding for the purchase of software and hardware to accommodate the development of the electronic syllabus and course reader. The main resources for this effort were provided through a grant from the Georgia Tech Foundation. The university is shifting from a quarter-basis to a semester-basis in 1999 and the instructor was awarded a grant to develop a semester-based equivalent to his quarter course on environmental impact assessment. The Foundation provided the equivalent of one month of faculty release time, two part-time undergraduate student assistants for six months, and the required disk capacity and CD-ROM production equipment.

Initial Deployment

The web site for the course was initially implemented on a Pentium 90 computer running OS/2 and Apache server software in Winter 1997. The first test of the Web site, providing the syllabus and online course readings, was a disaster. The online syllabus worked just fine. The readings, however, did not work well. The computer network available to the students could not accommodate the viewing of large documents in Adobe Acrobat format during the first few weeks of the course. During the fourth week of the course, the Web server went down (and remained down for two and a half weeks) when the hard disk drive crashed. Once a replacement hard drive was obtained and information was recovered from the damaged drive, the Web site was reinitialized on the Pentium 90 under a Windows NT environment. Midway through the quarter, students were making use of the online readings. However, some of the students who did not care for reading the documents on a computer screen opted to print much of the required reading material on the shared network printer. Needless to say, these students were not popular when multiple 50-page print jobs were printing.

The second test of the course, with expanded materials, will be undertaken in Fall 1997. To address the issues identified in Winter 1997, a few changes will be made. First, the network computer cluster used by the students has been optimized for the materials. Second, the course will be made available to the students on CD-ROM, providing them with the flexibility to examine (and print) the materials outside of the shared network computer labs. Students will even be able to print the readings at a local copy shop. Finally, course readings (typically government documents) will be obtained in an original electronic format from the author(s) so that the use of files in graphics format can be minimized.

Evaluating Course Success

Placing a new education technology in the hands of students will only succeed if the tool is utilized. While a course instructor can require students to access basic course materials such as lecture notes, students must independently make the effort to study supplementary materials such as government regulations (El Kordy, 1994). Ongoing assessment and evaluation of the new technology is required to ensure that student concerns and interests are addressed (Chinowsky

and Baker, 1996). The authors will assess the success of the course through surveys and by monitoring specific access to the class Web site:

- Data Access - The number of repeat uses, materials most frequently accessed (and least often accessed), and the case studies reviewed by students will be tracked electronically on the course server. The collected data will be examined to examine the course elements which are receiving heavy use by the students as lecture supplements.

- Case Library Robustness - The storage, access, and categorization of environmental case studies is fundamental to long-term success of case-study teaching methods. Access and use of the electronic case studies will be a key indicator of their value as concept-illustrators. The need to expand this course component will be based in part on monitoring case study use and in part on interviews of students.

- Teaching Effectiveness - While effectiveness of a technology is difficult to monitor for a short-term project, key indicators can be identified through follow-up interviews. Survey data collected from each course offering will be used to determine: material use, potential content changes and improvement, and issues or case studies that should be added to the material.

The data collection efforts will provide the authors with critical information suggesting the system improvements that should be made. Ongoing interaction with both government and academic partners will identify changing student and curricular demands. Assessment results will be used to target electronic course components that should be improved, supplemented, or newly developed.

Conclusions

The World Wide Web can be used to deliver course materials to students very efficiently. The need to reproduce paper copies of syllabi and course readers is reduced, and can in some cases be eliminated. Tremendous amounts of resource material, previously identified by the instructor as "relevant," can be provided for a course at a single location. Plus, the Internet provides a convenient means for student interaction with complex material as well as with each other. However, the resource requirements associated with developing a Web-based course are staggering. All of the electronic material must be assembled, converted and/or created and then carefully organized in proper computer delivery framework. True, once the Web materials are created the burden associated with offering the course is significantly reduced. But the initial startup resource costs are high. New user-friendly software packages such as Microsoft's Front Page and Internet Assistant Packages are making the creation of Web pages easier, but packaging the materials into a seamless product is still resource intensive. The resource requirements for developing Web-based course materials may make cooperative ventures between faculty members and even colleges very attractive.

The initial Web-based environmental impact assessment course described in this paper is focused on helping students understand basic environmental requirements surrounding major engineering projects. The course provides a forum for students to interact with the electronic material

individually and in group projects that are coordinated by electronic communication. The next generation of the course will add an entirely new dimension; the case study. In contrast to traditional lecture formats where material is described at length by the instructor, case study development and reporting provides an opportunity for student self-discovery. After an appropriate introduction to a specific topic, students will review environmental impact assessments, government documents, World Wide Web sites, and will interview regulatory staff to determine the adequacy of the case in question. In this way, a broad spectrum of environmental data will be accumulated and analyzed for various topics covered in the course. This process of self-discovery should increase student understanding and awareness and will also yield additional course materials over time.

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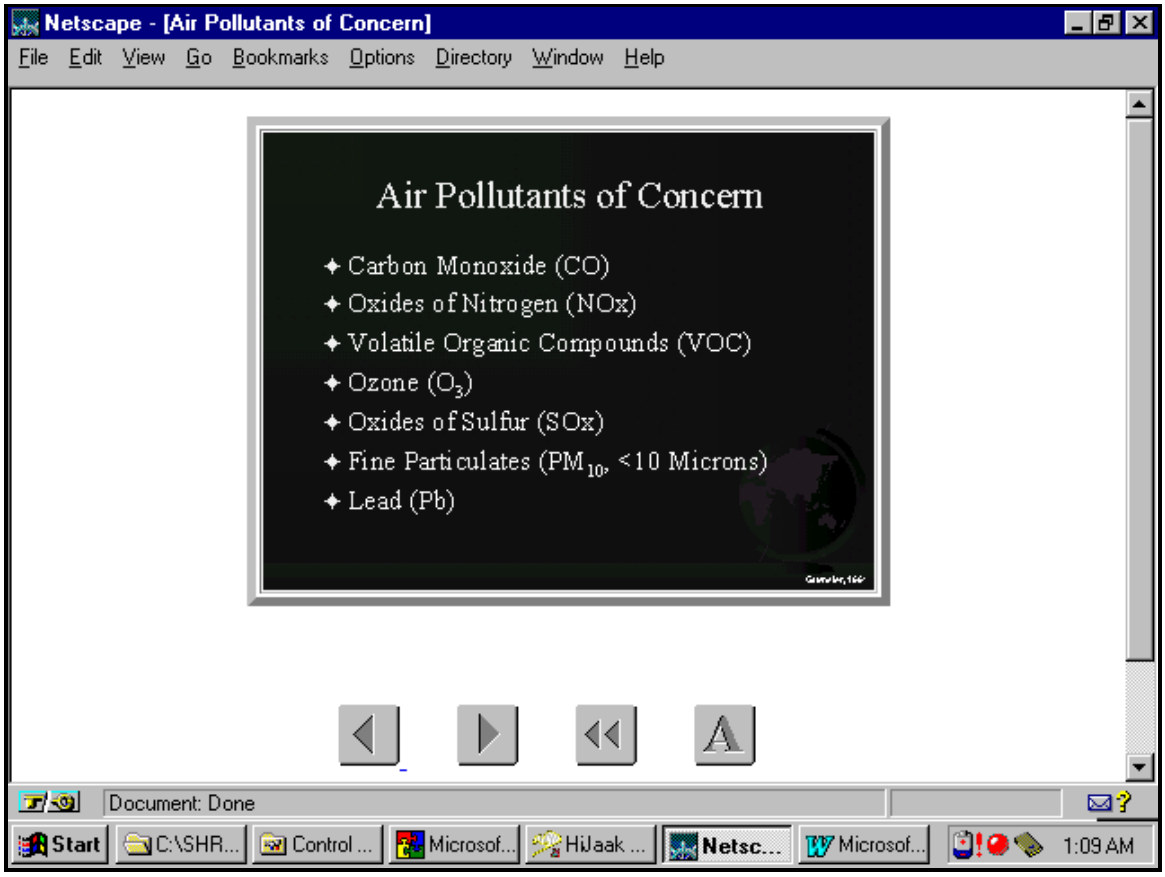
Figure 1
Example of Converted Slide Using Internet Assistant for PowerPoint



Environmental Monitoring and Assessment (MSc). Award. Master of Science.Â Our MSc Environmental Monitoring and Assessment masterâ€™s degree develops the professional skills required for a rewarding career as an environmental scientist in a fast-growing and rapidly-changing industry. Highly skilled environmental scientists are critical for the safe and responsible governance of our environment.Â Your course leader is a data scientist and spatial analyst with research interests in how patterns in environmental factors affect human wellbeing and biodiversity. Visit Dr Patrick Osborneâ€™s staff profile to learn more about his work. â€œI chose to study here because of the modules that I could take. Environmental impact assessment (EIA) has become an increasingly integral part of the industrial and commercial development process in relation to the delivery of sustainable development. This module aims to develop a sound appreciation of the importance of conducting EIA, together with an understanding of the techniques by which this can be achieved. In conjunction with an appreciation of what is happening globally in relation to EIA. Also the environmental assessment of plans and programmes by SEA is considered. The module will be delivered fully online through study materials via the blackb 1 Environmental impact assessments in development cooperation. The sustainable use of natural resources and protection of the environment is one of the fundamental objectives of Swedish development cooperation. This objective shall be an integral part of all Swedish development cooperation - only then can it contribute to sustainable development.Â The environmental, health-related, social and economic aspects of a project are parts of a whole.Â Monitoring and evaluation of the projectâ€™s real environmen-tal effects and that planned measures to reduce negative ef-fects have actually been taken in accordance with the EIA, shall be made together with other monitoring and evalua-tion of the project, during and after implementation (See section 5 below).