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ABSTRACT

The rapid advancement of communication technologies is resulting in a wide array of design and development choices for distance learning projects. The 58th Special Operations Wing at Kirtland Air Force Base, New Mexico, is developing a prototype distance learning project designed to serve geographically separated learner populations. Project staff are designing, developing, and implementing a prototype transportable process for transmitting interactive multimedia curriculum instruction over the World Wide Web to geographically distant locations. This curriculum strategy uses standard computer-based hardware and commercial off-the-shelf authoring and playback software and hardware. Course and lesson content include use of compressed video, digital audio, and graphic animation to deliver instruction and solicit interactive feedback. Among the problems encountered are the amount of time needed to code each frame of courseware and accommodating changes in website addresses. Lessons learned include the following: (1) investment in initial design is crucial; (2) careful consideration of content is necessary due to bandwidth and connection limitations; and (3) not all lessons can be adequately converted to web-based training. (KC)

DESIGNING, DEVELOPING AND IMPLEMENTING WWW-BASED DISTANCE LEARNING

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The rapid advancement of communication technologies is resulting in an overwhelming list of design and development choices for distance learning projects. The 58 th Special Operations Wing at Kirtland AFB, New Mexico is developing a prototype distance learning project designed to serve geographically separated student populations. This project, begun in August of 1996, designs, develops, and implements a prototype transportable process for transmitting interactive multimedia curriculum instruction over the World-Wide Web (WWW) to geographically distant locations. This curriculum strategy uses standard PC-based hardware and commercial off-the-shelf authoring and playback software and hardware. Course and lesson content include use of compressed video, digital audio, and graphic animation to deliver instruction and solicit interactive feedback. This paper details the process used to design, develop and plan implementation for this prototype program, and describes the problems encountered and solutions used to solve those problems. This paper concludes with implementation recommendations for distance learning developers who may be contemplating using this technology.

About the Author

Mr. Pete Riley is an Assistant Professor in the College of Mass Communication and Media Arts at Southern Illinois University at Carbondale. He specializes in the design, development and implementation of multimedia applications and training. He previously worked for Lockheed Martin as a Distance Learning Coordinator/Developer and Courseware Technical Director at Kirtland AFB's Mission Training Support System (MTSS). He has over fifteen years of instructional development and education and training experience ranging from academic and flight instruction to course development, with emphasis on CAI and distance-based multimedia production. His research interests include technology-based solutions for education and training applications. He holds a BS in Workforce Education & Development and M.Ed. from Southern Illinois University at Carbondale.

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INTRODUCTION

A new thrust toward the use of technology-based training and education has emerged in the past 10-15 years. Primarily due to the focus shift within academia and industry from teaching to learning, this graduation toward use of technology is providing opportunity to classes and groups of people previously unreachable except through traditional stand-up classroom instruction means.

The explosive growth of the Internet and World Wide Web (WWW) is now providing a medium and tools by which we can begin to provide training and education. Grimes (1993), describes classical examples of distance-based education and training, such as Isaac Pittman's shorthand correspondence course in 1840. In addition, the University of Wisconsin used the term in its 1892 catalog of correspondence courses.

New methods for delivery of distance education are being searched for daily. Satellite, teleconferencing and instructional television are but a few of the methods available to organizations and universities for distributive learning. These methods are costly, and are not always viable options for everyone. Wiggs and Seidel (1987) noted this when they described the challenge to successfully train military personnel. The complexity of military specialties have continued to increase along with the weapon systems and equipment they employ. Simultaneously, decreases in funding, personnel, training devices and other resources continue to make effective training increasingly difficult to accomplish.

Kemske (1996) addressed a survey that showed that only 12% of companies who use technology-based training are using the internet. Allen Communication (1996) attribute ignorance about the WWW and development tools to this low percentage.

According to Kilby (1996) Web-based training (WBT) is a new approach to distance learning in which computer-aided instruction is transformed by the technologies and methodologies of the World Wide Web and/or intranets. It presents up to date, active content in a structure allowing self-directed, self-paced training in any topic. WBT is media-rich training fully capable of evaluation, adaptation, and remediation, all independent of computer platform.

Kilby (1996) goes on to state that WBT is an ideal vehicle for delivering training to separate locations anywhere in the world at any time. New advances in computer network technology and improvements in bandwidth are ushering in capabilities for virtually unlimited multimedia access. Although primarily focused on Web browser-based training, Kilby's idea that highly effective WBT can be crafted to meet the training needs of a diverse population today appears to be reality.

The current focus of WBT development appears to be on learning how to use the available tools and organize content into effective instructional systems. Instructional designers are still struggling with issues of user interface design and programming for high levels of interaction. According to Kilby (1996) there are few examples of good WBT design visible on the public Internet. However, it is anticipated that increases in WBT capabilities due to technology advancements will quickly make this statement untrue.

PROJECT CONCEPT

The Air Force has been using interactive multimedia at the 58th Special Operations Wing (SOW) in Albuquerque, New Mexico to train crew members for special operations and rescue aircraft since 1990. Since the courseware was designed to be used at external sites throughout the global special operations and rescue community, a delivery process to these units was developed. Previous methods of courseware delivery to units at 16 sites world wide included CD-ROM mailings twice annually, and prior to that, courseware was distributed on 3½" diskettes. The CD-ROM distribution method worked well at first, but it was soon discovered that accommodating aircraft systems and tactical procedures updates was difficult at best. The 58 SOW began to search for different options for

accommodating the learning requirements of its distance students and end users.

The challenge was one of providing accurate, validated courseware to the distance sites without a major cost impact, and using a technology that was available to all locations. A design concept of separating content from structure was researched and proposed. This concept (see Figure 1.) would enable the courseware structure (executable files, large video, animation and audio files) to be developed and written to CD-ROM, while content files (text, small graphics, etc.) would be downloaded real-time from a web server via Transmission Control Protocol/Internet Protocol (TCP/IP) or modem WWW connection. Two problems presented themselves; this courseware would have to be developed using the same (or a compatible) courseware authoring software that was being used at the time, and this courseware would have to run from a browser-based environment.

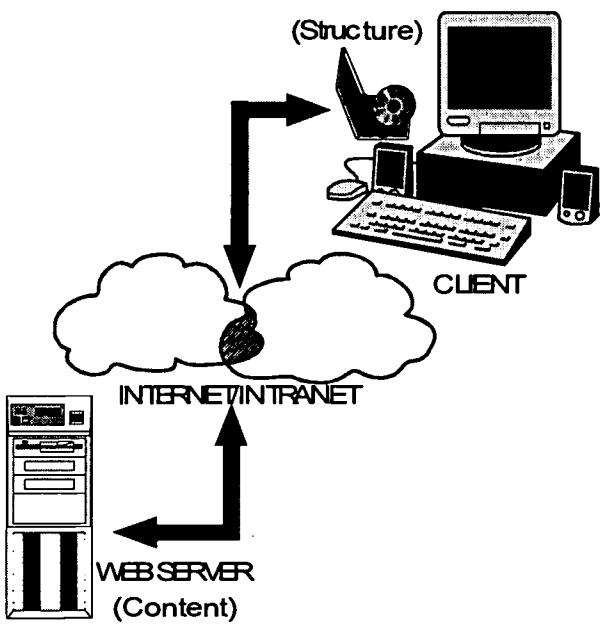

Figure 1. WBT Conceptual Design

DEVELOPMENT

One of the first requirements when addressing any computer-aided training project is to select an appropriate authoring package based on customer requirements. Three different authoring systems were contemplated at the 58 SOW, with Allen Communication's Quest Net+ being selected as the final authoring package of choice. Over 600 hours of interactive CAI had already been developed at the 58 SOW using earlier versions of the Quest product, and paid big dividends with authoring familiarity. In addition, it was (at that time) the only product available on the market that supported all the 58 SOW requirements. It featured the following capabilities:

- Real-time transfer and updating of data and course content. For example, as long as an internet connection can be maintained, updated files can be delivered to the client PC, ensuring up-to-date courseware.

- Peer-to-peer capabilities for team training simulations, distance learning, centralized data tracking, and remote training. For example, not only can this software provide real time updating of files, but it also accommodates connection between students to enable gaming, simulations, or other team training situations.

- Quest objects are available for any internal and extended network. This means that every entity used in the courseware can be used in both intranet and internet training situations.

- Support of TCP/IP and URL file access. Files can be transferred using TCP/IP connection and any web site address, or Uniform Resource Locator (URL).

- Capability to update and add dynamic content to titles during runtime. The distance student or user does not have to worry about his or her courseware becoming outdated. Updates fed through TCP/IP or modem connection are transparent to the end user, and provide a current curriculum.

- Quest titles can read files stored on any web site. With the exception of restricted access and copyright laws, any file, at any available and accessible location on the WWW, can be accessed and used in training.

- Up to the minute data updates to CD titles. This means that the courseware at the client site will only be as outdated as the data on the host WWW server.

Perhaps the biggest plus with selecting the Quest NET+ system was its capability to provide WBT without requiring a web browser. All content downloaded from the internet can be displayed from within each of the Quest lessons. An Internet Service provider (ISP) or TCP/IP connection was all that was required to support the development.

Once the authoring tool was selected, a design concept was sketched out. Initially, the focus was on utilizing as much of the existing courseware as possible, and converting this courseware to a distance-based product. However, this task proved to be more difficult than initially envisioned. The problem was one of keeping courseware updated without having to redistribute additional CD-ROMs or other media. Questions raised during the design brainstorming sessions were:

1. How to determine which content portions would be capable of being updated using the internet as a transfer tool. For example, we did not want to consider updating large video files using the WWW due to the extremely long transfer time requirements.

2. How to accommodate major revisions to these courses if the content change was not enough. For example, if a complete rewrite was required of the course structure, but the content remained fairly consistent, would it be easier to send an updated structure over the WWW, or simply mail out a new structure CD-ROM?

3. What was the easiest method for telling the student that updates were available for the lesson? This question involved possibilities of using e-mail, and an up-front frame within the courseware that provided a text file (transferred from the WWW) indicating that updates were or were not required.

4. Should files be downloaded and stored on the client machine hard drive or maintained in a file cache for each session? These were both viable options. The only limitation to using a cached system was that if a connection could not be made to the WWW, the courseware would not run. Whereas if the files were located on the hard drive, in the event of a loss of WWW connection, the most recent files (prior to that session) would still be available.

Each of these problems were addressed separately. It became evident that perhaps the first consideration was to determine which types of lessons would be best served using this particular WBT design. It was decided that using a templated lesson for aircraft systems would serve as the best prototype. However, this decision soon changed after discovering that certain technical information in the aircraft flight manual was export restricted. Since security solutions had not yet been addressed, it was decided to use a topic that would not be restricted to export or to public release. The topic of "Introduction to Special Operations " was selected, and the design was once again reworked.

Using the Air Force's Instructional System Design (ISD) model, an ISD Management Plan was developed. This plan ensured that a 'roadmap' to keep the ISD process on track for this unique project was maintained. This plan contained the following information:

- Approval dates/signatures
- Definition of the project
- Overall project responsibility
- Individual task responsibility
- Milestones
- Identified constraints
- Support requirements

Once the course design was baselined, development began. Using a URL retrieval scheme unique to Quest Net+, each frame that required data from the web server was given a single line call to the file containing the data on the web server. This permitted quick navigation of the lesson when not transiting frames requiring downloaded data from the web. Two options were considered: download all required update files at the beginning of the lesson, or download the files as they were required. The first option would allow all information to be downloaded at once, but would require a delay of up to 30

minutes (depending on the amount of data to be retrieved). The second option would require coding for the URL retrieval that could be implemented a number of frames prior to the requirement. The data would then be downloaded in the background, and by the time the frame was presented, the data would be available, resulting in very little or no delay to the student. The second method of data transfer was selected over the initial download option of all required files. This decision was made primarily due to the lesson content and the amount of data transferred.

The prototype lesson was built in a modular fashion to allow for ease of future modification and addition or deletion of modules as required. It was important to structure the lesson in this manner so that a 'plug and play' content could be used. For example, if a new module was required to be added to a lesson, the new structure could be downloaded along with the other required files and embedded into the lesson.

The lesson was completed and testing is currently underway using both modem and TCP/IP connections. Transfer rates were tested during development and varied with both the Internet Service Provider (ISP) and TCP/IP methods of data transfer. Average times required (in seconds) for downloading 15 text files, 100k of graphics, and 24k of digital audio (.wav) files prior to running the lesson varied during testing (see Figure 2.) TCP/IP transfer rates varied widely during testing due to inconsistent WWW access speeds and network traffic. At times the connection to the WWW server providing the files would drop, causing the lesson to stop running. This was due to the unreliable TCP/IP connection that was used during testing. It is anticipated that a stable connection using TCP/IP will provide a seamless transfer with no interruption to student training. ISP download time varied based on modem BPS rate, network traffic, and service provider connection quality.

Time for download is not a lesson performance factor since each file is downloaded just prior to being needed. This causes a transparent download time for the end user. In other words, most of the time the student doesn't even realize data is being downloaded for use since this happens in the background. On some occasions, when transfer rate is very slow, there is a noticeable delay in retrieving the file.

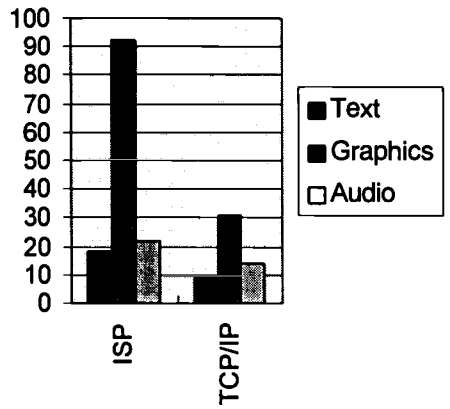

Figure 2. Download Rates (Seconds)

IMPLEMENTATION

At the time of this writing, the prototype is still in developmental testing, with an anticipated delivery date of 15 August 1997. It will then enter a 115 day tryout period where data will be collected on its performance and effectiveness.

Implementation on a large scale using this prototype as a baseline will not be decided on until performance factors are analyzed and tabulated. It is anticipated that wide spread use of this form of distance learning will be implemented at the 58 SOW.

Preliminary testing using TCP/IP and ISP access has shown that the minimum recommended client requirements for this type of WBT are as follows:

- Pentium 133 PC or compatible
- 16 MB RAM
- Windows 3.11 or 95
- VGA (minimum 16 bit color)
- Mouse or touch screen
- 16 bit sound card
- 1.2GB hard drive
- 28.8 BPS modem or TCP/IP

Web server space requirements vary depending on the amount of information being used for the lesson. For the prototype lesson, a total of 3.4 MB of server space was required. This does not include space requirements for future lesson expansion, additional video, audio or text files.

RECOMMENDATIONS AND LESSONS LEARNED

As with any new project, mistakes were made during the development of this prototype. Initially, the concept for separating structure from content seemed to be a relatively painless and simple task. However, consideration was not given to the amount of time it would take to incorporate the coding required for the necessary file transfers. Each frame of courseware that required a transfer file needed an additional 17 lines of software code with specific calls to URL locations. This meant that each frame required and additional 10 minutes to develop.

Additionally, a problem that has yet to be resolved is how to accommodate changes in URL locations, or restructuring of WWW servers. At present, the only viable option is to change URL code within the lessons and redistribute new structure files on CD-ROM.

Specific issues and lessons learned include:

1. Investment in design time up front before development was crucial to the success of this project. We found that spending more time to cement the lesson and connection designs up front saved us time in the end. There were many occasions to change the baseline, but the initial designs were used, regardless of the potential enhancements that were later possible.

1. Careful consideration should be given to exactly what content will be "distance loaded." The current band width issue mandates that transfer of large files is not feasible. Lengthy download times, TCP/IP time-outs, and other connection problems only serve to complicate this problem. The transfer of small bitmap, text, and audio files should be considered in the design. Only consider using transfer files necessary to be updated periodically within the lesson.

1. Individuals developing WBT using this format and software should be competent in the use of variables and some C++ software coding. Current authoring software packages are becoming more and more user friendly. This is allowing individuals not previously capable of developing CAI to now do so. With the inclusion of WBT into the development equation, it is necessary to use C or C++ (or similar languages) to create code that will "talk" to the WWW.

1. Not all lessons can be adequately converted to WBT. Care should be taken in selecting which lessons to convert or develop using this method. As with any conversion project, the content of the lesson must be the primary consideration when weighing factors for conversion. Converting a lesson to use WWW transfer that is not likely to require frequent updating is not cost effective or necessary.

1. Media management is a bit difficult due to the fact that all lesson executable and content files are contained in a single directory on the client machine. This is required due to flexibility requirements for lesson updates. For most development projects, separate file folders for graphics, audio, video, and text are normally used for configuration management purposes. A single file folder structure is recommended for WBT using Quest NET+.

This WBT strategy should be considered carefully before initiating a development project. The beauty in this design is that once the updates are downloaded, no further connection is required. Thus, if an internet connection is lost or unavailable, the courseware is only as old as the last connection and download. Be careful to consider this fact when contemplating using the cached method for content. Once the lesson is exited, the cache is dumped, and no information is maintained on the client machine. In this instance, the connection must be reestablished before content can be viewed.

SUMMARY

Distance based education and training has been alive and well for over 150 years. New technologies and media may come and go, but the requirement to accommodate the student at a distance lives on. Web-Based Training is a unique, cost effective means of meeting distance learning challenges today. Effective design, coupled with quality content and media can be the basis for high quality interactive WBT. No single medium will solve every distance learning

problem or issue, nor will it enable us to reach every potential student. We should therefore continue to search for and discover new methods for reaching the non-traditional student.

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