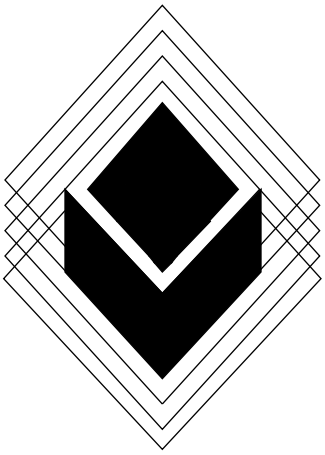
OVERVIEW

The World Wide Web as a Universal Interface to Government Services



Center for Technology in Government

The full report, The World Wide Web as a Universal Interface to Government Services, is available on the CTG Web site as both a downloadable and a hypertext document.
A limited number of printed copies are also available.

Since the final report contains hundreds of links to sites on the WWW, we recommend that readers use the hypertext version which also contains a search engine and other navigation aides.

The hypertext document is located at
http://www.ctg.albany.edu/resources/htmlrpt/ittfnlrp.html

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The World Wide Web as a Universal Interface to Government Services

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Acknowledgments

The Universal Interface Project of the Internet Technologies Testbed involved more participants in prototype development than any previous CTG project. Staff from several organizations conducted technology investigations and developed prototypes in four service areas: information dissemination, business applications, group collaboration, and education. We acknowledge with thanks their dedication to the project and their unique and valuable contributions to a better understanding of how the Web can help improve services to the public.

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Project overview

Introduction

The World Wide Web has become an increasingly important way for people and organizations to communicate. It is being used to disseminate information and to transact business. It promises to provide 24-hour access to government information and services. As a universal interface to services, the Web offers many potential benefits to both users and providers of information services. It presents a unified and user-friendly gateway to a myriad of resources; it can reduce the learning curve and training costs; help government reach an expanded audience; give citizens anytime, anywhere convenient access to government information and services; allow government to integrate information and services which originate at different agencies and on different platforms. The objective of this project has been to examine and demonstrate the technical capabilities of the World Wide Web as a universal interface for the delivery of New York State and local government services to citizens.

The project was launched with an October 1995 workshop called "New York on the Internet." At that workshop, more than 170 people, representing state and local government and the private sector, helped craft an agenda for CTG's Internet Testbeds. Participants focused on the management, policy, and technology dimensions of the Internet. They identified benefits and hurdles to government's use of the Internet, and defined some of the deliverables of the Testbeds. These desired deliverables exemplified how important electronic networks have become for communicating in today's world: to disseminate information, to transact business, to link remote offices to central databases, to link agencies with their suppliers and contractors, and to exchange information between agencies and levels of government. Two Internet Testbeds were initiated to address the issues and learning objectives raised by these workshops: an Internet Services Testbed which emphasized the design and delivery of information-based services, and the Internet Technologies Testbed which explored key technical issues that underlie many kinds of networked services.

The primary objective of the Internet Technologies project was the examination and demonstration of the World Wide Web as a universal interface for the delivery of New York State services to citizens. Specifically the project posed two questions:

- Can New York State government use the Web as a universal interface for delivery of all or most services to NY State citizens?

- Can New York State government use the Web as a universal interface for conducting business within and among agencies?

In this "proof of concept" effort the project team investigated existing applications; developed prototypes; conducted hands-on experiments, instructional activities, and demonstrations; and documented their implementation experiences in the following four service areas:

- Information Dissemination
- Business Applications
- Group Collaboration
- Education

Center for Technology in Government project

In the late fall of 1995 a call for proposals was distributed for the Internet Technologies Testbed. Six proposals were received and two proposals were selected for investigation and prototyping.

- Demonstrate the use of the WWW as a common interface for a variety of services/ activities

- Implement prototype application(s) which interface production systems with Web clients

The project team included the following government and academic partners:

- SUNY System Administration
- Division of Housing and Community Renewal
- Empire State College, Center for Learning and Technology
- NYS Forum for Information Resource Management
- Office of Real Property Services
- SUNY Plattsburgh
- University at Albany
- NYSERNet, Inc.
- CTG professional staff and graduate students

The project team also included six corporate partners. Deloitte & Touche/DRT Systems and Bluestone, Inc. were instrumental in the development of the SUNY Web to Legacy prototype. EMI Communications Corporation and NYNEX provided the necessary technology and assistance to support the public presentation of the project results. This event included 16 Internet connections for live demonstrations of the prototypes as well as two Internet connections which supported the six Web-based presentations. Silicon Graphics supported the project by presenting its VRML products as part of the Information Dissemination service area. Microsoft Corporation also provided support for the Group Collaboration service area by demonstration of its NetMeeting product.

Project objectives

The Center worked with two groups within SUNY System Administration, the Office of Educational Technology and System Administration, to investigate whether New York State government can or should use the Web as a universal interface for the delivery of all or most services to NY State citizens and for conducting business within and among agencies.

The methodology used for this investigation was:

1. Identify all of the types of services currently offered/needed by SUNY System Administration.

2. Determine whether each service can be effectively delivered over the Web in 1996. The intent was simply to prove that the service could be effectively delivered using the Web, by building a prototype application or by evaluating similar existing systems.

3. Identify the functional needs of SUNY System Administration and determine what is and is not technically "doable" using a Web interface.

4. Share findings through a public demonstration and report.

Project workplan

Planning for the Universal Interface project activities began in March 1996. Early planning sessions resulted in the identification service areas that could be investigated as part of the project work.

A number of concepts and capabilities were identified in each service area along with potential products or applications that would be evaluated or prototyped. Each of these concepts and capabilities was assigned to either the CTG technical staff or the SUNY System Administration staff for research, implementation, demonstration, and reporting.

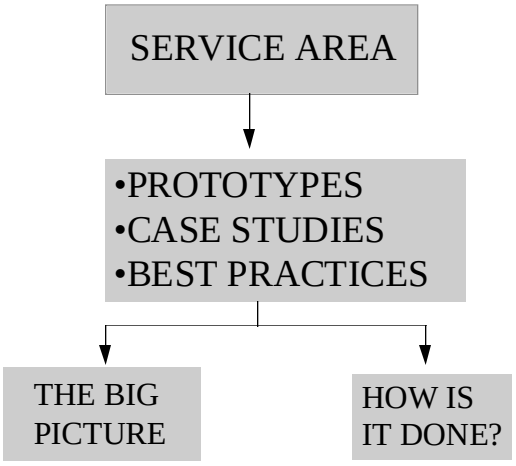


Table 1 lists the four service areas, and the concepts and capabilities investigated in each. Each of the next four sections of this report overviews one of the four service areas: Information Dissemination, Business Applications, Group Collaboration, and Education. In the full report, each chapter begins with an overview of the service area and then

Table 1. Four Service Areas and the Concepts/Capabilities Investigated

Information Dissemination	Concept searching Personalized pages Audio Streaming Video Streaming Multi-Media VRML
Business Applications	Interactive forms using client-side editing Real-time interactions with production systems Interface to legacy systems: putting mainframe transactions on the Web "as is" Interface to legacy systems: mirroring legacy database on a Web accessible database Interface to legacy systems: live connection to databse using middle-ware Integration of multiple back-end systems/platforms with single web front-end
Group Collaboration	Asynch conferencing Document/file sharing White boarding Data Sharing Calendars/scheduling
Educational Services	Distance learning Web-based training Web-based education

presents results. The concepts and capabilities were examined from primarily a technical/functional perspective (i.e., what is technically feasible, effective, efficient). Two methodologies were used to report results: a question template and case studies. The question template provides consistency of review in evaluating the various products and applications. The template consists of a series of questions that were answered for each potential application. This methodology was used to report the results in the Information Dissemination and Group Collaboration chapters. Case studies were used to examine where we are in the transition to the Web as a universal interface. The case study method was used to report results in the Education and Business Applications chapters. The full report is available on the CTG Web site (http://www.ctg.albany.edu/resources/pdfrpwp/ittfnlrp.pdf) and in a limited number of printed copies. The hypertext version is available at (http://www.ctg.albany.edu/resources/htmlrpt/ittfnlrp.html).

Information dissemination

The World Wide Web originated as a means of sharing information among a dispersed group of people and this ready access to data and knowledge is still the predominant reason most people sign on to the Web today. Governments at all levels are using the Web to improve citizen access to their data. Among the potential benefits are: helping governments reach an expanded audience; giving citizens anytime, anywhere access to government information; providing a single point of entry to data from diverse sources; providing a customer view of information rather than an agency view; presenting a more unified and user-friendly interface for accessing government data; and making use of graphics, audio, and video to add impact, ease-of-use, and improved clarity. In addition, many of these same benefits can be realized by using the Web to share information within and among agencies. The Web can serve as a unifying factor, improving the vital communications needed to integrate a diverse and distributed work force.

Although information dissemination is the most obvious and familiar of the service areas examined, there are many new trends on the horizon which are beginning to change the nature of this service. These changes add significant value to traditional mechanisms for exchanging information. They offer compelling reasons for using the Web from the standpoints of both the information deliverer and the information seeker. Significant among these trends are:

- **Personalized presentation of data.** The World Wide Web allows organizations to create a single presentation which can reach many people. Interestingly, though, this strong benefit sometimes turns into a negative when the communication becomes impersonal and the Web pages overflow with "too much" information. Small steps are being made in the direction of more personalized delivery. Through the use of HTTP cookies, customers are being asked for their information preferences so that personalized news pages can be dynamically created by a server side program and delivered to the client on demand. 'Agents' are another mechanism for achieving similar results. These programs sit on the client's machine and perform customized searches over the Internet for requested information.

- **Client-side processing.** The personal workstation revolutionized the computer industry by bringing the power of the computer processor to the user's desktop. Networked computing, and the Internet in particular, initiated another revolution by allowing users the opportunity to access information from around the globe. Client-side processing combines the best of these two models. It allows users to pull information from anywhere on the World Wide Web and then lets them manipulate that information on their own desktops using their Web browsers. Java, JavaScript, and plug-ins are popular mechanisms for achieving client-side processing.

- **Integration of multiple forms of communication.** Integration (the ability to represent multiple types of information such as data, voice, and video by a common digital format) and deregulation of the communications industry (by the Telecommunications Act of 1996) will dramatically change the nature of information delivery. The lines of distinction among broadcasting, telephony, print, and other media will soon be

blurred as these various formats are delivered over the same device. The World Wide Web is proving to be one of the forerunners in this arena. For example, audio conferencing is already providing telephone service over the Internet. In another example, streaming technology allows large chunks of information (such as a one hour speech) to be heard or seen almost immediately just as in a television broadcast; but instead of being forced to watch or tape that broadcast when it is being aired, the customer can choose what and when to view by the click of a button. As this new era continues, consumers will undoubtedly enjoy much greater control and access to information, entertainment, news, and communications with others.

- **Concept searching.** Text searching and database searching are traditional tools for discovering information. Unfortunately, these mechanisms fall short if the exact word or phrase contained in the needed document or record is unknown. Concept searching helps users to search for an idea instead of an exact word. For example, a search on 'the meaning of life' may return documents on Aristotle which do not contain any of the words in the search phrase. Concept searching is a particularly important tool for the Internet since information is coming from such diverse sources and can be expected to contain a rich variety of words.

- **Increased use of multimedia.** Audio, video, and virtual reality are currently being used by a limited number of Web sites to improve the effectiveness of their presentations. Widespread use of these technologies will have to await improvements in bandwidth since the amount of data needed to be transmitted over the network is far greater with multimedia applications than with simple text or graphics.

  Multimedia can have a tremendous impact on the effectiveness of information delivery. Instructions for assembling a complex product, for example, are more easily grasped when viewed in three dimensional mode where the product can be rotated and even seen from the inside out. As another example, a government official's address to the public has more meaning and impact when the inflections and emotions can be heard through audio, enhancing what can be gained from a written text of the same speech. As data transmission speeds continue to rise while prices for bandwidth drop, multimedia will play an ever increasing role in effective delivery of information.

Service delivery considerations

While the emergence of these new technologies provides exciting opportunities for improved information delivery, their use often comes at a cost. This cost may take the form of an increased demand on the service deliverer, requiring specialized skills, increased time to implement, or the cost of additional hardware and software. Perhaps even more significantly, the cost may also take the form of a reduced audience for the product. Increased bandwidth requirements or the need to use a particular Web browser or the need to download a specialized browser plug-in program may stand in the way of some of the intended audience receiving the message. With this in mind, it is important for service deliverers to look carefully at the intended audience and gauge the perceived benefits of improved service delivery against the possibility of reducing audience size

when choosing a more technologically advanced method of delivery. In some cases, it may be desirable to deliver the information in more than one format - a more universal format available to all as well as a format which takes advantage of the latest technology for a more effective presentation.

It is also important to note that it is generally a matter of time (and this time may be measured in "months" in this fast-paced environment) before the wider audience has access to the more advanced resource requirements. For example, the newest Web browsers will automatically incorporate many of the plug-ins which previously needed to be downloaded and installed, thus making their functionality more convenient for the inexperienced user. With this in mind, an organization may be more comfortable in its decision to employ higher-end solutions to meet information dissemination needs, particularly if it offers some low-tech options as well.

Business applications

Many organizations are seeking ways to take advantage of the World Wide Web client/server architecture in order to enhance the functionality and efficiency of core business processes. While this service area has shown itself to be the most complex and the most expensive to implement, it is also the area with the largest potential payback. The open standards employed by the Internet, the universal interface offered by the World Wide Web, and the public nature of the underlying network combine to offer striking advantages over traditional computerized business applications. Our case studies for this project, along with a review of best practices in this arena, have highlighted a number of these benefits:

- **Improved access at a reduced cost.** The Internet is a public network, offering ubiquitous access to information and services. This access allows outreach to large categories of people who could never have access to more traditional business systems: those working at home, collaborators from other organizations, staff who travel and work at continually changing locations, and the general public. Access is made available to these individuals 24 hours a day, seven days a week, on all major platforms.

  In addition to improving outreach, Internet access is far less expensive than using private networks and leased lines. With the use of cryptography and other security measures[1], even private transactions can be offered over this public network. One study has indicated that using the Internet as a secure pipeline can result in savings of 23% to 50% over the use of leased lines[2].

- **A user-friendly interface.** The World Wide Web interface is graphical, intuitive, and already understood by a large number of people who may be participating in the business process. This advantage alone often justifies the move to Web-based applications. Learning curves are reduced, training expenses are cut, and higher participation is ensured as the comfort level of the audience is increased.

- **Ability to streamline the business process.** With improved access and a more user-friendly interface comes the ability to reduce the middle layers of a business process so that the entire operation is streamlined. For example, a middle layer in an organization may be responsible for collecting business information from others, formatting and entering that data on a computer application to which only they have access (or which only they understand), and then distributing reports to others once processing has been completed. Under a Web-based model, information can be entered by the individuals actually conducting the business. As an example, employees could enter their purchase requisitions or travel expenses directly into the business application using a Web interface. Managers could enter their proposed budgets. Students could apply to colleges or register for courses. These individuals can also have immediate and direct access to the information they need from the organization to carry out their work. This streamlined approach can result in cost reductions, a decrease in errors, and more immediate input of, and access to, important business information.

- **Ability to integrate diverse systems.** Since the World Wide Web uses open standards for communicating information, it can often serve as a force for integrating multiple applications running on multiple platforms. Middleware applications can pull data from multiple back-end systems and combine that information into a single Web presentation. Information entered on a Web page can be distributed back to these multiple systems as well. As one example, an entrepreneur beginning a new business could find start-up requirements from several state agencies in a unified Web presentation. This entrepreneur could then fill out a single form and have the information from that form distributed to the back-end systems of those same agencies. Such integration could have dramatic impact on the quality of service delivery to consumers and could also improve the coordination and effectiveness of each participating agency.

- **Shifts processing away from expensive mainframes.** Web-based solutions allow processing to be shifted away from the mainframe onto less expensive machines. In some cases, an entire mainframe application can be replaced by a system running on lower priced servers and workstations. In other cases, a mainframe application can have part of its process (such as the user presentation and/or transaction editing) replaced by the Web-based front-end. The result can mean significant savings and/or greater longevity for the existing legacy system.

Costs and payback

The following table, provided by Gartner Group, illustrates the escalating costs associated with more advanced uses of the Web.

Typical Overall Web Site Implementation Costs			
Site Objective	**Low**	**Average**	**High**
Point of Presence	$20,000	$65,000	$75,000
Advertising	$250,000	$300,000	$350,000
Sales/Marketing	$400,000	$500,000	$700,000
Distribution	$1,000,000	$1,500,000	$3,000,000

Point of Presence:
To be present on the Web

Advertising:
Information dissemination about programs, products, services

Marketing and Sales:
Outreach through the Web for new customers

Distribution Channel:
Distribution of software and various information products such as articles & books

Despite the fact that greater complexity generates higher costs, Gartner concluded that the payback period actually declines as the site complexity increases. Based on client feedback, this payback period was estimated to average only 10 months for the Distribution sites. [3] Payback was measured in reduced advertising costs, increased sales, and decreased distribution costs.

Web / Legacy implementation strategies

Fortunately, there are a variety of choices for incorporating the Web into existing business applications. These range from complete redevelopment of a mainframe application onto a more Web-accessible platform to real-time Web server interaction with mainframe legacy systems.

Transitioning to a Web based application

When replacing a mainframe application, it is often desirable to migrate from the legacy application to the Web-based application in stages. Steps for achieving this migration can include any or all of the following:

- **Copying of mainframe data onto a Web-accessible database in batch mode**. For example, data can be retrieved from the mainframe on an overnight (or hourly) basis and reorganized on a Web-accessible database to be available over the Internet. At this stage, Web access to the new database is limited and often mimics the mainframe access.

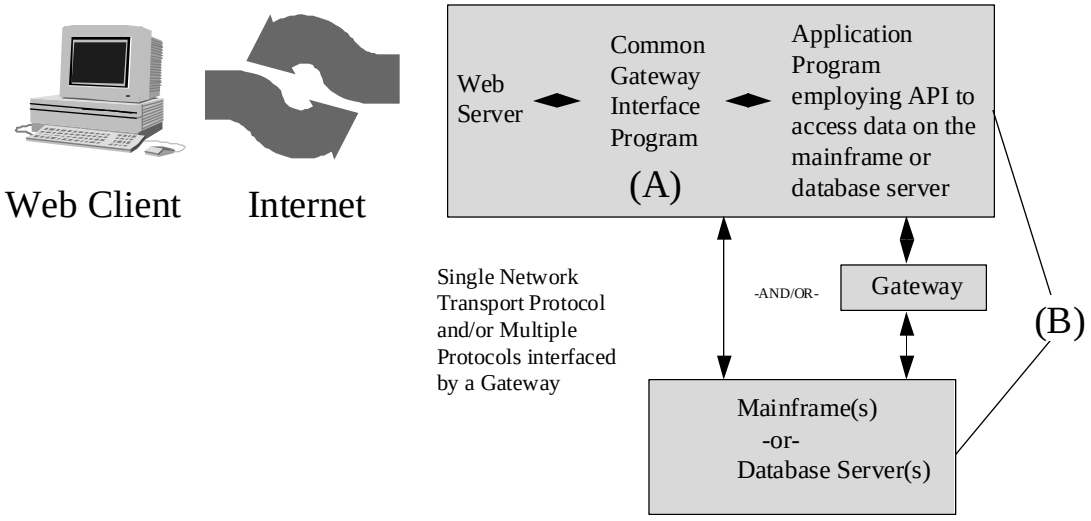
- **Gradual rewriting of the user interfaces to the new database in order to take advantage of the Web architecture.** These improvements can begin with Web pages providing enhanced information retrieval, such as self-directed searches, and then progress to Web-based data entry and updating.

- **A shift from using the mainframe database as the primary system to using the server database as the primary system**. During this stage, the Web system drives the business process and data is transported to the mainframe on a regular basis in order to print reports or to interface with other mainframe systems.

- **Total replacement of the mainframe system with the Web-based system**. All functionality is now incorporated into the new system.

Web connectivity for legacy applications

There are also a variety of approaches available for real-time access to mainframe legacy applications. More solutions are being made available every day as software companies react to increasing demand. A typical solution might consist of the following components:



The Common Gateway Interface (A)

Common Gateway Interface programs are used to process the input submitted by a Web client using an HTML form. When a form is submitted to the Web server, the server calls the CGI program which has been identified within the HTML code of the form. Input from the form is then made available to the CGI program using the Common Gateway Interface Standard. The CGI program can process the input data itself or call on other programs such as database or mainframe interfaces. Thus, information submitted by the form can interact with legacy applications. The CGI program can also dynamically create HTML pages to be passed back to the client. A database search could be conducted using the input fields, for example, and the results passed back to the user in a dynamically generated Web page.

Access to the mainframe (B)

Popular access methods from the Web server machine to a mainframe include the following:

- **Direct access to a single mainframe application.** Legacy applications come with a variety of mechanisms for tapping into their data. These generally involve software which sits on both the mainframe and the Web server machine, each communicating with the other over an acceptable network transport protocol. Popular access methods include:

- **SQL** - This is the 'Standard Query Language' adopted by most relational databases. Although this is considered a 'standard,' each proprietary database usually has its own slightly different version of the SQL implementation. Application programming interfaces (APIs) are made available by the software companies so that SQL communication can be implemented as a called procedure from applications written in a variety of programming languages.

- **ODBC** - This is a flavor of SQL initiated by Microsoft. It is more generic than the proprietary SQLs identified above, but it is also generally slower. Thus, greater flexibility is traded for reduced response time. Depending on the expected transaction volume, the slower times may not be noticeable to the average user.

- **3270 terminal emulation** - This method is often used for CICS[4] applications. Here, APIs are made available which allow an application sitting on the server to act like a "dumb terminal" connected to the mainframe. The application is able to send keyboard strokes to the mainframe (thus executing transactions) and then read the output generated by the CICS application (usually displayed on a terminal screen, but now delivered to the application). This approach is also referred to as "screen scraping."

- **Other proprietary methods** - A variety of additional access methods exist for the various mainframe application platforms. These can be supplied by the primary vendor or by third parties.

- **Synchronization of access to multiple applications**. The access methods identified above can be used to connect to more than one application. In this case, it may be necessary to ensure that all updates to mainframe systems are "in synch." Methods such as two-phase commit, recovery, and rollback are often employed. The basic idea behind these mechanisms is simply to ensure that all files are updated simultaneously or the transaction does not take place.

- **Replication of data**. When the legacy data is originating from remote sites and/or involves complicated data structures, it may be desirable to pull selected fields from each remote system and replicate them on a new integrated database. This replication can provide a simpler view of the data, making application development quicker and less prone to error. Synchronization is then employed to update the back-end systems on a timed or trigger-dependent basis.

Practical results

Two case studies are presented in the full report which demonstrate practical solutions to the goals of Web/Legacy System integration. The first study summarizes the experiences of migrating a large scale, mainframe-based, legacy application (America's Job Bank) to a World Wide Web based architecture. The second case study reviews the prototype implementation developed at SUNY System Administration for implementing real-time connectivity from the Web server to the mainframe Purchasing Card System.

[1] For an overview of issues related to Internet Security, see the CTG Security Seminar at http://www.ctg.albany.edu/projects/inettb/security.html.

[2] Sun Microsystems, Internet-based SVPNs: The Cost of Ownership [online], available at http://www.incog.com/execsumm.html.

[3] Gartner Group, Calculating Payback on Web Marketing Projects, July 22, 1996

[4] CICS is a common protocol used for online transactions on an IBM mainframe.

Group collaboration

Enhanced group collaboration would seem to be a natural consequence of the World Wide Web. The ubiquitous access of the Internet and the common interface provided by the Web lend themselves to an easy exchange of ideas and the opportunity for joint decision making. This collaborative process can range from a completely informal flow of ideas to a highly structured and purposeful interchange. In addition, collaborative models can be categorized by time and location. Synchronous groupware enables people to work together at the same time (usually from different locations), using such tools as whiteboarding, application sharing, file transfer, interactive audio, interactive video, and chat (real-time conversations that are transferred in text and displayed on each of the participant's screens). Asynchronous groupware allows contributions to be made over time, at the convenience of the participants. Tools in this category can range from simple email to specialized applications that encourage focused problem solving. The benefits that can be expected from increased use of Web collaboration tools include the following:

- **Greater participation in the decision-making process.** As government and industry enterprises are "rethinking, reinventing, and recreating" themselves to work more efficiently and effectively, workgroup collaboration tools are looked on as products that can widen participation in the decision making process. These tools help people work together independent of time and/or place and allow people at all levels with various skills to contribute to decision making.

- **More time to generate ideas**. Web-based collaboration tools can be used to generate ideas over a longer span of time than would be possible using traditional face-to-face meetings. As Dr. John Rohrbaugh and Dr. Sandy Schuman pointed out in a recent Government Technology article, "Part of the reason for improved brainstorming in computer conferencing is the additional time for good ideas to lead to even better ideas, perhaps entirely new ways of thinking about a problem or its solution." Ideas and decisions made over the Web can be used to replace conventional meetings or can be used to generate ideas in preparation for such meetings.

- **Cost savings**. A reduction in face-to-face meetings can result in considerable savings in both time and money. These savings include the accumulated travel time and expense of each participant as well as the effort expended in organizing and implementing the meetings and conferences. Face-to-face meetings can be reserved for those situations where physical proximity is a critical success factor.

The groupware market

According to Virtual Workgroups Magazine, July/August 1996, there are over 20 million groupware users today with growth expected to reach 100 million over the next four years. Many of these users will be looking to the Web as their choice for groupware implementations.

A number of major software vendors are vying for this market. Product offerings include extensions to existing products (such as LOTUS Notes, Microsoft Exchange, the Netscape browser, or Microsoft's Internet Explorer) as well as new software developed specifically for the Web (such as Digital's WebForum). Product features vary widely and new features and products are introduced every day.

Practical results

The project prototypes and related case studies presented in the full report highlighted the need for careful planning and execution of any group process aimed at delivering explicit results in a specified period of time. Many groupware products do not provide for group facilitation or group management but simply allow for enhanced electronic communication to take place. A well thought-out process for moving the discussion forward is imperative for successful results. Groupware products currently exhibit limited use of group dynamics and group psychology. Most seem best suited for small groups of two or three people.

Prototypes were developed to explore the features of synchronous groupware. These include implementations of Microsoft's NetMeeting and Netscape's Cool Talk. In addition, Web-based scheduling was explored with an implementation of WebCalendar. Asynchronous groupware was reviewed within the Education segment of the Testbed.

Education and training services on the Web

The convergence of telecommunications, telephony, and computing has made possible an evolution from the traditional educational model to a new learner-centered model. Dr. William Graziadei of SUNY Plattsburgh sees the next decade as a time when "telecommunication technology will exert increasing influence over the ways in which learners and those who assist them spend their time." He says the convergence connects the participants "in ways not previously possible and thus provides access to instruction and training information WHEN, WHERE, HOW, and AS MUCH as the learner wants."

John Gehl, editor of the Educom Review[1], in a November/December 1996 article "The Curriculum has Run its Course," calls for less focus on the where and when of education and more on the what and the why. He too, sees the convergence of technologies as the opportunity to reduce the bureaucracy of education and to focus on the goals of education.

Often students drive this innovation through the establishment of e-mail groups and "class home pages" where information and ideas can be shared. Instructors have also found using the WWW for the submission of assignments and the dissemination of information to be extremely valuable. The State of New York has begun investigating the possibilities of using the Web as a mechanism to provide training videos. Under such a plan employees would be able to access training films whenever their schedules allowed.

How do we get there from here? As educators struggle with this question, institutions are taking advantage of a wide range of Web technologies to deliver research, reference, teaching, learning, and training services. These Web-based services can range from simple information dissemination such as a course catalog, to a full course management system, all the way to an extensive program of all the courses leading to a degree.

Education and training are provided by colleges, universities, and schools and (increasingly) by industry, government, and nontraditional sources. Grassroots efforts are taking place across the nation to bring schools into the Internet era (such as NetDay '96). The Internet II Project, the next generation of university networks for the national research community has begun "in response to the growing privatization of the network and the frequent congestion of its commercial replacement." Over the next three to five years as many as a hundred universities, a number of federal agencies, and many of the leading technology vendors will work on the "Internet II Architecture." While there are already thousands of educational opportunities on the Web, these developments signal enormous growth ahead.

Our research for this project highlighted both benefits and drawbacks in the use of the Web in the educational process:

- **Lower cost to deliver courses and training materials to students and staff.** Courses that would be too expensive to offer at some campuses because of limited enrollment or lack of faculty in a specialized area are now possible. Business can reduce the time and cost associated with travel time for training.

- **Greater opportunity for collaboration and sharing.** The Web increases opportunities for collaborative work and sharing of information, ideas, and courses among campuses and other providers.

- **Greater access to courses that can be taken any time, any place.** "Anywhere" courses can be delivered to a learner at a campus, at the office, or at home, and the time may be "any time." Distance learning can be supported in both synchronous (same time) and asynchronous (different times) modes. Equity of access to certain courses can be improved as courses that require specialized faculty no longer require that faculty member to teach in one place at a time.

- **Greater access to research and reference services.** The Web offers access to indexes of current journals, full text of articles, electronic references, and extensive full text search facilities with millions of documents available for the asking.

Practical results

Case studies are presented in the full report which demonstrate current implementations of the Web as a technology to support a learner-centered model of education. The cases summarize experience in using the Web as a tool for both academic programs and professional training. The cases discuss the benefits and drawbacks of the increasing trend towards Web-based education and training services in the academic, public, and private sectors.

[1] Educom is a nonprofit consortium of colleges and universities which addresses critical issues about the role of information technology in higher education

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