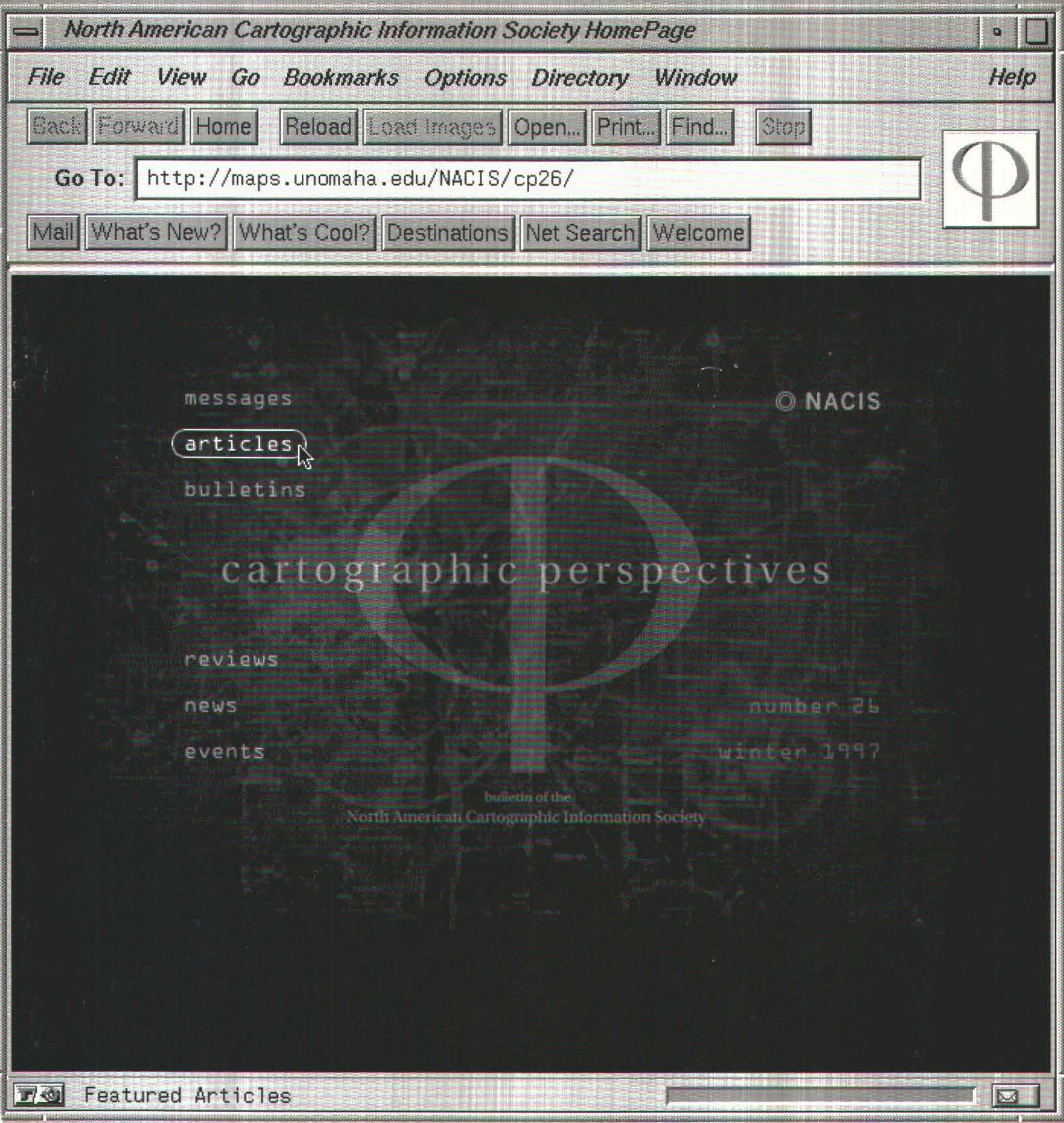
North American Cartographic Information Society HomePage
File Edit View Go Bookmarks Options Directory Window Help
Back Forward Home Reload Load Images Open... Print... Find... Stop
Go To: http://maps.unomaha.edu/NACIS/cp26/
Mail What's New? What's Cool? Destinations Net Search Welcome
messages
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North American Cartographic Information Society
Featured Articles

journal of the North American Cartographic Information Society

cartographic perspectives

Number 26, Winter 1997

in this issue

messages

FROM THE PRESIDENT

As may be guessed from the cover, this issue deals with cartography in the era of the Internet. The cover de-picts the graphic from the home page for this issue (http://maps.unomaha.edu/NACIS/cp26). The buttons on the interactive graphic may be used to access the links associated with the articles. This is the first time that *Cartographic Perspectives* appears both in paper form and as a web page. We hope the journal will continue to be offered as a com-bination of the two separate mediums.

From modest beginnings as ARPANET in the late 1960's, the Internet has become a major form of communication. Encompassing such diverse services and proto-cols as e-mail, newsgroups, ftp, and the World Wide Web, the Internet is now an integral part of our society. The use of the Internet has expanded rapidly in recent years with the introduction of the World Wide Web. The web integrated the delivery of text, graphics, pictures, sound, and even video clips. It has also made

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the distribution of maps more cost-effective and convenient.

It is hard to say how many maps are available through the World Wide Web. Estimates put the number of web servers at 660,000 (early 1997). There are a number of web sites that distribute static maps but much of the effort in web mapping is concentrated on interactive maps. Here, the user can select the area to map and what features to include. Web-based, interactive mapping exists in all forms. One of the most popular is street mapping. For example, the GeoSystems' MapQuest site (http://www.mapquest.com) creates maps of cities in the U.S. centered at any user-specified location and at different scales. Interactive thematic mapping is also possible for mapping census data for cities and counties (http://www.ciesin.org). Another form of dynamic cartography is exemplified by those sites that offer weather information with new maps presented every hour or less.

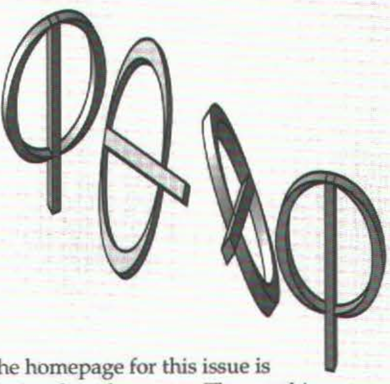
The interactive/dynamic mapping sites receive considerable usage. GeoSystems, for example, reports that it creates 800,000 user-specified maps every day, and up to 1000 a minute. Other sites report over 100,000 maps accessed on a daily basis. At least a million, perhaps as many as ten million maps are downloaded through the Internet every day. The Internet has become a major distributor of maps. Moreover, the medium is changing the way maps are presented and used. Its impact on cartography will likely be greater than that of the printing press.

Cartographers criticize the quality of maps that are available through the Internet. In comparison to maps on paper, these maps have a much poorer resolution and many are poorly designed. Indeed, a new medium seems to attract those who can adapt to its technology, and not necessarily people who can contribute significantly to its content. The invention of printing had much the same effect. The T in O map, a biblical view of the earth that entirely left out the western hemisphere, was still widely available in the 16th century because it had been printed. McLuhan's famous motto "the medium is the message" is particularly appropriate to describe the effect of both printing and the Internet.

As we contemplate this new era in cartography, we are at the same time saddened by the deaths of three prominent academic cartographers - Prof. Sherman (Washington) - Prof. Jenks (Kansas) - Prof. Dahlberg (Northern Illinois). All three contributed significantly to the development and growth of academic cartography. Their contributions were in different areas but they shared a commitment to cartography and its development as a form of communication and as a science. Cartography benefitted greatly from their work. All three left a lasting impression on the discipline and we hope to honor these individuals in coming issues of CP.

Michael P. Peterson
University of Nebraska at Omaha

about the cover



The homepage for this issue is depicted on the cover. The graphic was created on a Silicon Graphics O^2 Desktop Workstation using Adobe Illustrator and Adobe Photoshop. The screened back image behind the Cartographic Perspectives logo is a 1:500,000 scale VFR aviation chart centered over Omaha, Nebraska. The typeface used for the logo was Utopia. The buttons on the left are set in OCR-A Regular while the NACIS button to the right uses News Gothic. On the homepage, the 3D Cartographic Perspectives logo was extruded and rendered in Specular Infini-D on a Macintosh PowerPC. Finally, the dynamic highlighting of the buttons on the actual page is made possible by Netscape's JavaScript, described in the Cartographic Techniques section of this issue. You can visit the NACIS Web site at "http://maps.unomaha.edu/NACIS/cp26. To use all features of the web site, be sure to use Netscape Navigator 3.0, Microsoft Internet Explorer 4.0, or better. The cover and homepage were both created by James Swanson.

Cartography and the Internet: Introduction and Research Agenda

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A Note from the Editor: This article is the first example of what will hopefully be a new trend in articles appearing in *Cartographic Perspectives*. The article exists both in printed form and as a web document. What appears here in bold/italic type is a hyperlink that may be used in the corresponding WWW document to access other documents, particularly examples of maps. The hyperlinks are embedded within the text and in the references. The text is designed to introduce the basic concepts; resources on the web serve to illustrate and expand upon these concepts. The material is interdependent and the reader is encouraged to examine the various links that are a part of this article. The web document can be accessed at:

http://maps.unomaha.edu/NACIS/cp26/article1.html

The Internet is helping to redefine how maps are used. Maps are now delivered to the user in a fraction of the time required to distribute maps on paper allowing them to be viewed in a more timely fashion. Weather maps, for example, are posted on an hourly basis. Most importantly, maps on the Internet are more interactive. They are accessed through a hyperlinking structure that makes it possible to engage the map user on a higher-level than is possible with a map on paper. Finally, the Internet is making the distribution of cartographic animations possible. The Internet presents cartographers with a faster method of map distribution, different forms of mapping, and new areas of research.

INTRODUCTION

Large numbers of maps are now distributed through the Internet. Individual web sites respond to over 800,000 requests for maps every day (e.g. GeoSystems MapQuest) and there are thousands of web sites that distribute maps. A major reason for this change in how maps are delivered to the user is cost. It is simply less expensive to distribute maps through the web than it is to print and distribute them on paper. A second reason is time. Maps on computer networks are delivered in a fraction of the time previously required for maps on paper. This also makes the delivery of maps more current. A third reason is the potential for interaction. Users can choose a location to map and the features to include on the map. A fourth reason is the potential for the display of cartographic animations, a long neglected form of mapping. These are just a few of the reasons that the distribution of maps through the Internet is growing rapidly.

"Individual web sites respond to over 800,000 requests for maps every day. . ."

This paper and the associated documents on the World Wide Web (http://maps.unomaha.edu/NACIS/cp26/article1.html) examine this new way to distribute maps. The first section will review the growth, development, and use of the Internet, the World Wide Web, and Web search engines. The second part examines the current state of Web-based mapping. The last part addresses those areas of cartographic research associated with the Internet that need further research.

THE INTERNET AND THE WORLD WIDE WEB

The Internet has been described in many ways. In the simplest sense, the Internet may be thought of as a system for transferring files between computers. These files, manipulated as numbers and ultimately stored and transferred in binary 0s and 1s, may consist of text, pictures, graphics, sound, animations, movies, or even computer programs. Defined in terms of hardware, the Internet may be thought of as a physical collection of computers, routers, and high-speed communication lines. In terms of software, it is a network composed of computer networks that are based on the TCP/IP protocol. In terms of content, the Internet is a collection of shared resources. Finally, and most importantly, from a human standpoint, the Internet is a large and ever-expanding community of people who contribute to its content and use its resources.

"The beginnings of the Internet can be found in ARPANET - a computer network created for the Advanced Research Projects Agency and funded by the U.S. Department of Defense."

The beginnings of the Internet can be found in ARPANET - a computer network created for the Advanced Research Projects Agency and funded by the U.S. Department of Defense. The initial purpose of the network was to help scientists work together and also to create a network with a redundantly linked structure that would continue to work even after a limited nuclear attack. The original Network Control Protocol (NCP) was implemented in 1969 between Stanford University, UC-Santa Barbara, and the University of Utah. ARPANET switched from the NCP protocol to the currently used TCP/IP (Transmission Control Protocol/ Internet Protocol) on January 1, 1983. Many view this date as the beginning of the Internet.

The ARPANET model specified that data communication always occurs between a source and a destination computer. Further, the network connecting any two computers is assumed to be unreliable and could disappear at any moment. Data sent from computer to computer was put in an "envelope," called an Internet Protocol (IP) packet, with an appropriate "address." The computers - not the network - had the responsibility for routing the messages. All computers could communicate as a peer with any other computer. If a certain connection between two computers was inoperative, the computer would reroute the message to another computer that would attempt to "deliver" the message.

The ARPANET model was attractive to governments and universities that had not standardized on a particular computer system. The data communications model specified by ARPANET was emulated on a local level to connect often different computers within an organization, particularly when desktop workstations became widely available by the mid-1980s. Workstations, in particular, created a new model of networking. Rather than connecting to a single large timesharing computer per site, users wanted to connect their entire local networks to ARPANET.

"The Internet has become an international computer network that links academic, military, government, and commercial computers."

The model was also used in the late 1980s by NSFNET, commissioned by the National Science Foundation (NSF). NSFNET was designed to distribute the computing power of five supercomputers at major universities so that they could be used for scholarly research. Increasing demand on the network throughout the 1980's forced the U.S. government to commission the NSF to oversee the entire Internet network. More research and educational institutions were connected on a high-speed Internet "backbone." Eventually, Internet service providers (ISPs) expanded the network to include telephone access from homes.

The Internet has become an international computer network that links academic, military, government, and commercial computers. It is not managed by any one entity; rather, it is a system of networks based on the TCP/IP protocol that are linked together in a cooperative, non-centralized collaboration. The Internet consists of five main components or protocols: 1) File Transfer Protocol (FTP) for exchanging files between computers; 2) Telnet - a remote log-on procedure for accessing programs on remote computers as though they were local; 3) e-mail - an electronic mail system whereby one can exchange mail messages between Internet users and many networks outside the Internet (e.g., BITNET); 4) Newsgroups - discussion groups which distribute information to groups of users providing a forum for researchers; and 5) the World Wide Web - a hypermedia system that incorporates most aspects of the previous four services and delivers files in multiple forms, including text, pictures, sound, and animation.

The text-based file transfer systems, including FTP, Telnet, e-mail, and newsgroups developed quickly throughout the 1980's. FTP servers became fairly widespread by the end of the decade but as the number of available files kept increasing, searching for a particular file became unmanageable. Search systems, including Archie and Gopher, were established to help find particular files but the complexity of these systems limited their general usefulness. The prevalence of text files and the difficulty of transferring and viewing graphic files made FTP less than appealing to most computer users.

The World Wide Web

The introduction of the World Wide Web in the early 1990's addressed many of the problems associated with using the Internet. Files could now be accessed using a pointing device such as a mouse. A link within a document could access another document on that computer, or any other that supported this protocol. The selection of a link automatically made a connection to the remote computer and downloaded the document which could be a text, graphic, sound, animation, or any other type of file. Based on the concepts of hypertext and hypermedia, the web promoted a logical linking of files, much as the human brain links related pieces of information. The World Wide Web was a milestone in network computing technology because it opened the Internet to people with little computing background. It is largely responsible for the dramatic growth of the Internet during the early part of the 1990's.

"The introduction of the World Wide Web in the early 1990's addressed many of the problems associated with using the Internet."

The World Wide Web was developed in 1989 at the European Particle Physics Laboratory (CERN) located near Geneva. Tim Berners-Lee played a large role in designing the system. It was intended to assist researchers in high energy physics research by linking related documents. The developers wanted to create a seamless network in which information from any source could be accessed in a simple and consistent way. The WWW introduced the principle of "universal readership," which states that networked information should be accessible from any type of computer in any country using a single program. A prototype of this new protocol was completed in 1991 and was widely accepted by 1994. The system was quickly embraced because it also incorporated the previous protocols for file exchange, including FTP, newsgroups, and mail.

"The World Wide Web was developed in 1989 at the European Particle Physics Laboratory (CERN) located near Geneva."

The early popularity of the WWW was demonstrated by the quick adoption of the Mosaic WWW browser. Developed and freely distributed by the National Center for Supercomputer Applications (NCSA) in Urbana, Illinois, Mosaic was released for all common computer platforms, including UNIX, PC/Windows, and Macintosh, in September of 1993. Implementing the hypermedia file-access structure, the program incorporated hypertext and hyperimages to create links to other documents, either text or graphic. The growth of the web during this period was particularly dramatic. Much of the increase in WWW traffic can be attributed to Internet access providers, including such commercial ventures as America Online.

World Wide Web Browsers

Mosaic from NCSA was the first widely-accepted, multimedia-based web browser. Many other web browsers have since become available, although some browsers, such as Lynx, only display text. The most widely used browser is Netscape Navigator. Its main programmer, Marc Andreessen, wrote Mosaic then left NCSA to help form Netscape Communications, Inc. The company experienced phenomenal initial investment in the mid-1990s based on the expectation that there would be continued growth of the Internet, particularly the web. A variety of other browsers are also available. Updated versions of Mosaic can still be obtained at no cost from NCSA, and Microsoft provides the Explorer browser along with its Windows operating systems. Updates to the popular browsers are available through the web, and new functions are being added to the software on a regular basis.

"The capabilities of World Wide Web browsers can be enhanced with "helper" programs called plug-ins that add certain capabilities to the browser."

The capabilities of World Wide Web browsers can be enhanced with "helper" programs called plug-ins that add certain capabilities to the browser. For example, most browsers cannot display QuickTime™ or MPEG files that are standard formats used for the display of animations. Separate plug-ins must be downloaded and installed to display these files.

All browsers download and display material from an "http" site (HyperText Transfer Protocol). The "http" address has a consistent structure, as in the example below:

http://maps.unomaha.edu

The "http" prefix is always followed by a colon and two slashes (some browsers, such as Netscape, no longer require the "http://" as part of the address). Following this is the actual address beginning with the name that has been assigned to a particular computer; in this case, "maps". Next is the "domain" name that indicates where that computer is located (the University of Nebraska at Omaha, or "unomaha"). Finally, the "edu" specifies that the computer is at an educational site. This particular address will display a "home page" for that computer. By adding directory and file name information, a user can access other files on the system:

http://maps.unomaha.edu/NACIS/cp26/article1.html

This address would display a file called "article1.html" within a directory (or folder) called cp26 that is within the directory NACIS. The file is the web page associated with this article.

Web Search Engines

"Search engines work continuously to find and sort new material."

A search engine consists of two major types of programs. The first examines all known web pages and creates an index based on a defined set of keywords. The second program responds to user "keyword" requests to this index. A particular keyword may return many "hits" or matches. The ordering of matches is based on a variety of criteria, sometimes a function of how often the particular keyword is included in the document. Search engines work continuously to find and sort new material. For example, AltaVista, operated by the Digital Equipment Corporation, indexes material - "crawls the web" - at 3 million pages a day. By mid-1996, AltaVista had indexed 30 million pages and the site was receiving twelve million daily keyword requests. The purpose of the search engine is to find new material and to update HTTP addresses to pages that have already been indexed.

Depending on the search engine, a keyword will return a large number of documents. For example, the keyword "maps" returns 1,549,205 matches with the AltaVista search engine (February 1997). This means that the search engine found this many documents that contained the word "maps". The combination of "maps+world" returns only 800. There are many ways of limiting the search to a more specific topic, but the syntax for doing so varies among the different search engines. Effectively "surfing the web" requires a good working knowledge of several search engines.

MAPS ON THE WEB

Graphics, including maps and images taken from satellites, have become a major component of the web. This can be attributed to the relatively lower cost of placing color graphics on the web compared to printing. When the costs of shipping and distribution are added, the cost advantages of distributing maps and images over the Internet become even more apparent.

Graphics on the Internet are usually based on a raster format in which the image is represented as a grid of "picture elements" called pixels. Each grid square is assigned a number that is represented as a grey shade or color. The most common grid format for graphic files is GIF (Graphics Interchange Format). Limited to 256 shades or colors, GIF files have become a standard way of distributing pictures in electronic form. This graphics format is widely adopted and supported by most of the web browsers. An alternative image display format is JPEG (Joint Photographic Experts Group). This format is better suited for pictures because it is not limited to 256 shades or colors. However, the format makes use of compression algorithms that result in a loss of detail. Although not as apparent on pictures, this loss of sharpness is noticeable on maps in a fuzziness introduced in the line-work.

"Graphics on the Internet are usually based on a raster format in which the image is represented as a grid of "picture elements" called pixels."

Static Maps

Many of the static maps available on the Internet have been scanned from paper maps and stored in a GIF or JPEG format (***scanned map of Africa***). Although the scanning of maps quickly converts a map into digital form for transmission, the maps that result are often illegible. Sometimes, so little care is taken in the scanning process that the text on the back side of the paper map will appear in the scanned version. The screen pattern (little dots) will be visible on printed maps, particularly those printed in color.

"Many of the static maps available on the Internet have been scanned from paper maps and stored in a GIF or JPEG format."

Other forms of static maps include weather maps, maps of demographic distributions (***Current temperature map, United States Per Capita GNP***), and other types of thematic maps. Most of these maps have been designed specifically for display on a computer terminal and are much more legible than maps that have simply been scanned. Weather maps, in particular, account for much of the network traffic. They have been displayed on television for many years and incorporate design considerations that make them more suitable for display on a computer monitor. All of these maps are in the GIF format.

Static maps with a higher spatial resolution are also available on the Web. A common file type that is used for these maps is Adobe's Portable Document Format (PDF) based on Adobe's widely used Postscript™ language. PDF files are designed for both screen viewing and for printing. Because they are "resolution independent," they can be made larger without loss of detail, and can also take advantage of the resolution of the printer. The ***Adobe Acrobat Reader*** is a plug-in that displays and prints these files.

Interactive Maps

To overcome the limitation of "spatial resolution" maps available through the Internet are typically more dynamic. They are updated frequently, generally incorporate some type of interaction, or display a series of maps that can be viewed as an animation. The combination of maps with the Internet is a significant development, not only for improving the distribution of maps but also because it makes a more interactive form of mapping possible – a form of mapping that engages the map user to a much greater extent than maps on paper.

"The combination of maps with the Internet is a significant development, not only for improving the distribution of maps but also because it makes a more interactive form of mapping possible - a form of mapping that engages the map user to a much greater extent than maps on paper."

A variety of web sites incorporate interactive maps. The user can change these maps by choosing various map display options. Map sites, such as those located at Xerox Parc and the Fourmi Laboratory in Switzerland, are early examples of the type of interaction that can be implemented with maps on the web. The interactive ***Xerox Parc*** site allows the display of alternative projections and separate map layers including country boundaries, waterways, and transportation networks. The site responds to nearly 90,000 daily requests for world maps. The map site at the ***Earthview*** displays views of the earth from the sun, the moon or orbiting satellites, and includes the overlay of current cloud patterns derived from weather satellites.

Maps that are frequently updated include maps of traffic flow, as in the example of the ***current traffic in Houston***. Interactive street level mapping of the US is available from ***MapQuest***, ***MapBlast***, and ***MapOnUs***. These maps are based on the TIGER map file, a product of the ***U.S. Census Bureau***, which maintains its own mapping site. The location of bank teller machines on these maps can be obtained through a site supported by ***VISA***. Interactive mapping with demographic data is available through ***CIESIN.*** This site lets the user choose an area and a data value to map within the United States. ***Geomatics Canada*** has implemented a type of on-line, interactive mapping system that has some of the characteristics of a GIS.

Animated Maps

Animated maps are also available through the Internet. Map animations are usually stored in a format designed for the display of digital movies, such as QuickTime or MPEG. The most common examples of animated maps on the Internet are those of weather patterns, most often depicting the movement of clouds as seen on television weather forecasts. The movement of cloud patterns associated with ***hurricanes*** is especially suited for viewing as an animation. Other types of animated maps include ***terrain fly-throughs*** in which a landscape, usually somewhat mountainous, is viewed as if it were being flown through with an airplane or jet. Animations are also available showing ***population growth*** in a region. Here a shading is applied progressively to depict the pattern of population growth. Finally, animations are available that depict ***temporal trends*** or alternative methods of data classification, such as changes in the ***classification method*** or ***number of classes***.

"The most common examples of animated maps on the Internet are those of weather patterns."

THE INTERNET AND CARTOGRAPHIC RESEARCH

One of the major problems associated with maps is the difficulty many people have in using them. It has been estimated that more than half of the educated population do not have a basic understanding of maps. The reasons for this are not well understood. Some see the problem as a lack of education specific to map use, while others say it is the maps themselves or, even more specifically, the static means of displaying maps on paper.

Whatever the reason, it is clear that people have a poorly formed mental representation of their local environment that becomes more distorted in the areas beyond their direct experience.

The Internet has made possible both new forms of maps and different ways of using them and, perhaps, has created a new category of map user. The phenomenal growth in this new form of mapping has highlighted a number of areas in need of research that can be broadly categorized under "map use" and "map development." Map use will be examined first.

"The Internet has made possible both new forms of maps and different ways of using them and, perhaps, has created a new category of map user."

Internet Map Use

Number of Maps Distributed – A large number of maps are sent through the Internet but the exact number is difficult to determine. Sites that advertise generally maintain records on the number of "hits" (file accesses). However, many sites that distribute maps do not advertise and therefore have no reason to keep a record of the number of people that access their site, or use their maps. How can map use on the Internet be measured when records are not kept of the number of maps that are distributed? One solution is to maintain a centralized, on-line data base of registered Internet map publishers along with records on the number of "hits" per map. The automated system would poll each site on a daily or weekly basis and record the number of hits for that time period.

Types of Internet Map Use – How maps are being used on the Internet, and the profile of the map user are more difficult to ascertain than simple "hits." Is the purpose of map use "casual" or "goal-oriented?" Is there a preference for certain kinds of maps? How are interactive maps being used?

Such questions are being addressed by research associated with the development of the ***Alexandria Digital Map Library***. The use of maps in this library is being studied by examining the log file of its web sessions. The log files maintain information on the types of maps that are accessed, how long they are viewed, what map is viewed before and after, and where the user clicks on the map. While this could appear to be an invasion of privacy, users entering the site are warned that their use of the maps is being monitored. Analysis of the log files provide valuable data on how the maps are being used, and who is using them.

"The log files maintain information on the types of maps that are accessed, how long they are viewed, what map is viewed before and after, and where the user clicks on the map."

Internet Map Use by Children - Despite a concern about the adult nature of some of the material on the Internet, it is clear that the Web is being used in education at all levels. The implications to cartography are enormous, particularly in the training of a new generation of map users. Current maps on weather, earthquakes, volcanic activity and other natural phenomena not only bring greater interest to these subject areas, but also promote the use of maps in their study. The graphical nature of the Web can promote the use of maps in a variety of ways. The use of Internet maps by children, in particular, deserves study.

Internet Map Development

The second major area of research is the development of new and better forms of mapping. Web maps have already permitted new forms of interactive mapping, and this may continue to be an area where most developments occur. However, a great deal of research and development work needs to be done with the other two forms of mapping - static and animated.

Graphic Design – Issues of graphic presentation have been difficult to address in a typical research framework. Through the Internet, many different types of maps can be viewed, thereby making comparisons and evaluations possible. A "gallery" of well-designed maps could be promoted to help improve map design. Although the quality of maps presently available through the Internet is not very good, the access to maps that it provides improves the exchange of information, including that on map design. Research is needed on how this exchange of information can best be accomplished.

"Most maps are presently distributed using the raster (grid-based) GIF and JPEG formats, and the proprietary, vector-based Adobe Acrobat™ PDF format. None of these formats are designed for maps."

File Formats – Most maps are presently distributed using the raster (grid-based) GIF and JPEG formats, and the proprietary, vector-based Adobe Acrobat™ PDF format. None of these formats are designed for maps. GIF and JPEG are used mainly to distribute pictures, the former limited to 256 colors and the latter implementing a sophisticated compression scheme. The PDF format is designed for the distribution of printed documents. All of these formats produce larger files than would be necessary for the distribution of maps, and therefore take longer to download.

This problem could be solved by more compact map file formats and methods of map distribution where the receiving computer (client) would partially "reconstruct" the map. The format could even be specific to a map type. For example, a format for a choropleth map could consist simply of polygon outlines in screen coordinates, associated shading values, and text strings. A client-side plug-in or Java applet would then reconstruct the map for display. The advantage of this approach becomes clear when another data set is chosen for display, and it simply downloads an updated set of shadings and text strings to update the map.

Map Printing - Another issue associated with static maps is the distribution of maps intended for printing. Paper maps will not disappear because of the Internet. On the contrary, while fewer maps may be mass-produced on printing presses, more individual maps will likely be printed with computer printers. The question then focuses on the quality of these individually printed maps when there is such a variety of printers available. To some degree, the widely used Postscript™ page description language that is used by higher-end printers addresses many of the basic printing issues but it cannot adjust for the different ways that printers render colors, or all of the nuances associated with printer resolution.

"Traditional methods of representing scale, such as the representative fraction or verbal scales are not viable unless the size of the map can be controlled on the screen and in the printed version."

Map Scale - The representation of map scale is a problem that is related to both the display of maps on the screen and the printed product. Display devices have different resolutions, and display text and graphics at different sizes. Traditional methods of representing scale, such as the representative fraction (e.g., 1:24000) or verbal scales (e.g., 1 inch:10 miles; 1 cm:10 KM) are not viable unless the size of the map can be controlled on the screen and in the printed version. The graphic scale is a solution to this problem because its size varies with the size of the map. However, the use of the graphic scale is inexact and cumbersome. If the representative fraction and verbal scales are to be used, efforts need to be taken to standardize the displays on both monitors and printers.

Large Format Maps - Finally, the printing of large format maps is an additional problem. The ***Maps on Demand*** system from 3M Corp. (http://www.mmm.com/front/bosnia/index.html) solves this problem by combining a large-format, ink-jet printer, specialized paper, and a print engine. However, the rasterized file required by the system is enormous and cannot be easily transmitted through the Internet. Plans are being made to maintain the basic information on CD-ROM and only transmit the changes by Internet. The system demonstrates that high-quality, large-format maps can be printed one at a time, and this method of printing can be at least aided by the Internet.

CONCLUSION

Maps are an important source of information from which people form their impressions about places and distributions. Each map is a view of the earth that affects the way we think about the world. Our thoughts about the space in which we live and especially the areas beyond our direct perception are largely influenced by the representations of space that we see, and the way we think about our environment influences the way we act within it. The Internet has already improved the distribution of maps. If done properly, the Internet also has the potential to improve the quality of maps as a form of communication, thereby changing both the mental representations that people have of the world and how people mentally process ideas about space and spatial relationships.

The Internet has changed the process of mapping and map use. The new medium has already led to more interactive forms of mapping and and the increased availability of cartographic map animations. A great deal of work will certainly be done in these areas. It is also important, however, to look at problems in the distribution of static maps and issues that deal with their display. Certainly, much work lies ahead in order to make the Internet an effective means of transmitting spatial information in the form of maps.

INTERNET REFERENCES

(Connect to this document at: http://maps.unomaha.edu/NACIS/cp26/article1.html)

On-line book about the Internet

Zen and the Art of the Internet

(http://www.cs.indiana.edu/docproject/zen/zen-1.0.html)

World Wide Web

An introduction to the World-Wide-Web

http://aslan.math.hmc.edu/codee/intro-www.html

World Wide Web Frequently Asked Questions

http://www.fcm.missouri.edu/book/www.htm

Glossary of World Wide Web Terms

http://www.ncsa.uiuc.edu/SDG/Software/Mosaic/Glossary/GlossaryTable.html

World Wide Web resources

An Overview of Browsers

http://www.ncsa.uiuc.edu/SDG/Software/Mosaic/Glossary/GlossaryTable.html

QuickTime Plug-in

http://quicktime.apple.com/sw/sw.html

MPEG Plug-in

http://www.intervu.com/player/player.html

Search Engines

How To Use Web Search Engines

http://www.monash.com/spidap2.html

Static Maps

Africa (scanned)

http://www.lib.utexas.edu:80/Libs/PCL/Map_collection/africa/Africa_pol95.jpg

Burma (scanned)

http://www.lib.utexas.edu/Libs/PCL/Map_collection/middle_east_and_asia/Burma.GIF

High Temperature Map

http://www.intellicast.com/weather/usa/hitemp/

United States Per Capita GNP

http://www.oseda.missouri.edu/graphics/us/pci90.gif

Files in Adobe Acrobat Format

http://maps.unomaha.edu/Peterson/funda/Maps/

Adobe Acrobat Plug-in

http://www.adobe.com/prodindex/acrobat/readstep.html

Interactive Maps

Xerox Parc

http://pubweb.parc.xerox.com/map

Earthview

http://www.fourmilab.ch/earthview/vplanet.html

Current traffic in Houston

http://herman.tamu.edu:80/traffic.html

MapQuest, **MapBlast**, and **MapOnUs**

http://www.mapquest.com
http://www.mapblast.com
http://www.maponus.com

U.S. Census Bureau

http://tiger.census.gov/cgi-bin/mapbrowse-tbl/

VISA

http://visa.infonow.net/powersearch.html

Canada

http://ellesmere.ccm.emr.ca/naismap/naismap.html

Animated Maps

Hurricanes

http://maps.unomaha.edu/AnimArt/Hurricane.mpeg

Terrain Fly-through

http://maps.unomaha.edu/AnimArt/flatgc.mov

Weather Fly-through

http://maps.unomaha.edu/AnimArt/CloudFLY.mov

Population Growth

http://maps.unomaha.edu/AnimArt/sf_bay900.mpeg

Spatial trend

http://maps.unomaha.edu/AnimArt/SpatTrend.MOV

Classification Method

http://maps.unomaha.edu/AnimArt/Class_Anim.MOV

Number of Classes

http://maps.unomaha.edu/AnimArt/GenAnim.MOV

Geographic Information Retrieval and the World Wide Web: A Match Made in Electronic Space

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This article looks at the access to geographic information through a review of information science theory and its application to the WWW. The two most common retrieval systems are information and data retrieval. A retrieval system has seven elements: retrieval models, indexing, match and retrieval, relevance, order, query languages and query specification. The goal of information retrieval is to match the user's needs to the information that is in the system. Retrieval of geographic information is a combination of both information and data retrieval. Aids to effective retrieval of geographic information are: query languages that employ icons and natural language, automatic indexing of geographic information, and standardization of geographic information. One area that has seen an explosion of geographic information retrieval systems (GIR's) is the World Wide Web (WWW). The final section of this article discusses how seven WWW GIR's solve the the problem of matching the user's information needs to the information in the system.

INTRODUCTION[1]

Information retrieval (IR) systems attempt to satisfy requests for either general information by providing documents on a topic, or precise data from a database. Geographic information requests are often a blend of the two. Information can come in a variety of formats but the critical measure of success is the relevancy of the retrieved documents to the information needed. The solution to the traditional information retrieval problem is a system's best match between a user's information need and the system-held documents that resolve the information need. One very problematic issue for the retrieval of geographic information is query formulation. Retrieval systems currently have limited support to operationalize a user's natural language or other geospatial queries as well as limited support for users to express their information needs to the system. Fortunately there are alternative query languages beyond that of basic boolean operators of "anding" and "oring" keywords.

"The solution to the traditional information retrieval problem is a system's best match between a user's information need and the system held documents that resolve the information need."

One alternative is "iconic query language" whereby a user creates a geographic query by using icons. An icon is a computer generated representation of a physical object; for example, a line representing a road or stream. Geographic information deals with physical objects that are in some cases hard to express with words. The ability to graphically create the query may facilitate more effective retrieval. Traditional query languages deal only with the precise (Cats AND Dogs) and cannot handle the vagueness of concepts such as "extremely low humidity" or "recent information." Users do not always think in precise terms, which can also make it difficult to retrieve information. By using a fuzzy query language,

"One very problematic issue for the retrieval of geographic information is query formulation."

[1] This article deals with information science issues pertaining to geographic information, such as the retrieval of information and ability to effectively query a retrieval system for information. This is not a technical article dealing with design or interface issues of specific geographic information systems. Pertinent articles not discussed are included after the reference section.

the concept can be converted into a number sequence that the system can use. Similarly, automatic indexing of geo-referenced information can also help a user to retrieve geographic information.

"The introduction of the World Wide Web (WWW) and clickable image maps have simplified the users' search and retrieval for geographic information."

The introduction of the World Wide Web (WWW) and clickable image maps have simplified the users' search and retrieval for geographic information. The relative infancy of the WWW and online geographic information systems (GIS) currently limit most GIR's to queries for specific factual data, further constrained from choices only from menus. Relatively few WWW GIR systems allow users to edit and save geographic information online. We examined seven WWW GIS systems to discover how "the match" between a user's information need and the system response for information was accomplished. We present our results below.

INFORMATION RETRIEVAL

This is the age of information. Year by year the amount of data and information increases exponentially with geospatial data accounting for a large proportion of this increase. Too much information can cause an information overload driving the need to weed out the irrelevant information in order to retrieve the relevant information. In information science, the discipline that deals with this subject is information retrieval or IR. IR deals with "the process of searching some collection of documents, using the term documents in its widest sense in order to identify those documents which deal with a particular subject" (Lancaster 1979, 11). Most IR systems and research attempt to resolve the classic IR matching problem mentioned earlier: The systems try to efficiently and effectively "match" a user's information need to the document or documents that can fulfill that need. Typical commercial IR systems use a Boolean-based query mechanism and an inverted file of terms and documents (e.g., DIALOG or LEXIS/NEXIS). There are other types of IR systems such as Salton's SMART system[2] based on vector space and Belkin's ASK ("Anomalous States of Knowledge")[3] system which instead of trying to get the perfect "match" tries to get the user close enough to the right documents, similar to browsing in a library stack.

According to Ray R. Larson (1996), six basic elements make up a retrieval system. All six retrieval elements are pertinent to the retrieval of geospatial data and information and will be addressed in the Geographic Information and Information Retrieval section of this paper. The six elements are: (1) retrieval models, (2) indexing, (3) how items are matched and retrieved, (4) relevance, (5) order of results, and (6) query languages. Van Rijsbergen (1979) adds query specification as a seventh element. With these seven elements, one can clarify the differences between retrieving information, and retrieving just data; that is, the distinction between IR and data retrieval (DR).

"With these seven elements, one can clarify the differences between retrieving information, and retrieving just data; that is, the distinction between IR and data retrieval (DR)."

Retrieval Models

The first element of the retrieval system is the mechanism or model the system uses. Some IR systems are based upon a probabilistic or approximate model that deals with "subjective issues"(Larson). This model finds information relevant to the user although the document may not satisfy all

[2] Salton, G. & McGill, M.J. 1983. *Introduction to modern information retrieval.* New York: McGraw-Hill.

[3] Belkin, N.J. & R.N. Oddy & H.M. Brooks 1982. ASK for Information Retrieval: Part I. Background and Theory. *Journal of Documentation* 38(2): 61-71.

of the user's requirements. However, DR (data retrieval), on the other hand, uses a deterministic model retrieving documents that contain the stated variables as required by the query. For example, DR is concerned with queries like seeking the number of widgets in the inventory at the Chicago plant. IR queries are concerned more with finding some information on widget construction or regional differences in processes concerning widgets.

Indexing

Indexing organizes the documents of a retrieval system to promote efficient and effective intellectual as well as physical access. In IR systems, indexing is "derived from the contents, " (Larson) such as keyword extraction. IR can also index terms from a controlled vocabulary (Pao, 1989) which is a preselected list of words that can be used to describe any document in the collection. In DR indexing the item itself is the indexing unit. For example, an automobile part in a parts database uses the part number or name as the indexing unit or entry point into the index.

Match and Retrieval

"DR systems are extremely precise but brittle and fail easily without signs of degrading."

When a retrieval system attempts to connect a user's information need to the documents that may resolve the need, the system matches and then retrieves the needed documents or pointers to the documents (page numbers, report titles, etc.). IR and DR use two different matching methods. IR uses a "partial match, best match" (Van Rijsbergen 1979, 2) method where the idea is "to find those items which partially match the request and then select from those a few of the best matching ones" (Van Rijsbergen 1979, 2). The IR system attempts to exhibit just those documents that can solve the information need. A retrieved document might not be the ideal, but it will be close enough (at least initially from the system's point of view). DR, however, uses an "exact match" method. When a particular datum is sought, the DR system returns that datum, or if not contained in the system, returns nothing. DR systems are extremely precise but brittle and fail easily without signs of degrading.

Relevance and Ordering

"An item is considered relevant if it satisfies the requirements of the user."

Larson's fourth and fifth elements pertain to the display of information. Each retrieval system has a "criteria" for the items retrieved. In the IR system, relevance is the reason that the items are retrieved. An item is considered relevant if it satisfies the requirements of the user. Again using the widget example, a user wants information on the widget construction done in a Chicago plant. An item retrieved that deals with that exact topic will be considered extremely relevant, whereas a document generally on widget construction is relevant, but not as relevant as the first item. Items that are retrieved by an IR system are ranked in a particular order, the most relevant items at the top of the list and the least relevant at the end. Ordering of the items retrieved by an DR system, on the other hand, are arbitrary without preference to the degree of relevancy of the item.

Query Language

The last two elements are Larson's query language element and Van Rijsbergen's query specification element. Both elements deal with the query mechanism of the retrieval system. In an IR system, queries are more natural-language like with less structure than the query language of a DR (e.g., Structured Query Language or SQL). A natural language query can be as simple as entering one or two sentences into the system or as complex as a series of paragraphs. The query mechanisms for IR systems are intentionally incomplete (Van Rijsbergen 1979). The user may either lack the ability to fully articulate the query or (since information needs are dynamic) not anticipate the full specifications, breadth, depth or precision of the information needed. Either condition may result in an incomplete formulation of the query. DR uses a query language such as SQL that is artificial and more structured, employing more restricted syntax and vocabulary (Van Rijsbergen 1979). The specifications of a DR query are a complete specification of the desired item and only that item.

"A natural language query can be as simple as entering one or two sentences into the system or as complex as a series of paragraphs."

GEOGRAPHIC INFORMATION AND INFORMATION RETRIEVAL

The retrieval of geographic information attempts to provide intellectual and physical access to geo-referenced information sources. Unfortunately, geographic information is not easily compartmentalized into just one retrieval system. Larson uses the six elements discussed above to investigate Geographic Information Retrieval's (GIR's) position on the "retrieval continuum." One end of the retrieval continuum is DR while on the opposite side is IR. GIR, coined by Ray R. Larson of U.C. Berkeley, is a combination of the information retrieval and data retrieval elements discussed in the previous section.

"Unfortunately, geographic information is not easily compartmentalized into just one retrieval system."

GIR's "retrieval model" is a combination of deterministic and probabilistic models. Retrieval of geographic information can range from searching out a single location, to finding all towns near a major highway spanning more than one dataset, to finding likely locations in disparate regions for further investigation. Indexing of geographic information also blends information and data retrieval. GIR can use elements from the item, such as "intellectual" or "inferential" indexing. GIR indexing may also be of the complete item, as in data retrieval, such as a map or data set. In matching and retrieval, GIR can use both, the "partial or best match" of IR and the exact match of DR. A "partial or best match" would be finding information on the towns near a major highway that match imprecise or value laden attributes (e.g., near, not too far from, etc.). GIR also uses the "exact" match method of data retrieval. For example, requesting data on carbon dioxide levels for a range of times, dates, and elevations at a particular place.

Standardization

One important means to facilitate the retrieval of geographic information is through standardization. The United States government has spent a vast amount of money compiling geographic data and standardization is seen as a way to cut spending and reduce data duplication. The Federal Geographic Data Committee (FGDC) has been working toward coordinating all federal "geographically referenced information" (Nerbert). In 1994, the FGDC was a partner in creating the National Spatial Data Infrastructure (NSDI) to help coordinate spatial data access. The NSDI will be the "Clearinghouse" for all the U.S. government geographic data. NSDI's functions are:

... developing and implementing standards for the framework and thematic data; producing framework and thematic data; implementing standards for geospatial data documentation and transfer; establishing procedures to use electronic networks to search for, access, and use geospatial data; and cooperating

in the development of state and regional councils and private sector agreements to accomplish these actions.[4]

The NSDI made freeWAIS, a Wide Area Information Server (Nerbert), the standard platform to be used by all governmental agencies for indexing and serving geographic data. Standardization of "geospatial" data will allow more effective search and retrieval of geographic information via the WWW or with GIR systems.

Experimental Query Languages

Geographic information needs can be difficult to express verbally, creating problems for both system and user when trying to form a query. The inability to accurately portray a query to a system will result in poor matches or the retrieval of incorrect data. Two innovative querying languages for GIR systems are iconic and fuzzy query languages. Both languages support improved query formulation and translation for system matching. The ability to express the information needs graphically can improve the matching capability of the system. Iconic query languages create graphical query icons. Lee and Chin (1995) created an iconic query language to simplify retrieval of geographic information from a spatial database. The icons used to build a query were lines, points, boxes, and asterisks. With a graphical user interface (GUI), the user can choose the icons to represent the geospatial information need. The GUI is linked to a database interface that is in turn linked to a relational database (INGRES). The database interface is used to translate the iconic query language into an expression the relational database can employ.

"Geographic information needs can be difficult to express verbally, creating problems for both system and user when trying to form a query."

The authors provide an operational example to show the effectiveness of an iconic query language user interface. This system is still in the early stages of development. There are also suggestions for improvements to future user interfaces, such as: the need for a wider choice of icons to choose from and a better user verification system (Lee and Chin, 1995).

"With a graphical user interface (GUI), the user can choose the icons to represent the geospatial information need."

No IR system permits or is capable of full natural language interaction with users. Users must know the system commands allowed for effective query formulation. Often with the more traditional IR systems (DIALOG, LEXIS/NEXIS, etc.) the commands are difficult to use or understand. Systems would be more user friendly if a user could enter a sentence or two in their own words to explain the information needed.

Natural language processing permits the system to consider the sentence as a whole rather than the interpretation of individual words. If one enters a query such as "I would like recent information on Bosnia," what should be retrieved? The pertinent information would not be a document that has the words "recent" or "information," but a document that has recently been written about Bosnia. The ability of a system to handle these nuances has potential for improving retrieval of geographic information. Fangju Wang has created a natural language user interface (Wang, 1994) that uses fuzzy query language. The fuzzy query language can handle modifiers such as "almost near" and "much higher than average."

The fuzzy query language uses fuzzy formulae to handle the modifiers. The basic fuzzy formulae would look something like this: X is F, where F is the "membership function," such as "high." Wang (1994) describes four classes of fuzzy formulae: (1) simple (temperature is low); (2) modification (temperature is very low), (3) comparison ("temperature is *slightly* higher (greater) than 10 0 C " (Wang 1994, 149)) and (4) quantitative

[4] A more complete description of NSDI may be found at URL **http://www.fgdc.gov/nsdi2.html**

("Find all the cities which are close to at least several camping sites," (Wang 1994, 149)). This prototype system was tested with ARC/INFO using a fuzzy SQL. The system translates the fuzzy SQL queries into standard SQL, so the database can be queried.

The author tested his fuzzy query user interface on an existing GIS of Canadian tourist and weather information. The sample queries followed the SQL format of "select-from-where"(Wang 1994). These queries varied in the complexity of the "selection conditions" of the "where" part of the SQL form. Preliminary testing of the user interface by Wang has shown that fuzzy query language interface has the potential to improve access to geographic information.

Indexing Geographic Information

Indexing documents is a major part of any retrieval system. Indexing describes a document's content then formulates a surrogate for the document. Indexing in IR systems determines what are acceptable terms (Pao 1989) for search and retrieval of information. Geographic terminology can be used in geographic information systems as indexing terms. Two projects that are trying to index automatically "geo-referenced" information are: GIPSY (Geo-referenced Information Processing System (Woodruff and Plaunt, 1994)) and Mark Carlotto's HyperMap system (Carlotto, 1995).

"Indexing describes a document's content then formulates a surrogate for the document."

GIPSY is a geographic indexing system that assigns index entries to text documents. Each indexing entry is a polygon previously associated with the text term from base maps. A user can input a query (in the form of a paragraph) and GIPSY will assign the polygons from a base map that relate to those terms. All the individual polygons associated with the text terms are then overlaid on the map forming a stack. Regions with the highest stacks are seen as the most relevant regions to the user's query. The query polygons are then matched to the stored document indexing to find the documents that are most relevant to the user's query. Those with the highest relevance are returned to the user as an answer set.

To assign index polygons, GIPSY first parses words in the text of the query or the document then extracts all geographical terms. The terms pulled out by the parser are matched to geographical terms found in a thesaurus. The spatial regions from the retrieved data sets are processed and then given a weight. The four used criteria to determine relevance are: (1) extracted geographic terms, (2) location and frequency of the terms, (3)"knowledge of the geographic objects in the database and their attributes," (Woodruff and Plaunt 1994, 649) and (4) "spatial reasoning about the geographic constructs occurring in phrases" (Woodruff and Plaunt 1994, 649). The final step is to stack the polygons. Here the polygons are mapped using the weighted information, the higher the polygon stack, the greater the relevance.

Mark Carlotto (1995) proposes the use of textual attributes and text processing for indexing and retrieving geographical information. In this system, text documents and queries that deal with geographic information are converted into binary vectors. Using various distance measures between the vectors (i.e., hamming distance), the system compares documents and queries. Because text documents that are less similar will have higher Hamming distances than documents that are more similar, distance can be used as a measure of relevance. Relational data can also be converted into "free text attributes" by concatenating the relational database field name with the field value (Carlotto, 1995).[5]

[5] An example of this process would be: "LandCoverTypeWater" (Carlotto, 1995)

Carlotto used a prototype software program, HyperMap, to retrieve geographic information. HyperMap is a multimedia browser displaying geographic information such as a map, images, sound, and movies. HyperMap indexes the information by converting text files into ASCII format. A parser extracts relevant information (geographic coordinates, time, etc.) from the ASCII format and the full text is converted into a vector. When a query is entered into the system, the system ranks and selects objects based on a score (one, if all terms are in the text, and less than one otherwise). Spatial queries are treated similarly to text queries with objects closest to the query normalized to one.

WORLD WIDE WEB AND GEOGRAPHIC INFORMATION

With clickable maps, PERL scripts, and JAVA applets, the WWW offers the ability to do interactive geographic information retrieval. The end user can search and retrieve geographic information from home, school or the library. A search of WWW GIR systems leads to various WWW systems that search and retrieve geographic information. Seven WWW GIS systems will be discussed in the following section because of their innovative ways of addressing the IR matching problem for geospatial information needs.

"With clickable maps, PERL scripts, and JAVA applets, the WWW offers the ability to do interactive geographic information retrieval."

The range of the geographic information that can be found on the WWW is limited. Most of this information is domain specific. For example, geographic information may only pertain to Australia or Canada or environmental information, and the user can only select information appearing on a menu. Some WWW geographic information retrieval systems do allow the user to enter search terms, but fewer allow the user to actually enter their own information into the WWW GIR system.

The WWW has given scientists the ability to share geographic information eliminating redundant data collection. The Environmental Research Information Network (ERIN)[6] is a WWW GIR dedicated to Australian environmental information. Scientists throughout Australia have access to the same information. Before the query is submitted to the system, the user selects an interface and a region for search. There are five interface choices: Mapsheet index, Minimum Bounding Rectangle (not yet operational), Biogeographic Regionalism, Major Catchment Region, and Named Regions. The mapsheet index interface was used to explore ERIN GIS. With the interface and regions selected, the user is given a PERL form to input the actual query. The user then chooses the data set themes and selects the dataset containment type (completely within the region, encompassing the region, or both). Users may also enter terms and use Boolean logic to broaden or narrow the query. The user is given the op-portunity at the query screen to select which WAIS server to search and select the maximum number of items to be returned by the system's search.

"The WWW has given scientists the ability to share geographic information eliminating redundant data collection."

If a user submits a less structured query, the system returns an SQL form of the query as well as all the query-matching data sets. The user can then selectively view maps of the data set coverages. Clicking on a map item provides metadata for the coverage (citation Information, online reference information, spatial domain keywords, data quality information, and so forth) along with all hypertext links to access additional text or geographic information. To view the actual data, the user may select the online_linkage URL.

The KINDS (Knowledge based Interface to National Data Sets) Project[7] is a user-friendly interface to browse or search the Bartholomew digital

[6] The URL is **http://www.erin.gov.au/cgi-bin/spatial_interface**.

[7] The URL is **http://cs6400.mcc.ac.uk/kinds**

mapset spatial data of the United Kingdom via the WWW. This project uses two different indexing techniques: thematic and geographic. The thematic index consists of themes such as danger zones, political boundaries, and scenic areas. The geographic index is based on the National Grid (map of the U.K. divided into fifty-five squares, each square with its own two letter code).

"Once the user selects an area of interest, a map with the selected area is highlighted and a list of thematic data about the region is retrieved."

The user can query the KINDS Project using either a geographic map interface or a freetext search engine with a National Grid map serving as the geographic interface. The user simply browses the map image selecting the cell of the Grid that is of interest (See Figure 1). Once the user selects an area of interest, a map with the selected area is highlighted and a list of thematic data about that region is retrieved.

The second interface to the system is uses a freetext search request strategy. The user is given a form to fill in the text search terms using boolean logic (AND, OR) and truncation (*, asterisk). The Boolean logic helps broaden or narrow the search strategy. A list of documents ranked by relevance score is retrieved with the more relevant documents appearing higher in the list and the user is presented the Feature Class (such as political boundaries or road), the Area Code (a two-letter code for the National Grid), and the relevance score for each item retrieved. By clicking on the document, the user retrieves a map of the area containing the Feature Class and the specifications of that data layer.

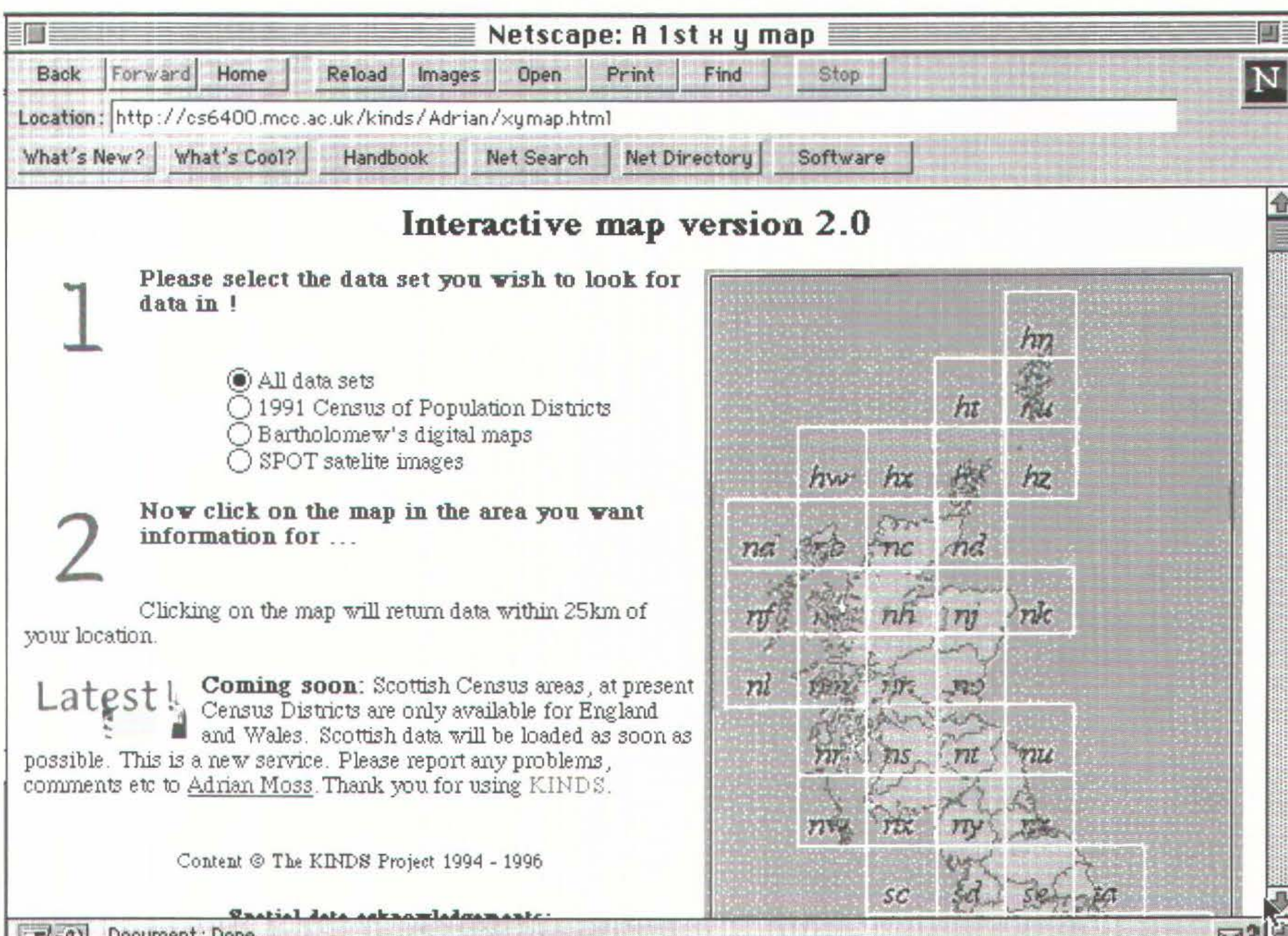

Figure 1.

The EWSE (European Wide Service Exchange)[8] homepage employs an innovative method for discovering information about what EWSE resources are in a particular region. The user is given a menu of image maps of Europe to search for the area of interest. Once the user selects a particular map, the area is presented at higher resolution. If the area selected is not appropriate, a user may easily return to the map menu by selecting a button on the WWW browser. When the region of interest is found, the user can click a button and retrieve EWSE resources for the selected area.

A second query screen for EWSE then pops up and the user is prompted to select a search for jobs, workshops, meteorological stations, products, or all of the above as well as a display format for information retrieved. The user can choose to have the output formatted with the desired information sorted by date, name, or type. In addition, the user can click on the retrieved documents to discover what events are occurring in that region.

MapQuest[9] is an interactive atlas produced by GeoSystems Global Corporation. This on-line atlas allows the user to "Edit" the map and has the ability to store searches, two features seen in few WWW GIR systems. The user can search or browse through the interactive atlas though a user friendly menu system with five choices: Find, View, Options, Edit and File.

"The retrieved map can be manipulated by zooming to streets and panning in cardinal directions of north, east, south, or west."

Querying the MapQuest atlas is done by using the Find menu. The user is presented a query form in which to enter as much information as possible about a location or business of interest. The form consists of the name, address, city, state and zip code to be used to search for the business. After the query form is submitted, a map of the area is displayed with a pin marker at the business location. The retrieved map can be manipulated by zooming to streets and panning in cardinal directions of north, east, south, or west.

Enduser browsing in MapQuest is done with the View menu. The user is given a map of the continental U.S., and with the zoom and pan buttons can browse the U.S. to discover the desired information.

One of the most interesting features of MapQuest is its capability to edit the retrieved maps. Editing is permitted only after the user fills out a form and becomes a MapQuest member. In Edit mode, the user can add points of interest (See Figure 2) to the desired area of the map. The user clicks on a point of interest on the map and then fills out a form that describes that point. There are eighteen types of points of interest ranging from health care to entertainment. Once the form is filled out, the point is saved.

"One of the most interesting features of MapQuest is its capability to edit the retrieved maps."

MapQuest's last menu option is File. This feature allows users to store map searches for later use. This feature is unique among WWW GIS systems.

The Australian Geodynamics Cooperative Research Centre (AGCRC)[10] homepage uses GRASSLinks to connect users with geographic information via the WWW. GRASS (Geographic Resources Analysis Support System) is a powerful public domain GIS system created by the U.S. Army Corps of Engineers. GRASSLinks is a good example of a user-friendly GIS interface (See Figure 3). No command input is needed, instead this system provides an easy-to-use query mechanism for the retrieval of geographic

8 The URL is **http://ewse.ceo.org**

9 The URL is **http://www.mapquest.com**

10 The URL is **http://www.ned.dem.csiro.au/AGCRC/4dgm/grasslinks/grasslinks.html**

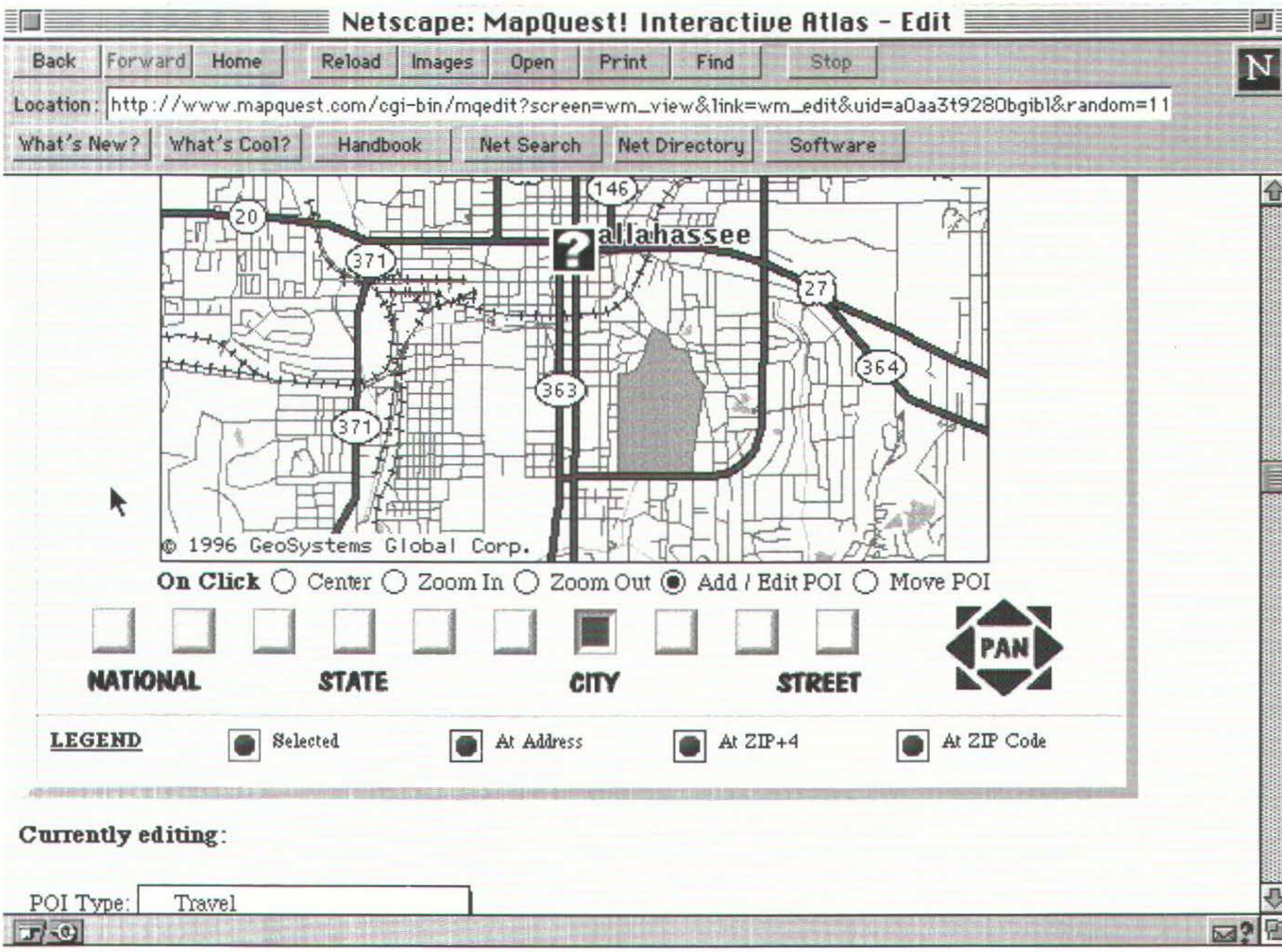

Figure 2.

"The AGCRC WWW GIS, though domain specific, is a prime example of how easy it can be to search and retrieve geographic information via the WWW."

information. If the commands for the system are too complex, usability of the GIS will be low and only those who have the time to learn the system will use it.

The AGCRC WWW GIS, though domain specific, is a prime example of how easy it can be to search and retrieve geographic information via the WWW (See Figure 3). After starting GRASSLinks, the screen displays a menu for creating a map. To create the backdrop of the map, the user selects one of sixteen available raster maps. In the next menu box, the user selects from among twenty-five vector layers. Users also select the colors of the vector layers. A third menu allows the user to select the number of site maps to plot as overlay points. A choice of three colors to display on the site maps is also available. The last two choices on this screen are region selection and the size of the map to be retrieved and displayed.

The delay in time between query and retrieval of the map is minimal, even though map creation was done on the fly in real time. Once the map is retrieved, the user can zoom-in or out, and pan across the map. One inconvenience of these manipulations is the need for the system to completely regenerate the entire map.

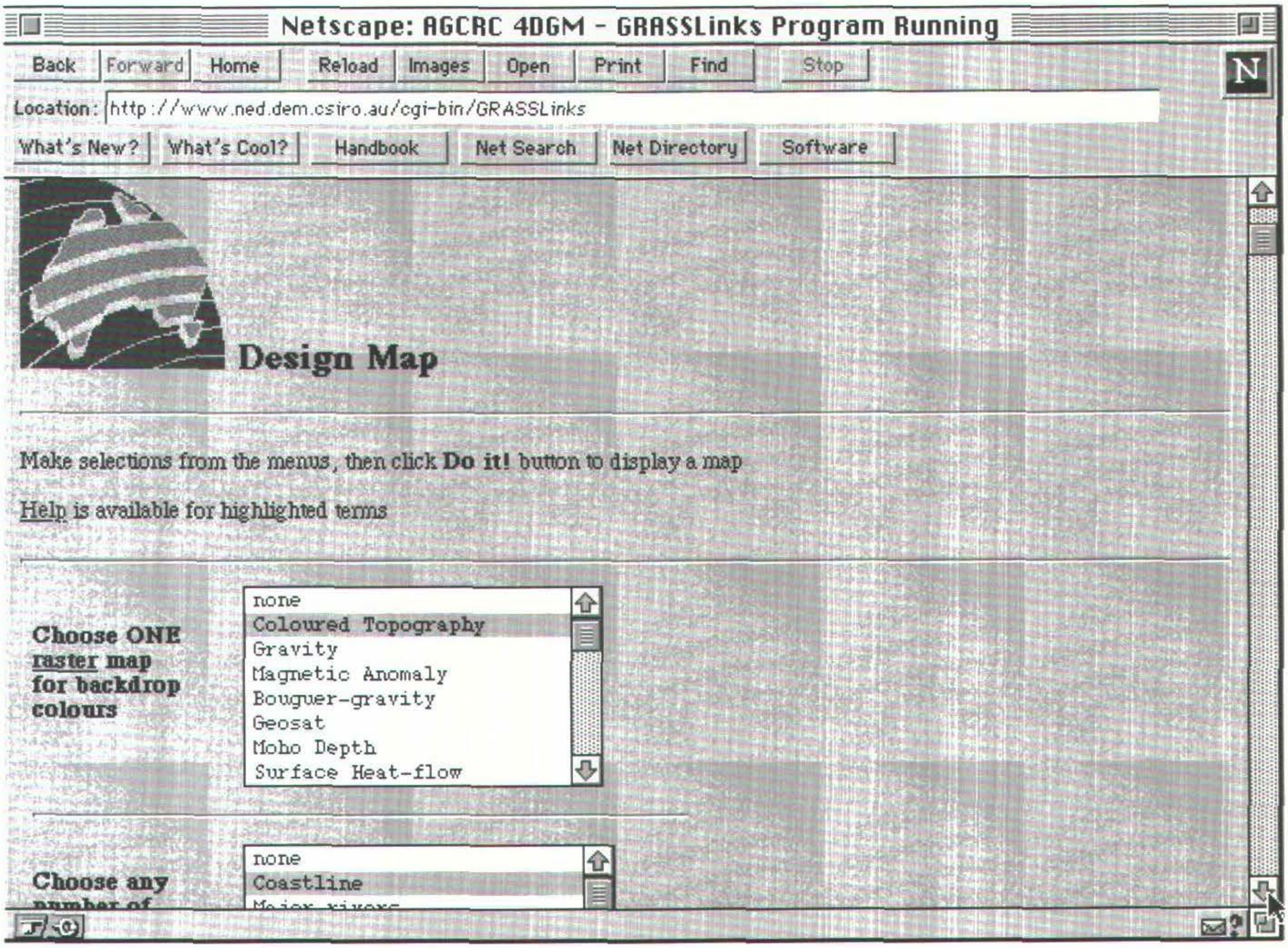

Figure 3.

The NAISMap (National Atlas Information Service)[11] is also a WWW interface to a GIS. This GIS deals with Canadian Spatial data and emphasizes geology, hydrology, the environment and biodiversity. NAISMap is a straightforward easy-to-use WWW GIS. Step by step query menus guide the user in creating the desired map. The first menu prompts the user to select as many map layers as desired from thirty layers.[12] NAISMap then orders the layers and gives the query back to the user for verification before processing.

NAISmap's next screen displays all the selected layers permitting the user to change the colors of each data layer. Once the colors are selected, the user can again submit the query.

"NAISMap is a straightforward easy-to-use WWW GIS."

TIGER Map Service[13] is a prototype browser that creates maps on-the-fly using TIGER/92 data. With the TIGER interface, the user can browse

11 The URL is http://ellesmere.ccm.emr.ca/naismap/naismap/naismap.html

12 Selection depends upon the system running the WWW browser. For example when using Netscape 2.0 running under a Linux operating system we can select as many layers as needed. When the same GIR system was queried using Netscape on a DOS machine we can only select one layer at a time.

13 The URL is **http://Tiger.census.gov/cgi-bin/mapbrowse-tbl**

maps or input search terms to retrieve geographic information. The user may also input exact latitude and longitude as a third option for search and retrieval of the desired geographic information at a particular location. To browse the TIGER GIS, users may change the preset values to the U.S., zoom in, and click on the desired geographic location. Once the user is close to the location, the four pan and zoom buttons can be used to find the exact location.

"The U.S. Gazetteer is a searchable index that retrieves both 1990 Census data and a hypertext link to a TIGER map."

A text search from the U.S. Gazetteer is done by inputting the name of the city, the state, and optionally, the zipcode for the desired geographic location. The U.S. Gazetteer is a searchable index that retrieves both 1990 Census data and a hypertext link to a TIGER map. Once the location has been found by either browsing, searching a term, or latitude / longitude, a map of the area is retrieved . With a map displayed, the user can zoom in and out and select from pop-up menus forcing layers to be displayed or hidden. Another menu on the screen gives the user the ability to display selected levels and themes of census data. A legend underneath the map explains the meaning of the different colors or lines, and includes the map scale.

CONCLUSION

The ability to access and retrieve relevant information, whether in textual or geographic form, is important in today's information age. By creating retrieval systems that emphasize the IR elements discussed earlier (such as relevance, ranking, and natural language querying) systems will become more effective and user friendly.

Indexing of geographic information will create more efficient systems and better access. Collected data can be automatically indexed using systems like GIPSY or the prototype HyperMap associating terms more easily with geographic locations. One possible future scenario would be to have users' access to all public geographic data from one GIR. The data, of course, could be distributed across many servers and would be accessed through a single user friendly interface.

Another way to make the access to geographic information easier is through experimental query languages, such as iconic or fuzzy query languages. Often, explaining geographic concepts in nature is difficult (Remember the last time you got directions and soon became lost in an unfamiliar city?) Therefore, why should users be limited to creating a query using text and boolean operators? Access can also be enhanced with natural query languages. The fuzzy query language user interface has the ability not only to improve access to geographic information but also traditional IR systems. A user could ask for documents that are close to a particular call number or that have been published recently. A fuzzy query can make natural querying easier and more effective for the user and the system.

"With the growing acceptance of the WWW, the public will want access to more geographic information."

With the growing acceptance of the WWW, the public will want access to more geographic information. Therefore, the user will need effective access and retrieval of geographic information. The WWW GIR systems discussed in this paper have begun to explore components to help in the retrieval of geographic information. Most of the WWW GIR's discussed in this article permit users to browse the map for information or to present a query screen to enter search terms. These two methods are both effective ways to access information. However, both GIR systems are a mixed blessing: they are successful because they are easy to learn and use; but, represent static queries that do not allow unanticipated or flexible query formulation, since the user can only select from the predetermined menu items.

The seven WWW GIS's discussed are innovative methods for access and retrieval of geographic and textual information. We especially note that MapQuest offers the ability to edit and save searches, something few search engines offer for free. Conventional vendors such as DIALOG and LEXIS/NEXIS offer such amenities for text based searches but at an additional cost. The ability to customize the geographic information can be highly beneficial for a user. For example, the Tiger Map Service allows users to modify images by placing a colored stick pins on the map (however, this is quite limited compared to MapQuest's customability). EWSE's ability to access textual along with pure geographic information is quite effective since a geographic browser should permit users to access all sorts of information.

"The seven WWW GIS's discussed are innovative methods for access and retrieval of geographic and textual information."

GIR's are improving on the WWW yet better systems are still possible. From an IR standpoint, not all of the six elements were used by any of the WWW GIR's. Natural language queries are still not possible and most systems do not retrieve information ranked by relevance and only one of the seven retrieved textual information by relevance. Improvements as mentioned above will further assist users of geographic information to meet their information needs in the years to come.

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Cartography on the Internet: Thoughts and a Preliminary User Survey

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This paper reviews the design and delivery of maps through the Internet. The paper also reports on the findings of a pilot study undertaken to solicit user reactions to a set of Internet maps, to test whether professional geographers and non-geographers judge Internet maps differently, and to identify key issues in cartography related to the Internet. The study concentrates on Internet maps for tourism and travel. The paper does not offer definitive conclusions, but instead attempts to raise questions and methodological issues, and to stimulate debate.

Keywords: Maps, Internet, Map Design, User Survey, De-construction, Tourism

INTRODUCTION

The Internet, also known as the "Information Highway," "Infobahn," or the minimalist "Iway," offers new challenges and possibilities for the representation and communication of information, including cartographic information. Although the current focus on the Internet may exaggerate its true potential, it is undeniable that the Internet has already begun to have an impact on society — at least on that portion that owns a computer. Inevitably, the Internet will continue to establish itself as a source of information, and the map will be a part of it all.

Maps and the Internet would seem to be a perfect match: a new technology with which to display maps accessed by an audience numbering in the millions. Studying maps on the Internet is a logical next step in a research agenda where cartographers have studied maps in a variety of media: in newspapers and on television, (Gilmartin 1985, Balchin 1985), in magazines (Monmonier 1989), on journal covers (Paul 1990), and even on postage stamps (Davis 1985). Along this line, a pilot project was initiated to investigate Internet maps. This research was undertaken to fulfill the requirements of an undergraduate fourth year special reading course in advanced cartography. The ideas behind the pilot project were to pose and address methodological issues, to ask potential Internet users to critique the design elements and communication quality of a set of Internet maps, and to approach the survey with a post-modernist perspective as laid out by its two chief proponents, J. B. Harley (1990) and D. Wood (1993).

". . . the Internet will continue to establish itself as a source of information, and the map will be a part of it all."

To achieve these goals and also gather general comments on the design and quality of Internet maps, a user survey was conducted of two different groups of potential Internet map users. A distinction was made between academic/professional geographers and non-geographers, hypothesizing that these two groups view Internet maps differently because of the former's professional familiarity with maps and their training as critical thinkers.

The study added a post-modernist perspective in order to learn how participants of a map survey would respond to the use of non-traditional cartographic measures, and to determine whether it would be possible to stimulate, as Harley put it, "a closer and deeper reading of the cartographic text" (1989, p. 8) on the Internet. This is not to down-play the importance of traditional design and graphic elements in evaluating maps, but to seek de-constructionist thoughts from the Internet map critics so that alternative methods of cartographic critique could be explored.

In summary, this paper reports on a survey designed

- to solicit user reaction to the quality and design of a set of Internet maps;
- to evaluate whether map users would consciously or sub-consciously de-construct Internet maps; and
- to test whether professional geographers and non-geographers view Internet maps differently.

The first part of this paper discusses the design of the survey and the reactions of the participants to a selection of Internet maps. This is followed by a more general discussion of cartography and the Internet, identifying key issues for the cyber-cartographer.

METHODOLOGY

Three methodological issues had to be addressed:

- how to select a set of Internet maps to include in the survey;
- whom to survey; and
- how best to design and conduct the survey.

Map Selection

The Internet "does not support a structured, objective or exhaustive search for Internet maps."

The Internet is a very large network that is difficult, if not impossible to search systematically. It was decided, therefore, to simplify the search by focusing on tourism and travel maps, assuming that there would be sufficient variety within this group to facilitate an interesting comparison. An advantage of the hypertext organization of information on the Internet is that it supports unstructured, personal freedom-of-information navigation. The corollary is that it does not support a structured, objective or exhaustive search for Internet maps. Thus, an informal and unstructured method was used to collect the Internet maps. The search started with a previously visited homepage that was known to be geared towards tourism and travel and from there followed links to other tourism and travel related homepages. If a dead-end was encountered, the steps would be retraced until another path could be explored. Internet maps relating to tourism and travel were selected if they had the correct theme, and did not have to rely upon additional text or graphics for explanation. Maps had to be designed as 'stand-alone' documents to ensure that they would be assessed fairly; even good maps can fail when they are taken out of context.

"Interactive maps were not included in the survey because they are not strictly 'stand-alone' documents."

An initial sample of 18 maps was reduced to a set of ten maps. The emphasis in selection was on variety of quality and style with no conscious effort being made to select only the best or worst maps. Interactive maps were not included in the survey because they are not strictly 'stand-alone' documents and can not be reproduced outside of the hypertext environment. This was unfortunate because, although rare, interactive travel maps are some of the most exciting maps on the Internet.

One of the unanswered research questions identified in the pilot project was how to bring objectivity and structure into such a search and selection process. The cartographic research community will have to address this issue, and decide what is and what is not acceptable. It will be interesting to learn how other researchers will handle this methodological question of representative sampling of Internet maps, and how the research community will respond.

Selecting Survey Participants

Because this was an undergraduate assignment to be completed within a limited time frame, and given the lack of financial support for the study, a relatively small sample of both professional geographers and non-geographers were surveyed. In the end, sixteen geographers and fourteen non-geographers participated in the survey. Members of the geography group were restricted to faculty, professional staff, and graduate students of the Geography Department at the University of Victoria, British Columbia. Non-geographers were defined as anyone without a college or university degree in geography, and without any formal training in cartography. This sample was drawn from the community in Victoria, British Columbia. Both groups were 'samples of convenience' although all efforts were made to avoid age, gender and educational bias, especially among non-geographers. The age of participants ranged from 21 to 63 years. There was an unavoidable gender bias towards males in the group of professional geographers owing to the present demographics of the Geography Department at the University of Victoria.

". . . sixteen geographers and fourteen non-geographers participated in the survey."

Survey Design

The ten Internet maps were arranged as a slide show presentation on a computer screen. The order in which the maps were presented was fixed in the same order as listed in **Table 1** and shown at http://geography.geog.uvic.ca/dept/internet_maps. Participants controlled the

MAP TITLES

Map 1: The City of La Paz - The City of Peace
Map 2: Map of Arizona
Map 3: Southern Gulf Islands - Ferry Routes
Map 4: Montreal Subway
Map 5: Bicycle Route Map - Adanac Area of Vancouver
Map 6: Access Routes to Victoria BC
Map 7: Clayoquot Sound in Vancouver Island
Map 8: Northern Ferry Routes
Map 9: Map of the Butchart Gardens
Map 10: Map of Grand Canyon Village

For additional information see http://geography.geog.uvic.ca/dept/internet_maps.

Table 1.

rate at which the slide show advanced. They were instructed to cycle through the slides and examine each map before commencing the map evaluation. The maps were displayed at their original size with titles included. In situations where there was no title on the original map, a title or reference was added. This title or reference led to the map from the hypertext link that activated the map.

A semantic differential approach was employed to record individuals' reactions to the maps. Survey respondents were given the set of questions listed in **Figure 1**. They were asked to rate their answers on a series of bipolar adjective scales using five word pairs: accurate-inaccurate, biased-unbiased, ethical-unethical, powerful-weak, convincing-unconvincing. No additional information was offered concerning these word pairs. Such a technique of recording individuals' reactions has been employed with

"They were asked to rate their answers on a series of bi-polar adjective scales using five word pairs: accurate-inaccurate, biased-unbiased, ethical-unethical, powerful-weak, convincing-unconvincing."

success in previous studies of maps (Taylor 1974, Dent 1975) and has been found to be sensitive to perceived differences between thematic maps (Gilmartin 1978).

Participants also were asked to record what they thought was the purpose of the map. An optional comments section was added to give participants an opportunity to record additional remarks or impressions. There was no time limit for completing the questionnaire, but most people required from 20 to 30 minutes to finish the survey, although some spent up to 1 hour.

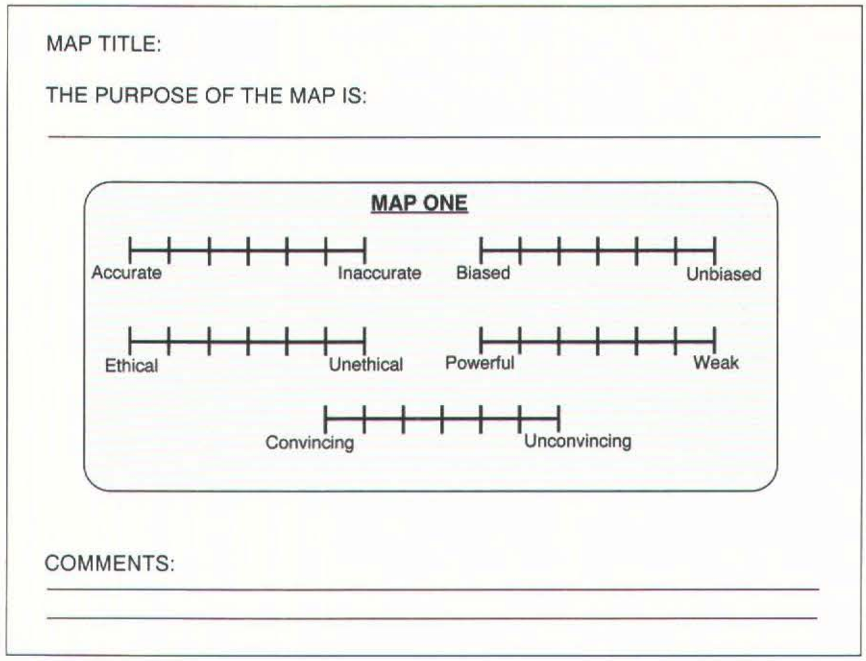

Figure 1.

SURVEY RESULTS

Tables 2a and **2b** show the summaries of the scores from the five bi-polar questions for the ten maps viewed by the professional geographers and non-geographers respectively. Shown are both mean and modal scores which were derived from the 7-point word-pair continuum. Potential scores for each word-pair ranged from a minimum of 1 (i.e."accurate") to a maximum of 7 (i.e."inaccurate"). Respondents were told to leave the questions blank if they felt that a word did not apply to a given map. **Table 3** shows the number of times the respondents chose this option. **Tables 4 and 5** identify the maps that scored best and worst respectively using the five bi-polar questions and differentiating between professional geographers and non-geographers. Readers are encouraged to view the ten Internet maps when studying the results. Respondents' answers to 'map purpose' and their 'general comments' will be reported throughout the discussion below.

"The similarity between the responses of the geographers and non-geographers was surprising."

Both groups produced very similar mean and modal scores for each map. The similarity between the responses of the geographers and non-geographers was surprising. A Wilcoxon signed-ranks test was applied to the 50 word pairs (10 maps, 5 word pairs each) to test for between-group difference. Of the 50 group scores, only two (Map 6, "biased-unbiased", and Map 7, "powerful-weak") were found to be significantly different at the 95% confidence level. This represents 5 percent of our total, which could occur by chance. It is concluded, therefore, that the two groups did not score the maps differently.

Table 2a. Geographers

MAP	Accurate - Inaccurate	Biased - Unbiased	Ethical - Unethical	Powerful - Weak	Convincing - Unconvincing
	Mean (Mode)	Mean (Mode)	Mean (Mode)	Mean (Mode)	Mean (Mode)
1	2.9 (2)	4.7 (4)	2.5 (2)	4.0 (5)	3.6 (3)
2	3.2 (2)	3.8 (2,3)	3.0 (4)	3.5 (2,3)	2.9 (2,3)
3	4.3 (3)	3.3 (2)	3.2 (2)	4.2 (3)	3.6 (2,3)
4	2.5 (1,2,4)	3.9 (3)	2.2 (2)	2.1 (1)	2.0 (1)
5	4.1 (6)	2.8 (2)	3.3 (2,4)	5.3 (6)	4.3 (6)
6	4.5 (5)	3.8 (3,4)	3.6 (4)	5.3 (5)	4.8 (4,6)
7	4.4 (3,6)	4.1 (4)	3.7 (4)	4.5 (5)	4.1 (2,5)
8	4.4 (6)	3.6 (3)	3.5 (2,4)	4.9 (5)	4.4 (5)
9	3.3 (2,4)	3.6 (4)	2.6 (2)	3.9 (3)	3.2 (3)
10	2.7 (3)	3.7 (3,4)	2.8 (2)	2.9 (4)	3.4 (3,4)

Table 2b. Non-Geographers

MAP	Accurate - Inaccurate	Biased - Unbiased	Ethical - Unethical	Powerful - Weak	Convincing - Unconvincing
	Mean (Mode)	Mean (Mode)	Mean (Mode)	Mean (Mode)	Mean (Mode)
1	2.5 (2)	4.6 (4)	3.1 (Blank)	4.2 (4)	4.0 (5)
2	2.9 (2)	2.3 (1)	3.5 (4)	2.9 (2)	2.6 (2)
3	4.5 (3)	3.6 (2,4,6)	3.5 (4)	3.9 (2)	3.8 (3)
4	2.7 (1)	3.8 (2)	1.8 (4)	2.0 (1)	1.5 (1)
5	2.8 (2)	2.5 (2)	3.3 (Blank)	4.1 (2,6)	4.5 (4,6)
6	4.4 (4)	2.7 (2)	3.6 (4)	5.9 (6)	4.9 (6)
7	3.9 (3,4)	3.2 (2)	3.3 (Blank)	2.9 (1,2)	3.0 (2)
8	3.9 (4)	2.8 (2)	4.0 (4)	4.4 (6)	4.6 (4)
9	3.1 (2,4)	3.7 (4)	3.2 (Blank)	3.4 (3)	2.8 (2,3)
10	3.1 (2)	2.8 (2,4)	3.8 (4)	2.8 (2)	2.9 (3)

Notes: **1. Multiple** modes indicated.
2. Mode score of *blank* indicates that the most popular answer was to leave the continuum blank.

Word Pair	Geographers (160 responses)	Non-Geographers (140 responses)
Accurate - Inaccurate	4 (2.5 %)	0 (0 %)
Biased - Unbiased	12 (7.5 %)	16 (11.4 %)
Ethical - Unethical	28 (17.5 %)	41 (29.3 %)
Power - Weak	1 (0.6 %)	1 (0.7 %)
Convincing - Unconvincing	0 (0 %)	3 (2.1 %)

Table 3. Number of Blank Responses

Tables 4 and 5 show that geographers and non-geographers generally agree upon what were the best and worst maps in each category, especially when combining best and worst maps with their next highest or lowest score. There appeared to be no explanation as to why the Montreal subway map (Map 4) scored consistently high. It is a map that abstracts geographic space and highly simplifies the geography of a transportation system, yet respondents perceived it as highly accurate, most ethical, most powerful and most convincing. The maps of access routes to Victoria (Map 6 and Map 8) consistently received the lowest scores. Comments revealed that respondents generally disliked both maps for the same reasons. Both geographers and non-geographers criticized the maps for lacking legends, titles, north arrows and scales. Illegibility of text and excessive spatial distortions were other common complaints.

"Both geographers and non-geographers criticized the maps for lacking legends, titles, north arrows and scales."

	Geographers	Non-Geographers
Most Accurate	Map 4 (mean 2.5)	Map 1 (mean 2.5)
Runner-up	Map 10 (mean 2.7)	Map 4 (mean 2.7)
Least Biased	Map 1 (mean 4.7)	Map 1 (mean 4.6)
Runner-up	Map 7 (mean 4.1)	Map 4 (mean 3.8)
Most Ethical	Map 4 (mean 2.2)	Map 4 (mean 1.8)
Runner-up	Map 1 (mean 2.5)	Map 1 (mean 3.8)
Most Powerful	Map 4 (mean 2.1)	Map 4 (mean 2.0)
Runner-up	Map 10 (mean 2.9)	Map 10 (mean 2.8)
Most Convincing	Map 4 (mean 2.0)	Map 4 (mean 1.5)
Runner-up	Map 2 (mean 2.9)	Map 2 (mean 2.6)

Table 4. The "Good" Maps

	Geographers	Non-Geographers
Least Accurate	Map 6 (mean 4.5)	Map 3 (mean 4.5)
Runner-up	Map 7/8 (mean 4.4)	Map 6 (mean 4.4)
Most Biased	Map 5 (mean 2.8)	Map 2 (mean 2.3)
Runner-up	Map 3 (mean 3.3)	Map 5 (mean 2.5)
Least Ethical	Map 7 (mean 3.7)	Map 8 (mean 4.0)
Runner-up	Map 6 (mean 3.6)	Map 10 (mean 3.8)
Least Powerful	Map 5/6 (mean 5.3)	Map 6 (mean 5.9)
Runner-up	Map 8(mean 4.9)	Map 8 (mean 4.4)
Least Convincing	Map 6 (mean 4.8)	Map 6 (mean 4.9)
Runner-up	Map 8 (mean 4.4)	Map 8 (mean 4.6)

Table 5. The "Bad" Maps

Table 3 reveals that both professional geographers and non-geographers had difficulty evaluating bias in the maps, and commenting on possible violation of ethics. Respondents indicated that the word pairs 'biased-unbiased' and 'ethical-unethical' were considered least applicable to the maps. This may mean that map readers are not familiar with or trained to evaluate maps in terms of bias and ethics, whereas the concepts of accuracy and power (effectiveness) of communication are familiar.

"...map readers are not familiar with or trained to evaluate maps in terms of bias and ethics..."

Professional cartographers accept that all maps distort and are biased because they show only a very selective portion of a three dimensional reality in two dimensions (Monmonier 1991). Cartographers know that maps are abstracted, authored pieces of communication. Nonetheless, it would appear that many of the survey participants from both groups expressed uncertainty or confusion at the idea of assessing the ethics or bias of a map. Future research is required to determine whether the blank responses are an indication that the viewers felt the Internet maps were unbiased or unethical, or whether they saw the concepts of bias and ethics as an inappropriate measure of maps. The latter seems the more probable explanation.

MacEachren (1995) points out that maps with well-chosen colors and that include neat, easy to read text and symbols subtly suggest to the viewer that they are truthful; that these maps will inspire confidence. He agrees with Wood (1993) that the 'best' maps are neat, trim and efficient, never flashy. Indeed, for a map to work, it must connote veracity (Wood

1993). The results of the survey supports these observations. The maps that were rated the most accurate, ethical and convincing were also the maps that looked the most professional by our standards. Comments for these maps included "easy to read", "nice choice of colors", and "effective". It is suspected that most cartographers would agree with our respondents' selections of the best maps. An interesting point is that these maps were also assumed to be the most accurate and the most ethical of the sample; perhaps because they were the best looking.

Tourist maps are full of "cartographic silences." They do not necessarily show where the competition is located, what you will see as you drive to the attraction (e.g. clear-cuts from logging), or the presence of a foul-smelling pulp mill located across the river. Nonetheless, only once did a survey respondent suggest that a map was "not telling the whole story". This respondent knew that one of the maps did not show all of the possible routes to a destination and concluded, therefore, that the map communicated a bias toward the major local commercial carrier, in this case British Columbia Ferries.

"Tourist maps are full of 'cartographic silences'."

The two most disliked maps in the survey were those depicting ferry routes to and from Victoria. Because these maps were thematically and graphically similar, they were included in the survey to check the consistency of participant evaluations. Participants criticized the excessive spatial distortions and inaccuracies in these maps which were subsequently characterized as inaccurate, unreliable, sloppy, amateurish, and devoid of integrity. It is of interest to observe that, by comparison, the map of the Montreal subway system received very favorable comments and was rated by both groups as the most ethical, powerful and convincing map of the survey. The extreme spatial distortions of the subway map did not appear to bother viewers although it was evident that subway routes are not straight lines and that the stations are not evenly spaced. Perhaps the geographic distortions inherent in the Montreal subway map were considered acceptable because they created a simpler, easier to understand map, or because subways travel underground in a world that is less familiar – a world where it is not possible to look at scenery out the window – so there is not need to care about geographic accuracy. Some of the map viewers did note that relative locations are more important on subway maps than actual location. But, there is a certain inconsistency in map evaluation given that ferry route maps were not extended the same cartographic license.

Analysis of respondents' answers to the "purpose of the map" revealed that there was great similarity in response, both between and within groups. Responses were typically variations on or an elaboration of the titles provided. This led to the conclusion that Internet map viewers took the maps at "face value." Participants did not attempt to read a deeper purpose or ascribe an ulterior motive to the maps.

After testing to determine whether professional geographers and non-geographers view and critique Internet maps differently, the results reported in Tables 1 through 5 were not able to prove significant differences. Professional geographers did not produce a deeper and more thorough analysis of Internet maps.

"Professional geographers did not produce a deeper and more thorough analysis of Internet maps."

An attempt was also made to explore whether map users would consciously or sub-consciously de-construct Internet maps. If as post-modernists believe, maps are imbued with layers of meaning, hidden agendas and political overtones, these were not apparent to the survey participants through either direct or indirect questioning. De-construction is, at heart, the search for alternative meanings (Harley 1989). No alternative meanings were identified by the respondents in the set of Internet maps. Preliminary conclusions, therefore, are threefold. First, map readers are naive and simplistic in their use of maps, and lack the critical thinking skills necessary to de-construct Internet maps. Second, the survey methodology failed to elicit what it set out to measure because of methodological flaws. Third, map de-construction is an interesting academic exercise with little application in the real world. Future research is required to definitively verify any of the three possible conclusions. Of special interest would be to see how those who have taken a cartography course dealing with post-modernism and de-constructionism would interpret maps.

INTERNET MAP TYPES

This study has given us some insights into the maps that are available through the Internet. The following are some specific comments on tourism and travel maps on the Internet, as well as general comments on the types of maps that are available through the Internet.

Searches revealed a general shortage of tourism and travel maps. Numerous homepages for tourist destinations and attractions had no maps of any kind. Given that these pages exist presumably to inform, raise awareness or entice people to visit, the lack of even simple locator maps is mysterious. A case in point is the official homepage for Disneyland. This homepage was rich with information about the park, all geared to entice and inform potential visitors. However, the hypertext link entitled "How to get to Disneyland" presents the viewer with four paragraphs of text describing the highway system of southern California. There are no highway or locator maps on this homepage. This oversight is typical and emphasizes the need for more travel and tourism maps on the Internet, as well as opportunities for cartographers to supply those maps.

"Maps designed and drafted specifically to suit their place on the Internet were only rarely encountered."

A more general investigation of Internet maps revealed that most maps have one of two origins. Generally, they are scanned paper maps but occasionally they are digital maps created for purposes other than display on the Internet. A third hybrid class of maps has evolved. These maps were originally a conventional scanned paper map, but were subsequently digitally edited or customized. Maps designed and drafted specifically to suit their place on the Internet were only rarely encountered.

Where maps designed specifically for the Internet were found, they exploited the new technology to its fullest. The Internet had interactive maps revealing hypertext linked layers of information that encouraged the viewer to explore the study area at various scales and from different thematic angles. Some of these maps were found to provide links to associate attribute information and supporting text (for example, an accompanying news story) activated by a simple click of the mouse. Some of these maps were intuitive, intelligent and easy to use. Some verged on pieces of art.

An example of a web-savvy design is the interactive Penn State campus map (http://www.psu.edu:80/psu/UniversityPark/campusmap.html). This site actually is a "virtual tour" of the campus that provides visitors with zoom-capable maps (activated by clicking on the map itself) which reveal increasingly detailed information. At the largest scale, photographs accompany the maps, enhancing the "tour" experience. This site was easy to navigate and decidedly user-friendly.

The "real-time" sea-surface temperature maps produced by the Space Science and Engineering Center (SSEC) incorporate another exciting new possibility of Internet cartography, i.e., real-time maps (http://www.ssec.wisc.edu/data/sst/latest_sst.gif). Rapid and extensive dissemination of information has long been recognized as a key attribute of the Internet. The Web gives cartographers the opportunity to produce an up-to-date map and have it used later that day by people around the world. Currently, weather maps and satellite images are the most common type of "real-time" spatial data available on the Web, but there are other tantalizing possibilities such as traffic-flow maps of metropolitan areas, and maps which display environmental events such as oil spills and forest fires. Realizing the full potential of real-time cartography will require the development of automated GIS expert systems that continuously receive, process, and publish information over the Internet.

Animated maps are another recent cartographic development taking advantage of the Internet. Currently, some of the best examples are produced by the National Geophysical Data Center at http://www.ngdc.noaa.gov/mgg/image/images.html. These maps are fascinating to view although awkward to download given their file size. They are extremely data-rich documents that are usually measured in megabytes, rather than the kilobytes of static maps. This data-volume problem will remain a concern until data transmission and network connection speeds increase.

"...the general principles of good design do not change, even when the technology does."

The rare innovative map taking full advantage of the latest advances in 3-dimensional and virtual reality 'plug-ins' (software designed to enhance your web browser) demonstrated the potential that the Internet has to offer cartography. The new hypermedia technology can free the cartographer from conventional design constraints. Of course, all these technological design opportunities do not guarantee a better map - the general principles of good design do not change, even when the technology does.

INTERNET MAP QUALITY

Unfortunately, it must be reported that while great design opportunities exist, the majority of today's Internet maps are low quality. Scanned paper maps do not translate well to the new medium. Major problems include image quality degradation, warping from improper scanning, coarse scanning resolutions, and over-reduction which renders many maps unreadable. Commonly, when serif and italicized fonts are used on paper maps, they become blurred in the transfer to a digital format.

In examining Internet maps today, it is clear that scanning is a reductive process, and that there is a fundamental difference between paper and digital maps, especially digital maps on the Internet. The digital medium dictates that digital maps must be significantly less complex to remain legible at 72 dpi (the standard resolution of computer monitors). Furthermore, Internet maps must be small documents given that the average user is downloading them with a 14.4 baud or, at best, 28.8 baud modem. Few Internet users are willing to wait the 10 minutes it takes to download some of the largest maps included in the sample. On the Internet, size (digital storage) of image is very important. Internet map designers will need to realize that an Internet map must be accessible in a few seconds in order to be effective. Until connection speeds increase, a 100 k document is perhaps a realistic ceiling.

"A possible solution to the problem of excessive document size is the use of layered maps."

A possible solution to the problem of excessive document size is the use of layered maps. By incorporating a few basic elements of GIS technology, the cyber-cartographer could provide "assembled" maps consisting of a set of files, each significantly less complex than an entire map, and hence, smaller digital documents. For example, the traditional topographic map in its paper form is a data-rich item that serves a variety of map users well. Unfortunately, it does not translate well to the Web because it is too complex. The digital equivalent of the topographic map, therefore, will have to be simpler. If the digital version could be delivered as layers, it could then be customized and users would get exactly what they wanted.

Another problem with many of the maps on the Internet is that they can not be displayed in their entirety on a standard computer screen. The image must be scrolled in order to view it all and to find relevant information, including title, legend, etc. These maps are difficult to read, frustrating and confusing. In addition, many of the travel maps failed to offer basic cartographic information (north arrows, scales, legends), leaving viewers bewildered or frustrated. Maps should entice, not confuse. The general poor design and many fundamental cartographic mistakes in design led us to two conclusions. First, most cartographic products presented on the Internet are produced or edited by people with little or no formal cartographic training. Secondly, the new computer medium has removed some of the traditional design controls; that is, the graphic artist and/or cartographer can no longer dictate how their product is displayed.

Traditionally, the cartographer had control over map presentation: the size of the map, type of paper, the printing technique, etc.. These controls do not exist in cyberspace. Those designing graphics for the Internet must accept that their work will be viewed on a wide range of monitors with varying quality, size and color capabilities. The same digital map will look vastly different from monitor to monitor. Internet cartographers must consider how their product, created on a top-of-the-line 21 inch color monitor, will look if downloaded by a user with a 15 inch monochrome monitor.

A possible solution to this dilemma is, of course, to provide more than one version of the same map. Cartographers could offer the choice between a deluxe version of a map intended for the user with a fast connection and high-end equipment, and a regular version that caters to the 'worst-case scenario' user (i.e. a black and white monitor, slow modem). The cyber-cartographer, as a courtesy to the user, should always include a thumbnail sketch of the map (i.e. 5 kilobytes) that would allow the user to get a sense of image complexity and whether it is worthwhile to download the image. The latter could simply be included along with the map title.

"The challenge is to merge the best design aspects of traditional cartography with the opportunities offered by the new medium."

Although the quality of paper maps has not yet been duplicated on the computer screen via the Internet, digital advances should eventually help achieve this level of quality. Creating facsimiles of the paper map on the computer screen, however, should not be the driving force behind Internet cartography. The Internet medium offers opportunities for innovation in map design, including map animation, variable scale and variable resolution maps, multi-media, map interaction, and customized mapping. The challenge is to merge the best design aspects of traditional cartography with the opportunities offered by the new medium.

SUMMARY AND CONCLUSION

Internet cartography is in its infancy. The Internet creates both new challenges and new opportunities for the cartographer. Little is known about what users want from and expect of Internet maps. This pilot survey raises some methodological issues that need to be resolved and also showed that most of today's Internet maps were not designed by trained cartographers. Cartographers may have designed the original paper maps from which the majority of Internet maps were scanned - but it is unlikely that they controlled the final appearance of their maps on the computer screens. As Keller and Wood (1996) pointed out, cartographers have two choices when faced with technological change. Cartographers can choose to watch passively as others, presumably graphic artists and computer specialists, continue to shape the future of cartography on the Internet, or cartographers can choose to become active players themselves.

The challenge is for cartographers to realize the full potential of the new information medium, to be willing to abandon efforts to reproduce paper maps on the computer screen, and to take over active leadership in the emerging cyber-cartography. In the process, cartographers should not be concerned solely with the technology. They should remember the words of Brian Harley, Mark Monmonier, Denis Wood and others who explain that all maps are potentially imbued with layers of meaning, hidden agendas and political overtones, and that there is no such thing as a single homogeneous group of map users. When embracing the new technologies and the new opportunities, cartographers should understand how the Internet may change representation and communication of space and place, and what inadvertent messages may be delivered to their audiences.

There clearly is a need for both, *more* maps and *better* maps on the Internet, and considerable research to be done. The study reported here is simply an attempt to raise some questions and methodological issues, and to stimulate debate.

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Life After Lectures: The Internet as a Resource for a Senior Undergraduate GIS Course

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This paper explores potential uses of resources available on the Internet to assist students with a course-related GIS project, and to prepare them for continuing involvement with GIS after the classroom. A homepage was constructed for a new fourth year Applied GIS course at the University of Guelph (http://www.css.uoguelph.ca/geo/home448a.html). The course homepage was designed to integrate information that students could use for their projects and, recognizing that many of the students were in their final semester at university, to investigate opportunities available after graduation. The students evaluated the homepage at the end of the course, and indicated that they found the Internet was an excellent way to become aware of the broader GIS community, and they particularly appreciated the recognition this course gave to their career goals.

INTRODUCTION

During the past several years, use of the Internet as a means to convey cartographic and GIS information has grown at a pace few could have predicted. An incredible wealth of diverse information is now available at literally thousands of sites created by governments, universities, private companies and individuals. This instantly accessible desktop resource is changing the way researchers seek and disseminate information, and in some cases, even the way research is conducted. It is increasingly common to find URL addresses accompanying print versions of journal articles, while publications such as *GIS World* and *GIS Europe* regularly report on notable sites or developments on the Internet (Sieber et al, 1995; Thoen, 1995, Parsons, 1995). Recent texts on digital mapping also include a discussion of Internet resources (Clarke, 1995; Peterson, 1995).

"Making these on-line resources available to students, particularly at the undergraduate level, is a challenge for educators."

Making these on-line resources available to students, particularly at the undergraduate level, is a challenge for educators. Apart from the physical constraints associated with providing adequate student access to computers, there is the pedagogical question of how best to integrate this new tool into the curriculum, in a way that best meets students' needs. This report describes the design and implementation of a webpage intended for use in a newly developed fourth year undergraduate course in Applied GIS, at the University of Guelph. Details of the HTML programming to set up the page are not discussed; rather it is the intended use of the homepage, and students' evaluations of how well these objectives were achieved, that is the focus of this report.

THE COURSE

This twelve-week course required students to design and execute an individual GIS project dealing with a real-world problem in any area of geography. Students were assessed primarily on a written research proposal, a final written report, and a poster display of their project. Because of the wide range of ideas and methodologies developed by the students, the Internet seemed an ideal way to access relevant information and technical knowledge from a global network of experts.

Planning for the first offering of this course coincided with two opportune events. Firstly, the University of Guelph's Teaching Support Services group (TSS) requested that faculty propose projects aimed at incorporating electronic instructional media, including webpages, into their teaching. Secondly, a new lab equipped with eight networked Pentium microcomputers was opened in the Department of Geography. Internet access, not widely available on campus, would be possible using Netscape on these computers, and the lab would be dedicated to the 25 students in the Applied GIS course during its first offering.

A proposal was developed to design a webpage tailored to the needs of the students in this course. Ideally, the webpage would provide a navigational framework for students to explore various types of course-related information, while at the same time provide numerous "jumping off" points for students to undertake their own searches on their individual topics. The following objectives of the webpage were identified:

"...the webpage would provide a navigational framework for students to explore various types of course-related information..."

- *dissemination of course information*, such as reading lists, assignment instructions, and course scheduling details.
- *collection of bibliographic references* pertaining to the topics selected for projects
- *acquisition of digital maps and datasets* for use in the execution of the GIS projects
- *communication with GIS experts*, for advice on methodological issues or technical problems.
- *familiarization with post-graduation opportunities in GIS*, particularly graduate school programs and employment possibilities.

The last objective recognizes the fact that many of these students are in their final year at university, and will spend significant effort and time during the semester exploring options for pursuing their career goals after graduation. The webpage component that facilitated this effort turned out to be extremely popular, and suggested the title for this report.

THE COURSE HOME PAGE

The Applied GIS course homepage is easily accessible from the University of Guelph homepage which appears as the initial Netscape menu on the department computers. The course page (*Figure 1*) opens with a welcoming banner followed by four clickable icons for quick access to the departmental, college, and university homepages, as well as to the WWW (Yahoo search). The remainder of the course homepage is divided into seven main sections, each delimited with a bold header preceded by a red dot. Together these sections provide links to nearly 200 other GIS-related sites, and are organized around the proposal objectives outlined above. A brief description of each section is provided below, but it is hoped that the reader will access the site to appreciate the information content of each set of links, as well as their hierarchical set-up.

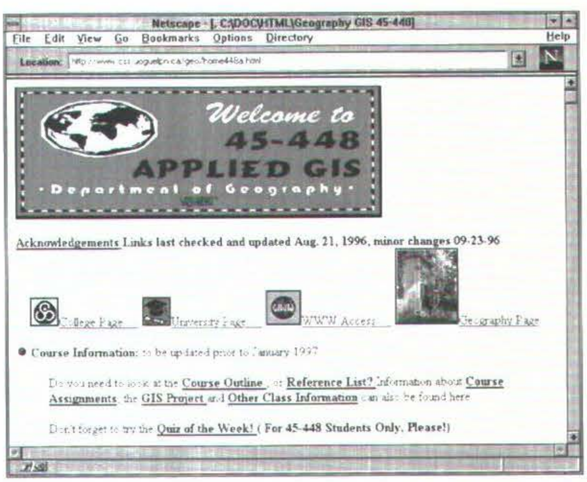

Figure 1: Applied GIS course homepage on the web (Part 1 of 4).

COURSE INFORMATION

All general course information (*Figure 1*) pertaining to administration, evaluation, and scheduling is provided here. A student class list, with email addresses and project topics, is included. The *Quiz of the Week* challenges students to find a particular bit of geographic trivia on the Internet (such as the latitude and longitude of the mouth of the Mersey River!).

REFERENCE INFORMATION AND BIBLIOGRAPHIES

In keeping with objective two (*Figure 2*), this section contains links to sites offering basic technical information (including FAQs and glossaries) and bibliographic information. These reference sites would not only serve to suggest ideas for possible project topics, but would also assist with the literature review once a subject area was selected. Students created an annotated class compendium of their own references (gleaned from hardcopy as well as digital sources), which was added to the webpage.

Numerous links to government organizations, scholarly associations, and private companies involved with GIS are organized in this section. The homepages of many GIS firms provide a listing of current employment opportunities; such sites are clearly indicated with a symbol.

NEWSGROUPS AND LISTSERVS

This section (*Figure 3*) includes extensive information about GIS newsgroups and listservs. Instructions for subscribing to and using over twenty-five GIS related listservs are provided in a tabular format. Corresponding with objective three above, students were encouraged to post queries to appropriate lists when they needed help, and to take advantage of the generously provided technical expertise that exists worldwide.

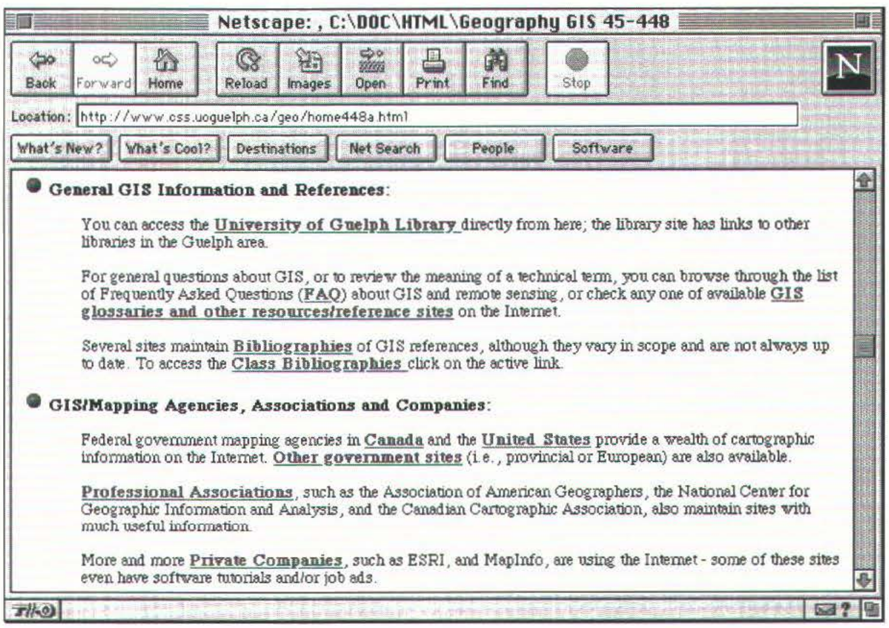

Figure 2: Applied GIS course homepage on the web (Part 2 of 4).

DIGITAL MAPS ON THE INTERNET

Each student in this course worked with different data and a different geographic area. It was anticipated that this section (*Figure 3*), which provides links to various sites from which digital maps can be downloaded, would supply the basemaps and datasets required for many of these projects. *Figure 4* illustrates how sites in this section are organized to facilitate searches.

POST-GRADUATION OPPORTUNITIES

This section (*Figure 3*) of the homepage is devoted to information of special interest to graduating students. It includes links to many sites that

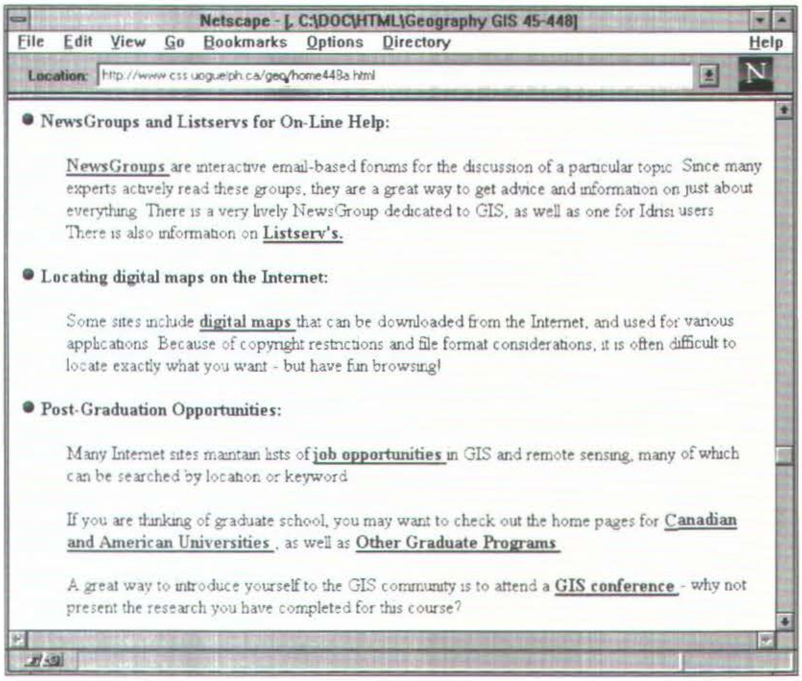

Figure 3: Applied GIS course homepage on the web (Part 3 of 4).

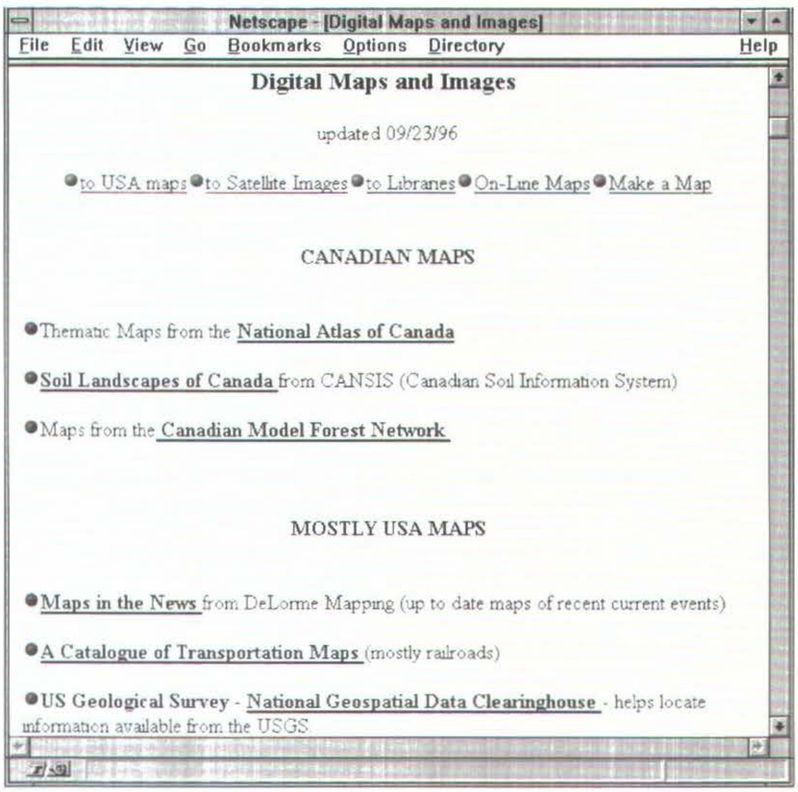

*Figure 4: Menu which appears when **digital maps** is selected from the course homepage.*

contain GIS job listings (*Figure 5*), as well as links to every university in North America. Sites announcing upcoming GIS conferences are included, and students were encouraged to submit the posters they prepared for this course to an appropriate meeting.

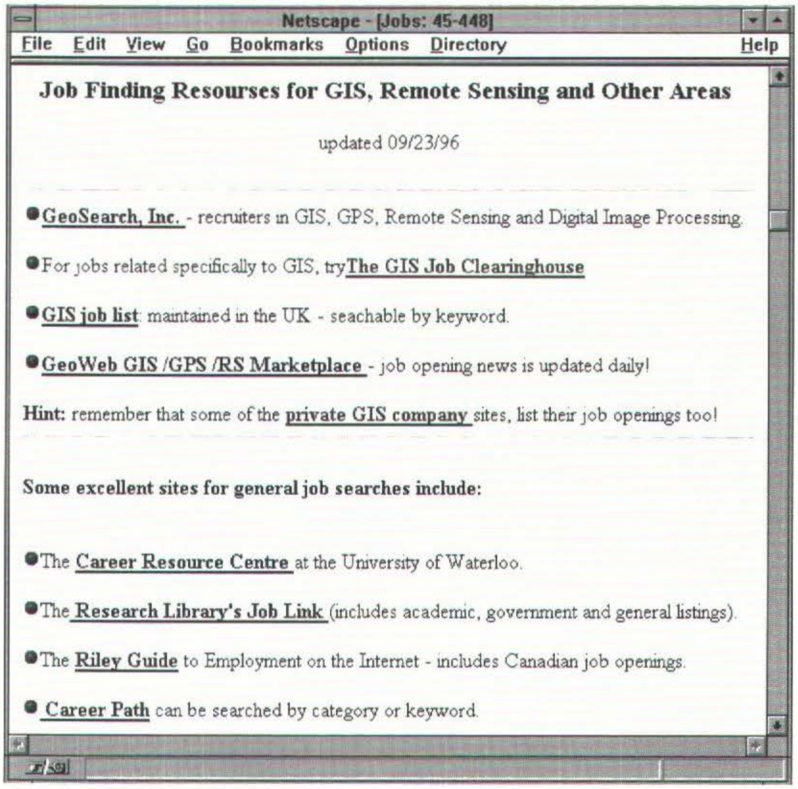

Figure 5: Menu which appears when ***job opportunities*** *is selected from the course homepage.*

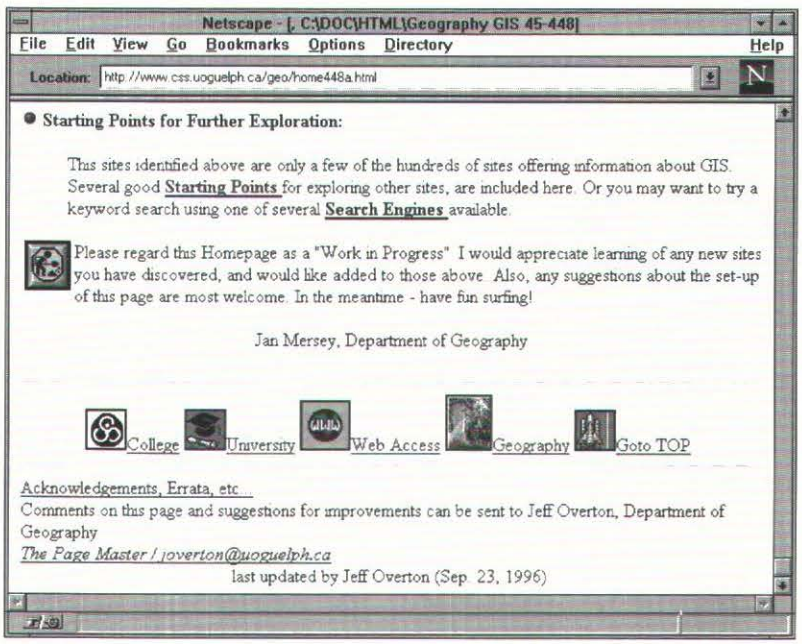

Figure 6: Applied GIS course homepage on the web (Part 4 of 4).

STARTING POINTS FOR FURTHER EXPLORATION

The last section (*Figure 6*) of the homepage includes a list of GIS starting points and search engines enabling students to accomplish their own unique searches tailored to their project theme. Well known starting points such as those developed by Jeremy Crampton (*Cartography Resources on the Internet;* Crampton, 1995) and Kenneth Foote (*The Geogra-*

45-448 World Wide Web Homepage Evaluation

1. Before this semester, had you ever used the Internet?

   20% yes, regularly — 10% yes, once or twice
   20% yes, occasionally — 50% no

2. How many times (approximately) this semester did you access the 45-448 homepage?

   AVG=30 (Range 6-75)

3. Indicate how useful you found the following components of the 45-448 homepage:

	not useful				very useful	
a) course information:	1	2	3●	4	5	(3.3)
b) GIS bibliographies:	1	2	3	4●	5	(4.1)
c) government sites:	1	2	3 ●	4	5	(3.5)
d) private company sites:	1	2	3	●4	5	(3.9)
e) news groups:	1	2	3●	4	5	(3.2)
f) digital map sources:	1	2●	3	4	5	(2.3)
g) university sites:	1	2	3	4●	5	(4.4)
h) job opportunity sites:	1	2	3	●4	5	(3.9)
i) conference sites:	1	2	3	●4	5	(3.8)
j) starting points:	1	2	3	4●	5	(4.1)
k) search engines:	1	2	3	4	●5	(4.8)

4. How would you assess the overall utility of the 45-448 homepage as a resource for this course?

   not useful 1 2 3 4●5 very useful (4.6)

5. Rate how important to you the homepage was for the following purposes:

	not important				very important	
a) provided basic familiarity with the Internet	1	2	3	●4	5	(3.9)
b) helped with my class project	1	2	3●	4	5	(3.3)
c) helped with job/grad school planning	1	2	3	●4	5	(3.6)
d) helped with other courses	1	2	●3	4	5	(2.9)
e) provided non-course related information	1	2	3	4●	5	(4.1)
f) made me aware of the broader GIS community	1	2	3	4	●5	(4.6)

Figure 7: Applied GIS homepage evaluation. Results are shown within the brackets.

pher's Craft; Foote, 1994) appear in the list. As students become more familiar with the Internet they can go directly to such links to find the information they need.

COURSE HOME PAGE EVALUATION

A two-hour training session on the use of Netscape was provided to students at the beginning of the semester. Several short assignments (copies available on the webpage) requiring Internet searches helped direct students toward resources they would find helpful. At the conclusion of the course, students were asked to evaluate the usefulness of the homepage and to suggest any modifications that might increase its effectiveness. The results clearly indicated that not all of the initial objectives were achieved with the same degree of success. A summary of the evaluation results is presented in *Figure 7.*

About half of the students had not previously used the Internet, about 20% were regular users, while the rest had some minimal exposure. During the twelve week course each student accessed the course homepage an average of 30 times, although there was a wide range (from 6 to 75) among individuals. Generally more experienced users had fewer, likely more efficient, sessions.

Students indicated that overall they found the homepage to be a very valuable course resource, but when asked to assess the usefulness of specific homepage components, some interesting facts emerged. Leading the list of most useful components were the search engines and starting points included in section seven. Since each student was researching a different project theme, it is logical that individualized searches would be necessary. This also suggests that students can quickly learn to navigate on their own throughout the Internet, and that even without a customized course homepage, the Internet could still be a valuable research resource.

". . .students can quickly learn to navigate on their own throughout the Internet. . ."

Another aspect of the course homepage that received a very high rating was the link to other universities included in section six. Although it was not required that students explore any university sites for the course, these senior students had a keen interest in finding out about programs and courses at other institutions. It is important that educators appreciate what a significant instrument the Internet has become for advertising their programs and attracting new students (both graduate and undergraduate). Efforts put into departmental homepage design are not wasted.

On-line GIS bibliographies, included in section two, also received good scores from students. Each student was required to complete a literature review, and sites such as the *GIS Master Bibliography* from Ohio State University were found to be particularly helpful in this regard. The page components providing information on job opportunities and upcoming conferences ranked next in usefulness. Students frequently explored the private industry sites that included job opportunities, as well as the newsgroups advertising jobs in the local area. One student (a teaching assistant) applied for several GIS jobs she located on the Internet, and six students presented their posters at the Annual Conference of the Canadian Cartographic Association in Toronto, at the conclusion of the course.

Page components receiving a rather neutral rating included government sites (section three) and course information (section one). The latter was likely due to the fact that hardcopy course outlines were supplied in class (a departmental requirement). Sites that were found to be of little use by many students included newsgroups and listservs (section four) and sites for accessing digital maps (section five). These results were surprising because during the development of the homepage it was anticipated that both these components would be very valuable in a project-oriented course of this type. It turned out that not a single student managed to download a geographic file that they could use in their GIS analysis! Although four students downloaded files, they found that the formats were incompatible with the GIS software they were using, and reformatting was difficult. Part of the problem also lies in the fact that the majority of the projects were in Canadian locations, and copyrights restrict free access to much of the digital data produced by the Canadian government. It is more difficult to explain the low use rate of listservs and newsgroups. A few students made extensive use of these resources while the majority stuck to browsing and did not venture their own inquires. This is a more challenging aspect of Internet communication to master, and perhaps additional instruction needs to be included on this topic.

". . .students found the page more helpful for planning post-graduation activities than for helping with their course projects."

Students were also asked to rate how important they felt the homepage was for various purposes. It is interesting to note that students found the page more helpful for planning post-graduation activities than for helping with their course projects. In general, students did not make much use of the Internet to acquire information for other courses, but they did access non-course related sites regularly. Perhaps the real value of the homepage, however, is captured by the purpose to which students assigned the highest rating: *it made them aware of the broader GIS community.* Providing students with a comprehensive understanding of their discipline, and an appreciation of the resources and opportunities that exist worldwide, are fundamental learning objectives of any university program. The Internet has an important role to play in helping educators achieve this aim.

CONCLUSION

The integration of a custom-designed webpage into this senior undergraduate course, as a means to facilitate exploration of GIS resources on the Internet, proved to be an extremely worthwhile experiment. Students not only gleaned information from sites that was pertinent to their GIS projects, but appreciated the recognition the course gave to their personal career goals. Many students had a strong interest in continuing their involvement with GIS "after lectures" and found the Internet an excellent way to investigate graduate school and job opportunities. Discovering individuals and agencies from all over the world that share an interest in this rapidly evolving technology and its applications added a unique dimension to this course that could not easily be gained through other means.

A valuable addition to the webpage would be the completed student projects, including both maps and text. Having their own work showcased on the Internet would allow students to creatively demonstrate their skills to potential employers or graduate supervisors. Arrangements might be made with faculty at other institutions to assess and comment on the student projects, providing feedback for those wishing to publish or present their work at conferences. Finally, the webpage evaluations identified certain features that need additional attention. In particular, more instruction on the use of listservs and newsgroups must be provided, and efforts made to establish some friendlier solutions for converting digital files into formats compatible with department software.

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cartographic techniques

MOUSEOVER MAPPING

by James M. Swanson

While Hypertext Markup Language (HTML) works well as a standard for describing page layout and hypertext linkages, it has kept the World Wide Web from becoming a truly interactive medium for maps. Although the multimedia capabilities of today's Web browsers are are comparatively advanced, watching a movie or hearing a soundbite can hardly be considered direct interaction. New developments such as Java and VRML have the potential to change this. This article will concentrate on JavaScript and a technique for making maps more dynamic, called *mouseover mapping.*

JavaScript is Netscape's cross-platform, object-based scripting language for the Web. Do not confuse it with Java. While they are syntactically similar, Java is a compiled programming language used to create small applications or applets that are downloaded from the server and executed on the user's machine. JavaScript, on the other hand, is a scripting language that is actually integrated into the HTML and interpreted at runtime by the browser.

To use JavaScript, it is important to have some understanding of object-oriented programming. In the object-oriented paradigm, an object is a construct with properties that are either variables, other objects, or functions known as methods. When you look at a Web page, think of everything except the text as an object: the forms and buttons are objects, the images are objects, even the page itself is an object. These objects exist in a hierarchy that reflects the structure of the HTML document.

JavaScript is event-driven. Events are actions that occur as a result of something the user does; for example, clicking on a button, selecting text in a field, or moving the mouse over a hyperlink. In many cases, object properties can be dynamically changed within the HTML document. This is very powerful because it liberates the Web page creator from a severe restraint imposed by HTML. Before, you were limited with what the browser was told to display. Now, without having to link to a new page or execute a server-side script, the user can instantly change an image or validate the data in a form.

In mouseover mapping, the user's movement of the mouse over *hot buttons* changes the displayed map or some aspect of it. These buttons are simply hyperlinks which can exist within the map or outside of it. The actual linkage, however, has been disabled and a JavaScript *onMouseOver* event handler has been included.

```
<A HREF="javascript:ignoreClick()"
onMouseOver="swapMap(imageName)"></
A>
```

The first part of this tag tells the browser to do nothing if the user clicks on the hot button. The second part makes a call to a map-swapping function embedded in the document HEAD. Between the open and close of the anchor tag, the hot button can be defined as text, an image, or an image map SHAPE. Remember that the base map image must be inserted into the HTML code before the mouseover links.

```
<IMG NAME="mapName" SRC="path/
fileName" WIDTH=imageWidth
HEIGHT=imageHeight>
```

Since this map image is a JavaScript object, the source property associated with it can be accessed with the following notation:

```
document.images[mapName].src
```

The routine that actually does the swapping of map images is really very simple.

```
function swapMap(imageName)
 {
 document.images[mapName].src =
 eval(imageName + ".src")
 }
```

The *eval* function performs the concatenation of the two strings and returns the value. If the entire map image does not need to be changed each time, HTML tables can be used to break up your image into discrete parts. However, each section of the map must be given a different map NAME. The original image can be swapped back in when the mouse leaves the hot button by including the *onMouseOut* event handler in the anchor tag above. The syntax will be the same as the onMouseOver event handler, but the two must be separated with a semicolon.

Also, the browser does not access the server to download new images. All of the images that will be used have been preloaded by another short script.

```
{
imageName = new
Image(imageWidth,imageHeight);
imageName.src = "path/fileName"
}
```

Finally, the pieces are put together:

```
<HTML>

<HEAD>
<TITLE>MouseOver Mapping</
TITLE>
<SCRIPT LANGUAGE="JavaScript">
<!—

// TASK: PRELOAD IMAGES
{
imageName = new
 Image(imageWidth,imageHeight);
imageName.src = "path/fileName"
}

function swapMap(imageName)
// TASK: SWAP IMAGES
 {
```

```
 document.images[mapName].src =
eval(imageName + ".src")
 }

function ignoreClick()
// TASK:  IGNORE HYPER-REFER
ENCE
 {
 }

// END—>
</SCRIPT>
</HEAD>

<BODY>

<IMG NAME="mapName" SRC="path/
fileName" WIDTH=imageWidth
 HEIGHT=imageHeight >
<A HREF="javascript:ignoreClick()"
onMouseOver="swapMap(imageName)">Change
 Map</A>

</BODY>

</HTML>
```

Now the dynamic behind mouseover mapping has been explained and the code foundations are in place, the uses of this form of mapping can be examined. The most evident use is for highlighting. When the user moves the mouse over a geographic region, the area changes shade or color. In the same manner, when the mouse arrives at a particular point on a map, the name can appear next to it. This is especially useful considering the complexity of some maps. *Live legends* would be another use. Depending on the type of map, moving the mouse through the classification hierarchy might display all categories, only bodies of water, or just rivers. For choropleth mapping, hot buttons across the bottom of the map could represent different ways of classifying the data. These buttons could be units of time, too, if maps with temporal components such as weather or erosion are to be displayed.

Finally, mouseover mapping provides a unique solution to the limited resolution of today's monitors. Detail is often sacrificed in order to fit the whole map on your screen. With mouseover mapping, a region of interest can pop up in greater detail on the map as a *close-up bubble* or in another image area, frame, or window. This technique can also be used to display attribute data that corresponds to the mouse's position on the map.

With an understanding of digital image manipulation, a willingness to experiment with JavaScript, and a little imagination, a lot can be done with mouseover mapping. Hopefully, it will be helpful in making maps on the World Wide Web more interactive.

cartography bulletin board

University Cartographic Laboratory Homepages: Marketing Tool or Marginal Presence

by Donna G. Schenström and David C. Wilfahrt
Cartographic Services Laboratory
University of Wisconsin-Milwaukee

Over the past two years the popularity of the World Wide Web has exploded. Colleges and universities throughout North America are placing information on departments, faculties, and research facilities in cyberspace. Many university cartographic laboratories fall into these offerings. This report explores some of the cartography lab sites examining their subject matter, focus, scope, and goals.

The breadth of most pages are greatly influenced by the prominence of Cartography as an area of study within the university, be it housed within Geography or some other Social Science or Earth Science. Page breadth is also affected by each laboratory's mission. Who the lab serves, or who the target client is, greatly influences how the lab's homepage is marketed.

Laboratory pages are also influenced by the role GIS, GPS, Remote Sensing, and multimedia play within the Department and the University. Many cartography laboratories do not stand alone, but rather are combination labs offering a variety of spatial analysis services with technical, digital and informational aspects.

Common Cartographic Laboratory Purposes

Professional map/graphic design and production work for:
- Home department (Geography) faculty
- College faculty
- University faculty
- Outside clients and contracts
- Research
- Student Recruitment

Student map/graphic design and production access for:
- Coursework
- Research
- General experience

Cartography Laboratory Homepage Themes

- Opening page
- Mission statements
- Ongoing research, completed research, work samples (in text or graphic description)
- Facilities listings
- Faculty Use Policy
- Fee Schedules - Pricing
- Guidelines for facility use
- News Articles & Press Coverage
- Faculty & Staff
- WWW Listings, Virtual Libraries
- Map Ordering

Cartography Lab Sites

Memorial University of Newfoundland http://www.mun.ca/GEOGRES/MUNCL.HTM
Ohio State University
http://www.cfm.ohio-state.edu
The Pennsylvania State University
http://www.deasy.psu.edu
Syracuse University
http://www.maxell.syr.edu/geo/cartolab.htm

University of Wis.-Milwaukee
http://www.uwm.edu/Dept/CartLab
Florida State University
http://www.freac.fsu.edu

Cartography Lab at Rutgers University

by Mike Siegel, Cartographer
Geography Department
Rutgers University

The Rutgers University cartography laboratory primarily creates thematic maps to accompany the publications or presentations of faculty and graduate students. The revolution in desktop computer technologies during the last few years has caused an evolution of our cartography lab and the services we offer the university community. The production of map artwork is now completely done using computer technology. Duplication is almost completely digital. We still print computer generated artwork onto conventional slide film, but that output may soon become electronic too.

This evolution is also spreading the production of artwork beyond the confines of the cartography lab. As the software for creating thematic maps and other presentation materials has become easier for anyone to use, more people in our department are interested in creating their own graphics. Now that a personal computer on a desk is as common as a telephone, a lot of manipulation and graphic representation of spatial data is being done by individuals in their offices. Since a desktop computer can replace a light table, lettering machine,drafting supplies, and a darkroom for the production of thematic maps, the idea of a cartography lab being a defined place is changing. At this point, a virtual cartography lab is just and idea, like a virtual geography department on the Internet, but it is a lot of fun to think about.

Although there is cartography being carried out in individual offices, we maintain several computer labs in the department that remain hubs of cartographic activity because of two functions that have not been changed by technology. The labs contain specialized equipment that is too large or expensive to put in every office. Also, the special facilities in the labs allow us to teach cartography in a hands-on manner that could not be done in an ordinary classroom. The need for training sessions in the use of this hardware and software has increased with the interest of geographers here in preparing graphic materials for teaching in smart classrooms. Designing multimedia "classware" to communicate geographic information in new ways is a natural extension of creating thematic maps.

The Geography Department's cartography facilities include: a lab that contains our flat map collection, light tables, and a fledgling smart classroom with a Power Macintosh computer, color flatbed scanner and a b&w laser printer; a lab with ten Pentium computers, several 486 PCs, digitizing tablets, and a color inkjet printer; a lab with six Power Macintosh computers, a flatbed color scanner, a slide scanner, and a b&w laser printer; and four laptop computers for instructors to project maps and graphics in Rutgers' new smart lecture halls. The Department also has a specialized climate research laboratory equipped with several computers including a Sun SparcStation. All of our rooms have recently been wired to allow us to share information or to connect to the Internet.

In addition to moving towards the development of multimedia graphics, the cartography lab staff is getting more involved in helping to design web pages. We hope to share good design principles with geographers interested in creating web pages for their classes. The Internet is also helping us lessen the effects of Rutgers being spread out on several different campuses. By linking homepages, we hope to help students find out about courses related to cartography in different departments and research centers at the university. Also, we have started to create an electronic image and map library from the slide collections of people in the department, and from links to images available on the Internet. Now, if we could only link up all the cartography labs and map libraries around the world via the Internet. That is a virtual cartography lab to dream about.

map library bulletin board

THE UNIVERSITY OF CHICAGO MAP COLLECTION

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The University of Chicago Map Collection, which holds more than 380,000 sheets, is one of the largest university map libraries in North America.

The Collection was founded in 1929. The Collection's first curators aimed in particular to amass contemporary maps. With substantial funds at their disposal, they made a serious attempt to acquire all then-available topographic map sets, especially but not exclusively for Europe, Canada, and the United States. They also did what they could to obtain urban and geology maps, again concentrating on Europe and North America.

Much of what is unique to the Collection stems from this early collecting activity. There are numerous detailed topos from the early 20th century that are held by few other libraries. There are also a very large number of city maps (including planning maps) from the 1920s and 1930s that may not be held anywhere else.

The early curators also acquired older maps. Several thousand historical maps were purchased from the John Crerar Library in 1929. Additional historical maps were added throughout the 1930s and a certain number of older maps were transferred from the existing central library when the Collection was founded. But, in general, the collection of early maps is not as strong as that in many other major libraries. Given the continued focus of faculty interest in the modern world and the growth of the nearby Newberry Library after World War II as a center of the study of cartography, there has never been any need to put much emphasis in this area.

The Map Collection had little financial support between the late 1930s and early 1970s, but, after World War II, it ranked quite high in the Army Map Service's distribution lists and during the 1950s and 1960s, the Collection acquired large numbers of maps of the Soviet Union, Japan and India, largely through the efforts of Professors Chauncy Harris and Norton Ginsburg of the Department of Geography and Maureen Patterson of the Library.

Since the 1970s, some effort has been put into building on the Collection's strengths. Topographic maps of many parts of the world have been acquired. The Map Collection now has 1:50,000 topographic coverage for most of Western Europe, Southern Canada, and Mexico. It has purchased contemporary topographic sets for Latin America as well as for other parts of the Third World, as available. Recently, it has been taking advantage of the release of topographic maps from the Soviet Union and Eastern Europe. It has, for example, acquired 1:200,000 Soviet topos of most of the populated parts of the former USSR, much of the Middle East, and a large part of China. Considerable effort has also been put into updating holdings of urban and geology maps.

One of the Collection's peculiarities is that its holdings were, until recently, entirely uncataloged. But, in recent years, Map staff have begun the process of rectifying this situation. As of the early fall of 1996, there were about 11,750 map records in the University of Chicago's on-line catalog. However, since the Collection holds between 75 and 80,000 titles, there is a long way to go. Cataloging Department policy has dictated that only about a quarter of the records (mostly, those with LC copy) are considered to have been "finished." Only "finished" records are reported to OCLC.

The Map Collection has been acquiring digital cartographic data since 1992. It holds two major software packages, Sammamish GeoSight Professional and ArcView 2.1. With its ability to generate maps from depository data, the Sammamish program has been the most frequently used software in the Collection. In addition to the standard U.S. government materials and ESRI data sets, the Map Collection has also acquired some Chicago-area digital data. The Collection has also installed Paradox and Dbform, data-base management programs that can be used to manipulate data, and Macromedia Freehand, a drawing program. The Collection also holds some stand-alone mapping packages—including Street Atlas USA and Global Explorer—that contain both data and software.

The Map Collection has a site on the World Wide Web. Its URL is http://www.lib.uchicago.edu:80/LibInfo/Libraries/Maps. From here you can navigate to a list of some of the major sources of cartographic and spatial data available over the Internet (http://www.lib.uchicago.edu:80/LibInfo/Libraries/Maps/mapweb.html) as well as to set of Chicago 1990 census maps prepared by Map Collection staff (http://www.lib.uchicago.edu:80/LibInfo/Libraries/Maps/chimaps.html).

The Collection houses approximately 1500 atlases and several hundred reference books. There is also a small travel collection. This contains both classics (e.g., WPA guides, Baedekers) and a representative selection of contemporary guidebooks as well as thousands of current travel brochures.

The Map Collection is located on B-Level of the Joseph Regenstein Library, 1100 E. 57th Street, Chicago 60637. Hours are Monday to Friday, 12 to 5.

Map Room
Colorado School of Mines

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The Colorado School of Mines (CSM) is located 13 miles west of Denver in Golden. Founded in 1874 to meet the state's growing need for professional geologists and mining engineers, the school currently enrolls 3,000 students-2,000 undergraduate, 1,000 graduate. The emphasis of the school has shifted from geology and mining to engineering; approximately 40% of the undergraduates are enrolled in the Division of Engineering. In addition to the traditional programs of mining engineering and geology, CSM also offers tive grees in the physical sciences, including strong programs in metallurgy, geophysics, and petroleum engineering. The School of Mines is a research university; however, the necessary information resources for research have not translated into money for the Library. From 1991 to 1995, the Library's acquisition budget rose a total of 1%, while journal inflation for the sciences for that same time period ran close to 15% per year. Massive cuts were made in the journal collection because of these budget inadequacies.

The Library at the Colorado School of Mines was formed in 1874 with the founding of the School. Maps were set aside as a separate collection in the mid-1950's, when the Arthur Lakes Library was built. The Map Room was established in its present location when the Library's addition opened in 1978. It houses over 175,000 maps and 6,000 books and atlases. It has a staff of 1.5—1 map librarian and 1 half-time assistant. The collection is considered to be one of the best in the Rocky Mountains.

The Library has been a participant in the Government Depository Program since 1939. At least 50% of the maps now added to the collection come via the Depository Program. The budget for acquisitions for the Map Room is limited—approximately $2,000 a year. Because of this, great care is needed in making selections of maps. Many maps are acquired as gifts, usually from alumni or local mining and engineering companies. In fiscal year 1995-96, the Map Room added over 2,300 maps that were received as gifts. Many more gift maps were placed in the annual book sale. These gifts were of a surprisingly high quality; while USGS topos seem to be the most common items donated, the Map Room received a large number of geologic and topographic maps of Africa and the USSR.

The greatest strength of the Map Room is its excellent collection of mining and geology maps. Many of these items are unique; copies of company documents showing mine workings, field studies, or geology. Many have come to the Library as gifts. Particular emphasis is placed on finding and keeping mining maps of Colorado and the Rocky Mountains. The Map Room keeps multiple copies of geologic maps (such as the USGS thematic maps) and topographic maps of the state of Colorado. Duplicate or superseded maps from outside Colorado are not kept. This policy has allowed the staff to weed some of the collection, freeing up valuable drawer space.

Students are the primary users of the Map Collection, and their numbers ebb and flow with the school year. Most of the undergraduates do simple research projects requiring Colorado geologic maps. Graduate students' requests are far more complicated and range far afield.

The general public also uses the Map Room quite often. Public users fall into two general categories: corporate and "miners." Many companies use the Library to do research in the area of natural resources management and or discovery. Corporations purchase borrowing privileges annually. "Miners" are people who look as if they just walked out of a mine or people who ask, "I just bought some property up in Clear Creek County. There is an old mine on my property. How much gold is left in it?" These questions sometimes can be answered by consulting those unique mining maps that the Map Room owns. In order to aid in reference, the Library has created homepages on the World Wide Web. The Map Room alone has contributed over 100 pages, including a description of the Map Room, a list of all the Colorado topos ever produced by USGS, and connections to other map libraries. Most useful are the pages that explain how to find a geologic map, how the Map Room is organized (including an explanation of the Library of Congress G-schedule for classification), and a listing of Frequently Asked Questions (FAQs). The Map Room's homepage is located at http://www.mines.edu/library/maproom/

The two greatest challenges facing the Map Room (other than the acquisition budget) are space and access. While the Library and the Map Room have room to grow, the Map Collection suffers in places from a lack of adequate drawer space. Part of this problem was alleviated by the acquisition of some used map cases this past winter. After completing some weeding, the entire collection was shifted. The staff estimated that it would take an additional 380 drawers to alleviate the overcrowding problem; unfortunately, only 80 empty drawers were available. In prioritizing the shift, Colorado and Western states received the most consideration. In addition to the lack of drawer space, the Map Room has cases that measure only 71 x 118 cm., as compared to standard drawers that measure 98 x 127 cm. These smaller cases often damage maps.

The Map Room provides open access to its collection. Unlike many map collections, the map cases are never locked. The Map Room is open all the hours the Library is open. However, staff are only available Monday through Friday 8 to 5. Except for reference items and maps housed in the Map Room Office or Archive, everything in the collection including atlases and sheet maps, may be checked out. Close to 90% of the maps are cataloged and may be accessed through the Library's online database, CARL (telnet to csn.carl.org). In order to facilitate better access to the collection, the cataloging backlog was eliminated in the spring of 1996. Retrospective conversion of the remaining items is underway. To further improve access, signage in the Map Room has been improved and finding aides have been placed on the World Wide Web. Finally, the collection development policy has been revised and the collection has been weeded accordingly.

The Map Room recently purchased the ArcView package for schools and libraries. The staff is currently wrestling with all of the problems other map libraries are dealing with as far as GIS: access, support, data acquisition, hardware, time investments, and so on. Only one professor on campus is formally teaching classes in GIS. These are at the graduate level, although undergraduate classes have been proposed. Within the next year, the Map Room plans to have an active GIS workstation.

The Map Room at the Arthur Lakes Library on the campus of the Colorado School of Mines is dynamic and important. It's rich collection of geology and mining maps is seen as an asset to students, businesses and the public.

SERGE A. SAUER MAP LIBRARY UNIVERSITY OF WESTERN ONTARIO

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The Serge A. Sauer Map Library has grown from a small collection of teaching maps in 1966 to a comprehensive collection housing 221,000 sheet maps and 2300 atlases. The map library is one of only a few collections in Canada that is funded solely by the Department of Geography and not the main university library system. We serve the university community as well as the general public. The collection is named in honor of the first curator of the map library who retired after 25 years of service in 1991.

In addition to the typical maps you would expect to find in a map library - road maps, topographic maps, general maps of various countries - the Serge A. Sauer Map Library at the University of Western Ontario has a few collections of special note. Within this group of "treasures" are: Fire Insurance plans for over 380 different Canadian cities; U.S. Soil Surveys for about 1700 counties in various states; almost 1000 current foreign urban plans; 5400 nautical charts for numerous areas of the world; a "time series" of Canadian maps; and all BA, BSc, MA, MSc and PhD theses of the Department of Geography.

However, the largest collection of special material is the Great Lakes Cartographic Resource Centre which was developed between 1983 and 1985. This project was financed by a grant from the University of Western Ontario Academic Development Fund and has become an integral part of the Map Library. The Centre is founded on an extensive cartographic collection, consisting of maps, atlases and air photographs, relevant to the Great Lakes basin. Original charts (1815-1825) by Henry Bayfield and published by the British Admiralty were purchased, as well as facsimile reproductions and photographic copies. Additional charts published by British Admiralty (1866-1904), NOAA (1915-present), U.S. Corps of Engineers (1850-1950), and Canadian Hydrographic Service (1912-present) provide substantial coverage of the Great Lakes basin. This is particularly useful for tracing changes to physical features over time (e.g. Pelee Point and Long Point, Ontario), harbor development, and shoreline variations. Some charted areas have eight or more editions that a researcher may consult. Other map series include: Shoreline Inventory; Great Lakes Flood and Erosion Prone Areas; Petroleum Resources; Oil and Gas Exploration Licences and Drilling Sites; Shore Property Erosion Stations; Ontario Land Inventory, and Hazard Lands. The Petroleum Resources maps 1:30,000 indicate locations and status of oil and gas wells on land and under water; producing, abandoned, pool boundaries, etc. Government reports that used maps of the Great Lakes basin are also in this collection. A limited number of air photos were purchased to cover the shoreline. The depth of coverage inland is determined by topography and other factors. It is scarcely possible to exaggerate the significance of the Great Lakes region. The purpose of the Great Lakes Cartographic Resource Centre is to pull together cartographic material from Canadian and U.S. institutions, academic and governmental, which focus on the Great Lakes. As a result, a course has been developed in the Geography Department entitled "Ontario and the Great Lakes", and there has been a substantial increase in interest from visiting researchers from outside the university community.

A recent addition to the collection is the development of the Digital Spatial Data Library which allows for digital scanning and transfer of resources and access to maps, remote sensing imagery and spatial data on CD-ROM.

We are very excited about the purchase of a rare set of maps entitled "A copy of the maps and report of the commissioners under the Treaty of Ghent, for ascertaining the northern and northwestern boundary between the United States and Great Britain 1828." There are 7 maps of the western Great Lakes area with this report. There are only 3 other known copies in North America.

A departmental home page that has a section about the map library is at: http://www.geog.uwo.ca

Oregon State University

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The Map Room at Oregon State University has a new address—not that is has moved, yet. For the past five years Kerr Library has been fund raising to expand the 33-year old building. In April, 1996, it was announced that the Wayne and Gladys Valley Foundation had donated $10 million dollars to the cause and the "new" library would be known as The Valley Library. Hence a new address on the letterhead and business cards.

The actual construction for the expansion began on June 17th with the sealing of the north entrance to the library and the blackening and boarding up of the first floor windows.Completion of the building project will take nearly three years as the older portion of the library will undergo considerable renovation after the newer portion is completed.

The Map Room, currently on the first floor, will eventually move to the third floor and be merged with the government documents area. Administratively, this occurred a number of years ago with the designation of the Special References Area which is now known as the Government Information and Maps Team(GIST) but physically the areas have remained distinct. Over the next twelve to eighteen months, many collection development, and cataloging decisions will need to be made in order to ensure a smooth transition to the new location. Luckily, many of the collection's maps are already in Ulrich Planfiles which should be easy to move as they come equipped with their own wheels.

Typical of the types of pre-moving projects is the inventory being done for the USGS 15 minute scale topographic maps.These maps had multiple filing locations and are now being reorganized into two Ulrich Planfiles. The superseded 7.5-minute Oregon topographic maps will also be inventoried and filed within one of these cases so that all of the historic large scale topographic maps will be in one, easily controlled, location. Additional projects will include recataloging and encapsulation of historic local maps and assessing the cataloging backlog to identify materials which are not to be added to the collection.

The Kerr name hasn't been lost to campus however; it moved across the street to reside at the Kerr Administration Building. Mailing Services is going to have a significant amount of work delivering mail to the right place for sometime to come.

reviews

SOFTWARE REVIEW
Netscape Navigator 4.0
reviewed by Rex G. Cammack
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Netscape Communication Inc. is distributing Netscape Navigator 4.0 Preview as a component to Netscape Communicator Standard Preview via the internet. The software can be downloaded from Netscape Communication Corporation at http://www.netscape.com/comprod/mirror/client_download.html through the use of a World Wide Web browser. The preview version of Communicator Standard is free. At the time of writing this review, Communicator was only available for the Intel platform using Windows 95 or Windows NT operating system. Netscape's Communicator Standard is a suite of software designed to integrate numerous desktop functions into one software suite. Netscape Communicator Standard is made up of five integrated parts:

- Netscape Navigator - Browser software
- Netscape Messenger - Email software
- Netscape Collabra - Newsgroups interface software
- Netscape Composer - Integrated HTML editor and text editor
- Netscape Conference - Real time audio and data collaboration software.

All five of these products are of interest for daily computing but this review will focus solely on Navigator 4.0 and will consist of five parts: (1) Condition for review, (2) What is Navigator 4.0, (3) Functions of Navigator 4.0, (4) Functions being developed for official release, and (5) Conclusions.

Condition for Review

Before reviewing Navigator 4.0, it is important to understand the hardware and software configuration used during the evaluation. Netscape Communicator Standard Preview was installed on Intel Pentium/133 platform running Windows 95 and connected to the internet using TCP/IP ethernet connect. The computer has 32 megabytes of RAM memory and a graphic color capability of millions of colors. In addition to the hardware environment the following software components came with Netscape Communicator Standard Preview: JAVA, JAVAScript, Live Audio, Live 3D, Quicktime, and Netscape Defaults Plugins. Software performance is not examined in terms of data processing speed.

Performance based evaluation is important, however, since several key components are not yet fully functional. Performance could change significantly between the preview version and the final release of Navigator 4.0.

Navigator utilizes the advantages of plugin technology which can greatly increase the capabilities of Navigator to handle and display robust multimedia data. Many third party developers have created plugins that are compatible with earlier versions of Navigator. Plugins (e.g., Macromedia Shockware, VRML) are an important part in the software solution for presenting interactive maps. Because of the sheer number of available plugins and the differences in their functionality, a review of them falls outside the scope of this review. The attention here is focused on the core capabilities of Netscape 4.0.

What is Netscape Navigator 4.0?

Netscape Navigator 4.0 is the newest version of Netscape's popular internet and intranet browsing software based on HyperText Transport Protocol (HTTP) and Hyper Text Markup Language (HTML). Navigator facilitates the accessing of information and network applications on the World Wide Web (WWW), local area networks, File Transfer Protocol (FTP) sites among other network protocols. Navigator 4.0 utilizes a Graphical User Interface (GUI) for browsing media enriched documents passed across computer networks.

The primary format of these enriched documents is HTML. HTML was devised as a standardized language so both creator and user can display documents in a timely manner. As this computer application has grown in recent years, HTML evolved to meet the changing needs of the user community. With each update of the HTML standard (see http://www.w3.org/), Navigator has adjustments to handle these new formatting standards.

This review focuses on the new interface, new HTML standard, JAVAScript, and JAVA. All four of these items are being updated with this release of Navigator 4.0. The preview version of Navigator includes many new features although some are not yet functional. To simplify this review, new features that work will be addressed, first then the proposed new features.

Functions of Navigator 4.0

In this version of Navigator, the interface between the software and the user has been significantly altered. Many of the new features are intended to make repetitive tasks easier to perform. One such new feature is the forward and backward listing. In the previous version of Navigator, users blindly worked with the forward and backward buttons not knowing where the buttons were pointed. In this version, the backward and forward button contain a pop up menu from which to select a location. Users can still click on the forward and backward buttons and move to the next location, but the list increases the user's control of movement at the icon level. Netscape has also replaced the old forward and backward icons with new icons.

Another user interface issue addressed in this version of Navigator, is the customizable toolbars. One aspect of this improvement, which cartographers will find useful, is the collapsible toolbars and location feature. The amount of screen space the user has is limited and often an HTML document will spill over the bottom of the screen. With the collapsible toolbar and location field, the user can increase screen space with a click of the mouse button. This feature is a significant improvement. Navigator has many other interface enhancements but the majority are related to the other components of Communicator so will not be included in this review.

One of the most important aspects of this version of Navigator is the inclusion of the new HTML standard. The last version of Navigator was HTML 2.0 savvy, while the current version works with HTML standard 3.2 (http://www.w3.org/). HTML standards are proposed and formalized by an international commission. In late 1996, HTML 3.0 was proposed, but, like many commissions on standards, total agreement by the commission and the user committee fell apart. In this case, HTML 3.0 basically dissolved. In the aftermath of this collapse, the commission started working on a new version of the HTML standards. The result is HTML 3.2 which many have mislabeled as HTML 3.0. Some of the documents from Netscape Communication Inc. have stated that Navigator is HTML 3.0 savvy when, in fact, it is HTML 3.2 savvy. This is confusing because the commission on HTML is constantly issuing new standards for review. During the review process, important changes are suggested and consequently, the new improved standard is then released for further review. The whole process can take months to years before a new standard is finally reached.

Of all the new HTML standards, Navigator 4.0 supports two that are particularly important to cartographers: layering and absolute positioning. When a WWW document with layers is transferred to your computer, Navigator can show all or some of the layers depending on the users interaction. The interaction expands the usefulness of the document and the exploratory actions of the user. Layers do increase the amount of data transferred but it consolidates them into one transfer action instead of the old work-around of transiting more data after each interaction. By embedding layering into HTML, designers and users can steer clear of other more complex solutions such as JAVA, and JAVAScript.

The other feature already available in Navigator is absolute positioning. A WWW document can be organized using a pseudo Cartesian coordinated system. The location of individual elements on the document can be specified in terms of X and Y screen position. As in cartography, the ability to place elements in exact locations will increase the quality of WWW documents. The current methods of placing information on the page is vague and difficult to work with. The absolute positioning increases the designer control of document formation and display that will increase the effectiveness of the documents.

JAVA is a programming language that can be transmitted across the WWW more efficiently with Navigator 4.0 through the increased ability of JAVA program (applets). When users browse the WWW, they run across documents that are constructed with the JAVA programming language. In some cases, JAVA defines the format of the document while, in other cases, small programs (applets) will be downloaded to your computer and run. Early on, the developers of JAVA saw that applets could be viruses so they restricted its ability to read or write to the hard disk and controlled its action in RAM memory. In the new version of Navigator, the JAVA applets can be granted 4 different types of permission on your system:

- limited disk access
- limited disc access and network usage
- limited disk read access, unlimited disk write access
- unrestricted access

Permission is set prior to downloading and executing of the applet. In doing this, Navigator has increased the power of applets. In cartography, an example would be choropleth mapping. A computer would have a set of tab delimited tables of census data for Wyoming counties with one of columns being the FIPS code. An applet that is given read permission can read the data and map it. If write access is given to the applet the resulting graphic could be stored on your computer. Once stored, the graphic can be imported into any program that can read the format. Other improvements in JAVA have been made, but the access feature will expand the limits of the WWW more than any others.

In between HTML and JAVA is a scripting language called JAVAScript.

JAVAScript is a set of functions that can be embedded inside HTML documents thereby increasing the available functions. With JAVA, developers would need to become more involved in programming than they would like. So to simplify some of these functions, JAVAScript was developed. JAVAScript, like JAVA, is constantly being updated. Navigator 4.0 will support the latest version of JAVAScript, but since JAVA has been promoted more than JAVAScript, many users still know little about JAVAScript.

Many of the functions in JAVAScript can be used by cartographers to increase map interactions. Though they are not new to this version of Navigator, they are still important. A function that was designed to improve interactions and design appearance is the MouseOver function. This function is designed to change the appearance of the document depending on where the mouse is located on the page. Most of the time, MouseOver is used to show active elements in a content list. In map interaction, MouseOver could be used to add specific information to the map. An example can be seen at: http://maps.unomaha.edu/Peterson/methods/Interact/Swanson/Swanson/html.

Functions Being Developed for Official Release

This version of Navigator 4.0 is a prerelease version therefore many new features are not yet working. The following are features not currently available but should be included in the official release of Navigator 4.0. First, the HTML 3.2 standard has cascading style sheets (http://www.w3.org/pub/WWW/TR/WD-css1.html). Style sheets are intended to store preferences for displays within the WWW document. When Navigator includes these style sheets designers, users will be able to customize the document more independently. In addition to the style sheets are WebFonts and OBJECT tags. WebFonts will allow a browser to see a document in a font included in the Navigator package. This will eliminate font substitution when desired fonts are missing from the users computer. The OBJECT tag will allow the designer to include different types of media under one central tag instead of having a special tag for each separately.

The monitoring of keyboard interactions is inherent to Navigator. Currently, most of the keyboard interactions go unnoticed so by including them, the designer increases the amount of interaction with the user. Many times users get started on WWW documents with long animation sequences embedded in them. Often these animations can be skipped and the stop animation and applet feature will make this possible. Also planned for inclusion in Navigator is CrytoAPI. CrytoAPI will make it possible to send secure information over the WWW. Netscape

Communication Inc. is attempting to add this feature in hopes of developing more commercial transactions on the WWW. Many users of the WWW are reluctant to send financial information over the WWW. By implementing CrytoAPI more commerce will hopefully follow.

Conclusions

In the current preview version, Navigator 4.0 provides increased functionality not available in the current Navigator 3.0. The change to the graphical user interfaces are well justified and will not cause major retooling for experienced users. The upgrading of its compliance to the HTML 3.2 standards offers new design concepts which are of great value to cartographers. If Netscape Communication Inc. can deliver on the many other promises, Navigator 4.0 will open many new routes of exploration for users. Users on the leading edge of content creation will need the preview of Navigator 4.0 in order to develop future WWW documents. Currently, I have both Navigator 3.0 and Navigator 4.0 preview installed. I have been experimenting with the new features in the preview version but I realize that the majority of users can not view these new pages. Interaction over the WWW will increase once the official release comes but even then a short lag period will occur as users upgrade to the new version.

This review of Netscape Communication Inc. preview version of Navigator 4.0 is mixed. The working features will increase the ability of cartographers to develop WWW context. The content of a WWW document can be more interactive if the developers use the new functions. If the proposed features are added, Navigator will have moved significantly forward, however, until that happens the user has no real need to get the preview version of Navigator 4.0. Content developers should take a look at the preview version and see what is possible and begin to develop new WWW document that will take advantage of the new functional power of Navigator. To conclude, the current and proposed future of Navigator will enhance map-makers and map readers' interactions if the map-makers choose to utilize the new tools within Navigator 4.0.

NACIS news

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PRELIMINARY PROGRAM NACIS XVII

The Seventeenth Annual Meeting of the North American Cartographic Information Society

Visit our progam web site at http://leardo.lib.uwm.edu

Oct. 1-4, 1997
Lexington, Kentucky

WEDNESDAY, OCTOBER 1, 1997

3:00 - 5:30 p.m.
NACIS BOARD MEETING

3:00 - 7:30 p.m.
REGISTRATION

7:30 - 9:00 p.m.
OPENING SESSION
Keynote Speaker: Karl Raitz, University of Kentucky
Kentucky's Place and Patterns

9:00 - 11:00 p.m.
POSTER SESSION / EXHIBITS AND RECEPTION
Organizer: Donna Schenstrom, Univ of Wisconsin - Milwaukee

THURSDAY, OCTOBER 2, 1997

8:00 - noon
POSTER SESSION / EXHIBITS
Organizer: Donna Schenstrom,
Univ of Wisconsin - Milwaukee

8:30 - 10:00 a.m.

A. PLENARY SESSION PANEL DISCUSSION:
SOFTWARE FOR DESIGNING PUBLICATION-QUALITY MAPS:
WHERE ARE WE NOW & WHAT CAN WE HOPE FOR?

Organizer and chair, Anne E. Gibson, Clark Univ.
Participants: David DiBiase, The Pennsylvania State Univ.; Mark Mattson, Temple Univ.; Charlie Frye, ESRI; and others.

10:30 - 12:00 a.m.

B. PAPER SESSION
DESIGNING MAPS WITH TODAY'S TECHNOLOGIES

Producing high-quality maps from GIS data: the Water Resources Atlas of Florida;
James R. Anderson, Jr. &Louis Cross, Florida State Univ.

Problems of cartographic design in GIS-T;
R. Gordon Kennedy, Washington State DOT

Using Adobe Acrobat PDF technology to support multiple map designs, map formats, & media
Scott C. Wilcox, U.S. Bureau of the Census

C. Paper Session
Theoretical Issues in Cartography & Cognition

Cartographic metaphors for browsing very large data archives;
Barbara P. Buttenfield, University of Colorado

An examination of various neural network models for use in geographic visualization;
David K. Patton, Slippery Rock Univ. of Pennsylvania

Criteria of formalization of the process of feature selection;
Georg Gartner, University of Technology Vienna

12:30 - 2:00 p.m.
Luncheon and Annual Business Meeting

2:00 - 6:00 p.m.
Field Trips and Tours

• Kentucky Natural Resources & Environmental Protection Cabinet's GIS Branch, Frankfort •
The oldest GIS agency in state government will demonstrate some of its recent applications and conduct a tour of the office (includes a visit to the Kentucky Vietnam War Memorial).

• PlanGraphics, Inc., Frankfort •
A leading international consultant and systems integrator of geographic information systems and information technology. PlanGraphics' headquarters is in Frankfort, with regional offices located in Maryland, Texas, Colorado, Arizona, and the Middle East (includes a visit to the Kentucky Vietnam War Memorial).

• Labrot & Graham bourbon distillery •
Labrot & Graham has been restored to its 1840s operating condition and produces bourbon using the original Scottish "pot still" method.

• Self-guided walking tour of downtown Lexington •

7:30 - 9:00 p.m.

Map Collectors' Show and Tell
An informal gathering where collectors of maps of all sorts are invited to discuss and show examples (maybe even negotiate some trades?) of their collections with similarly-addicted souls. Hosted by Pat Gilmartin, Univ. of South Carolina.

FRIDAY, OCTOBER 3, 1997

8:00 - noon
Poster Session / Exhibits
Organizer: Donna Schenstrom, Univ of Wisconsin - Milwaukee

8:15 a.m. - 9:30 a.m.

D. Panel Discussion
Revise &Resubmit:The Future of Cartographic Research Publications
Organizer and chair, Cynthia A. Brewer, The Pennsylvania State University

E. Panel Discussion
Is the Virtual Map Library in Sight?
Organizer and chair: James O. Minton, University of Tennessee - Knoxville. Participants: Christopher Baruth, AGS Collection; Denise Stephens, University of Virginia - Charlottesville; John Sutherland, University of Georgia.

10:00 - 12:00 a.m.

F. Paper Session
Map Production and Design Issues

The UO InfoGraphics Lab experiment: an organic approach to cartographic problem-solving and research facility development;
James E. Meacham, University of Oregon

Staircase locks 3-D model;
Claudia James and Joseph W. Stoll, University of Akron

Abstracting reality: making guidebook maps;
Ren Vasiliev, Geneseo, NY

Rapid transit system maps;
Dennis McClendon, Chicago CartoGraphics

G. Paper Session
Interactive software n the classroom

The virtual internship: an application of the narrative form in computer-assisted learning;
David DiBiase, The Pennsylvania State University

An interactive multimedia geography lesson for dyslexic students;
Alison E. Philpotts, Michigan State University

Cartography, GIS and the Web;
Jeremy Crampton, George Mason University

Perspectives on integrating interactive cartography into an introductory human geography course;
Charles P. Rader, University of Wisconsin - River Falls

12:00 - 1:30 p.m.
Lunch Break
Editorial Board Meeting, Cartographic Perspectives

1:30 - 3:00 p.m.

H. Paper Session
Mapping on the World Wide Web

Interaction, animation, multimedia, visualization, and the Web: mapping out a "New Cartography;"
Michael P. Peterson, University of Nebraska - Omaha

VRML: three-dimensional mapping on the Web;
James M. Swanson, University of Nebraska -Omaha

Shocking the map: using Shockwave to create interactive maps for the World Wide Web;
Rex Cammack, Southwest Missouri State University

I. Paper Session
Evaluating Cartographic Elements

Revisiting the poly-centered orthographic world projection: changes and revisions, and the importance of shape;
Bordon D. Dent, Georgia State University

Visualizing flow lines through time: a comparison between animated and chess maps;
Harry Johnson & Elisabeth Nelson, San Diego State Univ.

An evaluation of motion in the recall of landmarks from an animated map display;
Keith Rice &Aaron Weier, Univ. of Wisc. Stevens Point

3:30 - 5:00 p.m.

J. Paper Session
Producing Maps with Today's Technologies

Constructing surface cartograms using ArcInfo;
Nikolas H. Huffman and David A. J. Ripley, The Pennsylvania State University

Combining raster imagery and vector data to produce geologic maps;
B. J. Stiff, Illinois State Geological Survey

GPS/GIS integrated systems to benefit all phases of aircraft navigation;
Ronald M. Bolton, NOAA

K. Paper Session
Cartography: Pedagogy & Analytical Applications

Lessons from past masters: a pedagogical tribute to the late Robert C. Kingsbury and John C. Sherman;
Peter R. Galvin, Indiana University Southeast

Virtual cartography instruction: current status and developments;
Paul S. Anderson, Illinois State University

Cartography of disturbed landscapes in regions;
Felix N. Ryansky, Far-Eastern Branch of Russian Academy of Sciences

L. PostScript Mapping Roundtable.
Organizer and chair, Dennis McClendon, Chicago CartoGraphics.

3:30 - 5:30 p.m.
NACIS Board Meeting

6:30 - 10:00 p.m.
Annual NACIS Banquet
Guest Speaker, John Pickles, University of Kentucky

SATURDAY, OCTOBER 4, 1997

9:30 - 11:30 a.m.

M. Panel Discussion
Mapping on the Web:
The International Dimension
Organizer and chair: Michael Peterson, University of Nebraska - Omaha. Participants: William Cartwright, Royal Melbourne Institute of Technology; Georg Gartner, Technical University - Vienna; Michael Peterson, University of Nebraska - Omaha

N. Paper Session
Mapping the World for Children

An analysis of pre-school children's mapping abilities in a familiar environment;
Amy Lobben, Michigan State University

American images of the world: nineteenth century school atlases;
Jeffrey Patton, University of North Carolina - Greensboro

Searching for maps that bridge reality and thought in geographic education;
Henry W. Castner, Pittsboro NC

The ICA/Petchenik Children's Map Competition: exploring ways of linking it to the curriculum;
Henry W. Castner, Pittsboro NC

WORKSHOPS

8:30 - noon
Photoshop f/x for Cartographers
Tom Patterson, National Park Service

8:30 a.m. - 4:30 p.m.
Thematic and Interactive Mapping with ArcView
Charlie Frye, Environmental Systems Research Institute

SATURDAY AFTERNOON ACTIVITIES
• Keeneland Race Course • Kentucky Horse Park •
• Shaker Village of Pleasant Hill •

Hotel Information

NACIS XVII will be held at the Radisson Plaza Hotel, Lexington, KY
The hotel is located at 369 W. Vine Street.

Reservations can be made by calling the hotel at (606) 231-9000 or Radisson reservations at 1-800-333-3333. Be sure to specify that you are attending the NACIS Conference.

• Room rates: $99 for single or double •

FEATURED PAPERS

Each issue of *Cartographic Perspectives* includes featured papers, which are refereed articles reporting original work of interest to NACIS's diverse membership. Papers ranging from theoretical to applied topics are welcome. Prospective authors are encouraged to submit manuscripts to the Editor or to the Chairperson of the NACIS Editorial Board. Papers may also be solicited by the Editor from presenters at the annual meeting and from other sources. Ideas for special issues on a single topic are also encouraged. Papers should be prepared exclusively for publication in *CP*, with no major portion previously published elsewhere. All contributions will be reviewed by the Editorial Board, whose members will advise the Editor as to whether a manuscript is appropriate for publication. Final publication decisions rest with the Editor, who reserves the right to make editorial changes to ensure clarity and consistency of style.

REVIEWS

Book reviews, map reviews, and mapping software reviews are welcome. The Editor will solicit reviews for artifacts received from publishers. Prospective reviewers are also invited to contact the Editor directly.

TECHNICAL GUIDELINES FOR SUBMISSION

Literature cited should conform to the Chicago Manual of Style, 14th ed., University of Chicago Press, Chapter 16, style "B." Examples of the correct citation form appear in the feature articles of this issue. Authors of Featured Papers should submit four printed copies of their manuscript for review directly to

Dr. Michael Peterson, Chair of the *CP* Editorial Board, Department of Geography, University of Nebraska - Omaha, Omaha, Nebraska 68182. Manuscripts are reviewed by a minimum of two referees. The recommendations of the reviewers and the Chair of the *CP* Editorial Board are sent to the Editor of *CP*. The Editor will contact all authors to notify them if their paper has been accepted for publication and if revisions are necessary prior to publication. The following technical guidelines should be followed for all accepted manuscripts (these guidelines also apply to book, map, and software reviews).

Material should be submitted in digital form on 3.5" diskettes. Please send a paper copy along with the disk. Text documents processed with Macintosh software such as *WriteNow*, *WordPerfect*, *MS Word*, and *MacWrite* are preferred, as well as documents generated on IBM PCs and compatibles using *WordPerfect* or *MS Word*. ASCII text files are also acceptable.

PostScript graphics generated with *Adobe Illustrator* or *Aldus FreeHand* for the Macintosh or *Corel Draw* for DOS computers are preferred, but generic PICT or TIFF format graphics files are usually compatible as well. Manually produced graphics should be no larger than 11 by 17 inches, designed for scanning at 600 dpi resolution (avoid fine-grained tint screens). Continuous-tone photographs will also be scanned.

Materials should be sent to: Mr. James R. Anderson, Assistant Editor- *Cartographic Perspectives*, Florida Resources and Environmental Analysis Center, UCC 2200, Florida State University, Tallahassee, FL 32306-2641; (850) 644-2883, fax: (850) 644-7360; email: janderso@mailer.fsu.edu

COLOPHON

This document was desktop-published at the Florida Resources and Environmental Analysis Center, Florida State University, using Apple Macintosh computers. Word processing was accomplished primarily with *Microsoft Word 6.0* ; page layout with *PageMaker 6.0*. Graphics not rendered with *Aldus FreeHand* , *Adobe Illustrator*, *Corel Draw*, or *ATLAS*GIS* were scanned from paper originals using a desktop scanner. The *PageMaker* document was output at 2400 dpi. The bulletin was printed by offset lithography on Warren Patina 70# text stock. Text type is set in Palatino, a face designed by Herman Zapf.

NACIS membership form

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The North American Cartographic Information Society (NACIS) was founded in 1980 in response to the need for a multidisciplinary organization to facilitate communication in the map information community. Principal objectives of NACIS are:

§ to promote communication, coordination, and cooperation among the producers, disseminators, curators, and users of cartographic information;

§ to support and coordinate activities with other professional organizations and institutions involved with cartographic information;

§ to improve the use of cartographic materials through education and to promote graphicacy;

§ to promote and coordinate the acquisition, preservation, and automated retrieval of all types of cartographic material;

§ to influence government policy on cartographic information.

NACIS is a professional society open to specialists from private, academic, and government organizations throughout North America. The society provides an opportunity for Map Makers, Map Keepers, Map Users, Map Educators, and Map Distributors to exchange ideas, coordinate activities, and improve map materials and map use. *Cartographic Perspectives*, the organization's Bulletin, provides a mechanism to facilitate timely dissemination of cartographic information to this diverse constituency. It includes solicited feature articles, synopses of articles appearing in obscure or non-cartographic publications, software reviews, news features, reports (conferences, map exhibits, new map series, government policy, new degree programs, etc.), and listings of published maps and atlases, new computer software, and software reviews.

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