INTERACTIVE MAPPING ON THE

WORLD WIDE WEB

by

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ABSTRACT: The World Wide Web is a promising new media for cartography. It allows the creation of interactive maps that can be accessed by the general public. There is a wide variety both in methods used and in the overall quality of current Web sites. This report reviews the state of interactive mapping on the World Wide Web and offers some guidelines for creating successful interactive mapping Web sites.

Introduction

The World Wide Web has created a new way to disseminate information. Groups that dispense spatial information have been quick to take advantage of the Web's ability to display graphic images, including maps. The interactive nature of the Web allows people to create Web sites or "pages" that put control over the creation and display of maps and other images into the hands of computer users. Geographic Information System (GIS) users are among those that have begun to make use of the Web. There are now more than 140 sites featuring interactive maps, most of which have been created in the last two years. As technical problems are overcome, it is becoming easier to create interactive mapping sites. Many GIS vendors have recently introduced software to assist in connecting GIS to the Web. This creates the potential to increase the computer-using public's access to spatial data.

Most sites that feature interactive mapping lack attention to accuracy and are not sensitive to the user's ability, or lack thereof, to understand the data, perhaps because few sites are designed by cartographers. Several authors have complained of the lack of graphical design training in GIS users (Kimerling, 1997; Monmonier, 1996; Weibel and Buttenfield, 1993) and this lack is apparent on many Web sites. The Web can be a great tool, but technical ability must be combined with good design in order to make effective sites.

This project has two purposes. The first is to review the state of interactive mapping on the World Wide Web. The second purpose is to establish a set of guidelines for the creation of interactive mapping sites. Guidelines would encourage the use of cartographic principles and documentation in

making easily understandable, high quality maps. Good documentation can help prevent the misuse of data.

Literature Review

Geographic literature on the Internet has largely been limited to the transfer of spatial data using file transfer protocol (FTP). Most computer users cannot afford GIS software required to display and manipulate spatial data files directly. Methods of displaying spatial data on the Web and technical papers describing how to link GIS and the Web have been published on the Web (Calkens, 1996; Huse, 1995; Schroeder, 1996). Most of these focus on using Common Gateway Interface (CGI) forms to create an interface between the GIS and the Web. Using the Java programming language is a more versatile method of creating interactive sites, although there are fewer guides on how to use Java. Many of the technical problems in creating mapping sites have been overcome, especially with the growing use of the Java programming language.

Few papers mention the quality of the sites being created or the implications of the general public's increased access to spatial data. The consensus seems to be that interactive mapping sites are not particularly useful yet, but that they have the potential to become a powerful tool in broadening access to spatial data (Thoen, 1995b). The most prolific writer on this subject is Bill Thoen. Thoen has written articles for GIS World in addition to publishing articles and a "WebGIS" resource list on his own Web page. Thoen finds the increased use of the Web for Interactive maps exciting and believes the quality of the sites will improve as Web technology advances (Thoen, 1995b).

Methods

Site Reviews

My project selected interactive mapping sites to be reviewed from lists of sites which have already been compiled. The following lists are used: Duda (1997), Katz (1997), Lime (1997), MacLennan (1997), Morris (1997), Essinger (1997), Slatcher (1997), and Thoen (1997). I included as many sites as time allowed, beginning with those sites on more than one list. Interactive mapping is defined as any map in which the user can manipulate the display of the map, from simply zooming and panning on the map to querying and analyzing the data displayed. I have reviewed these sites using a standardized form in order to make classification and comparisons easier. An example of the form is given in Appendix A. The reviews are in Appendix B.

Guideline Development

I asked the administrators of these web sites several questions referring to their pages and their thoughts on the general use of interactive mapping on the Web. These questions were also asked on the WebGIS (DISTGIS@ag.arizona.edu) e-mail discussion list and the comp.infosystems.gis newsgroup. The questions are:

What motivated you to create the site?

What problems did you encounter in creating and maintaining the site?

Who uses the site? What do they use it for?

What does the future hold for interactive mapping and/or Web GIS?

What makes a good interactive mapping site?

What problems do existing sites have?

What should be included in a set of guidelines for interactive mapping sites?
Would you have used a set of guidelines in creating your site if they had been
available? Why or why not?

The guidelines are based on responses to these questions, the literature (primarily Huse, 1995; Plewe,
1996; Thoen, 1995), existing guidelines on map design (Kimerling, 1997; Monmonier, 1996;
Robinson, 1995), and Web site design (Apple, 1997; Berners-Lee, 1995; Levine, 1996; Lynch and
Horton, 1997; Siegal, 1996). The guidelines take the form of a list of things to be considered when
creating a site. They are suggestions and tips rather than rigid rules or technical specifications.
General suggestions are more likely to be followed and will not become outdated as quickly as more
specific or rigid guidelines. They include references to good examples and where to go for technical
assistance. The guidelines will be distributed to administrators of existing sites and published on my
own Web site. My Web site will be maintained and the guidelines will be able to evolve as technology
changes.

Results

Summary of Existing Sites

Almost every author on the subject has emphasized that it is impossible to do much GIS analysis on the Web (Newcombe, 1996; Plewe, 1996; Thoen, 1995; Thrall, 1997). For this reason I have used the term "interactive mapping" rather the "WebGIS," which implies more GIS functionality than really exists. Sites can be divided into several categories (Plewe, 1996; Thoen, 1995). The simplest are static maps which I have not included in my reviews. The simplest interactive maps are imagemaps which are rapidly becoming ubiquitous on the Web. These are otherwise static maps which have "hot spots" defined within them which link to data or other Web sites. While these sites have been included in my reviews, I have focused on more complex sites. Most GIS-based sites are either map generators, which access pre-made maps, or map servers, which create maps "on-the-fly."

Sites linked to a GIS have commonly used CGI forms in which users can define the parameters of a map, which will then be generated and displayed. Most of the older, more established sites use this method. Examples are the TIGER Mapping Service (http://tiger.census.gov/cgi-bin/mapbrowse-tbl), NAIS (http://ellesmere.ccm.emr.ca/naismap.html), and the Xerox Parc Map Viewer (http://mapweb.parc.xerox.com/map). This method is largely limited to creating maps that have already been anticipated (Newcombe, 1996). Huse (1995), however, was able to use this method to create what is currently the closest thing to a GIS on the Web. Her GRASSlinks, used by REGIS (http://regis.berkeley.edu/grasslinks/index.html) is the only site I found allowing users to do spatial analysis such as buffering, overlay, and reclass operations.

Java can be used to create maps which are more interactive and intuitive. With Java the user can have much more direct control of the map and the Web designer can include features such as menus which most users will be familiar with. Java is still a fairly new technology and most Java sites did not run as smoothly as their older counterparts. Java also suffers from bandwidth problems. Bandwidth is the speed of transmission over a network. Since Java requires large data transfers Java-based sites may be difficult to view by someone with a slow Internet connection (such as access over a modem). Other new forms of creating interactive maps such as VRML (virtual reality modeling language) currently are difficult to use but have great potential for the future.

Another possible way to create sites, using X windows, is the most interactive. This basically gives users remote access to the GIS directly. It is limited, however, as most people do not have X windows emulation software. These sites were not included in the review because I did not have the hardware or software available to use them.

I reviewed 55 sites, which included nearly all of the self-styled WebGIS sites and a sampling of other types of interactive mapping sites. The wide variety in the methods used to create sites have blurred the categories of sites used by Plewe (1996) and Thoen (1995b). I looked at several aspects of each site (see Appendix A) including both the technical capabilities of a site and how well it is presented. Most sites were very good in two or three of the criteria and poor in the others. A few outstanding sites deserve special mention.

TIGER mapping service, created by Brandon Plewe and Chris Stuber:

This site is probably the best all around interactive mapping site. It was one of the first created and uses a custom written program. It accesses the Census Bureau's TIGER files, covering the entire U.S. The site gives the user a tremendous array of options and still manages to be clear and uncluttered. It is easy to use and very intuitive. The maps follow general principles of map design and look very nice. The page links to metadata, or data about the data, and documentation on the site as well as a Frequently Asked Questions (FAQ) list. The site's biggest problem is its popularity which can slow it down (Stuber, 1997).

REGIS/GRASSlinks by Susan Huse:

This is probably the best GIS site. As mentioned previously it is the only one to offer spatial analysis abilities. It also has an impressive array of options, and the available layers are presented in a menu-like fashion, making it easy for users to see what they are doing. Like the TIGER site there is metadata and documentation available. The map output is not quite as nice as the TIGER site though. It lacks some cartographic elements such as a scale. The site is also clearly designed for the GIS user. Someone unfamiliar with GIS may not understand how to best make use of the site. Both the GIS software (GRASS) and the application linking it to the Web (GRASSlinks) are in the public domain.

University of Minnesota's Fornet by Steve Lime (http://www.gis.umn.edu/bwcaw/mapping.mapit.html):

This site includes the Boundary Waters Canoe Area Wilderness server, which is one of the nicer

Arc/Info-based mapping sites. Fornet also includes an example of how to display Arc/Info shape (shp) files on the Web using Java.

West Virginia's TAGIS by Jamie Leonard (http://poca.osrme.gov/form/feature.html):
Another excellent Arc/Info-based site. This site gives users access to more databases than most sites. It is possible to get lost in the volume of data offered. It also includes animated "flybys" of selected regions. This site is slowed down considerably by the use of frames and animation.

Earth and Moon Viewer by John Walker (http://www.fourmilab.ch/earthview/vplanet.html):
Impressive site which shows orthographic views of the Earth and the Moon using a mosaic of satellite imagery. Day and night regions of the Earth are adjusted, based on the current time. Users are given many options in changing the view, including control over the center point, altitude, time, and what image is viewed.

Other impressive uses of interactive mapping include real-time weather maps, like the Weather Visualizer (http://covis.atmos.uiuc.edu/covis/visualizer); and traffic maps, such as the Vauxhall site (http://www.vauxhall.co.uk/trnet/tn-finfo.htm). The Xerox Parc Map Viewer is another old site which has stood the test of time. It generates simple boundary maps anywhere in the world which are easily customized. The ICE site (http://ice.ucdavis.edu/ice_maps/) is notable for its excellent explanations of GIS and the data presented and good instructions on how to use the site, making it user-friendly for somebody that is not familiar with GIS. Unfortunately, the site has licensing problems, which make the maps unavailable most of the time.

Along with the good sites there are many that are difficult to use. The biggest problem cited by Web site designers was slow transmission speeds. Nobody wants to wait ten minutes for a site to produce a map, Web guides recommend avoiding anything that takes longer than ten seconds to load (Lynch and Horton, 1997). Stuber (1997) noted that most users of interactive mapping sites are willing to put up with a little sluggishness, but sites should still try to be as fast as possible. Other problems cited include sites that lack maintenance, have out of date or incomplete data, are not user-friendly, or lack documentation. Some sites produce maps lacking legends or any indicator of where the mapped area is located. Examples are the Regio Data (http://www.pi.net/~hverbeek/server_gis.html) and the Murray Basin (http://www.agso.gov.au/map/mb_make_map.html) sites. Other maps do not explain the data, like the otherwise good Berkeley GIS Viewer (http://elib.cs.berkeley.edu/geo_data/) which does not have legend, labels, or the ability to query, making the maps useless. Some sites simply make ugly maps, like the Demographic Data Viewer (http://sedac.ciesin.org/plue/ddviewer/) and Java Interactive Routing (http://www.cs.umn.edu/research/shashi-group/routing.index.html) sites. The GIS vendor sites are often among the worst in terms of graphic design. These sites often use fake data and are only partially functional. While they intend to simply show what is possible, vendors may be better off linking to fully functional sites using their software, as ESRI (http://www.esri.com/base/products/internetmaps/internetmaps.html) does. The Spatial Net demo from Object FX (http://www.objextfx.com/products/spatlnet.html) is notable exception to the generally poor quality of demonstration sites. Very few sites include metadata or sources of any kind, making their data less useful than it could be. Many Java and VRML sites simply do not work or take too long to load, hopefully this problem will lessen as the bandwidth capacity of the Internet is improved. Sites failing to work can also be the result of not being maintained.

Guidelines

As mentioned before, these are general design guidelines and are not technical in nature. The intent is to be a resource for those involved in creating new interactive mapping sites. It includes suggestions on how to make sites more useful, tips on where to go for technical help, and examples of good and bad design. The guidelines are directed primarily toward designers of GIS-based sites, they are, however, intentionally broad to accommodate the variety of interactive mapping applications. It should be emphasized that creating an interactive mapping site is not a simple task and should not be undertaken lightly. Successful sites require a large investment in time and money.

Purpose

Designers should keep in mind the purpose of their site and their potential audience. Whom are you designing the site for? Is it for the general public or other GIS users? Are they likely to have a high speed connection or are they accessing your site via a modem? Questions like these will help you determine how much you have to worry about bandwidth and what level of instructions you should offer the user.

Basics

There are a few things all sites should have. The first is a title. Titles are particularly important in Web documents because it is used by Web searches and when a site is bookmarked. The title should clearly identify the contents of your site. For example, "Virginia County Interactive Mapper" is a much more informative title than "Java SDV."

Be sure to sign and date your Web pages. Solicit comments from your users. Feedback from users is the best means of finding out problems with your site and is a good source of suggestions. Dates are also important due to the rapidly changing nature of the Web. They allow a user to quickly tell if a site is being maintained and whether the data you present is up to date. Dating your pages is more effective than saying your data are "current" or "new." On a related note, maintain your site. You should periodically check your links to make sure they are still active and check any mapping tools (like query) that you offer to make sure they are working properly.

If you have a GIS-based site, be sure to include metadata if you want your data to be useful. Sol Katz (1997) maintains a list of metadata related resources, including standards. The GRASSlinks site demonstrates a nice way to unobtrusively include metadata on your site. Even if you do not expect others to use your data directly, you should still list your sources. It is also wise to explain the limitations of your data to help prevent any misuse. The TIGER site includes this sort of information in a FAQ list. If you want to be helpful to other interactive mapping Web site designers, you should also include some documentation on how you created your site. Some sites, such as GRASSlinks and Andy Wick's Cool Java Map Page (http://maps.purple.org/map/index.html), even include the source code on their pages. Currently there is quite a bit of documentation on how to use CGI to link a GIS to the Web. Documentation on Java and VRML is more difficult to come by.

Site Design

Web design guides offer quite a bit of advice regarding your overall site design. To briefly summarize you should make it easy to navigate your site and maintain a consistent look to your pages. Do not bury your content. Users should be able to access your data with three or fewer clicks (Lynch and Horton, 1997). If you have a large site, you should include a table of contents. The use of headers or footers is a good way to repeat an abbreviated table of contents on each page.

The biggest issue for interactive mapping sites is what type of GIS-WWW interface you want to use. The basic choice is between a form-based page using CGI and using Java. According to the responses I received both have their pros and cons. Java is more interactive and versatile, while forms are faster and more reliable. Java is also not yet supported by all Web browsers and generally requires more programming experience to implement well. Despite its problems, Java has more potential for truly interactive mapping. Most commercial browsers and GIS-WWW interfaces will probably support Java in the future. Bandwidth problems will also hopefully be overcome. The Mapquest (http://www.mapquest.com/) site uses Castanet software to speed up their Java performance (Strand, 1997). The best solution is to offer more than one version of your site, then your users can choose whichever interface they prefer. Unfortunately, many sites do not have the time or resources to do this. You should base which interface you choose on the purpose of your site and your users. Some applications may be impossible without using Java. If you want to accommodate users with slow connections and old browsers you should stick with forms and basic HTML.

Page Design

Page design is what most Web design guides focus on. I will repeat some of the more important points here. Each page should be an independent document. Others may link to pages in the middle of your site and users may want to print out pages, so a page should be able to stand on its own. Web guides recommend a balance between text and images, to keep your page visually interesting. If you do not have any training in graphic design, you may want to take a look at the "Yale Style Guide" (Lynch and Horton, 1997). You should also keep you pages short, most guides recommend only one or two screens worth of information in a page. Longer pages, however, are easier to maintain and easier for users to print out. If you use a long page, it is a good idea to include internal links to different sections of the page. Most of the lists of Web sites used in this report use this approach.

"Creating Killer Web Sites" (Siegal, 1996) offers many tips on formatting pages in HTML. One useful trick is using blank GIF files to control the layout of your page. Tables can also be used effectively to control your layout. Recently it has become popular to use frames to display more than one window of information at a time. Frames limit how much space you can devote to your map and will slow down a Web site considerably. Since most interactive mapping sites need all the speed they can get I do not recommend using them.

Graphics and Map Design

Obviously graphics are the focus of most mapping sites. You should know the difference between GIF and JPEG files. GIF is better for drawings and vector type graphics. JPEG is designed for photographs and other images that require more than 256 colors. Most maps will probably look better in a GIF format. Large graphics do slow down a site, so I recommend avoiding using many images other than your maps. Background graphics especially slow down a site and make it difficult to read. Something like a small logo graphic is OK.

Be careful of the size of your maps. Several sites I reviewed had maps that did not fit on a 15" screen and could not be resized. You can use the HTML height and width tags to define the size of an image. Users with 14 or 15" screens will usually have a resolution of 640 x 480 pixels. To be sure your map appears correctly you should restrict its size to 535 x 320 pixels (Lynch and Horton, 1997).

Maps should follow some basic map design guidelines. Like Web pages, maps should have an informative title and be as independent as possible. It should be clear where in the world the map is located. This is especially important for large scale (small area) maps. Not everyone knows where the Murray Basin or Clinch River are located. Small scale maps can show location and orientation by including latitude and longitude coordinates and grid lines. Large scale maps should also include a locator map, making it easier for the user to orient themselves. Some indication of scale should also be included on all maps. Scale can also be shown using coordinates and grid lines on small scale maps. For larger scale maps I recommend using the traditional bar scale, or simply including the scale as a fraction (e.g., 1:25000). The TIGER Map Service and the Berkeley GIS Viewer are examples

of maps with scales that change as the user zooms in and out. Finally, all maps need a legend. The query ability can substitute for a legend to some degree, but I still recommend one for any map that shows more than one feature. The Xerox Parc Map Viewer is an example of a site that can get away without having a legend, anything more complex should have one. Once you have a legend, make sure it is understandable. Having a legend with a bunch of codes on it is not much good if you do not explain the codes. Generally labels on your map are also a good idea, although they can clutter up your map. Many sites have labels as a layer which can be turned on and off, which is a good solution. Robinson (1995) provides a good guide to label placement.

Other aspects of map design are the same as more general graphic design. Monmonier's, How to Lie With Maps (1996) is a nice guide for basic map creation. Make sure that type on your map is readable. Features should be distinguishable, variations in the visual hierarchy should be used to make important features stand out. Try to avoid making the map too cluttered. The Cool Java Map Page is an example of a map that is difficult to read because of clutter and a lack of hierarchy. Use appropriate symbols and colors. Colors in particular are often used carelessly. Maps showing gradations in data from low to high values (e.g., many thematic maps) should use light to dark color scales or different sized objects. Primary colors, like those used on the Demographic Data Viewer site make thematic maps very difficult to interpret. If your map is an imagemap, the hotspots should be obvious.

The best solution to map design is to put as much of it into the hands of the users as possible. Many sites give users control over colors and which layers are turned on. Other possibilities include control

over line types, the order in which features are drawn, and what symbols are used for point features.

Miscellaneous

Some sites have made impressive displays using animation and VRML. Many Web guides recommend avoiding animation because of bandwidth concerns. Multimedia, however, is one of the things that attracts people to the Web. I encourage the use of animation and VRML, simply warn your users by listing the file size. This lets them know they are in for a wait. Do not use frivolous animations that do not contain any content (such as animated logos), they will simply slow down your site. There is a lot more experimentation that could be done with both animation and VRML. One possibility would be to use animation to show a time series of maps. VRML sites could try giving users more control over the maps, such as changing the base layer.

Unfortunately I do not have many tips for Java. Most Web guides do not have a section on Java. Try to keep Java applets as small as possible to minimize loading time. Otherwise, take advantage of what Java has to offer. You can embed menus into your map to make it easier to use. Beware of overwhelming users with options. Try to make it clear how your site works.

As I mentioned before almost no sites allow users to do spatial analysis. GIS vendors should incorporate abilities similar to those in GRASSlinks into their Internet mapping software. It should also be possible to make custom programs for spatial analysis in Java. The IRIS (http://allanon.gmd.de/and/and.html) site is notable in that it allows users to manipulate the database

directly, the site includes documentation. While there may be security concerns in giving users access to the database, this is another way to let them do their own analysis.

I did not have the time or resources to compare the different commercial GIS-WWW interface tools. The responses I received recommended avoiding making sites that require specific plug-ins. Requiring plug-ins restricts access to your site, and I did not see any plug-ins that did anything that could not also be done in Java.

Accommodating Differences

Most E-mail I received cited increasing access to spatial data as one of the goals in creating an interactive mapping site. With this in mind you should try and accommodate the wide variety of Web users. Do not design a site with a specific browser, such as Netscape, in mind. There are hundreds of different Web browsers and catering to one will exclude people that are using other browsers. Using Java contradicts this suggestion, but I suspect Java will be supported by more browsers in the future due to its popularity. You can do this by having multiple versions of your site, such as a Java and a non-Java or a frames and non-frames version. You can also accommodate text-only browsers by including alternate text for your images. Obviously those with text-only browsers will not be able to make full use of your maps, but they should be able to tell what is on your site so they know if it is worth going back to with a different browser. Your site will look different based on the user's browser and operating system. Test your site with several different browsers to see if it looks right. Siegal (1996) offers tips on how to control colors and layout over different browsers. If you switch to a different interface to take advantage of a new technology, like Java, it is a good idea to leave

your old site up so that people with old browsers can still access it.

Make sure you have instructions on how to use your site and explanations of your data. If you are catering primarily to other GIS users, you may not need much explanation. Experienced users may even be annoyed by too much text, as they want to get to the data as quickly as possible. You may want to consider offering direct FTP access to your database so that they can skip the maps entirely. Unfortunately there is no standard file format that has gained common usage among GIS users, so you may want to offer several options if you decide to use FTP. One possibility to watch is the Spatial Data Transfer Standard from the Federal Geographic Data Committee (1997). Novices on the other hand, may not even know what a GIS is. For them you may want to not only explain your data and how to use the site, but general GIS concepts as well. The ICE site offers an example of how to accommodate both groups by offering extensive instructions and explanations as separate help files, which the experienced user can simply skip.

Think globally when creating your site. It is called the World Wide Web for a reason. This is one of the reasons I recommend using locator maps. Write out the date on your pages since the U.S. and Europe use different conventions when abbreviating dates. Avoid slang or jargon that may be difficult to translate. See Lynch and Horton (1997) for other tips on how to accommodate other languages.

Conclusion

The future for interactive mapping looks bright. Interactive mapping on the Web has the potential to increase the general public's access to spatial data to solve everyday problems in planning, resource management, and other fields. It is rapidly becoming a tool rather than a toy (Thoen, 1997). While it is currently easiest to program sites yourself, commercial packages should make it easier for non-programmers to create interactive mapping sites. Java has made it possible to come close to a true GIS on the Web. The biggest technical problem remaining is bandwidth, which Web page designers have little direct control over. Many of the problems facing sites are now design issues rather than technical problems. It is important that Web site designers "don't get so lost in the novelty of the Web page that basic standards of editorial and graphical design get tossed aside" (Lynch and Horton, 1997). Creating a successful mapping site requires the combination of knowledge from several disciplines including computer programming, cartography and GIS, and graphic design. Hopefully the guidelines presented in this report will help improve the quality and usefulness of maps and spatial data available on the Web.

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Tom Abeles, Christiane Boehner, Ted, Bowen, Ashley Bryett, Peter Burden, Bernie Conners,

Rupert Essinger, Adam Holt, Jon Kimerling, Steve Lime, Phil Massam, Bob Moore, Bryan

Morgan, Christer Nilsson, Dave Nuttall, Joel Register, Rich Signell, Steve Slatcher, Tracy

Solarek, Lisa Stapleton, Chris Stuber, Maurice Szmurlo, Jeff Talbot, Bill Thoen, Martin Weinelt,

Dawn Wright

Appendix A

Review Form

<u>Title:</u> Name of the site.

<u>Author:</u> The designers and maintainers of the page, if they are given credit.

<u>Organization:</u> The organization, institution, or company that is supporting the site.

<u>URL:</u> The site location or address.

<u>Summary:</u> Provides a brief overview of the site.

<u>Zoom/Pan/Query:</u> Describes if and how well the user can perform these simple functions by clicking on the map.

<u>Layers:</u> Describes the data layer(s) being accessed and whether the user has any control over the appearance of different data layers.

<u>Metadata:</u> Describes what data about the data are present and any documentation on how the site was created.

<u>Cartographic Elements:</u> Describes whether the map includes basic cartographic elements such as a scale, locator map, legend, labels, or map coordinates.

<u>Text:</u> Describes textual explanations or instructions accompanying the map.

<u>Appearance:</u> Describes the visual appeal of the map and any problems with resolution.

<u>Friendliness:</u> Describes how user-friendly or intuitive the site is.

<u>Higher Functions:</u> Describes whether any spatial data analysis by the user is possible.

<u>Multimedia:</u> Describes whether the site has taken advantage of the multimedia aspects of the web, such as using pictures, animation, or sound.

Appendix B

Interactive Mapping Web Site Reviews

The following sites were reviewed using Netscape 3.0 and Windows 95 via a modem. The reviews are highly subjective, which is why I have not attempted to rate the sites. I did not consider sites that are libraries of static maps, primarily non-English, use X-windows, or take more than thirty minutes to load.

Title: AnchorageMap

Organization: Geonorth, Inc.

URL: http://www.geonorth.com/

Summary: A street and parcel map of Anchorage, AK. The site uses Arc/Info, Map Objects and Java. You must register to see the site.

Zoom/Pan/Query: Yes, you can zoom and pan. You can query and get parcel information (zoning and tax assessment data).

Layers: None that can be manipulated by the user.

Metadata: None

Cartographic Elements: None

Text: Brief instructions on how to use the site.

Appearance: Nice, better than most Arc/Info-based sites.

Friendliness: Poor. The site is intuitive to those that already know GIS. Novices may have trouble figuring out what they are doing.

Title: Active Maps

Organization: InternetGIS.com

URL: http://www.internetgis.com/

Summary: Demonstration of the Active Maps Internet server. The site includes several thematic

maps of the US. A street map and network map demos caused Netscape to crash. The

site uses Java.

Zoom/Pan/Query: Yes. You can also query the database using a conditional statement, although

this feature did not work when I tried it.

Layers: None that can be manipulated by the user

Metadata: None

Cartographic Elements: Has a legend. Missing scale, locator map, and coordinates. It is set up to

easily add labels and coordinates.

Text: None, expect for promotional material about Active Maps.

Appearance: Poor, maps are fairly ugly. Categories for demographic maps are fixed, creating

some maps with only two categories. The colors are OK, but could be improved.

Friendliness: Low

Title: Arc/Info Web Interface Demonstration

Author: Phil Massam

Organization: Univ. Of Edinburough

URL: http://www.geo.ed.ac.uk/home/research/massam.html

Summary: A somewhat dated Arc/Info demonstration project. Users are taken through a series of

steps to create a map. There is a separate page for each step. The maps do not have real

data. The site often does not work. I could not get an actual map.

Zoom/Pan/Query: Can pan and zoom. Can not query.

Layers: The site has two data layers and two vector overlays that can be turned on and off. Users

can change colors and line types of the vector layers.

Metadata: None, although there is detailed information about how the site was created.

Cartographic Elements: I could not create a map.

Text: Useful help section.

Appearance: Some of the pages could probably be combined to give the site a more consistent

look.

Friendliness: High when it works.

Title: Arkansas Interactive Mapper.

Author: Amandi Quvalis

Organization: University of Arkansas, NASA

URL: http://www.cast.uark.edu/products/MAPPER/

Summary: The site leads users through "cook book" instructions to make maps of Arkansas.

Users get to choose area to be mapped and layers. You can also choose colors of line and

point layers and the size and resolution of the final map. The site uses GRASS. It is not

especially interactive.

Zoom/Pan/Query: No

Layers: The site has 27 possible base layers, 60 possible vector overlays, and 59 point layers.

Many of the layers are repeated.

Metadata: None

Cartographic Elements: Has a scale and coordinates, but no legend or locator map. Users can choose whether or not to have labels.

Text: Very good instructions. They take Users step by step through the map making process. Concepts are explained, but the data is not.

Appearance: Nice

Friendliness: High

Title: GIS Viewer

Organization: UC - Berkeley (Berkeley Digital Library)

URL: http://elib.cs.berkeley.edu/geo_data/

Summary: A Java-based interface with GRASS. The site displays a map of Northern California with a list of layers that can be turned on or off by clicking on them. The site is easy to use, but the query does not seem to be working. There is also a separate image map of California dams. The site caused Netscape to crash.

Zoom/Pan/Query: Zooms and pans very easily, simply by scrolling across the map with the mouse. Should be able to query and even do simple analysis, but that did not work when I tried it. Query works fine on the dams map.

Layers: The site has 22 layers that can be turned on and off. You can even have more than one raster map shown at a time, although it makes for a confusing map.

Metadata: Yes

Cartographic Elements: The map has a scale, coordinates, and a locator map. It is missing a

legend and any sort of labels.

Text: Good explanations and documentation.

Appearance: Maps are nice, but the lack of a legend and not being able to query makes them

useless at the moment.

Friendliness: Fair

Higher Functions: None, although should be able to do simple area calculations.

Title: Blue Skies

Author: Alan Steremberg and Christopher Schwerzler

Organization: University of Michigan

URL: http://cirrus.sprl.umich.edu/javaweather/

Summary: The site contains real-time weather maps of the US. Queries without having to

actually click on the map.

Zoom/Pan/Query: Can partially zoom (actually toggles between regional and national scales),

cannot pan. Queries very simply. Moving the mouse over a weather station automatically

displays data on the screen.

Layers: None, could have eight. Currently they are separate maps.

Metadata: None

Cartographic Elements: The maps have a legend, but no scale or coordinates.

Text: Good introduction. No explanation of the data. Information section is planned for the site.

Appearance: Very nice.

Friendliness: High. Very intuitive, easy to use despite lack of instructions.

Higher Functions: Real-time data.

Multimedia: None, has plans for movies.

Title: BWCAW Map Server

Author: Steve Lime

Organization: University of Minnesota

URL: http://www.gis.umn.edu/bwcaw/mapping/mapit.html

Summary: The site creates maps of the Boundary Waters Canoe Area in Northern Minnesota by accessing a GIS via a CGI script. It has nicer cartography than most of the ARC/INFO-based sites.

Zoom/Pan/Query: Yes, can query information on lakes, portages, and campsites.

Layers: There are five layers of data users can overlay onto the basemap which contains boundaries and hydrography. Layers include roads, campsites, and portages.

Metadata: None, but there is documentation on how the site was made.

Cartographic Elements: Scale, coordinates, locator map, and labels are all present.

Text: The page has clear instruction on how to use the site and, like the ICE site, it explains GIS concepts. There is also a FAQ which answers basic questions about the site.

Appearance: Very nice maps.

Friendliness: High, the site is straightforward and easy to use.

Title: Caris

Organization: Universal Systems Ltd.

URL: http://universal.ca/new-index.html

Summary: The site contains several maps demonstrating the Caris Internet server. Examples include a road map of New Brunswick with some tourism info on it, parcel maps overlaid on air photos, and several maps that can be queried to determine what other maps are available for that point. Like most demonstration sites, there is not much real data here. The site uses frames.

Zoom/Pan/Query: Yes, maps use buttons to zoom and pan and control which database is being queried.

Layers: The tourism map has four layers that can be queried. Users cannot manipulate layers.

Metadata: None

Cartographic Elements: A Scale, Legend, and Coordinates are available for all maps. There are no locator maps.

Text: Good instructions on how to use the site. No explanation of data.

Appearance: Very nice.

Friendliness: High.

Title: City of Oakland

Organization: Oakland Community and Economic Development Agency

URL: http://199.35.5.101/index1.htm

Summary: The site has parcel maps of Oakland, CA with zoning information, not especially

interactive. It uses ArcView and Map Objects.

Zoom/Pan/Query: Yes, can query parcels and get owner information and zoning codes. Can search on an address like a street atlas.

Layers: Users have no control over layers. The map includes some background layers (Roads, boundaries) and aerial photographs which the user can turn on and off.

Metadata: Zoning codes are explained, otherwise none.

Cartographic Elements: None

Text: Includes some explanation of the maps and a brief description of GIS. Also gives instructions on how to navigate through the maps.

Appearance: Very nice except for the lack of cartographic elements. Photos come through clearly.

Friendliness: High

Multimedia: Uses photos effectively

Title: City of Ontario

Author: Robert Flores

Organization: City of Ontario, CA

URL: http://gis.ci.ontario.ca.us/gis/index.htm

Summary: This site is somewhat similar to the Oakland site. It has a parcel map, city projects map, and a map showing polling places. They are not especially interactive. You can search on addresses. The site uses ArcView, Map Objects, and Java. It is hampered by having maps larger than a normal screen that cannot be resized. Part of the legend and

pan tools are cut off and unusable. It probably works well on a screen that is 17" or

larger.

Zoom/Pan/Query: Can zoom and pan. Can query and get extensive data on parcels. Cannot

query projects. Can query polling places to get addresses.

Layers: None that can be controlled by the user. Only one layer can be queried on each map.

Metadata: None

Cartographic Elements: The map has a legend and locator map, although they are difficult to read

because they are cut off by the edge of the screen. No scale or coordinates.

Text: None, except brief introduction.

Appearance: Nice, except for the sizing problem.

Friendliness: Fairly easy to use, but no instructions or explanations are given.

Title: Clinch River Environmental Restoration Program

Author: Bill Hargrove

Organization: Oak Ridge National Laboratory

URL: http://www.esd.ornl.gov/programs/CRERP/INDEX.HTM

Summary: The site contains primarily static maps. It is included in the reviews because users can

define a stream reach (by clicking on it) and create a video/flyby of the selected reach of

stream.

Zoom/Pan/Query: No

Layers: Data layer contains samples of Cesium (shown as floating balls in the video). Background

is from a DEM. Neither can be manipulated by the user.

Metadata: Yes

Cartographic Elements: None

Text: Data are explained, could use more instructions on how to use the site and the map could

use some cartographic elements (especially a locator map).

Appearance: Videos look good. It is difficult to tell what you are seeing at first.

Friendliness: Good, although the site assumes you know Tennessee

Multimedia: Great animation.

Title: Cool Java Map Page

Author: Andrew Wick

Organization: Virginia Tech.

URL: http://maps.purple.org/map/

Summary: The site is a map based on the Digital Chart of the World. It is more interactive than

most maps but is ugly. The map is Java based and can be manipulated by either the mouse

or the keyboard. Users can also control the level of generalization (labeled as accuracy on

the site).

Zoom/Pan/Query: You can easily zoom and pan. There is no database associated with the map,

but you can query latitude/longitude or UTM locations of anywhere on the map. The map

also includes URL locations that link to the site they represent.

Layers: There are four base layers, and labels and URL sites. Users can turn these on and of and

change what color they are.

Metadata: The source of the data is given and documentation for the site is included, including

source code.

Cartographic Elements: Does not have a scale. Legend is not on the map, but is visible when layers are changed. Labels and coordinates are present.

Text: Very little, source and documentation are on a separate page. No instructions, although there is a menu of possible keystrokes.

Appearance: Poor, produces a very ugly map due to lack of visual hierarchy and poor labeling. Labels overlap and are often nowhere near the object they are supposedly labeling. The black background does not help either.

Friendliness: Low

Title: Demographic Data Viewer

Organization: CIESIN

URL: http://sedac.ciesin.org/plue/ddviewer/

Summary: The site makes thematic maps from census data. It is easy to use and gives users a lot of control over what is mapped. Unfortunately it makes truly ugly maps.

Zoom/Pan/Query: No. Users do choose area and scale of the map via a CGI form. Users can pick county, state or county maps. Data can be mapped at five different scales from state to block group.

Layers: Hundreds of population census categories can be mapped. Users also choose number and type of categories.

Metadata: Yes, extensive documentation is available.

Cartographic Elements: None, except for a legend, which does not have real values on it.

Text: Good explanations and instructions.

Appearance: Poor. The maps can only use primary colors, making horrible maps.

Friendliness: High

Title: Dynamic Object Oriented GIS

Author: Peter Korp

Organization: Argonne National Laboratory

URL: http://doogis.dis.anl.gov/

Summary: A demonstration project in using OOGIS and Java to make a map. It does not have

much content yet. There is a map of the US with various information displayed, but no

legend, so it is not clear what is being mapped.

Zoom/Pan/Query: Yes, using Java applets. It works smoothly. Query gives distances to all

objects within some radius. Object codes are not explained.

Layers: None that can be manipulated by the user. Appears to use TIGER base maps.

Metadata: None, although how the site is made is documented.

Cartographic Elements: None

Text: How to use the site and how it was created is clearly explained. The data are not explained

at all.

Appearance: Fair

Friendliness: Easy to use, but not informative.

Title: Earth and Moon Viewer

Author: John Walker

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

Summary: This is more of a remote sensing site than a mapping site. You can create impressive

views of the Earth or the Moon from space. Users control the viewing perspective. You

can choose the altitude above any user-defined point. You can also view the Earth as seen

from any satellite. Users can change the date and time the Earth is being viewed (default

is the present time).

Zoom/Pan/Query: Can zoom and pan. Can not query.

Layers: You can choose from five image mosaics, and can choose a map or orthographic

perspective.

Metadata: Yes, extensive metadata and other documentation are available.

Cartographic Elements: Latitude and longitude coordinates of the center are given as well as the

altitude. Legends are available for some of the images.

Text: Excellent explanation of both the data and the site.

Appearance: Excellent.

Friendliness: High

Higher Functions: Real-time data.

Title: Ecotourism Interactive GIS

Organization: Adelaide University

URL: http://www.gisca.adelaide.edu.au/cgi-bin/eco/ecogis

Summary: This is a map of the "Green Triangle" region of South Australia (the SE corner) showing conservation areas and vegetation types. Users can query information about the different parks and reserves in the region. The site uses ARC/INFO and CGI.

Zoom/Pan/Query: Yes, query does not access a database but links to more information about the park clicked on.

Layers: There are 14 layers users can turn on and off by using check boxes. These include hydrography, roads, parks and reserves, vegetation types, and labels.

Metadata: None

Cartographic Elements: The map has scale, legend, labels, UTM coordinates, and locator map. The scale changes as you zoom. Could use a larger locator map, for those not familiar with South Australia.

Text: Detailed instructions are given on how to navigate the site. Very little information about the data is given.

Appearance: Nice overall. The map itself could use some minor improvements (labels are hard to read).

Friendliness: Quite user-friendly, although someone not from South Australia might not know what they are looking at.

Multimedia: Query uses HTML links to connect to park management plans and aerial photographs of the parks. So far there are only six of these links.

Title: ERIN

Organization: Department. of Environment, Sport & Territories

URL: http://www.erin.gov.au/database/db.html

Summary: The site uses imagemaps to access their database. There are several maps on the site, including a directory of environmental organizations and a habitat map. The site is not really interactive.

Zoom/Pan/Query: Can not zoom or pan. Can query.

Layers: None

Metadata: Yes

Cartographic Elements: Yes, the maps are excellent.

Text: Varies, some maps have good instructions while others do not have any.

Appearance: Excellent

Friendliness: Varies, the data directory maps are high. The habitat map is low, you need to know the scientific names of species to make it work.

Title: ESRI Internet Mapping Solutions

Organization: ESRI

URL: http://www.esri.com/base/products/internetmaps/internetmaps.html

Summary: The initial page describes the purpose of interactive maps on the web and describes two ESRI products that help create them. They are the Map Objects and ArcView map servers. The site has several demonstrations of sites made with the servers. The three

ArcView demos and one of the Map Objects demos did not work when I tried them. The remaining five demos are summarized below - since they are demonstration sites they are pretty light in terms of content. Much of the data has been made up just for the demonstration. 1) San Francisco Street Atlas - this site is similar to other street atlas sites which are reviewed later, but covers only downtown San Francisco. 2) Thematic Map Maker - makes simple thematic maps of states (mapping census data by county), users choose data layer, classification method, and number of classes. The maps are very ugly. 3) Toxic Release Inventory - Similar to the Friends of the Earth site, only for the US. The data are not as nicely presented or explained though and the maps are ugly. 4) Redlands, CA - Maps city improvement projects on a parcel map. You can query the map for a picture and information about the project. 5) King County (WA) Bus Itinerary - Maps the Seattle metro area public transportation systems and allows users to enter in a time, start point, and destination. The best route will be shown with text instructions on which buses to catch at what time. Most of the information below is about sites 4 and 5 as they are the most interesting. ESRI's site also contains links to other sites putting GIS on the Web using Map Objects, but these are reviewed separately.

Zoom/Pan/Query: Yes, all of the maps other than the thematic map maker can zoom, pan, and query.

Layers: All of the maps only have one layer, and background features. Users can not manipulate layers or display characteristics of any of the maps.

Metadata: None, except that the thematic mapping and toxic release maps list their sources.

Cartographic Elements: None

Text: Very little except for the initial page. Most of the demos would benefit from having more than minimal instructions. The Itinerary map is somewhat complex and was hurt the most by the lack of instructions.

Appearance: Quite disappointing. ESRI put most of their effort into showing what can be done and not much on making it look good. Most of the maps do not have any labels or legends, making them difficult to interpret. The thematic maps use color schemes that can place the darkest colors in the middle of what should be a light to dark progression. Maps are also not centered or balanced, making them look odd. The toxic release map needs more background features to help orient users.

Friendliness: As noted, some more instructions would help. The sites assume geographically literate users. The Itinerary map starts with a map of the entire state when the data only covers the Seattle area, forcing users to zoom in several times before they can see the bus routes.

Higher Functions: The Itinerary site is impressive in figuring out shortest routes and comparing them to bus schedules. It is one of the more potentially useful sites reviewed. As noted above it needs some help in terms of appearance and user-friendliness.

Multimedia: Queries on the Redlands site show actual photos of the city improvements

Title: Geocities, Lycos, Maps on Us, Yahoo

Organization: Commercial sites. Lycos, Maps on Us, and Yahoo are all based on maps by Etak Corp.

URL: http://www.geocities.com/BHI/geoviewer.html; http://www.proximus.com/lycos/;

http://MapsOnUs.com/poc/maps.samplempa.html; http://www.proximus.com/yahoo/

Summary: These four sites which are almost identical. They are all street atlases which are almost
the same as the Street Atlas CD-ROMs which are commercially available. They are all
based on TIGER files and cover the whole US and can center on a town or a street
address entered by the user. Geocities can also center on an Internet domain name.
Yahoo can figure out itineraries for trips up to 1,000 miles.

Zoom/Pan/Query: Can zoom and pan, can not query.

Layers: None that can be manipulated.

Metadata: None

Cartographic Elements: None

Text: All have fairly simple, straightforward instructions.

Appearance: Nice, all are much more glossy looking than the other sites reviewed. They contain
advertisements.

Friendliness: High

Title: GeoMedia

Organization: Intergraph

URL: http://www.intergraph.com/iss/geomedia/webmap/

Summary: This is a demonstration site for Intergraph's Internet server. It requires a separate
Netscape plug-in to view the maps. The site contains three demos, one of which is
operational. That is a parcel map of Huntsville, AL. This is the only site cited by other

Web site designers as poorly designed.

Zoom/Pan/Query: Zooms using the mouse. Can not pan. Can query the parcel database by

typing in an address.

Layers: None that can be manipulated. Map just shows streets and address numbers.

Metadata: None

Cartographic Elements: None

Text: Almost none other than promotional information about their plug-in.

Appearance: Frame intensive. The map is OK, but small due to frames. The lack of cartographic

elements make it difficult to interpret.

Friendliness: Low

Title: Grasslinks for the AGCDC

Author: Simon Cox

Organization: Australian Geodynamics Cooperative Research Centre

URL: http://www.ned.dem.csiro.au/AGCRC/4dgm/grasslinks/

Summary: The site contains geologic maps of Australia. It uses GRASS and HTML. Users

choose a raster base map and any desired vector and point layer overlays. The site uses

lists to pick layers so you can only pick more than one if they are adjacent in the list.

Users also choose the region of map, map size, and colors.

Zoom/Pan/Query: Yes, can zoom and pan. Can query the raster base map.

Layers: The database has 20 raster layers, 28 vector layers, and 8 point layers to choose from.

Users control the colors of the vector and point layers.

Metadata: Sources of data are given.

Cartographic Elements: The map has a scale, legend, and coordinates. There is no locator map.

Text: Very little. There are some instructions. There is no explanation of the data.

Appearance: Nice, but could use a locator map.

Friendliness: Low, maps would be confusing to anyone who is not a geologist.

Title: Great Lakes Map Server

Organization: EPA/CIESIN

URL: http://epawww.ciesin.org/arc/map-home.html

Summary: This map accesses three EPA datasets for the US portion of the Great Lakes basin.

　　　The site is ARC/INFO and CGI-based.

Zoom/Pan/Query: Zooming takes two separate pages, one to choose each corner of the desired

　　　map extent. The map does not pan or zoom out (except by starting over). Can query the

　　　Permit Compliance System database getting the name and address of the site. Can not

　　　query the other databases.

Layers: Has six layers of geographic features plus the three site layers which users can turn on and

　　　off through check boxes.

Metadata: None

Cartographic Elements: None

Text: Good explanation of how to zoom in and choose a map extent and categories. Does not

　　　explain the data at all.

Appearance: Pretty plain, maps are very simple.

<u>Friendliness:</u> Good, although the zooming could be streamlined and the data could use some

explanation.

<u>Title:</u> IDGIS

<u>Author:</u> Yew Choo

<u>Organization:</u> Texas A&M University

<u>URL:</u> http://starr-www.tamu.edu/choo/idgis/intro.html

<u>Summary:</u> This is a demonstration project using Java and ArcView. It is badly in need of a

locator map. The site sometimes causes Netscape to crash.

<u>Zoom/Pan/Query:</u> Yes.

<u>Layers:</u> Users have a choice of six layers which can be turned on and off. Only one can be

queried at a time.

<u>Metadata:</u> None

<u>Cartographic Elements:</u> Has a scale and coordinates. Needs a legend and locator map.

<u>Text:</u> Explains how to use the site, but does not explain data.

<u>Appearance:</u> Fair

<u>Friendliness:</u> Fair, easy if you already know GIS.

<u>Title:</u> ICEMAPS

<u>Author:</u> Harvey Chinn and Karen Beardsley

<u>Organization:</u> Information Center for the Environment (ICE)

<u>URL:</u> http://ice.ucdavis.edu/ice_maps/

Summary: The site contains statewide maps of California showing various environmentally related

data. The site did not really work when I tried it. The site has a limited number of

Arc/Info licenses which prevent access to the maps most of the time.

Zoom/Pan/Query: You can zoom by entering latitude, longitude coordinates for the desired map

extent or by picking preset regions off of lists (100+ available).

Layers: Users choose which of 27 layers are mapped via check boxes.

Metadata: Extensive

Cartographic Elements: Has a legend and coordinates, but is missing a scale and locator map.

Text: Has the nicest and clearest instructions of any of the sites reviewed. Explains GIS in

general as well as the specific site. Users can change the level of help offered.

Appearance: Nice, but could not access detailed maps.

Friendliness: Extremely high.

Title: Interactive Pollution Mapping

Organization: Friends of the Earth (UK)

URL: http://www.foe.co.uk/cri/html/postcode.html

Summary: The site creates large scale maps of England showing chemical release sites. The site is

ARC/INFO and CGI-based.

Zoom/Pan/Query: Yes, can create a map by zooming in from a small scale map of England or by

entering in a postcode. Can pan but can not zoom back out. Query accesses the Chemical

Release Inventory, which is an annual report of the names and amounts of all toxic

releases.

Layers: Only one database layer, the data are nicely presented and explained. Geographic features

are very general (roads, counties, urban areas). None of the layers can be manipulated.

Metadata: None on the site, but the source of the data is listed and the limitations of the data are

discussed at length in a narrative format.

Cartographic Elements: None, but the towns are labeled.

Text: Has an instructional page before you get to the map describing how to zoom and query.

Appearance: Nice, but quite basic.

Friendliness: Very simple, easy to use. Sometimes the map does not work, particularly with

slower connections.

Title: IRIS

Author: Nathalia and Gennady Andrienko

Organization: Pushchino State University

URL: http://allanon.gmd.de/and/and.html

Summary: This is a demonstration of the IRIS Internet Server. It uses CIA world book data to

map thematic maps of Europe. The site allows users to view and manipulate the database,

choosing exactly what is to be mapped. Users do not have much control over map

appearance. The site is very slow and the demos often do not work (also includes Russian

forestry and City of Bonn examples I could not get to work). The server opens many new

sessions which can rapidly clutter your screen.

Zoom/Pan/Query: No

Layers: Databases include many categories that can be mapped. Only one can be displayed at a

time.

Metadata: Yes, also includes documentation on IRIS and on how the site was created.

Cartographic Elements: Has a legend, no scale or coordinates.

Text: Yes, extensive instructions and explanations are present. There are translated from

German, making it difficult to follow at some points.

Appearance: Nice when it works. The maps look OK. Cluttering is a problem, although users

have some control over this by which datasets they choose.

Friendliness: Fair, users have to actually read the instructions to figure out what is going on. Easy

for someone already familiar with GIS.

Higher Functions: Only site to really let users manipulate database.

Title: Java Interactive Routing for Minneapolis

Author: Andrew Fetterer

Organization: University of Minnesota

URL: http://www.cs.umn.edu/research/shashi-group/routing/index.html

Summary: This is a Java-based map of Minneapolis. The map is supposed to calculate the

shortest route between an origin and destination chosen by the user. It did not really work

when I tried it. The route was displayed on the map, but driving instructions were not

given. The site would be more useful if intersections could be entered by typing in names,

rather than clicking on them.

Zoom/Pan/Query: No

Layers: None that can be manipulated.

Metadata: None

Cartographic Elements: None

Text: Includes good instructions on how to use the site and has explanation of how site works.

Appearance: Poor, produces very ugly maps. There are no visual hierarchy or background

features to help users orient themselves.

Friendliness: Low

Title: Java SDV

Author: Bill Thornton

Organization: Ohio EPA

URL: http://chagrin.epa.ohio/JavaSDV/

Summary: This site has two types of maps. The Java-based maps of Ohio and a sample watershed

map did not have any data available when I tried them. There is also a CGI-based map of

Ohio that partially works.

Zoom/Pan/Query: Can zoom on the Java maps, there are plans to be able to zoom on the CGI

map. Can not pan or query.

Layers: CGI map has 10 layers that can be turned on and off.

Metadata: Yes

Cartographic Elements: None except for a legend.

Text: Not much that is helpful. There are some describing plans for the future. The Java map

needs instructions.

Appearance: Poor

Friendliness: Low

Title: Java shpClient

Author: Steve Lime

Organization: University of Minnesota

URL: http://www.gis.umn.edu/fornet/java/shpclient/

Summary: This is an experimental Java site of downtown St. Paul, MN. This site is not very

interactive yet. Users can zoom, pan and turn layers on and off. Steve Lime also designed

the BWCAW site.

Zoom/Pan/Query: Can zoom and pan, no query. Query abilities are planned in the future.

Layers: Has six layers that can be turned on and off by check boxes.

Metadata: Yes.

Cartographic Elements: Has a legend. No scale or coordinates.

Text: Not much yet, a brief introduction explaining what is planned for the site.

Appearance: Fair

Friendliness: Fair, not much here yet.

Multimedia: One of the layers is a TM image of the area.

Title: Mapblast

Organization: Vicinity Corp.

URL: http://www.mapblast.com/

Summary: This is another street atlas site, it is also based on maps from Etak. It is similar to the

Yahoo and Lycos sites, but with a few more options. Like other street atlases, the site

creates maps centered on a user-defined address or street intersection. The site allows

users to choose from four different styles for their map. You can calculate routes between

points, using one of three algorithms. When I tried this, the calculated route used

nonexistent highway exits.

Zoom/Pan/Query: Can zoom and pan easily. Can not query.

Layers: None that can be manipulated.

Metadata: None

Cartographic Elements: None, except for labels.

Text: Very little, but the site is fairly intuitive.

Appearance: Maps are OK, but are hurt by the lack of cartographic elements. Labels are hard to

read in places.

Friendliness: High

Title: **Map-it**

Author: Rich Signell

Organization: USGS

URL: http://crusty.er.usgs.gov/mapit/index.html

Summary: This is a very simple site. It makes maps based on latitude and longitude coordinates

entered by the user. It is based on GMT (Generic Mapping Tools).

Zoom/Pan/Query: No

Layers: None

Metadata: None

Cartographic Elements: Has coordinates and scale. No legend.

Text: Has a good, brief explanation.

Appearance: Good maps, not much to them.

Friendliness: High, although not as nice as the Xerox server.

Title: Mapquest

Organization: GeoSystems Global Corp.

URL: http://www.mapquest.com/

Summary: This is the best of the street atlas sites. The site has worldwide coverage. The scale

available varies but goes down to street level for the U.S., Canada and most of Europe.

The site allows users to zoom in from a world map, as well as centering on addresses.

Like other sites it can calculate routes (U.S. only). It can also add points of interest to the

map (worldwide). The site allows users to modify parameters of the route algorithm (such

as whether to favor or avoid highways). The algorithm seemed to work better than the

one at the Mapblast site. The site has HTML, Java, and Active X versions. In terms of

how much it is used, this is probably the most popular site reviewed.

Zoom/Pan/Query: Can zoom and pan. Can query points of interest.

Layers: Has 14 categories of points of interests which can be added to the map, most of which

also have subcategories. Includes things like recreation, banking, health care, etc. Uses

pictographic icons so the points can be identified, even without a legend.

Metadata: None

Cartographic Elements: Has a scale and labels. Lacks a legend and coordinates.

Text: Some, mostly hints on how to find places.

Appearance: Maps look nicer than the other street atlas sites. Labels are easier to read. It could use a legend. The map can get very cluttered if you turn on too many of the points of interest.

Friendliness: High, very intuitive.

Title: Murray Basin Hydrogeology

Author: Prame Chopra

Organization: Australian Geological Survey

URL: http://www.agso.gov.au/map/mb_make_map.html

Summary: The site contains a map of a watershed. It is based on Arc/Info and uses CGI for forms. It needs a locator map.

Zoom/Pan/Query: Can zoom and pan. Can query the salinity yield base map.

Layers: Has five layers, can display up to three at a time. Users can turn layers on and off and can choose the color of the layer.

Metadata: None

Cartographic Elements: Missing Locator map and scale. Has coordinates. Has a legend, but it is on a separate page from the map.

Text: Almost none.

Appearance: Fair

Friendliness: Poor, almost no explanation.

Title: NAIS

Author: Glen Newton

Organization: Canadian National Atlas Information Service

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

Summary: The site creates a map of Canada from layers chosen by the user. It uses a program custom written for the site.

Zoom/Pan/Query: No, users pick a province or the entire nation to map from a list.

Layers: You can choose from 30 layers to map and picks colors and shading of the layers. Unfortunately can only map one map at a time unless they are adjacent in the list because there is no way to pick more than one off the list. This may be a browser problem rather than a site problem, check boxes work better. Layers available include basic geographic features (rivers, roads, boundaries), stream flows, wetlands, geologic data, demographic data, and the ranges of a wide variety of wildlife.

Metadata: None

Cartographic Elements: None

Text: Almost none

Appearance: Very nice, but the lack of any cartographic elements is a problem. Could also use better control over layers so that users can choose background features.

Friendliness: It is fairly easy, but there are not any instructions or explanations at all. Assumes you already know how a GIS works.

Title: Online Map Creation

Author: Martin Weinelt

URL: http://www.aquarius.geomar.de/omc/omc_intro.html

Summary: This is another GMT site. It is a little more sophisticated than the Map-it page. It makes a simple map based on latitude and longitude coordinates entered by the user. Users can turn on and off layers and can choose the projection.

Zoom/Pan/Query: No

Layers: There are five Layers that can be turned on and off via check boxes, more layers are planned for the future. Users can also add points by entering in coordinates for them.

Metadata: Yes

Cartographic Elements: Has scale and coordinates. Does not have a legend. Labels can be added.

Text: Yes, good explanations and instructions.

Appearance: High

Friendliness: High

Title: Pennsylvania Statistics

Author: Ian Bowles

Organization: Pennsylvania State University

URL: http://www.maproom.psu.edu/cbp/

Summary: The site makes simple thematic maps of Pennsylvania by county. It is not especially

interactive. The site uses CGI, users input parameters for the map.

Zoom/Pan/Query: No

Layers: Over 60 categories of census data can be mapped, these are subdivided into even more

categories. Only one can be mapped at a time.

Metadata: Source is given.

Cartographic Elements: Has a legend, missing scale and coordinates.

Text: Short, clear instructions on how to use the site and where the data come from. Data are not

explained, users are referred to the Census Bureau.

Appearance: Fair

Friendliness: High

Title: Regio Data

Author: Harm Verbeek

URL: http://www.pi.net/~hverbeek/server_gis.html

Summary: This is a GIS site of the Rotterdam area using Java. It makes thematic maps at the

neighborhood level. It is still very much under construction so it is not particularly useful

yet. The site does not have any real data yet.

Zoom/Pan/Query: Can not zoom or pan. Can query.

Layers: Can choose variable to be mapped from several databases, no real data yet.

Metadata: None

Cartographic Elements: Has a legend. Missing scale, coordinates, and a title. Have to dig a bit

just to find out it is supposed to be Rotterdam.

Text: Contains a help file which explains what is planned for the site.

Appearance: Lack of cartographic elements is a serious problem, there are no clues as to where the map is located. Thematic maps look OK otherwise. Users are given control of the colors used.

Friendliness: Not really operational yet.

Title: REGIS/Grasslinks

Author: Susan Huse

Organization: UC-Berkeley

URL: http://regis.berkeley.edu/grasslinks/index.html

Summary: This is an extensive site that gives users access to a GIS covering the San Francisco Bay Region. This is the closest to a 'true GIS' available on the web and is the only site giving users access to GIS analysis tools like buffering and overlay. The GIS combines data from a large number of sources including: San Francisco Estuary Project, Bay Conservation and Development Commission, Regional Water Quality Control Board, Delta Protection Commission, and various other state agencies. Some layers cover northern California or the entire state, while others are limited to specific watersheds. The site is based on GRASS, a public domain GIS.

Zoom/Pan/Query: Yes can pan and zoom, and can query on 57 different layers.

Layers: Has 57 possibilities for a base (raster) layer and 50 possibilities (many the same layers) for vector overlays and one layer of sites. The user chooses the colors of the layers and the region to be mapped. The layers are chosen off of lists which has the same problem as on

the NAIS map (can not pick more than one unless they are adjacent). There is also a new

beta version which allows the user to pick the base map from a menu like list of layers

with a small map of the layer along with the name and description. There are not as many

layers with this option.

Metadata: Extensive, including documentation and source code for GRASSlinks and explains how

the site is created.

Cartographic Elements: None, except for a legend which can be added if you only have one or

two layers. You can also find the latitude and longitude of a point by querying it.

Text: Good explanations of the data and some instructions for using the site. Assumes some GIS

knowledge.

Appearance: Very nice, the beta version is especially impressive. The maps look good, but as with

NAIS the lack of cartographic elements is a problem.

Friendliness: Site might be a bit complex for someone not familiar with GIS. While the site is easy

to use, users may not understand what they are doing.

Higher Functions: You can calculate areas, reclass, combine and buffer data to create custom

maps. Some of these may be hard to figure out if you are not familiar with GRASS. This

is the only site I found that has these analysis functions.

Multimedia: Includes air photos as a possible layer.

Title: Spatial Net

Organization: Object/FX Corp.

URL: http://www.objectfx.com/products/spatlnet.html

Summary: This is a demonstration of an object oriented Internet server. Like other demonstration sites it does not have any real data. It contains medical and realty information on a street map of a fictional city. Users pick a point and enter a search radius and choose what to search for (type of medical facility or house wanted). Any items found will be placed on the map and can then be queried for further information. Database information has links to further databases such as doctors or community services near the chosen site. Community services can then be mapped and also queried.

Zoom/Pan/Query: Can pan and zoom. Can query nine types of medical facilities and eight types community services. House searches are based on criteria entered by user (number of bedrooms, bathrooms, square feet, and price). The second demo is of a Sprint telephone network which shows "problem sites," which can be clicked on to determine the nature of the problem, who is being impacted, etc.

Layers: Users can toggle between medical and realty info, but do not really have control of layers. Only one layer on the Sprint map.

Metadata: None

Cartographic Elements: Has a legend, no scale or coordinates.

Text: Clear "cook book" instructions are present. Not much explanation though.

Appearance: Nice. Street map looks a lot better than the Sprint map.

Friendliness: Very intuitive, easy to use.

Multimedia: Really makes use of links within links. The map is always "active." Links include photos of houses, medical facilities.

Title: TAGIS

Author: Jamie Leonard

Organization: West Virginia Department of Environmental Planning

URL: http://poca.osmre.gov/form/index.html

Summary: This is an extensive site with an interactive map of West Virginia containing a variety of environmental quality related sites. Users can center the map on a chosen street address, watershed, USGS quad, town, school, church, stream, reservoir, airport, cemetery, dam, or hospital. The site is Arc/Info based and has a java and a non-Java version. The site is frames intensive.

Zoom/Pan/Query: Yes, the map starts with a state map and can zoom in to city street level. Contains eleven databases of environmentally related sites, all of which can be queried.

Layers: Contains 13 geographic feature layers which can be turned on and off via check boxes, as well as the 11 site layers (which can also be turned on and off). One of the layers is relief shading.

Metadata: Yes

Cartographic Elements: Missing a scale, but has legend, labels, and a locator map of West Virginia.

Text: Good explanations of the data, could use some more instructions.

Appearance: Very nice.

Friendliness: Good, although it is easy to get lost in the site. Not all of the site data are in the same place. The interactive map can be accessed from several points, not all of which have the same options.

Multimedia: Animation, can do "flybys" over a few selected locations.

Title: Thematic Mapping System

Author: William Yates

Organization: US Census Bureau

URL: http://www.census.gov/themapit/www/

Summary: This is another site making thematic maps from demographic data. Not as versatile in terms of setting the scale as the Demographic Data Viewer site, but it has much more data and makes nicer maps.

Zoom/Pan/Query: No, can toggle between National and State maps. Values are shown in a separate chart.

Layers: Has over 3000 variables that can be mapped from the 1980 and 1990 population census. Users can combine variables to map ratios, percentages and change over time. This ability makes a site a little more useful than other sites mapping demographic data.

Metadata: Yes

Cartographic Elements: None, except for a legend.

Text: Excellent explanations of data. Instruction for using the site are sparse.

Appearance: Very nice.

Friendliness: High

Higher Functions: You can enter equations for the variable to be mapped.

Title: TIGER

Author: Chris Stuber and Brandon Plewe

Organization: US Census Bureau

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

Summary: This is one of the most extensive mapping sites on the Web. It accesses TIGER files and census data. The site works like most of the street atlas sites, but gives users much more control over the map.

Zoom/Pan/Query: Can zoom and pan and can search by town or zip code. Covers the entire US. Does not query.

Layers: There are 21 layers that can be turned on and off via check boxes by the user. You can also map one of 18 census data categories as a thematic layer (two classification methods available, automatically uses six classes). Users can also add their own symbols (16 available) to the map, either by clicking on the map or entering latitude/longitude coordinates.

Metadata: Extensive Metadata available on the Census Bureau's home page. Also includes extensive documentation on how the Web site was created and how to use TIGER files on personal Web sites.

Cartographic Elements: Includes an adjustable scale, legend, labels, and coordinates. There is no locator map, although users do have the option of zooming out to the entire US (Washington, DC area is the starting map).

Text: Includes instructions and a Frequently Asked Questions (FAQ) list.

Appearance: Impressive, looks very professionally done. Map is of high quality.

Friendliness: High, the site is very clearly laid out and easy to use despite the large number of options available to the user.

Title: Traffic Net

Organization: Vauxhall

URL: http://www.vauxhall.co.uk/trnet/tn-finfo.htm

Summary: This is a real-time traffic map of southern England. It shows the major highways and where traffic problems are. The site uses the Shockwave plug-in.

Zoom/Pan/Query: Can not zoom, but pans very simply by moving the mouse across the map. Does not query.

Layers: None

Metadata: None

Cartographic Elements: Has a locator map, which can be turned off to get a bigger traffic map. Does not have scale or coordinates. Does have a Legend.

Text: Brief, but clear instructions on how to use the site.

Appearance: Good.

Friendliness: High.

Multimedia: Real-time data.

Title: Twin Cities Traffic Maps

Organization: Minnesota Department of Transportation

URL: http://www.traffic.connects.com/

Summary: This is a real-time traffic map for the Twin Cities freeways. It is not particularly interactive, but you can zoom and pan.

Zoom/Pan/Query: Can zoom and pan, can not query.

Layers: None that can be manipulated

Metadata: Yes

Cartographic Elements: None, although the site is well labeled.

Text: Very little, but does explain where the data comes from.

Appearance: Fair

Friendliness: High, site is easy to use. Not much to mess up.

Multimedia: Real-time data.

Title: Virginia County Interactive Mapper

Organization: University of Virginia

URL: http://www.lib.virginia.edu/gic/mapper/tigermap.html

Summary: The site generates maps of Virginia counties based on TIGER files. Users pick which county and what geographic features are to be displayed.

Zoom/Pan/Query: Can zoom in, can not pan or query.

Layers: There are 19 layers, in addition to the county base layer. Users choose which layers to display via check boxes.

Metadata: Yes

Cartographic Elements: Has a legend and labels. Lacks a scale, locator map, and coordinates.

Text: There is a nice introductory page that explains how to use the site and explains TIGER files.

Appearance: Nice and simple, maps look good.

Friendliness: Very user-friendly.

Title: Virtual Tourist

Author: Brandon Plewe

Organization: Kinesava Geographics

URL: http://www.vtourist.com/webmap/

Summary: This is one of many sites with image maps which contains links to other sites. It was one of the first and is still probably the best of the simple imagemaps. Virtual Tourist covers the entire world. There are other similar, more localized sites. This is the most common type of interactive map on the Internet.

Zoom/Pan/Query: Can zoom in but can not zoom back out or pan. Query links you to other sites.

Layers: None

Metadata: None

Cartographic Elements: None

Text: Varies

Appearance: Good

Friendliness: High

Title: VISA ATM Locator

Organization: VISA Corp.

URL: http://www.visa.com/

Summary: The site creates street maps based on a user-defined address in the U.S. or Canada. It shows the three nearest ATM locations and some information about them. The site uses Map Objects. It is not especially interactive.

Zoom/Pan/Query: Can not pan or query. Can zoom, but is limited to re-centering the map on one of the ATM locations.

Layers: None

Metadata: None

Cartographic Elements: None

Text: Almost none, although it does not require much.

Appearance: Good enough for the specific application of finding an ATM. Lack of cartographic elements and the ability to zoom would make it difficult to figure out where you are if you do not already know.

Friendliness: High

Title: GIS-VIS in a VRML World, Real Cites in Virtual Reality, Virtual San Francisco

Organization: Varies

URL: http://www.epa.gov/gisvis/vrml/; http://www.intoronto.com/; http://www.planet9.com/sfmodel.htm

Summary: I have grouped the VRML sites together because they are very similar to each other.

VRML sites are a simple form of virtual reality. Generally they are user-controlled "flybys" of a given 3D scene. While they are spatial representations, it is difficult to include any cartographic elements. Although few do, it is possible to query within a VRML page and links to other pages can be embedded in the scene. VRML could possibly be combined with Java to create very interactive scenes. Many VRML sites still have bugs and cause Netscape to crash.

Zoom/Pan/Query: Yes. If query is present, it is automatic, simply move the mouse over the object to be queried.

Layers: Usually only one. Can not manipulate data, but can change viewpoint.

Metadata: None

Cartographic Elements: None

Text: Varies

Appearance: Interesting views, although the resolution is often crude.

Friendliness: Varies

Multimedia: Virtual reality

Title: Weather Visualizer

Author: Steve Hall

Organization: University of Illinois

URL: http://covis.almos.uiuc.edu/covis/visualizer

Summary: The site contains real-time weather maps of the US, similar to the Blue Skies site. Includes all layers on one map. The database is more extensive then the Blue Skies site.

There are Java and non-Java versions of the site.

Zoom/Pan/Query: Can toggle between National and Regional scales. Can query, will display data

for nearest weather station. Three different data reports are available.

Layers: Includes nine layers which users turn on and off using check boxes.

Metadata: None

Cartographic Elements: Includes coordinates. No legend, scale, or labels.

Text: Extensive instructions on how to use the site and explanations of the data are present. Even

includes section on how to interpret radar and other satellite images.

Appearance: Very nice

Friendliness: High, very intuitive and easy to use despite lack of cartographic elements. Extensive

text helps.

Multimedia: Real-time data, includes satellite imagery.

Title: Xerox Parc Map Viewer

Author: Steve Putz

Organization: Xerox Palo Alto Research Center

URL: http://mapweb.parc.xerox.com/map

Summary: This site that allows the creation of simple base maps anywhere in the world. It is

somewhat similar to the GMT-based sites, although it offers more control over the maps

than they do. This site uses a custom written program.

Zoom/Pan/Query: Can zoom and pan, there are no data layers to query. Can zoom in on a place

name if it is in the Geographic Names Server.

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Layers: Maps contain only boundaries, rivers, and graticule. Can change colors and what

projection is used (four projections possible).

Metadata: Source is listed and has detailed documentation on how the site was created.

Cartographic Elements: None, except coordinates. Does not really need them though.

Text: None on the opening page, but there is an extensive FAQ which explains how the map is

created.

Appearance: Nice and simple.

Friendliness: Very friendly, it is a straightforward site. There is not much to mess up.