DISPLAYING (AND USING) HIGH-RESOLUTION IMAGES OF MAPS ON THE WORLD WIDE WEB

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The World Wide Web has revolutionized the way we use information and the kind of information we use. In early developments of the Internet, being able to access text held at a remote location was not only a breakthrough in technological engineering, but also a source of amazement at the potential for a new information age. Never before had information been distributed so widely and so rapidly. Quickly, technological advancements also allowed images to become elements of our Internet consumption, as computers became more powerful and connection speeds continuously improved. Then followed sound and moving images, which have made the Internet not only a dispenser of information, but also a part of our home entertainment systems.

Displaying digital reproductions of maps or any other high-resolution images, however, has not developed as quickly. Very few web sites exist that can render a map as useful electronically as it is in paper format. Attempts at this are numerous, but effective sites are few. Success, however, is slowly coming to hand, thanks to developments in file compression and display software. This article will examine some of these triumphs and will attempt to describe why they are successful.

In a 1997 *Meridian* article on digitizing maps, David Allen explained that it was practically impossible to display maps in any useful way over the Internet because of the large sizes of high-resolution images.[1] Four years later, the same problems exist, but with a bit of know-how and helpful software and hardware, solutions are at hand to rectify the situation. It is interesting to note that that edition of this journal was on digitizing maps, but not one article had the main theme of putting images of maps on the web. Certainly, anyone digitizing cartographic material in the year 2001 now has the intention of displaying them in one fashion or another on the Internet.

Many of us have scanned maps and loaded images on our web pages, but rarely have any of these digital reproductions come close to doing justice to our cartographic treasures. Both the large format of the originals and cartographic detail have made it difficult to provide access to images of maps that are both reasonably easily accessible and useful.

Images can be incorporated into the HTML coding of web pages in both Joint Picture Expert Group (JPEG, JPG) format and Graphics Interchange Format (GIF). Incorporating large image files into web pages however does not lend itself well to browsing as easily as one would with a paper map. A web-browser window is useful for scrolling text, as this task only requires slowly moving down the window. Once a word is read, it is no longer required in the vision of the user. As a result, browser windows can be maneuvered on the X and Y axes only and only one axis at a time. A map, however, requires examination in a variety of ways. It needs to be looked at as a whole, in sections, in zoomed views, shades of colour have to be examined next to each other, etc. To avoid the clumsiness of HTML pages, one option is for the user to download the image and view it in image editing software such as Photoshop or Paint Shop Pro. If the user is not going to use the image in a web browser, then a better quality format such as Tagged Image Format File Format (TIFF, TIF) can also be used. TIF files, however, tend to be quite large, making them difficult for some to download.

As an example of this type of situation, in 1997-1998 the University of Toronto Map Library had a copy of the 1876 *Bird's Eye View of Toronto* scanned at a very high resolution in order to have all the detail, including the ripples in the paper, reproduced digitally. A good sum of money was paid to have the item scanned in California. Plans were made to eventually display the image on the web. The digital copy was delivered on CD in a 170-megabyte TIF file. In order to make the image available over the web, a compressed JPEG version was created. Unfortunately, some of the resolution quality was lost in the conversion to JPEG, but most importantly the size of the image remained too big for most computers, at about 60 or 70 megabytes. In order to render the image to the size of the average screen, most of the quality of the resolution would have had to be compromised. Concerned with the lack of quality of such an endeavour, we decided against further creating such images for the web - at least for the time being.

While displaying quality images on the web has been difficult, scanning good quality images has also proven quite challenging. Most computers in educational institutions, even quite a few computers in homes, now boast a scanner attachment. Unfortunately, these are mostly of low quality, not allowing the scanning of high-resolution output. Often they have too small a scanning surface to allow the processing of large cartographic material. Most scanners are of the 8.5" x 11", or at best 8.5" x 17" size, thus making the scanning of maps difficult. The task may not be impossible, but it certainly is challenging. Using smaller scanners requires the image to be processed in sections. The sections are then stitched together, using image editing software or special batch processing software such as PanaVue (www.panavue.com).

Solutions

As technology has advanced in the last few years, several solutions to the outlined problems now exist. These are not perfect, but they do permit much more creativity and enhance the usefulness of digital images of maps.

Scanning technology, for one, has changed dramatically. While drum scanners are still quite expensive (and still dangerous to your brittle treasures), other options are now available. Large-format high-resolution flat-bed scanners with surfaces of 11" x 17" can be had for not much more than was paid for small-sized scanners just a few years ago. Smaller, good-quality scanners, if one still wants to venture in that direction, can now be had for very little money.

Digital cameras have become quite popular for this type of reproduction because the maps do not have to be moved around or rolled through a machine. A camera also allows for the reproduction of atlas pages more easily than a flat bed scanner. The map is, depending on the size of the item, put on a wall backing unit, using either magnets or a vacuum mechanism, or put on a large platform. While traditional digital cameras are of low-resolution quality, some special cameras can reach 300 dpi and higher. They are now being used quite extensively to do the work that scanners used to do. The most famous project using one of these types of cameras is, of course, the David Rumsey project (www.davidrumsey.com), which now houses several thousand images of maps. A feature article on this project appeared in a recent issue of *Mercator's World*.[2] Rumsey uses a PhaseOne PowerPhase camera to duplicate his maps.

The University of Toronto Preservation Division has also purchased a high-resolution digital camera (JenOptik Eyelike, www.academicimaging.com/tech/diginput/cameras/jenoptik/eyelike.html), because of our expanding repertoire of digital projects. Of major interest is the Barren Lands Digital Collection project, that will eventually incorporate all of J.B. Tyrrell's papers, photographs and maps (digital.library.utoronto.ca/Tyrrell) and the Greater Toronto Area Digital Mapping Project (www.library.utoronto.ca/maplib/gta). Although still in the planning phases, this latter project has taken advantage of the presence of the digital camera and digitized a few dozen items. The Toronto Public Library has also purchased the same camera and has developed a rich site of maps, atlases, photographs and documents (historicity.tpl.toronto.on.ca:9000). McGill University's Canadian Digital County Atlas Project (digital.library.mcgill.ca/countyatlas/)

used a PROGRES 3012 Genoptik Digital Camera to scan its atlas pages.

While the digital camera is fast becoming an option in many settings, most institutions still cannot purchase their own digital reproducing equipment. Services that will digitize your collection, custom create files and copy them onto laser optical disks are now quite common. As well, their prices have come down and are becoming more affordable. The University of Toronto used the services of Luna Imaging Inc. (www.luna-imaging.com) to create its first few digital images of maps before purchasing a digital camera. Luna was one of the few large-format scanning specialists in North America at that time. They originally created the David Rumsey digital collection, and provided the image search and display database and software for that web site.

Other services have sprouted since the late 1990s which also perform this type of high-resolution imaging. A few are even here in Canada. The Bibliothèque nationale du Québec, for instance, contracted Trigonix (www.trigonix.com) to digitize a collection of their maps. Another Canadian venture in this area is Vallillee Digital Imaging Solutions of Pickering (www.vallillee.com). They began by reproducing engineering and architectural drawings, but have since done maps and photographs for several projects.

The advantage of these scanning service companies is that they have extensive experience in reproducing large-format items and are knowledgeable in getting the most efficient and high-quality images from their equipment and software. Some, such as Luna Imaging and Vallillee, can provide clients with project consultation and software solutions. Luna has its own line of database retrieval systems called Insight. Vallillee is a Mr.Sid vendor. The big advantage of the Trigonix operation is the size of their reproduction equipment. They can digitally reproduce maps or drawings up to 42" wide, as compared to Vallillee who can scan up to 36" wide.

It is one thing to have the solutions to create good resolution images, but it is another to be able to make use of them. As mentioned above, many sites continue to put map image files straight in html format with the "<IMG SRC=" code. Site developers opt to put the TIF, GIF, or JPEG file in the tag. Whichever they choose, image files displayed this way are not being used to their full potential.

As previously mentioned, once a file is created in high-resolution format few conventional options exist that enable its display on the web. Some argue that a JPEG version of an original high-resolution image can be used without resolution loss, but others argue that JPEGs are inferior in quality and should not be used in applications such as Geographic Information Systems (GIS) software.[3] At the same time, a high-resolution TIFF file is quite often too large and cannot be downloaded by most users.

Luckily, in the last few years two companies, using advanced mathematical algorithms, have developed raster file compression software which have solved this dilemma. Earth Resource Mapping (www.ermapper.com) has produced the ER-Mapper / ECW Compressor, which is downloadable for free from their web site. LizardTech's counterpart is the Mr.Sid software, also downloadable from their web pages. Both packages can compress images to a ratio of 20 to 1 without resolution loss. Higher compression ratios of up to 50 to 1 are possible, but not without added noise or resolution loss. Files of up to 500 megabytes in most formats can be processed using this free software. Paid versions are available for compressing images larger than 500 megabytes. For a review and comparison of both of these software options, see Steve Wallace's "Features" article in *DirectionsMag.com* at www.directionsmag.com/features .asp? FeatureID=27.

The University of Toronto's example of the *Bird's Eye View of Toronto, 1876* illustrates well the compression powers of the software. When compressed in ER-Mapper, the file was reduced from 170 megabytes to 8.1 megabytes.

ER-Mapper and Mr.Sid Plugins for Paint Shop Pro and Photoshop are also available. These allow users to compress images in Mr.SID or ECW format from within the image-processing

software package of their choice. Plugins are also available for GIS and CAD software. Some GIS packages, such as ArcView, have extensions built-in which allow the use of these file types.

Once a raster image is compressed in this fashion, however, the file it is contained in cannot be placed on a regular web server and called up in the same manner as GIF or JPEG raster files. Server-side software must be installed in order to display the compressed images. Again, some of the server software is free, depending on the platform and the size of files served. For instance, Lizardtech has a free server-side software package for Linux, while ER-Mapper has a free version of its server software for images no larger than 500 megabytes. As well, with both formats the user must also install free client-side plugins, in order to access the files. Mr.SID formatted files can also be accessed using java applets and javascripts instead of a plugin. However, most of the sites I've viewed without a plugin have had inferior displays. Once the server software is installed, templates are provided for the creation of pages using the compressed files, making the creation of web pages with these file-types quite an easy task.

The advantage of this compression file approach is the availability of high-resolution images with the ability to pan, zoom, drag, and to view an entire item without scrolling. The most important part of the equation though is that all of this is done with very little required RAM. The image file does not need to be downloaded, but can instead be integrated with other images, mosaics of images, and meta-data or other descriptive text. The image can also be displayed in a variety of sizes, depending on the template chosen by the web developer. In short, bandwidth or RAM no longer limits the creativity of the display of high-resolution images on the web, and proper display of cartographic images has finally arrived on the web. And, with the availability of free options from these companies, most interested in serving digital images on the web can now develop a site for a relatively small investment in a web server.

Earth Resource Mapping and LizardTech have dominated the field for a few years, but alternatives are now starting to emerge. HMR Inc./Bentley Engineering's Microstation DesCartes (www.bentley.com) is a lesser-known product, but offers image compression and display options much like the two others above. As far as is known by this author, no free products exist from this company. Zoomify (www.zoomify.com), on the other hand, allows the creation of web pages around JPEG images with pan, zoom, and drag options. Developers wishing to create web pages can simply drag good quality JPEG or BMP files onto the Zoomify web page. An application on the Zoomify site is prompted from the file, and a folder with HTML and script files is written to your hard drive. Users can then ftp the folder and the files to their own web page. The files created can also be edited to customize the web pages. Text and other images can be added to the file as with any other normal web files.

As demonstrated, there are a few very good alternatives to displaying high-resolution images using HTML, but few institutions have taken notice as yet. The federal government agencies which deal with maps and images, for instance, are lacking any kind of presence in this field and have shown no leadership. The Canadian Museum of Civilization (www.vmnf.civilization.ca/vmnf/cartes/index-e.htm) has a total of seventeen maps displayed in JPEG format on its web pages. Very basic reproductions, the functions are limited to enlargements of sections of the file selected through mouse clicks. The National Map Collection's online exhibition, *Canada at Scale* (www.archives.ca/05/0514_e.html), has a total of 78 cartographic images but all are in JPEG format. They are nice reproductions, but of very little use as they are. Users cannot read any of the text, let alone any specific geographic or cartographic detail displayed on the image because of the limitations of the browser window. Even if a user were to download the image to view in image editing software, the resolution is such that it would not make a difference.

There are, however, some sites which display good resolution images of maps, even if they do not take advantage of compression software. One of the best institutional endeavours is that of the Bibliothèque nationale du Québec (www2.biblinat.gouv.ca/accueilnum.htm). Their project to digitize maps (about 1,800 maps are now posted) has done wonders for database access to

digital files. The one drawback is that the files can only be accessed in JPEG format. Another tremendous web page for cartographic images is McGill's *County Atlas* digital project. This site is extremely useful and well done. McGill has shown, with this project, that these types of efforts are not done in vain. Users who would previously have required access to the print copy of the atlases can actually use these images instead to do their research. Being scanned in the original colour instead of the facsimile black is also a treat for the user. The only drawback, again, is that the images are all in JPEG format and created to fit HTML defined browser windows.

These two projects are excellent. The files are in JPEG format, but they are still useful in the sense that one can download the image and view it in a viewer or editor and retrieve necessary cartographic, geographic, and other information because they were created with that use in mind. In other words, the choice of resolution has rendered them useful. However, both sites would be even better if they displayed their images using compression and display software.

The number of institutions that have noticed the new technological innovations in image compression and display is thankfully growing. The Library of Congress was probably one of the first to display the power of digital reproductions of maps. Their American Memory Project (memory.loc.gov) pages are loaded with large images, including hundreds of maps, which are displayed using Lizardtech's Mr.Sid compressed format. David Rumsey's collection of maps are also compressed using Mr.Sid, as are the images of the Toronto Public Library's history project. These last two use more features than the American Memory Project, such as pan, zoom, and drag tools. They, along with the University of Connecticut's Map and Geographic Information Center's Digital Historical Map Collection (magic.lib.uconn.edu/cgi-bin/MAGIC_HistList.pl), have truly harnessed the best features of the software and have unleashed the power of their maps close to the maximum extent.

The accessibility, both financial and technical, of this type of compression and display software makes the future mixing of cartography and the World Wide Web quite exciting. In fact, the development of this type of technology has allowed the development of new types of web sites that are slowly beginning to appear. There are now applications on the Internet which no one could have predicted as possible just a few years ago. Using web GIS software such as ESRI's ArcIMS, it is now possible to display digital air photos and maps over top of one another or side by side. A good example of such a site is the Miami Property Appraisers' office which has developed a web site displaying a complete mosaic of Dade County with an overlaid series of local maps (www.co.miami-dade.fl.us/pa). Another good example is the state of California's site which integrates Tiger census maps, topographic maps, Mapblast layers, and about a terabyte of air photos in a mosaic (www.earthetc.com/ecwgis/ecwgis_frame.htm). These two sites use the ER-Mapper Image Web Server package. Both illustrate the tremendous technological developments that have finally made maps on the World Wide Web useful. They show that the task of digitizing maps does not have to translate into vain attempts at simply displaying static images. There is still plenty of work to be done in creating digital maps on the web that are as useful as our paper maps, but the future looks bright.

Notes

1. See Allen, David "The Digital Imaging of Historical Maps and Aerial Photographs: An Overview", in *Meridian: A Journal of the Map and Geography Round Table of the American Library Association* (12) 1997, pp.5-14.

2. Sweetkind, Julie. "State of the Art: David Rumsey's Online Map Collection", *Mercator's World* 5(5), September/October 2000, pp.12-17.

3. Generally, a JPEG image can be saved from a TIF file without significant loss in resolution, but if it is saved several times it will degrade. Note, however, that a JPEG image can be viewed as often as it is requested without any deterioration. Resolution loss occurs when saving the image. For an in depth explanation of graphic formats, see *Digital Image File Formats, A Primer* by Rob Miracle at www.cameraboy.net/Digital/fileformats.html.