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# WEB MAP USE AND DESIGN: SHIFTING THE CARTOGRAPHY PARADIGM

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The introduction of mass printing capabilities led to what might arguably be called the last major revolution in cartography. We are now in the midst of another shift related to the production and dissemination of maps – the movement from print to online maps. As with printing, the Web has allowed maps to be created, disseminated, and used in ways that are vastly different than in the past, and the implications of this shift are yet to be fully realized (Fu and Sun, 2010).

As Chrisman (1991) noted: 'Kuhn's "paradigm shifts" (Kuhn 1962) have moved from an academic class to the world of self-help books. While there is certainly a role for creative thinkers, the actual paths of change are a lot more complex. …the close interaction between people, human organizations, material objects and scientific facts…And it is certainly important to remember that "things" are not necessarily subservient to ideas. Frequently, technological innovations are tied in a series of complex contingencies.' (Chrisman, 1997).

It is from this same perspective that I examine the impacts of the Web on cartography – poised at the brink of a new age for mapmaking, through a continuing series of events that have pushed us to a massive, primarily externally-wrought position of rethinking the role of the map and map maker today. This can be seen in the impact of the Web and is hard to imagine by removing the Web from the picture. Indeed, this shift has impacted cartography in all of its aspects. Consider the steps in the map making process (Kimerling et al, 2009):

• Thinking of ourselves as separate from the environment,

• Deconstructing the environment into constituent parts that can be classified and named,

• Gathering data about the features, attributes and phenomena that are the constituent parts,

• Processing the data to draw out the essential characteristics, and

• Manipulating and displaying the results graphically in a way that reveals something meaningful or interesting or useful about the mapped environment.

Of course, all of this is also encompassed in the essential components of a GIS. The role of the map as the primary repository of geographic data has been superseded by GIS which streamline and facilitate this function. And the capabilities of GIS to manipulate and graphically present geographic data have made GIS the most powerful mapping engine ever. Therefore this we can justifiably tightly couple cartography and GIS, rather than to make a specific distinction between them.

Online maps can play many more roles in communicating an increasing number of types of information. Cartographers can now think of their maps in new and sophisticated ways – the maps can portray much larger geographic extents than a typical computer screen (since readers can pan the display), they can be multi-scale (since readers can zoom), they can be real-time (as data from the source can be streamed to the server), they can be interactive (as readers query map content, change map layers, and more), they can be dynamic (as animations of the data are shown), and they can be communal (in that they are produced by a collective organizations).

Communal maps are composed of data from multiple sources at varying map scales and extents from contributors who best know the content for their local area ("local" not being restricted to only the largest scales). The key advantage of this communal characteristic of online maps is that the data on the maps is then the best available – that is, it's the most authoritative and current. Masses of individual depositors insure that the collective map has relevance and utility and is responsive to the users' needs. The communal composition of the map allows for uniformity of the essential mapped features, symbols, and labels, while local variations can provide for geographically unique features while being incorporated in ways that do not diminish or mask their importance or distinction.

The Web has introduced elements that precipitate the need for cartographers to sometimes radically shift the way they make maps to accommodate efficiencies that readers and users of their maps have available through ubiquitous web browsing functionality. It is no longer feasible to only consider a print map production or dissemination agenda – map readers now expect and even demand a different product and a more robust delivery system. The push-pull relationship between map readers and makers coupled with Web-enabled capabilities for maps has pushed cartography to the brink of its next paradigm shift.

Consider this traditional view of cartographer offered by Everett Wingert in 1997: “The map was independent of the technology used to produce it, and the joy and excitement of mapmaking was in compilation and design. The ultimate measure of a map’s success was in how it communicated ideas and information. Just making a map was not enough, a map had to show the cartographer’s attention to information and detail and every map had to be crafted carefully to best product terms of clarity and graphic design (Wingert, 1997).

To a traditionally trained cartographer, this sentiment still holds true. However, the map makers of today by and large have not had the luxury of being trained in an academic setting with hours spent with comrades in the bonhomie of the cartography lab. At one end of the spectrum, among professionals, many of today’s map makers are GIS specialists to whom mapping is an externally delegated and reluctantly accepted addition to the job. For lay persons, the love of mapping and maps has resulted in the construction of privately gratifying mashups, gaming-influenced animations, graphic design-influenced spatial information graphics, and the like.

For cartographers, map publication on-screen has required us to mitigate the consequences on the map display of lower screen resolution, limited screen size, and the projected light/additive color model impact on visual efficiency and fatigue. Many lessons have been learned since learned we first explored this new publication medium (Kraak and Brown, 2001). However, Web map publication has been necessitated more than just a shift in map production techniques.

One could easily at this point spin off into a discussion of the quality of maps seen on the Web today. Rather than engage in this fruitless conversation, it is more constructive to accept that map making is no longer confined to the cartographically-trained individual. The exciting thing is that more people are making maps and using than ever before in history, and the enthusiasm with which maps have been embraced – indeed the almost thoughtless way in which they have been accepted as a part of everyday life – can in many ways be much more gratifying for cartographers. However, this paper does not focus on topics that relate to the debates about neogeography.

Maps on the Web are assumed be fast, free, public, and eternally available. They are often interactive, intelligent (in that they can be linked to external data and other information sources), purposeful, and dynamic. Indeed, even maps that were not originally for the Web are often assumed to be ultimately accessible online. These new assumptions about maps have placed greater and different expectations on map makers – in particular, professional map makers. The ripple effects can be seen in all aspects of map making, and are considered in more detail here through examination of the data used to make the map, analysis and manipulation of the data, design and compilation of the map, and dissemination of final product.

Map makers are dealing with increasingly massive amounts of data (vector, raster, and imagery). Much of the data we use is now accessed online, and in fact there is a growing expectation that the data used to make maps WILL be continually available, downloadable, free, and consumable. This creates interesting challenges for storing and sharing map data. One option is to set up a server farm, hire staff to maintain the system, set up fire walls, monitor system stability, retain a duplicate system for failover, and so on. An alternative, using cloud computing, is to rent pre-configured servers from Amazon in the form of AMIs (Amazon Machine Images) for which you pay based on data throughput and machine time. In a matter of minutes, data can be copied to the server and services can be spun up. This also allows the use Elastic Compute Cloud (EC2), which delivers scalable, pay-as-you-go compute capacity in the cloud so that you can automatically spin up new servers at times of high demand and then drop back down when traffic is lower.

These same options can also apply to analysis and manipulation of the data which is becoming increasingly accessible in the cloud. The advantage is that you only use (and pay for) the functions you need for as long as you need them. Whether or not the cloud is used, the Web allows for easier collaboration with others to collect and analyze data.

In terms of map compilation and design, online maps are expected to be zoomable; therefore, these multi-scale maps involve compilation of a map for each zoom level. They are often multi-purpose and used as basemaps for mashups or in the compilation of a variety of other types of maps. They can offer multiple views into the data (linked displays, related graphs or reports, etc.) They are assumed to be interactive which can be manifested in many ways: they can be queriable through the use of pop ups, hyperlinks to other sites, etc.; they can provide analytical and geoprocessing capabilities they can be customizable through the selection of themes layered on the map and views created of the map (view the area of interest); and they are assumed in some cases to support the generation of print maps as well as online views.

Aside from the obvious challenges for map makers to develop the abilities to embed all of this functionality in their maps, map compilation itself is also moving onto the Web. Cloud-based map making tools are already in use and “Make a Map” online services exist from a number of providers.

Finally, there is the publication and sharing of maps on the Web. Cost of space in the cloud ranges from free (1 GB on ArcGIS Online) to vast amounts of money (consider the cost of serving all the data in the Google suite of maps). Maps published on the Web can be served as map services via REST endpoints, as map packages or map templates as downloads, and more. If a map is published as a service, rather than investing in server technology and training, you can use an Amazon AMI for the publication process. In the near future, you will be able to publish maps as map services directly from map making software, such as ArcMap.

What are the implications of all this? The Web is allowing more people to make, share, and use maps. Larger audience, more map makers, fewer requirements for software, fewer requirements for server infrastructure, and fewer requirements for storage space are having an impact on all aspects of map making, and indeed many of the aspects of map use. The bottom line is that the Web will help more people make more maps, and more maps will be more accessible to more people. The longstanding debate about the cartographic design quality aside, this is a shift that cartographers cannot afford to ignore.

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