cartographic Φ perspectives

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cartographic Φ *perspectives*

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in this issue

Letter from the Editor

Does size matter? This question occurred to me again at a business meeting of the Austrian Cartographic Society in May of 1999. The meeting was within walking distance of the Technical University's Department of Cartography and Reproduction Techniques where I was serving as a visiting Fulbright Professor for the spring semester at the invitation of its director, Prof. Fritz Kelnhofer. The meeting room was in an older building in the center of Vienna that now houses the East European Studies Institute on the upper floor. I later learned that Beethoven had given private concerts to the family that lived there but he was required to use the servant's staircase to reach the living quarters. I used the main stairway.

Cartography is taken seriously in Austria, a country of only 8 million people. Both the Technical University and the University of Vienna have well-established

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about the cover

"The cover design was created by Lou Cross. Lou is a cartographer and graphic artist with the Florida Resources and Environmental Analysis Center at The Florida State University.

The images used include digital photography taken at the Symposium on Maps and the Internet and a map generated through Cichlid visualization software.

The Cichlid software supports vertex/edge graphs, useful for modeling things like networks. The graphic used in this cover depicts the logical layout of the Internet's vBNS (Backbone Network Service). Cichlid is written and maintained by the National Laboratory for Applied Network Research (NLANR)'s Measurement & Operations Analysis Team (MOAT), located at the San Diego Supercomputer Center (SDSC).

(letter from the editor continued)

cartographic programs, the latter within the Department of Geography. There is a considerable national pride in the products of Austrian cartography, both past and present. The Technical University is working on another in a series of national atlases and the East European Studies Institute was completing its own atlas. The maps displayed on the walls around the room were from this atlas and depicted various social and economic variables for the Balkan countries.

The meeting room was full and I found one of the last chairs in the back of the room. The topic of the meeting centered on various business matters affecting the organization and other items in the news. I began to examine the maps from the atlas that were displayed around the room as discussion turned to the NATO bombing of the Chinese embassy in Belgrade, Yugoslavia, and an article that placed the blame on cartographers in the United States. This was further evidence, it was pointed out, of the decline of cartography in North America. The various thematic maps on the walls were large enough so that I could see the broad patterns that they depicted from a distance. I started to think of ways in which the distributions could be con-

veyed with interaction and animation in a smaller format, such as on the screen of a computer. The user would be able to select maps at different scales and view distributions side-by-side or as an animation. Each map wouldn't be as large or as detailed as those on the walls around me but, in total, the interactive and animated presentation would convey information in a more engaging way. The result would be a better cartographic product.

I also realized that this would be the last time that I would ever see these maps. They were so large that I could not think of taking a copy of the atlas with me. The distribution of the atlas was limited by the medium. The atlas would only be viewed by a small number of people. That was unfortunate because the maps depicted interesting cultural, social, and economic patterns that would be of interest to many people.

I had the opportunity to discuss my observations with Prof. Kelnhofer and others in the following weeks. I talked of a shift in the medium of cartography, from paper to computer, and what this meant to the way in which maps are distributed and used. I saw it as a change similar to a paradigm shift in science in which totally new underlying principles and

methods of research are adopted. I argued that we don't understand the influence of the medium, either paper or computer, on how we present and convey spatial information. Most of all, we know too little about how to present maps through an interactive medium.

Kelnhofer concluded that "we live in different worlds" and indeed we do. The difference, though, is not in technology. The computer resources at the institute would be the envy of any academic cartographer in North America. The equipment consisted of three Intergraph workstations, a large-format ink-jet printer, a complete darkroom facility with a Barco scanner / imagesetter, a lab with ten PCs and a video-display device for instruction, and a LINUX-based web and mail server. Nor is the difference based on human resources. The institute employs a total of ten people, four of whom teach courses on a regular basis. I cannot think of a comparable cartographic institute in all of North America, nor one that could create the atlas-quality maps that were being made there.

The different worlds are our choice of medium. I think of the computer and the World Wide Web as a medium with its potential for the display of maps with interaction and animation. I also see it as a way to distribute maps that can be printed far away from where they are created, either on smaller format printers or larger printers at centrally-located sites. Prof. Kelnhofer's medium is large format paper with high resolution output. In fact, I would often catch him using a magnifying glass to inspect the latest products of the institute. We were like two artists, one working in the medium of clay and the other in oil. What do two such artists have

Note from the Editor: The following two essays are in response to Michael Goodchild's essay that appeared in the previous issue of CP.

Cartography, Digital Transitions, and Questions of History[1]

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Introduction

In his "Cartographic Futures on a Digital Earth" Professor Goodchild describes how cartography and broader fields of geographical inquiry are currently coming to grips with what he calls 'the digital transition.' He stresses how this transition can also be seen as an opportunity — indeed a necessity — both for a rapprochement between GIS and cartography and for an extension of the scope and effectivity of the two together. This transition provides unprecedented opportunities for reworking cartography's traditional commitments to forms of mapping that are bound by the visual, flat, exhaustive, uniform, static, generic, precise, and slow. In practice, the transition has already occurred and GIS and cartography have already merged. In describing the nature of this transition Professor Goodchild offers a diagnosis of a pathology: the infective stages of the digital virus, barriers to its diffusion, and the possibilities attendant upon its adoption. Left to be sorted out is how the merger will be rationalized to increase efficiency of operations and what new goals can be achieved as a result of this merger. In this view, Professor Goodchild sees the real possibility of bringing into being long-held 'technological fantasies' of being able to provide upon demand all information about one place, using the Digital Earth as the equivalent of a geographical 'filing cabinet' for a global geo-library, and a corresponding transformation of the ways in which geographical and place-based information are provided and used. The future American world of digital place-based information envisaged by Vice President Al Gore thus offers an unprecedented opportunity for mobilizing efforts for the equivalent of a 'moonshot' — a vision and rallying point around which GIS and renewed cartographic imagination and practice will be able to flourish. The possibilities offered by this transition are made even more pressing and powerful by the general increase in interest by the wider society in maps and things geographic.

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The present paper responds to these ideas about the future of cartography in light of the 'digital transition,' and in doing so revisits the arguments in *Ground Truth* and elsewhere about the ways in which digital geographic information technologies are producing a wide range of new objects and new ways of seeing the earth, nature, space, place, citizen-subject, and bodies.[2] Indeed, in many respects and up to a point I agree entirely with Professor Goodchild's diagnosis and prescriptions of the present condition and future opportunities for cartography, GIS, and related geo-informational fields. Moreover, I find his linking of the opportunity structures that unite GIS and contemporary cartography to be extremely exciting. His remarks clearly signal the challenges posed and opportunities available to cartographic practice by the digital transition and his proposals for mobilizing effort around the Digital Earth project are – I think – exciting (especially given the emergence

of structures and institutions of the kinds he describes, such as the Alexandria Digital Library, the U.S. National Geo-spatial Data Clearinghouse, Terraserver, MapQuest, the MIT server of digital orthophoto quadrangles, and the U.S. EPA's place-based search systems). Moreover, I do think that Professor Goodchild's prognosis on the ways in which the digital transition will actually unfold is probably correct. In this sense, U.S. government officials (including former Vice-President Gore), state agencies, and public organizations have already begun to put the pieces of the 'moonshot' together. In what follows, however, I focus on several problematic issues raised by Professor Goodchild's "Cartographic Futures on a Digital Earth."

I make four central arguments:

(1)   much contemporary discussion of the digital transition presupposes only one path to the future;

(2)   like other transitions, the 'digital transition' produces geographies of its own, patterns of combined and uneven development, and – as a result – multiple and open paths to future worlds of geo-information;

(3)   all mappings (traditional and digital) have the potential to produce new social relations, but often they hide these relations. As with the information revolutions of the past, they become fetishes; and

(4)   in thinking about and working towards projects such as the Digital Earth, that combine digital spatial information with renewed cartographic practice, can we evacuate from these projects the fetishized ideologies of progress? Can we think of democratic transformations in the ways we map and use information in different ways than the History of Progress and the Sciences and Politics of Representation allow?

Geographies of Transitions

Since I am by profession and vocation a geographer and political economist of regional change and geopolitics, I will begin my remarks with some comments about transition theory. As an economic geographer and political economist, my work focuses on questions of democratic transitions variously involving transitions from industrial capitalism to monopoly and late capitalism, from Fordism to post-Fordism, from apartheid to post-apartheid, and most recently from communism to post-communism. In this post-1989 period, I find it particularly interesting that Professor Goodchild avoids the more common boosterist language of '*digital revolutions*' in favor of the phrase 'digital transitions.' Knowing his efforts over the years at building constituencies, opening dialogues, and extending the range of ideas brought to GIS, the turn to 'digital transitions' at one level signals a 'Realpolitik' in regard to the current and future relations between GIS and cartography. It certainly represents a recognition of the 'sea-change' in thinking about mapping practices and the growing importance and potential of geo-information. As Stephen Hall (1993, 8) has argued in *Mapping the Next Millenium*, we are in the middle of "arguably the greatest explosion in mapping, and perhaps the greatest reconsideration of 'space' (in every sense of that word)" since the times of Babylon, a redefinition that requires a rethinking and broadening of our conceptions of maps and mapping, one that

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"As an economic geographer and political economist, my work focuses on questions of democratic transitions . . ."

signals "nothing less than the reinvention of the idiom of geography" (Hall, 1993, 4-5). And so 'digital transition' signals a complex set of images and opportunities for building a better world.

But, in the term 'digital transitions' we can — I think — also see a signaling of something else. The deployment of the discourse of 'transitions' also brings to our conversations about the future of GIS and cartography a metaphorical political economy of 'democratization' and a particular notion of History. Michael Burawoy (1992) has recently warned that the language of transitions (what he calls 'transitology') has – especially since the events of 1989 – been triumphalist in nature, signaling a break with a constrained and drab past. (What better way to describe communism than using Professor Goodchild's own descriptions of the traditional commitments of cartography — flat, exhaustive, uniform, static, generic, precise, and slow.) In transition studies this 'break' has usually been seen as inevitable, motivated by the more flexible, dynamic, responsive, differentiated, and strategic structures and practices of democracy and capitalism. Transitions are, then, about a certain type of reading of the dynamics of political economy and presuppose a particular conception of History that is progressive and usually singular and linear.

> *"Transitions are, then, about a certain type of reading of the dynamics of political economy and presuppose a particular conception of History that is progressive and usually singular and linear."*

Thus, when Professor Goodchild asks us to think about the opportunities of the 'digital transition,' as a student of 'transitology,' I am immediately on my guard. 'Transition-talk' evokes for me a liberal progressivist ideology of 'breaks,' overcomings, and new universal futures (market capitalism and representative democracy); what Jacques Derrida in *The Specters of Marx* spoke of as the new specter haunting Europe, the specter of a new hegemony of neo-liberalism. To 'transition-talk' then, I would want to add questions about the geography of socio-technological change and the political economy of mapping: what are the geographies and the interests of the 'digital transition' and what seems to be presupposed in this particular triumphalist rendering of History? This is no revelation: Professor Goodchild and I have been collaborating indirectly through the National Center for Geographic Information Analysis for eight years now to foster precisely this kind of GIS-Society studies.

The cartographer Brian Harley (1989, 1990) has already opened up the spaces within which I want to think of this political economy of transitions and representation. In his various essays on 'deconstructing the map' and the 'power of the map,' Harley reminded us that the act of representing the world is an interested act that brings certain issues to light and submerges other possibilities. Behind the pretensions of objectivist and universalist cartography and GIS lay a variety of culturally determined and socially conditioned interests. Of necessity, the map is a tool whose form and context are selected, partial, and vested with a variety of such interests. This is, in many ways, an unavoidable situation, but it does require that the pretensions of universalism and disinterestedness be unmasked, the map be deconstructed, and its representations denaturalized. In a parallel vein, Denis Wood (1993) has shown how the *Power of Maps* resides in political and social power as well as in the technical capacities of the cartographic project, Svetlana Alpers (1983) has shown how Italian perspectival painting and the cartographic impulse that emerged in contradistinction in the low countries of the Netherlands and Belgium have to be thought of as distinct (though related) systems of representation, and more recently Martin Jay (1993) has shown how the universal goals of a single 'God's Eye View' must be 'disseminated' and understood in terms of multiple, different, and competing 'scopic regimes.'

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The geography of the 'digital transition' is, of course, difficult to describe, in part because it is changing so quickly. Last year's cautions about the 'over-reaching' claims of boosters are over-matched by far by the growth, diffusion, and accessibility of this year's products. So, writing any geography of the transition is fraught with danger and likely to be overly conservative in its judgments. But there are some things we can say. The last great universalist state-led project of mapping — the topographic surveys of the nation states — itself produced a highly uneven geography (Figure 1). The current 'digital transition' has its own

". . . writing any geography of the transition is fraught with danger and likely to be overly conservative in its judgments."
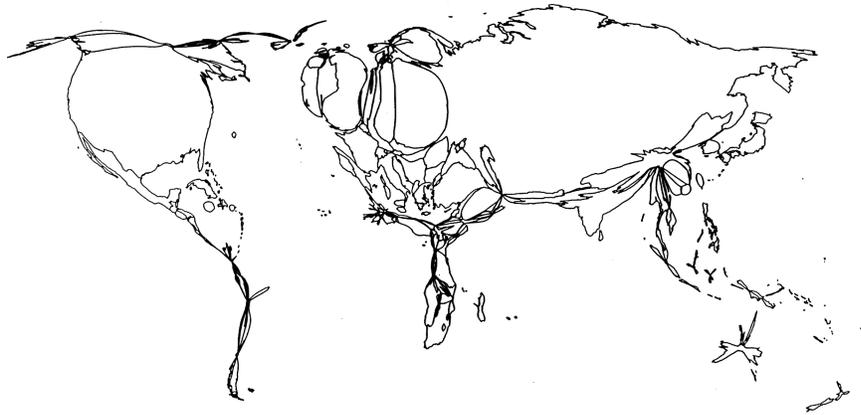
Cartogram of the worldwide coverage of topographic mapping (approximately mid 1990s). Each country has been distorted in proportion to the area of the map sheets of the most detailed coverage for the whole country. The base value of 1:1,000,000 is assumed everywhere. Most detailed complete coverage assembled from UN and International Cartographic Association reports.

Figure 1. 'Cartogram of the worldwide coverage of topographic mapping.' Source: Nicholas Chrisman. Exploring Geographic Information Systems, *John Wiley, 1996 with permission.*

uneven development. Harry Cleaver, for example, has calculated that the bulk of the growth of the U.S. economy in the 1990s can be attributed to the restructuring that resulted from the computerization of every aspect of economic, political, and social life.

These illustrations should give us pause for thought about the nature of the 'digital transition' so richly described by Professor Goodchild. First, what will be the geography of the Digital Earth project and its spin-offs, and second, what is and what will be the political economy of investment and use in GIS and cartography in the years ahead? I have been dealing with these issues elsewhere (see, for example, Pickles 1995) and so, for the present, I shall simply say that in contemporary GIS there exists a paradox where by on the one hand there seems to be an overriding concern when discussing the 'digital transition' to emphasize the democratizing of information and access to it that new digital information and geo-referenced technologies offer, and on the other hand the overwhelming evidence pointing to the fact that its diffusion, use, and further development seems increasingly to be in the hands of state bureaucracies, businesses and research centers of military strategic planning. I shall have more to say later about its use as a 'public' good and how we might re-conceptualize the new cartographies in terms of direct action and participatory democracy. For the present, I want to focus on one aspect of this paradox, the assumption of the democratizing capacities of the digital transition.

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Digital Earth and Mirror Worlds

If I am correct that Professor Goodchild's embrace of the 'digital transition,' place-based cartography, and the Digital Earth may also entail an embrace of the attendant political economy of Vice President Gore's "technological fantasy" of a world in which a new Americanism (thoroughly post-Fordist in nature) is in the making, can we think of the 'digital transition' differently? This is certainly a difficult undertaking. Vice President Gore's own understanding of the 'digital transition' is presented by Professor Goodchild (Gore *www2.nas.edu/besr/238a.html)*:

> Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees the Earth as it appears from space. Using a data glove, she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses, trees, and other natural and man-made objects. Having found an area of the planet she is interested in exploring, she takes the equivalent of a 'magic carpet ride' through a 3-D visualization of the terrain. Of course, terrain is only one of the numerous kinds of data with which she can interact. Using the system's voice recognition capabilities, she is able to request information on land cover, distribution of plant and animal species, real-time weather, roads, political boundaries, and population. She can also visualize the environmental information that she and other students all over the world have collected as part of the GLOBE project. This information can be seamlessly fused with the digital map or terrain data. She can get more information on many of the objects she sees by using her data glove to click on a hyperlink. To prepare her family's vacation to Yellowstone National Park, for example, she plans the perfect hike to the geysers, bison, and bighorn sheep that she has just read about. In fact, she can follow the trail visually from start to finish before she ever leaves the museum in her hometown.
>
> She is not limited to moving through space, but can also travel through time. After taking a virtual field-trip to Paris to visit the Louvre, she moves back in time to learn about French history, perusing digitized maps overlaid on the surface of the Digital Earth, newsreel footage, oral history, newspapers and other primary sources. She sends some of this information to her personal e-mail address to study later. The time-line, which stretches off in the distance, can be set for days, years, centuries, or even geological epochs, for those occasions when she wants to learn more about dinosaurs.

This is eerily reminiscent of David Gelernter's *Mirror Worlds*. In *Mirror Worlds*, Gelernter "describes an event that will happen someday soon. You will look into a computer screen and see reality. Some part of your world—the town you live in, the company you work for, your school system, the city hospital—will hang there in sharp color image, abstract but recognizable, moving subtly in a thousand places" (Gelernter, 1992, 1). The mirror world of virtual reality and spatial images is a "true-to-life mirror image trapped inside a computer—where you can see and grasp it whole" (p.3). These images "engulf some chunk of reality" (p.6) and the mirror world "reflects the real one" (p.6). "Fundamentally these programs are intended to help you *comprehend* the powerful, super-techno-glossy, dangerously complicated and basically indifferent man-made environments that enmesh you, and that control you to the extent that you don't control them" (p.6).

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How is this to happen? How will the "place" of mirror world permit one to enter, stroll around, and retrieve archival and live-medium information?

> The picture you see on your display represents a real physical layout. In a City Mirror World, you see a city map of some kind. Lots of information is superimposed on the map, using words, numbers, colors, dials -- the resulting display is dense with data; you are tracking thousands of different values simultaneously. You can see traffic density on the streets, delays at the airport, the physical condition of the bridges, the status of markets, the condition of the city's finances, the current agenda at city hall and the board of education, crime conditions in the park, air quality, average bulk cauliflower prices and a huge list of others.
>
> This high-level view would represent - if you could achieve it at all -- the ultimate and only goal of the *hardware* city model. In the software version, it's merely a starting point. You can dive deeper and explore. Pilot your mouse over to some interesting point and turn the *altitude* knob. Now you are inside a school, courthouse, hospital or City Hall. You see a picture like the one at the top level, but here it's all focussed on this *one* sub-world, so you can find out what's really going on down here. Meet and chat (electronically) with the local inhabitants, or other Mirror World browsers. You'd like to be informed whenever the zoning board turns its attention to Piffel Street? Whenever the school board finalizes a budget? Leave a software agent behind.
>
> <div align="right">Gelernter, 1992, 16-17</div>

Gelernter's world (and perhaps the world of the Digital Earth) is one where all information about place is available and mapped almost immediately, limited only by the speed of moving the mouse and dropping the agents. The new digital world is a mirror world — a world of hyper-textual information, geo-coded to a virtual globe, and devised to provide, as Professor Goodchild says, "all information about one place." But what does it mean to accept the grand narratives of the mirror world and the 'Digital Earth,' and what kinds of epistemological alternatives are available to us?

Maps Precede Territory and Produce Identities

If the geography and political economy of the 'digital transition' pose questions for the project of building the Digital Earth and related mapping practices, the epistemological assumptions at work pose even more challenging questions. It is to these epistemological issues that I now turn.

I think it is now fairly well established in critical studies (if not in practice) that the 'Cartographic Anxiety' of modernist, universalist cartography has been pretty much laid to rest. In its place we have a much more nuanced and multiform understanding of cartographic practice and use, and one in which the production of geographical images is understood to be a thoroughly social project. In this view, maps do not simply represent territory, but they also produce it. As Baudrillard (1981, 2-3) asserts, in important ways 'maps precede territory' (see also King 1996). That is, maps construct objects that in turn become our realities. Far from being a mere representation of private property, cadastral mapping gave legal and material form to the new territories and landscapes of private property. Booth's maps of London did not merely mirror the socio-spatial patterns of working class neighborhoods, but produced them as spatialized social

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categories in which new ways of thinking and representing the population as poor and unhealthy came into being; categories that have been the foundation for much urban social research since. What worlds are being produced in the digital transition and what conceptions of History are at work?

There is much that could be said here. For the sake of brevity, the kinds of issues that 'the digital transition' seem to evoke will be illustrated through a brief reading of Allucquere Rosanne Stone's *Desire and Technology at the Close of the Mechanical Age* and Walter Benjamin's *Passagen-Werk*, specifically his notion of History and Progress, and his discussion of four representational technologies – part of a previous representational transition — taken from nineteenth century Paris.

Benjamin's *Passagen-Werk* project was carried out in Paris up to and during the early years of the Second World War. The explicit goal of the project was an investigation of the cultural and economic transformations at work in nineteenth century Paris at a time of major capitalist restructuring, a time very much akin to our own end of century period of restructuring and change. In this project Benjamin was concerned with debunking mythic theories of history and overcoming "the ideology of progress . . . in all its aspects" (Benjamin quoted in Buck-Morss, 1989, 79):

> It can be considered one of the methodological objectives of this work to demonstrate a historical materialism within which the idea of progress has been annihilated. Precisely on this point historical materialism has every reason to distinguish itself sharply from bourgeois mental habits. Its basic principle is not progress, but actualization.

In turning to Paris, it is significant for our purposes to note that what was new at the time was not the urban brilliance and luxury of the city, but secular public access to them (Susan Buck-Morss, 1989, 81). Paris was, in this sense, a "looking-glass city" and a Mirror City that dazzled the crowds, reflecting images of new consumer goods and consumers,
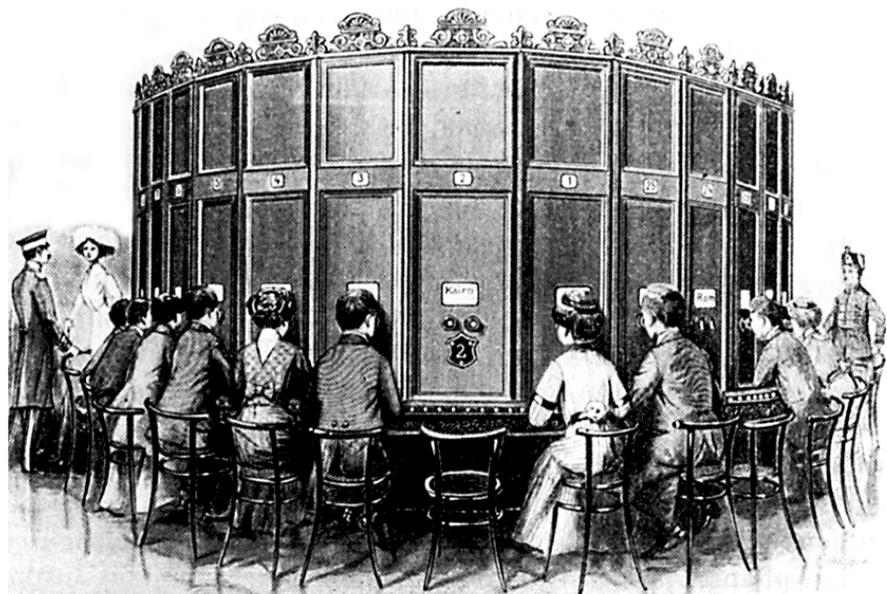

Figure 2. 'MirrorWorld of end-of-century Paris'. Source: V. Zglinicki, Der Weg des Films. Berlin: Rembrandt Verlag, 1956. Public domain. Reproduced from Susan Buck-Morss Dialectics of Seeing: Walter Benjamin and the Arcades Project, *MIT Press, 1991 with permission.*

but "keeping the class relations of production virtually invisible on the looking glass's other side." Benjamin called the spectacle of Paris the "'phantasmagoria' — a magic lantern show of optical illusions, rapidly changing size and blending into one another" (Buck-Morss, 1989, 81). In this system, everything desirable came to be transformed into fetishized images of commodities-on-display, and when newness itself became a fetish "history itself became a manifestation of the commodity form."

Benjamin sought to unmask this fetishized Mirror World of end-of-century Paris by describing what he called the 'ur-forms of the phantasmagoria of progress.' Four such ur-forms are of direct interest to our present discussion: the panorama, the arcade, the world exhibition, and the plate-glass shop window. Each represents elements of the informational transition that was occurring in the late nineteenth century as Western capitalist economies internationalized, and new global imperial geographies were built. The panorama was a new technology of visual representation that was organized and moved around different cities to present spectacles of one form or another to eager middle-class consumers (Figure 2). The panoramas provided sweeping views that rolled by the viewer at varying speeds, giving the impression of movement through the world at accelerated speed (Buck-Morss, 1989, 82). Panoramas were a common feature of the new commercial arcades that were springing up throughout the city ('the original temple of commodity capitalism'), and it was in the arcades that the flow of images and the flow of commodities came together. The arcades are the precursors of the department store and, in more contemporary form, the panorama and the arcade have conjoined as precursors for the Digital World of the internet and on-line shopping. But it is not just shopping that is commodified. Information itself has been rendered into a fetishized commodity.

With the culmination of the panorama and arcade experience emerged the great world exhibitions, the first being in London in 1851 — a Mirror World of a different kind; a Chrystal Palace (Figure 3). It was in these great international exhibitions and fairs that the 'pleasure industry' has its origin and it is they that:

> . . . refined and multiplied the varieties of reactive behaviour of the masses. It thereby prepares the masses for adapting to advertisements. The connection between the advertising industry and world exhibitions is thus well-founded.

The exhibitions and arcades incorporated another technology that became fundamental to a modernist sensibility: the large plate-glass window. This leant to sellers the ability to display goods for view, but prevented consumers from touching. Pleasure was now to be derived from the visual spectacle alone. The representation of far away places and possible ways of life came, in itself, to be a source of pleasure, as was the broadening experience and promise of movement, global reach, and speed. Exhibitions and
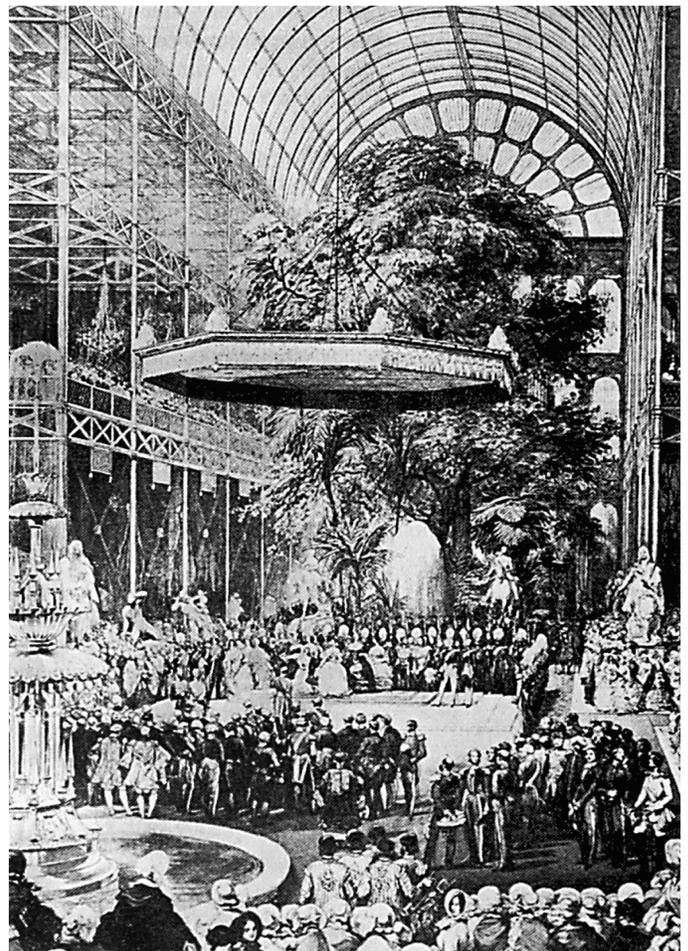

Figure 3. 'A glass arcade'. Source: Catalogue of the Chrystal Palace Exhibition, London. Public domain. Reproduced from Susan Buck-Morss <u>Dialectics of Seeing: Walter Benjamin and the Arcades Project</u>, MIT Press, 1991 with permission.

"Speed, information, and access came to symbolize progress."

Figure 4. 'Angelus Novus' by Paul Klee. Copyright the Israel Museum, Jerusalem. Israel Museum in Jerusalem. Reproduced from Susan Buck-Morss Dialectics of Seeing: Walter Benjamin and the Arcades Project, *MIT Press, 1991 with permission.*

arcades were then, for Benjamin, the source of a broader phantasmagorical politics: "a promise of social progress for the masses without revolution" (Buck-Morss, 1989, 86). "Each successive exhibition was called upon to give visible 'proof' of historical progress toward the realization of these utopian goals, by being more monumental, more spectacular than the last" (Buck-Morss, 1989, 87), and each show-cased the technologies that enabled the movement of goods around the globe. Speed, information, and access came to symbolize progress.

As an American professor at the end of the twentieth century looking forward to the restructurings of the next millenium, the Digital Earth project holds exciting possibilities. But it also sounds disturbingly like the display technologies of panorama, arcade, world exhibition, and shop-window of end-of-century Imperial Paris. For Benjamin, the mythic history of progress embedded in these exhibitions was so generalized that the possibilities for dislodging its hold on the masses was extremely limited. He resolved his dilemma by searching for 'counter-images,' and through these small, discarded objects (the trash of history) he sought to illustrate a different conception of history from which all traces of progress and development were eradicated. Paul Klee's painting, 'Angelus Novus,' provided a map for this vision of history which stood in marked contrast to the futurist myth of historical progress which could only be sustained by forgetting its past (Buck-Morss, 1989, 95) (Figure 4):

There is a picture by Klee called 'Angelus Novus.' An angel is presented in it who looks as if he were about to move away from something at which he is staring. His eyes are wide open, mouth agape, wings spread. The angel of history must look like that. His face is turned toward the past. Where a chain of events appear to us, he sees one single catastrophe which relentlessly piles up wreckage upon wreckage, and hurls them before his feet…. The storm [from Paradise] drives him irresistibly into the future to which his back is turned, while the pile of debris before him grows toward the sky. That which we call progress is this storm.

At the heart of mythic notions of history are a series of metaphors and images that Benjamin called 'wish-images', and they remain at the core of modernist and liberal conceptions of history as progress.

These images are wish images, and in them the collective attempts to transcend as well as to illumine the incompleteness of the social order of production. There also merges in these wish images a positive striving to set themselves off from the outdated—that means, however, the most recent past. These tendencies turn the image fantasy, that maintains its impulse from the new, back to the ur-past. In the dream in which every epoch sees in images the epoch that follows, the latter appears wedded to elements of ur-history, that is, a classless society . . . Out of it comes the images of utopia that have left their traces behind them in a thousand configurations of life from buildings to fashions.

Benjamin (V, p.1224-5 m version of the 1935 expose) quoted in Buck-Morss (1989, 114, 118).

In this new world of images, commodity fetishes and dream fetishes become indistinguishable. Food and other commodities drop magically onto the shelves of stores, and advertising and commerce come to be seen as the means of social progress (Figure 5). The democratization of

culture is now seen to be derived from the mass media, and they too become fetishes (Buck-Morss, 1989, 120).

The 'digital transition' is, of course, thoroughly embedded in these concepts of mythic History and the dissemination of wish images and fetishes. It remains an open and interesting question to what extent the universalizing mantra of digital information and mapping constitutes a new set of global exhibitions for the dissemination of information and goods; shop-windows for accessing information about all places or all information about one place. We must yet consider whether these are necessarily wish images and fetishes that reproduce a mythic promise of social progress.

Conclusion: Digital Transformations, Guerrilla Epistemologies, and Fragmentary Cartographies

Like Walter Benjamin, Allucquere Rosanne Stone (1995) also seems to have grown tired of trying to think of these issues in terms of utopian or dystopian perspectives, and — like Benjamin — she asks in *The War of Desire and Technology at the Close of the Mechanical Age*, what is happening in the deployment of emergent digital technologies? What kinds of 'counter-images' are available to us and what new forms of identity are being produced?

> *The War of Desire and Technology* is about science fiction, in the sense that it is about the emergent technologies, shifting boundaries between the living and the nonliving, optional embodiments . . . in other words, about the everyday world as cyborg habitat. But it is only partly about cyberspace. It is also about social systems that arise in the phantasmatic spaces enabled and constituted through communication technologies . . . I am interested in prosthetic communication for what it shows of the 'real' world that might otherwise go unnoticed. And I am interested because of the potential of cyberspace for emergent behavior, for new social forms that arise in a circumstance in which *body, meet, place*, and even *space* mean something quite different from our accustomed understanding. I want to see how tenacious these new social forms are in the face of adversity, and what we can learn from them about social problems outside the worlds of the nets.

Maps precede and produce territories and social identities. But what kind of objects and identities are being produced in the digital transition? What forms of territorialization are at work in the Digital Earth project? I have already suggested that Vice President Gore's vision is both about a digital informational world *and* it is about retraining and recomposition of the U.S. labor-force and the restructuring of the U.S. economic and geopolitical position in the world. It is, in a Gramscian sense, a new Americanism – a thorough-going post-Fordism, with important implications for the ways in which notions of social progress

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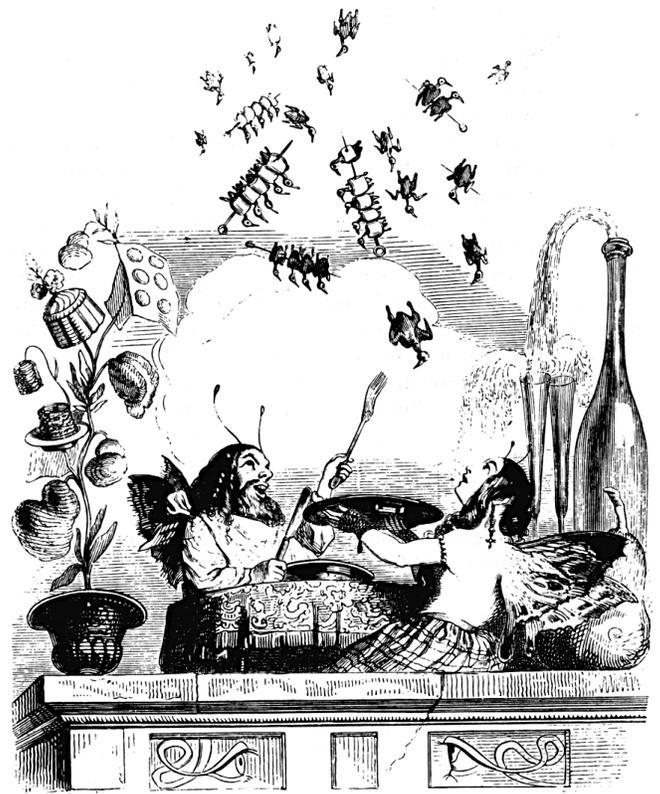

Figure 5. 'Human Happiness -- food for the asking in the Fourierist utopia'. Grandville, 1844. Public domain. Reproduced from Susan Buck-Morss Dialectics of Seeing: Walter Benjamin and the Arcades Project, *MIT Press, 1991 with permission.*

are being written, global relations understood, and an American (and global) future is being mapped.

There are many opportunities in this new digital world of geographical information and representation, but we cannot be silent about the real class and national politics at work in constituting and disseminating a vision of a classless future of digital information. But perhaps we can say that another kind of transition is at work in the digital transition, one that Professor Goodchild both describes well, but does not directly acknowledge. The turn to "things geographic" and the desire for place-specific information is — in this view — a different 'transition' that provides a serious challenge to the epistemological and political underpinnings of modern cartography and GIS, and the fetishized nature of the Digital Earth project.

Bruno Latour has recently asked, 'Have we ever been modern?' By this he means to ask whether the project of modernity was, or could ever be, fulfilled. Through a discussion of the debate between Boyle and Hobbes in the mid-seventeenth century, Latour shows how a modern notion of representation comes into being at this time and with it a binary distinction between science and politics that frames the geometry of the modern world. The Boyle-Hobbes debate stands, in this discussion, for an originary moment from which spring two related but separate notions of representation, underpinned by a single modern anxiety about the necessity of moulding and controlling the masses. One notion of representation is that which involves the political representation of the views of citizen in an emerging democracy—representative democracy. In this notion of representation, a modern notion of 'Society' is born as that structure of social relations that <u>must be</u> represented and regulated politically. The Leviathan will require maps of its territory and information about its citizens and places. A second notion of representation is that which involves the representation of natural objects and in this move 'Nature,' as we now know it, is produced. The 'constitution' of modernity is the structure of science and politics that keeps Society and Nature distinct and subject to regimes of representation by experts: political leaders on the one hand and scientific scholars on the other.

Latour's point is that even our most basic categories of 'Society' and 'Nature' have been produced historically as what he calls a governing 'constitution' of the modern world. However, as the title of the book *We Have Never Been Modern* indicates, Latour believes that the constitution and binary geometry of modernity have never been, and can never be, the structure of practice of everyday life of actual citizens. Instead, the constitution that keeps Society and Nature, Politics and Science, Representer and Represented separate, has given birth to, at times, uncontrollable and unrepresented/unrepresentable monsters and hybrids.

What kind of transition is at work then in this spatial turn? It is certainly one that — as Derek Gregory (1994) has argued — puts into question the Cartographic Anxiety of modernist thought and practice. In this sense, it challenges many of the assumptions that cartography and GIS have about its origins in representational thought, or as Richard Rorty (1979) has suggested, a modernist epistemology of science (and mapping) as the Mirror of Nature can no longer be sustained. In its place we need ways of thinking about geography and mapping that do not presuppose the master narratives of modern cartography, and that do not seek to hide the politics in science (or the interests behind the map, as Brian Harley taught us). The task is one of constructing a post-representational cartography and GIS.

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". . . the constitution that keeps Society and Nature, Politics and Science, Represener and Represented separate, has given birth to, at times, uncontrollable and unrepresented/unrepresentable monsters and hybrids."

But in this task, Professor Goodchild has highlighted precisely the possibilities of bringing together cartographic imagination and skill along with the information handling abilities of digital GIS. I would argue that this is as much a possibility to rethink the constitution of representational science and politics, as it is the possibility of creating a larger Leviathan—the Digital Earth. It is a possibility for an iconographic, not representational cartography. It is the possibility for an epistemology that Stengler (1997, 118) has called 'guerrilla' epistemology:

> . . . the problem of the contemporary sciences is not, for me, one of scientific rationality but of a very particular form of mobilization: it is a matter of succeeding in aligning interests, in disciplining them without destroying them. The goal is not an army of soldiers all marching in step in the same direction; there has to be an initiative, a sense of opportunity that belongs rather to the guerrilla. But the guerrilla has to imagine himself [sic] as belonging to a disciplined army, and relate the sense and possibility of his local initiatives to the commands of staff headquarters.

It is the possibility for a renewal of direct democratic practices that destabilize, and always have the tools to challenge any and all hegemonies—be they created by Representational Science in the name of Nature or by Representational Politics in the name of Society. "[I]t leaves us free to work at modifying these institutions without burdening ourselves with atemporal problems like those of Reason, Understanding, or the West" (Stengler, 1997, 118). It opens the possibility for a different epistemology and politics of 'digital transformations.'

Gillian Rose (1993) has suggested that the conception of the mirror and the Imperial Eye, so prevalent in the history of modern cartography, is also thoroughly masculinist in nature. In its place she suggests we need to think in terms of a different epistemology of mapping, one in which the mirror has been broken into a thousand pieces with each shard still reflecting, but without coherence, without the possibility of the universal view, and without the possibility of control. Is this a future that is possible or even desirable in the 'digital transition/transformation'? Is this a future way of thinking about mapping practice? Is this a new cartography?

George Landow (1992) has—in a different context—come to a similar conclusion. For Landow, digital information systems and specifically hypertext promise new ways of theorizing information and representation. The apparently infinite malleability and reproducibility of spatial information in digital systems allows, even forces us to rethink the relations among objects and practices that have been set in concrete for hundreds of years under the regime of print capitalism (Anderson 1991). Textuality, narrative, margins, inter-textuality, and the roles and functions of readers and writers are all reconfigured in the digital text. The digital transformations of geo-mapping in Roland Barthes' terms point to the possibility of the production of writerly (rather than readerly) texts, which do not dominate the reader and insist on particular readings, but engage the reader as an 'author' and insist upon the openness and inter-textuality of the text—that is, its openness to other texts and readings. That is, digitality opens up again the question of the participation of the masses and provides new opportunities for interactivity lost to an earlier nineteenth century information revolution. It became a transition and it commodified media, information, and images, and in the process it built the large state

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". . . digital information systems and specifically hypertext promise new ways of theorizing information and representation."

and corporate empires—the monopolies—that eventually led to Walter Benjamin's death.

How are we to think of the current opening offered by a digital revolution now that is still only about 20 years old? Certainly the opportunities offered by digital information and mapping systems are lost on few practitioners of geography and cartography today. New work habits, new research opportunities, new languages, new ways of governing ourselves, even new forms of the university are now all in process, if not in place. GIS has generalized and GIS and cartography are increasingly united on a common front (see Pickles 1999). But the question posed to us in 1974 by David Harvey remains, I think, especially pertinent today: what kind of digital transition (he said public policy), by whom, and for whom? What kind of GIS and cartography do we want to see in the new millenium, by whom will it be constructed, for what purposes, and whose interests will it serve: whose voices will it represent? At one level, this is precisely the question that enervates Initiative 19 (GIS and Society) of the NCGIA, and it is the democratic potential of the digital transition that is, in part, explicitly the goal of the Public Participation GIS Project (NCGIA/I-19/ Varenius). In one of the meetings of these groups, Stan Openshaw suggested that what we were seeking was a GIS-2 (a thoroughly decentered, user-accessible, and delinkable public GIS infrastructure). Efforts at building a GIS-2 might emerge on principles different from those that fetishize media, information, and the public. Indeed in town after town, village after village, and NGO after NGO experiments are going on that adapt new digital mapping devices to local needs. But they can, I think, do this only insofar as their efforts are not monopolized and fetishized. These grassroots cartographers and analysts certainly need access to information, and this seems to me to be precisely the pregnant possibility that Professor Goodchild's account of Digital Earth 'represents' for them.

At the end of his report on the condition of knowledge (*The Postmodern Condition*), Jean Francois Lyotard (1984, 67) left us with a warning that seems particularly pertinent today as we consider the forms of mobilization appropriate to building new geo-information and mapping systems for a truly democratic world:

> We are finally in a position to understand how the computerization of society affects this problematic. It could become the 'dream' instrument for controlling and regulating the market system, extended to include knowledge itself and governed exclusively by the performativity principle. In that case, it would inevitably involve the use of terror. But it could also aid groups discussing metaprescriptives by supplying them with the information they usually lack for making knowledgeable decisions. The line to follow for computerization to take the second of these two paths is, in principle, quite simple: give the public free access to the memory and data banks. Language games would then be games of perfect information at any given moment. But they would also be non-zero-sum games, and by virtue of that fact discussion would never risk fixating in a position of minimax equilibrium because it had exhausted its stakes. For the stakes would be knowledge (or information, if you will), and the reserve of knowledge—language's reserve of possible utterances—is inexhaustible. This sketches the outline of a politics that would respect both the desire for justice and the desire for the unknown.

"What kind of GIS and cartography do we want to see in the new millenium, by whom will it be constructed, for what purposes, and whose interests will it serve: whose voices will it represent?"

"These grassroots cartographers and analysts certainly need access to information, and this seems to me to be precisely the pregnant possibility that Professor Goodchild's account of Digital Earth 'represents' for them."

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NOTES

1. This paper was written as an invited response to Michael Goodchild's Keynote Presentation "Cartographic Futures on a Digital Earth." International Cartographic Association Annual Conference on "Touching the Past, Visualizing the Future," Ottawa, Canada, August 1999.

2. These ideas have been presented in various forms at invited keynote addresses to the annual NACIS Conference, Lexington, KY, 1997, and to the International Conference on "Writing, Speaking, Drawing Space," Tours, France, December 4-7, 1998.

Business, Governments and Technology: Inter-linked Causal Factors of Change in Cartography

This paper is in response to Michael Goodchild's "Cartographic Futures on a Digital Earth" that appeared in the previous issue of CP. It argues that he has focused too extensively on the technological changes in map-making. It is claimed here that an understanding of what has happened and might happen in the future can only be achieved through much greater consideration of the role and interests of business and of governments.

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City University
London

Backcasting is easy: can intelligent people forecast accurately?

L ike Professor Pickles, I too (sadly) found many things to agree with in Professor Goodchild's keynote speech. Evidence for my consistency of view can be seen in the key points I made to the 1993 ICA conference in Cologne (Rhind 1993) where I predicted that:

- cartography will be hugely affected by changes in technology,
- customers will dominate,
- globalisation of commerce will change 'the map business,'
- consistent mapping and geographic information will increasingly be needed for the whole world and for major regions, and
- standards will become crucial.

As a result, I will concentrate here on the things on which we differ, acknowledging that we may well all be wrong[4]. In a recent major publication, Messrs. Longley, Goodchild, Maguire and Rhind (1999, p.11) confessed that in their previous, extremely successful first edition of the 'bible of GIS,' they had totally failed to anticipate the changes wrought by the advent of the World Wide Web only a year after its publication! This 'error' does not compare with many others found in the literature about the impact of technology. I set out below two examples from the UK, but there are many others from most other nations (see, for instance, http://www.startribune.com/stonline/html/digage/forcast.htm and http://www.foresight.org/News/negativeComments.html#loc048).

> The Americans may have need of the telephone, but we do not. We have plenty of excellent messenger boys.
> *Sir William Preece, Chief Engineer of the British Post Office, in 1876*
> If the current growth in use of telephones continues, by 1950 we shall need all of the women of working age as telephone operators.
> *Sir William Preece, (still) Chief Engineer of the British Post Office, 1886*

The message is clear—the future will not be a linear extrapolation of the past. We should also recognise that not everything changes. Shapiro and Varian (1999), for instance, point out that the principles of the eco-nomics of trading on the Internet are little different from those in more traditional commerce. Some things also go back to what they were—the *Economist* leader (cited below) pointed out that we are now back to the low levels of privacy typical for the vast bulk of the populace in agrarian societies. Despite all this, much *has* changed and will go on changing.

"The message is clear—the future will not be a linear extrapolation of the past."

Some things wrong with the Goodchild thesis

In specifying eight characteristics of a map (a visual representation, flat, exhaustive, uniform in detail, static, generic, precise and slow to produce) Mike Goodchild implies that this is how mapping has to be. It does (and is) not. There are examples where mapping of information collected in the field can be speedy (such as routine delivery to customers within 24 hours of data collection) *and* tailored to particular needs. I agree of course that this has only become routinely possible with the advent of 'new technologies' ('new' in practice only; many of the concepts were defined in the nineteenth century).

A speedy reading of the Goodchild paper might also lead the unwary to believe that we all already live in a digital world. This is manifestly not so nor is it totally certain that this will occur everywhere as a single construct. Consider for example the following quote:

"A speedy reading of the Goodchild paper might also lead the unwary to believe that we all already live in a digital world."

> If the world were reduced to a village of 1,000 people:
> There would be 584 Asians, 124 Africans, 136 from the Western Hemisphere (both North and South America), 95 Eastern/Western Europeans, and 55 Russians. 520 would be female, and 480 would be male. 650 would lack a telephone at home. 500 would never have used a telephone. 335 would be illiterate. 333 would lack access to safe, clean drinking water. 330 would be children. 70 would own automobiles. Ten would have a college degree. Only one would own a computer.
> *Source: http://www.ntia.doc.gov/ntiahome/speeches/ntca120198.htm*

Perhaps echoing John Pickles, I also believe that the wider aspects of these technological changes have not been emphasised enough in the Goodchild treatment. These have crucial indirect impacts. Consider, for example, the following quotation:

". . . I also believe that the wider aspects of these technological changes have not been emphasised enough in the Goodchild treatment."

> Remember, they are always watching you. Use cash when you can. Do not give your phone number, social security number or address, unless you absolutely have to. Do not fill in questionnaires or respond to telemarketeers. Demand that credit and data marketing firms produce all information they have on you, correct errors and remove you from marketing lists. Check your medical records often. If you suspect a government agency has a file upon you, demand to see it. Block caller ID on your phone, and keep your number unlisted. Never use electronic toll-booths on roads. Never leave your mobile phone on - your movements can be traced. Do not use store credit or discount cards. If you must use the Internet, encrypt your email, reject all 'cookies' and never give your real name when registering at web sites. Better still, use someone else's computer. At work, assume that all calls, voice mail, email and computer use are all monitored.

> . . . Anyone who took these precautions would merely be seeking a level of privacy available to all 20 years ago . . . Yet . . . all these efforts to hold back the rising tide of electronic invasion will fail . . . Faced with the prospect of its [privacy] loss, many might prefer to eschew even the huge benefits that the new information economy promises. *But they will not, in practice, be offered that choice*. [my emphasis]
> *Source: Economist 1 May 1999*

This neatly introduces my main point: both Goodchild and Pickles almost totally ignore two of the key factors in how our world is being re-shaped—business and government (as table 1 shows). I now address these points, with particular reference to cartography.

It's all about money, stupid![5]

Almost all of the changes to our world are being made through the actions of business and government. It is, of course, true that much of this is underpinned by new science and technology which are driving significant fractions of the Anglo-Saxon economies. Some of this originates in universities; some in government research laboratories. But increasingly, much comes from private sector bodies, notably the pharmaceutical and defence companies—and spin-offs from them like Space Imaging.

The growth in the big players of capitalism in the last decade, especially the funders of new developments, has been staggering; BankAmerica for instance has increased its market capitalisation by a factor of 22. Such growth enables ever-greater global reach and, in turn (assuming no serious errors in investment policy), still greater accumulation of resources for investment in new business activities. Thus major new developments like high resolution satellites are being introduced on the basis of business cases that are predicated on selling imagery and related services across the whole world, leading to substantial predicted profits for the investors—especially for those early into what is seen by its proponents as a potentially huge market.

We are then seeing the globalisation of certain businesses, including some aspects of cartography with a growth in multi-nationals trading in almost all markets. The most obvious of these are the oil companies, software firms (notably Microsoft, but many others exist), banks and retail businesses. Despite many small local enterprises, a very large and growing fraction of the GIS and mapping market is supplied by Autodesk, ESRI, Intergraph, MapInfo and Microsoft. Indeed, more maps per day are probably made by a 100,000 or so sub-set of the 2 million or more users of AutoCad than by all trained cartographers; the former group have perverted the use of tools designed and bought for other purposes to map-making (V.V. Lawrence, Pers. Comm. March 1999). It also seems likely that the greatest (but unknown) number of maps of any kind plotted daily are those in encyclopaedias such as Encarta. Do-It-Yourself cartography is now commonplace.

One key to the world as we now know it has certainly been the 'massification' of cheap computer resources. But the reason why these developments have occurred and been important is not because they are desirable ends in themselves – their importance is predicated upon other, more generic business drivers. The key drivers have been quite simple: the advantages which come from the exchange of business-critical information, the ability to make elegant presentations in order to persuade bosses and peers, and the need to examine at least the financial consequences of different actions through 'what if' scenarios implemented on spread sheets. From these tools and, just as important, from the organisational procedures, knowledge and societal norms emerging from their use have spawned quite different ways of operating in many disciplines.

	Goodchild	Pickles
Cartography	12	24
Money	0	0
Business	0	1
Government/governments	3	1

Table 1. Incidence of key words in the Goodchild and Pickles papers (excluding references).

"Almost all of the changes to our world are being made through the actions of business and government."

"We are then seeing the globalisation of certain businesses, including some aspects of cartography . . ."

"One key to the world as we now know it has certainly been the 'massification' of cheap computer resources."

"There have also been significant commercial developments at the micro-scale which have impacted upon cartography."

As Mike Goodchild rightly says, there has been a move towards regarding GIS (and cartography as a sub-set of it) simply as another branch of the IT industry. The driver for this is that the greatest business benefits can not arise without destruction of the idiosyncratic and separate nature of the GIS (and to a less visible extent, the cartography industry). To integrate the geographical information dimension permits business-beneficial links between technical and customer files; it externalises the need for software expenditure and it minimises the risks of having a clutch of technical experts who can influence organisational business policy.

There have also been significant commercial developments at the micro-scale which have impacted upon cartography. We have seen many small 'start-ups' in cartography focussed often on market niches and exploiting standard software and hardware through innovative use of traditional skills. More generally, the advent of niche player 'start ups,' often highly flexible in market positioning and carrying low overheads, has been a feature of many European, North American and Australasian economies. The shift to out-sourcing many activities, with much work being contracted out to smaller firms or the self-employed, has played a significant role in fostering these new small businesses. In cartography as elsewhere this reduces overheads, minimises the need for tying up of capital and minimises social costs in the event of an economic slowdown. In short, it can reduce business risk.

"One particularly important aspect of all this is the nature of Intellectual Property Rights . . ."

One particularly important aspect of all this is the nature of Intellectual Property Rights since these influence how much money can be made under conditions of fair competition within the 'knowledge industries.' Such IPR is important to business and governments alike. The US federal government's global commitment to eradicating unlicensed use of software and 'pop' music—markets currently much larger than cartography ones—demonstrates that national commercial interests are high on politicians' agendas. There is nothing new in this: it is, for example, alleged that the apparently altruistic 'open skies at all resolutions' stance of the US government in the crucial 1966 UN debates actually reflected both political and nascent commercial advantage to Americans as one of the two countries with sophisticated surveillance technology.

Academic inputs have only had a modest influence on the digitally-based developments in cartography, these—as argued above—being mostly business-driven. What changed our world was not Waugh's creation of GIMMS (Rhind 1998) in the 1970s or the work at the Harvard Computer Graphics Lab (Chrisman 1998). The advent and successful selling of ARC/INFO—the most astonishing marketing success of the 1980s in our field—was far more important. Arguments about whether these earlier academic developments influenced the latter are little more than pedantry; what made the difference was the expansion of the market and the 'routinisation' of the tasks. Goodchild has cited the recent burgeoning of new map or image websites as evidence of the importance of our field – yet the bulk of the ones he cites are from the private sector.

". . . we in academia and in cartography have almost all been 'bit players' in an unfolding historical drama."

I conclude, with some reluctance given my own career history, that we in academia and in cartography have almost all been 'bit players' in an unfolding historical drama. Much of this has been business-driven but one other set of entities has played a key role. I can introduce this by an example: my signing of the British government's National Interest in Mapping Service Agreement on one day in 1998 was far more important to the mapping world than the cumulative impact of 200 plus published papers and articles in the rest of my career!

I'm from the government and I'm here to help you

Governments remain the major employers of cartographers world-wide, at least as can be determined from available sources of information. In the European Union, for instance, it seems likely that no less than 45,000 staff are employed in official national and state mapping agencies. This figure swells by a factor of about three if cadastral enterprises are included.

    This commitment to and interest in mapping is not surprising: cartography—or at least Geographic Information—underpins many government activities. Thus, as Ratia (1999) reports:

> When the European Commission invited representatives from the ministries in charge of mapping in member countries to a meeting in Luxembourg, at least the following ministries were represented: Ministry of Environment, Ministry of Agriculture and Forestry, Ministry of Housing and Physical Planning, Ministry of Finance, Ministry of the Interior, Ministry of Defence, Ministry of Justice. This shows how mapping and geographic information issues cover all the sectors of administration and it is in many cases a matter of taste which is the most natural ministry for these issues.

    But even—perhaps especially—within government, dramatic changes have occurred in recent years. Some of this is usually attributed to the effects of technology, e.g., the diminution in Ordnance Survey staff from 3,500 in 1979 to almost half that 20 years later. The real reason for such changes is, however, much more complex, especially when the much higher levels of certain kinds of skills now needed are factored into account (in Ordnance Survey, the work force now has ten times as many graduates as 20 years ago). The interacting factors include:

1) *Changes in societal attitudes towards governments*, with decreasing trust in the ability of central governments to act effectively. This has evolved alongside a widening recognition that individuals can only prosper by taking more responsibility for the future of themselves and their families, rather than leaving it to the state;

2) A growing unwillingness on the part of the citizenry to pay for increasing government expenditures (Foster and Plowden 1996); and

3) *Changes in government's own views of themselves*, typically evolving from a 'doing' role to one of facilitating, enabling and regulating – 'steering not rowing' to paraphrase Osborne and Gaebler (1991). Thus effectiveness and efficiency have joined probity, propriety and equity of treatment in the lexicon of governments such as those of Australia, Canada, New Zealand, Sweden and the UK.

    The consequences of all this have been dramatic: Ordnance Survey, for example, now does more with far fewer human resources, thanks to the combination of digital databases, business-like management, contracting out and market imperatives. Technology may have been a necessary factor but it has been far from the only driver of the change in map-making.

"Governments remain the major employers of cartographers world-wide . . ."

". . . the diminution in Ordnance Survey staff from 3,500 in 1979 to almost half that 20 years later."

". . . Ordnance Survey, for example, now does more with far fewer human resources . . ."

Globalisation of cartography

Mike Goodchild quotes with evident approval Al Gore's vision of a digital earth (unsurprising since he had some hand in forging that vision). In one sense, achieving this vision is already well-advanced. We can safely anticipate the advent of detailed imagery of many (but not all) parts of the world delivered to us in near-real time. We can now move maps and other information around the world at the press of a button. But we are still in a dire situation in regard to the quality, availability and accessibility of mapping in many parts of the world. On the best available estimates, only about half of the world is mapped at 1:50,000 scale, much mapping of sensitive areas is unavailable, and what is available is often 20 or more years out-of-date. And, even where mapping is available and up-to-date, the nationally-based nature of the mapping, so far as datums, content and depiction are concerned, render cross-border analyses, monitoring or business application a difficult and costly matter.

"... we are still in a dire situation in regard to the quality, availability and accessibility of mapping in many parts of the world."

There are two different approaches to remedying this situation. The first is for nations or business enterprises to collaborate in creating consistent, coherent, comprehensive and current mapping. This has already occurred in the commercial domain, with the creation of consortia to create and market road information for car guidance systems. Much discussion has also occurred within and between governments, in forums such as the European Union and the UN. Binding treaties such as Agenda 21 contain commitments to improving the quality and availability of environmental information—which necessarily includes mapping. Yet so far as most governments are concerned there is little real incentive to expend considerable financial sums on recreating mapping (which already broadly suits national needs) onto a basis which facilitates regional or even global activities.

"Yet so far as most governments are concerned there is little real incentive to expend considerable financial sums on . . .regional or even global activities"

The two obvious exceptions to this statement both involve the United States. Almost alone, the government of that country has the need for and the capability to acquire high quality global mapping. The National Imagery and Mapping Agency (or NIMA), the geographic intelligence information arm of the US military (http://www.nima.mil/) has made clear its determination to secure the best available information in support of any activities of US and NATO forces. Lencowski (1997) has summarised some of the military's strategies to achieve 'the information edge.' It is important to note that some low resolution digital geographic information is already made available to the public by the military; but the idea that 'best available' information is made generally available is counter to any sane military strategy. NASA, however, has made clear its commitment to collecting detailed global topographic information and disseminating it widely in the interests of science. There may well be some policy conflict in these two different approaches.

CONCLUSIONS

You can not sensibly consider what has happened and what might happen in cartography without considering the interests and express needs of business and government. It is not clear just how these interests will be manifested over the next few years – feasible alternative scenarios exist and the reality may well differ in different countries. But money and politics are embedded in decision-making within both of these sectors and these decisions impact upon the lives of all people, including cartographers. Technology is not a 'given' which changes the world in a predictable fashion: human beings change the world when they have the necessary incentives, skills and technologies. That is as true in cartography as it is anywhere else.

"... money and politics are embedded in decision-making ..."

I have long enjoyed working and arguing with Mike Goodchild; his paper stimulated these thoughts. I also found John Pickles' paper thought-provoking and enjoyable (though, for reasons given above, I am confident both he and Mike have been blinded to the most important factors relevant to our debate!).

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1. Vice-Chancellor and Principal, City University, London (formerly Director General of Ordnance Survey 1992-98 and Vice-President of ICA 1984-91)

2. 'Cartographic futures on a digital earth' Michael F Goodchild, presented to Ottawa ICA Conference, 1999.

3. 'Cartography, digital transitions, and questions of history' Rejoinder to M.Goodchild by J.Pickles

4. Appropriately, I too will use the first person in this provocation.

5. The title of a brutal but effective cameo article on drivers of the GI industry by Lobley (1999)

Internet Maps in the Context of Community Right-to-Know versus Public Safety

Rex G. Cammack
Lindsay Svadbik

As the human race learns to critically evaluate its actions within the earth's environment more closely, the public demands more knowledge about their personal living environments. Maps provide a clear means of showing the spatial relationships between people and the environment and making this information available in the form of maps through the Internet allows large numbers of people to make decisions about what is around them and how it might affect them. In this study, governmental rules are examined that concern mapping hazardous chemical materials and making those maps accessible to the public. The social issue to consider is what specific information to present and what interaction and analysis tools a cartographer provides to the public. As with all types of maps, the purpose of the map must be addressed. For an Internet map, any sinister intent of the user must also be considered. Issues of public safety must be evaluated when dealing with sensitive information. Public safety officials view knowledge about the location of hazardous chemical materials as both a public benefit and risk. This study will show how current governmental rules can dictate the development of an Internet map regarding hazardous chemicals and that Internet mapping methods can be used that lead to public awareness without increasing the risk to the public of possible terrorist attacks.

INTRODUCTION

In *Elements of Cartography*, Robinson et. al.,(1995) state that maps fulfill two important functions:

1. They serve as a storage medium for information which humanity needs.
2. They provide a picture of the world to help us understand the spatial patterns, relationships, and complexity of the environment in which we live.

In this new age of Internet mapping, presenting maps through the World Wide Web (WWW) provides new possibilities for storing information for humanity and providing a clear picture of the world to help us understand spatial patterns. In this context, Internet mapping can be considered a new paradigm in cartographic research – a paradigm that is at present poorly formed with little consensus on its main theoretical underpinnings and principle research themes (see Peterson 1997, Crampton 1999). While the new medium can make maps available to millions of people, the information that they depict may be considered too empowering to individuals with malicious intent. The purpose of this paper is to show how a set of laws intended to help the people of the United States can have a significant effect on the design and functionality of the maps available through the Internet, maps that are designed to provide environmental awareness.

"While the new medium can make maps available to millions of people, the information that they depict may be considered too empowering to individuals with malicious intent."

Hazardous Chemical Mapping

One aspect of environmental policy in the United States is educating the public about environmental issues within their local community. Environ-

mental laws now emphasize the need for public awareness. The rationale for this need is that a citizenry informed about environmental issues will lead to a healthier environment.

Under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) information about the location of chemicals stored in the community is available to the public. EPCRA provides the names and addresses of all the companies and individuals that store hazardous chemicals. Traditionally this information would be given to an individual in a tabular form and it was up to the individual to determine the spatial location of the hazardous chemicals. The spatial interaction between hazardous chemicals and the public is important in understanding and improving environmental conditions in a local community. Internet maps can be very beneficial in satisfying the public's right-to-know and help individuals make informed and independent decisions about hazardous chemicals in their community.

If a state or county agency were to satisfy the public's right-to-know through an online Internet mapping application, the resulting map must not violate the Chemical Safety Information Site Security and Fuels Regulatory Relief Act of 1999 (CSISSFRRA). The interrelationship between EPCRA and CSISSFRRA control what hazardous chemical mapping content and functionality a cartographer can include in an Internet mapping site. Before one tries to understand these Federal Acts and their effect on Internet map design, a brief review of the hazardous chemical mapping literature will show the evolution of ideas that lead to these Internet map use issues.

In 1994 Dymon reviewed the use of maps in the hazardous chemical management practice stipulated under the 1980 Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and a later amendment by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Title three of SARA (SARA III) is the Emergency Planning and Communities Right-to-Know Act (EPCRA). In brief, EPCRA says that states are responsible for creating emergency response plans. Under EPCRA each state has a state emergency response commission (SERC). These state commissions identify and put into place local emergency planning committees (LEPC). The LEPC's have the responsibility for designing and distributing local emergency plans. Part of this emergency planning process is tracking hazardous chemicals stored and used by industrial companies and individuals. In addition to tracking hazardous chemicals in the community, the LEPC does risk assessment plans and facilitates the organization of emergency responses during hazardous events. The information used in this planning process is gathered from local industrial facilities that use large amounts of hazardous chemicals. This hazardous chemical data can be stored and analyzed by the Computer Aided Management of Emergency Operations (CAMEO) software system. CAMEO was created originally by the National Oceanographic and Aeronautic Agency (NOAA) and later updated by NOAA and the EPA. The initial intent of CAMEO was to support the EPCRA planning mission (Monmonier 1999).

Monmonier (1999) discussed how the State of New York's Emergency Information System (EIS) uses automated mapping algorithms that combine the data collected by the LEPC, and dispersion models such as Areal Location and Hazardous Atmospheres (ALOHA) and Complex Hazardous Release Models (CHARM). These models calculate the spatial extent of the risk to humans that a chemical release would create (Figure 1). The automated mapping technology is intended to aid in the allocation of resources in the event of a hazardous chemical emergency.

". . . a citizenry informed about environmental issues will lead to a healthier environment."

"The interrelationship between EPCRA and CSISSFRRA control what hazardous chemical mapping content and functionality a cartographer can include in an Internet mapping site."

Both Dymon (1994) and Monmonier (1999) discuss how maps play a key role in the management of hazardous chemical events. In this role, maps are private tools to be used by the LEPC and emergency response personnel. The focus of the study is on what can and should the public know about hazardous chemicals before chemical emergencies.

The central issue is the balance between the public's right-to-know and public safety. As suggested above, the public is entitled by law to know what types of hazardous chemicals are being used in their community. By allowing the public to know what types of hazardous chemicals are in their local environment, the community can make informed decisions regarding planning, zoning and environmental policies. Communities can also protect themselves from unwanted hazardous chemicals.

The second issue that must counterbalance the communities' right-to-know is the Chemical Safety Information and Site Security and Fuel Regulatory Relief Act of 1999. In short, by allowing all information to be available to the public, some in the community are given information that can be used to plan and carry out terrorist acts.

"By allowing the public to know what types of hazardous chemicals are in their local environment, the community can make informed decisions . . ."

Chemical Safety Information and Site Security and Fuel Regulatory Relief Act of 1999

A new source of information being gathered and distributed by the Environmental Protection Agency (EPA) is the Risk Management Plan (RMP). The RMP is mandated by the Clean Air Act (CAA) under section 112 (r). The RMP must be submitted to the EPA by industrial facilities that handle large quantities of hazardous chemicals. The initial phase of the RMP*Info program is the creation of a national database containing all the information for the EPA Risk Management Plan Form (EPA 1999).

Several sections of the RMP document are for Off-Site Consequence Analysis (OCA). The OCA information shows how a company plans to handle the worst case scenario for chemical accidents, alternative releases, flammables, and flammable alternative releases. The EPA sees OCA data

". . . some in the community are given information that can be used to plan and carry out terrorist acts."
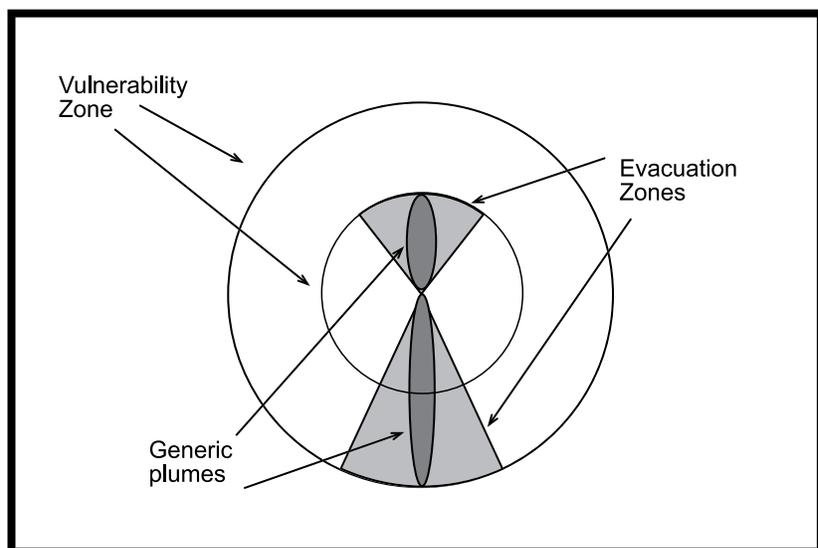

Figure 1. An example of graphic information restricted from Internet distribution by the Environmental Protection Agency. The graphic was first published in Cartographies of Danger - Monmonier 1997). *In Monmonier's (1997) book, this graphic illustrated how local emergency management staff could visualize danger zones during a hazardous chemical release.*

as important for community awareness but also useful for possible terrorist activities.

With accurate OCA data, local emergency management groups and concerned citizens can make improved decisions before and during hazardous chemical events. Dymon (1994) and Monmonier (1999) illustrate some mapping activities that aid local emergency management groups and local citizens to visualize and understand the risk and chemical events in their local environment. Providing access to this data falls in line with the purpose of EPCRA, however, the EPA is concerned about the intent of individuals given access to this information. The EPA and the Department of Justice have determined that terrorists could use this planning information to identify and target sites with the greatest potential for damage to the public. Governments and individuals have long used maps to plan hostile actions so it is not unexpected that an Internet map depicting hazardous chemical site information could aid in selecting the target for a terrorist act.

". . . the EPA is in the process of establishing 50 map-reading rooms across the United States."

The EPA and DOJ have determined four methods of distributing RMP data that will be a means of limiting access to the information by terrorists. First the EPA is in the process of establishing 50 map-reading rooms across the United States. The purpose of these map-reading rooms is to provide access to sensitive RMP documents in paper form. Individuals are limited to ten chemical sites per month and all the chemical sites within their community. Visitors to the map reading room are not allowed to mechanically copy the information but are allowed to take notes on the RMP data.

Secondly, enhanced access to local RMP data may be available by SERC and LEPC. A state SERC and/or local LEPC can establish a read-only map-reading room similar to the federal map reading rooms. These enhanced local access rooms will only provide RMP information to people living in or working within its geographic region. Individuals can only view RMP information of the local area. If an individual wants to view RMP documents from outside the local region, they must go to a federal map-reading room.

"The intent of the VZIS system is to inform the public whether a specific address falls in a vulnerable zone."

A third method of communicating information to the public under CSISSFRRA is the Vulnerable Zone Indicator System (VZIS). The VZIS system was started for public use in October of 2000. The intent of the VZIS system is to inform the public whether a specific address falls in a vulnerable zone. A vulnerable zone is the area falling inside the worst case or alternative release scenarios from RMP facilities. Vulnerable zone calculations and some of the data used to calculate vulnerable zones are part of the OCA data that CSISSFRRA is attempting to control. CSISS-FRRA allows an exception for distributing OCA over the Internet for this particular method. Individuals will be able to use this restricted OCA information to determine what RMP facilities are affecting the queried address. The EPA, SERC, or LEPC fulfilling the request will provide the inquirer with names of the chemical facilities affecting the address and refer them to the RMP*Info for more information. The request can be submitted and returned via electronic mail or other means.

"The potential benefit to public awareness of the new information gathered under CSISSFRRA is apparent."

The last way that the EPA is providing RMP information to the public is through the RMP*Info World Wide Web site. The RMP*Info site provides all the information from the RMPs to the public. RMP*Info gives online access to RMP information except restricted OCA data. Table 1 lists the information that are allowed and restricted for Internet distribution.

The potential benefit to public awareness of the new information gathered under CSISSFRRA is apparent. The United States government, however, has attempted to restrict the use of this information for terrorist acts. The following example is meant to show how an Internet map can

meet the needs of public awareness without putting the public at a greater risk for terrorist acts.

In the context of the Internet Map example for Greene County, Missouri, LEPC (Figure 2), the following issues must be considered. First, some specific factual information can, and some can not be distributed over the Internet (Table 1). In addition to this factual information, this legislation makes it illegal to provide the interaction tools to derive the worst case scenario. Both Dymon (1994) and Monmonier (1999) show how cartography and GIS can quickly calculate OCA information for the use of emergency response planning. Under the new CSISSFRRA, some interactive Internet map functions appear to be a violation of the law.

Internet Map Design Process for Hazardous Chemical Mapping

The specific intent here is to describe when Internet mapping is controlled and limited based on CSISSFRRA. When setting out to make this Internet map of hazardous chemicals in Greene County, Missouri, the preliminary was to make an Internet map with as much information and as many analysis functions as possible available to the public without violating the CSISSFRRA. Figure 3 shows the steps in the process of making the Internet map. Once the primary idea was established, the design and implementation of an Internet map began.

Sources of Sensitive Hazardous Chemical Data

The data collected for the project came from sources that do not violate the intent of the CSISSFRRA law. Table 2 provides a list of the different data
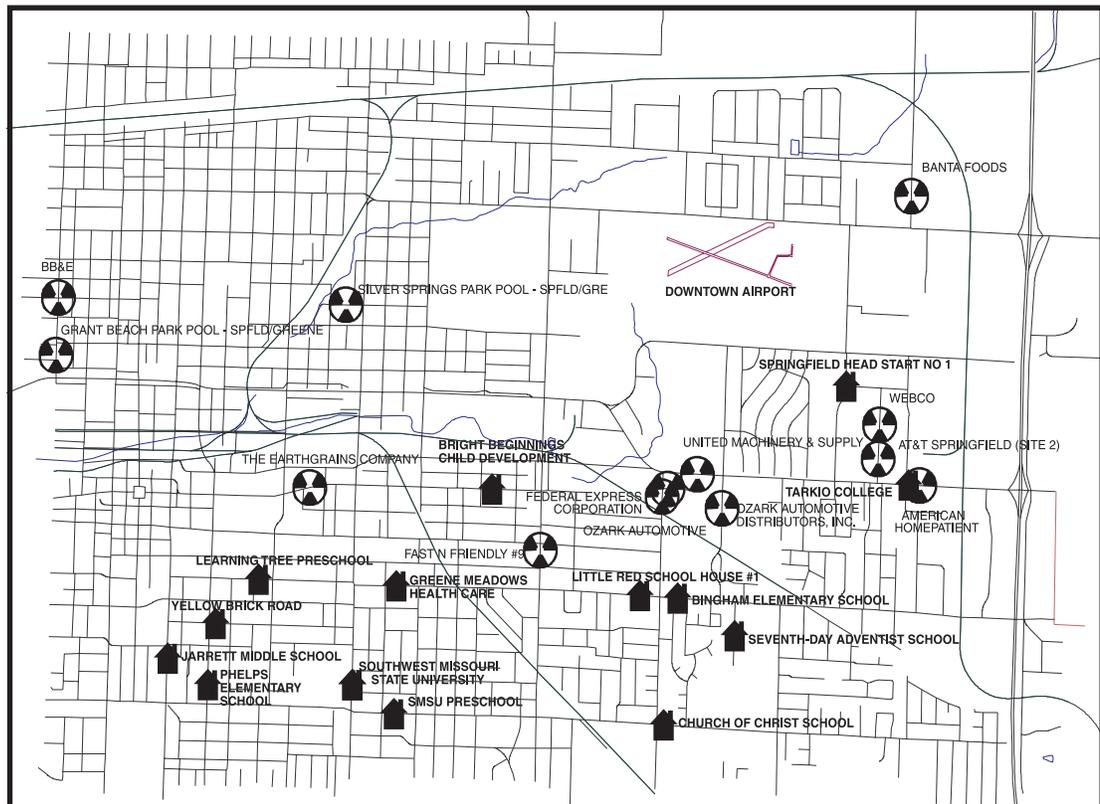

Figure 2. An illustration showing a hazardous chemical map. The map is generated from an Internet map file.

and interactive functions considered and/or used on the Greene County LEPC Internet map. The majority of the hazardous chemical information for the Internet map came from the Greene County LEPC. The Greene County LEPC stores hazardous chemical data in the CAMEO software. It is important to remember that this information was collected under the EPCRA and not CSISSFRRA. The locations of the hazardous chemical sites are recorded by address.

In addition to the hazardous chemical information, demographic information such as population densities and race characteristics were gathered. The Greene County LEPC also maintains an address database for populated places. This was the first issue of concern regarding the CSISSFRRA. One of the RMP items not allowed for Internet disclosures are public receptors. Public receptors and populated places are conceptually the same thing. Because the populated places came from a source outside of the RMP OCA data, they were added to the geographic database. If the only available source of the information was the RMP and it was protected by the CSISSFRRA, then that data was excluded from the geographic database.

Internet Map Functionality

In addition to the map content, the CSISSFRRA also restricts the tools to derive specific information. The issue the government is concerned about is public safety from terrorist acts. The primary functions that were restricted were ones that could be used to calculate damage totals. An example would be a set of functions that calculated the maximum number of people that could be killed if a specific site were bombed. The incorporation of modeling functions similar to ALOHA and CHARM was considered illegal. One specific function that was considered but not implemented for legal reasons was proximity and spread of hazardous chemicals (Monmonier 1997). However, many Internet map functions were added such as hypertext, zoom, panning, identify, and variable theme display, since they were considered legal.

Conclusions

Over the past 15 years hazardous chemical mapping has been used for planning and preparedness. The proactive use of maps in the industry and for emergency responsiveness has led to safer and more environmentally responsive activities. Mapping has provided the public with a better awareness of the spatial location of stored hazardous chemicals in the community. The United States government has mandated that information be provided to the public under EPCRA.

The hazardous chemical community has identified the Internet as a tool that will improve public awareness and preparedness. Yet the government also sees the Internet as a risk to public safety. Providing detailed data about hazardous chemical sites along with spatial analytical tools can aid individuals in planning terrorist acts. Because of this concern, the CSISSFRRA final ruling was implemented to restrict some OCA data from easy access. One of the specific restrictions was placed on the Internet distribution of data. By restricting Internet transfer of data, the government has limited the message and functionality of a hazardous chemical map on the Internet.

With careful consideration of CSISSFRRA and EPCRA, cartographers can make an Internet map that provides the public with information about hazardous chemicals. The example in this study shows that an Internet

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Information Not Allowed on the Internet

- Chemical name
- Scenario
- Quantity released
- Release rate
- Distance to endpoint
- Estimated residential population within distance to endpoint
- Public receptors within distance to endpoint
- Environmental receptors within distance to endpoint
- Graphic information

Information Allowed on the Internet

- Percent weight of chemical (if in a mixture)
- Physical state
- Model used
- Release duration
- Wind speed
- Atmospheric stability class (A-F)
- Topography
- Passive mitigation considered
- Active mitigation considered
- Endpoint use

See Risk Management Plans document for the EPA Form 8700-25.

Table 1. Off-site Consequence Analysis Information from Risk Management Plan

"The hazardous chemical community has identified the Internet as a tool that will improve public awareness and preparedness."

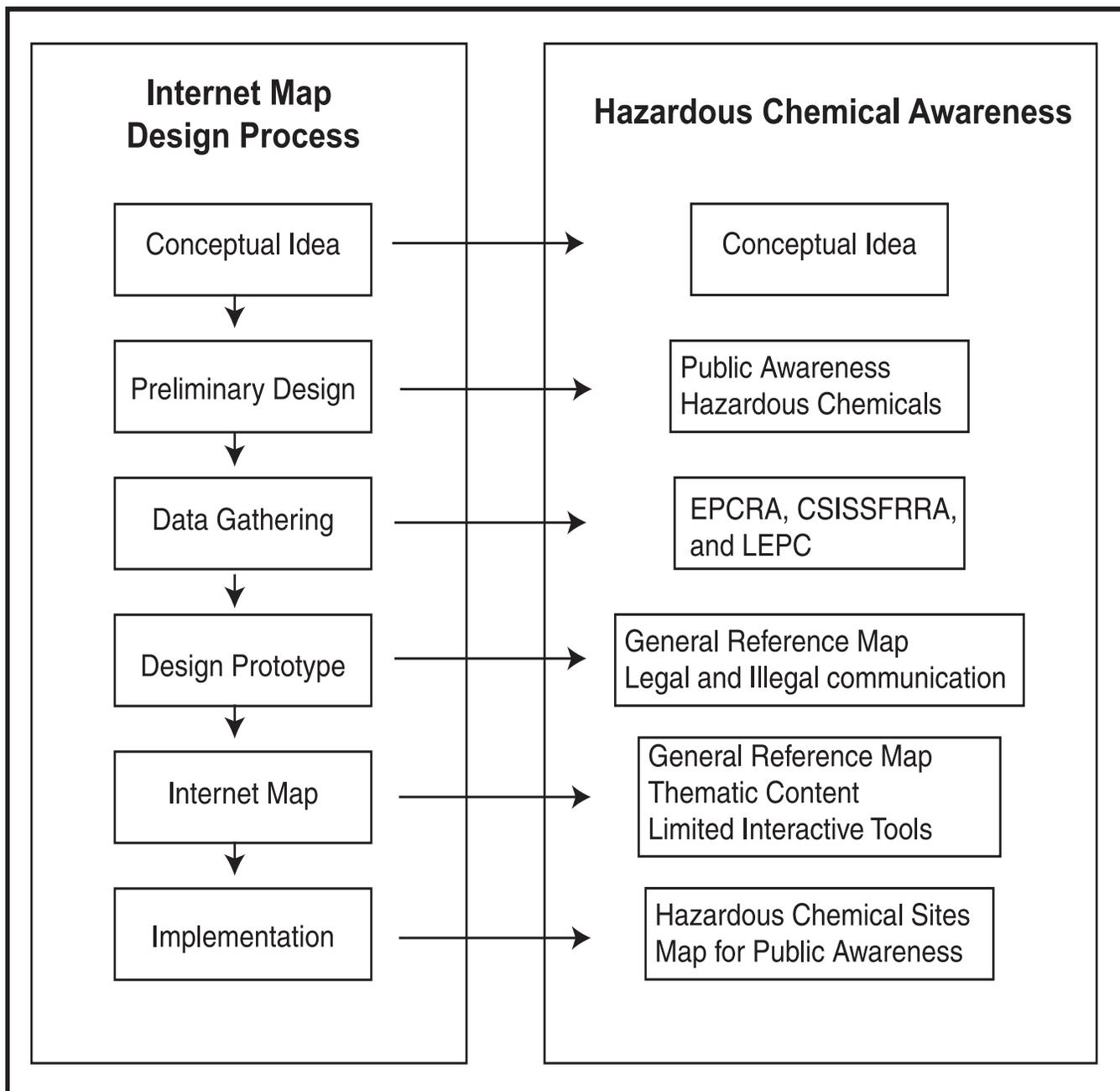| Internet Map Design Process	Hazardous Chemical Awareness
Conceptual Idea	Conceptual Idea
Preliminary Design	Public Awareness Hazardous Chemicals
Data Gathering	EPCRA, CSISSFRRA, and LEPC
Design Prototype	General Reference Map Legal and Illegal communication
Internet Map	General Reference Map Thematic Content Limited Interactive Tools
Implementation	Hazardous Chemical Sites Map for Public Awareness

Figure 3. The conceptual process for making an Internet map is illustrated. In this process, issues regarding hazardous chemical mapping are highlighted.

map in the spirit of community-right-to-know can be designed without violating CSISSFRRA. At present, it is not clear whether this restriction on information and its subsequent effect on cartographic communication will provide the desired benefit.

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Geographic Data   **Interactive Functions**

   Transportation   **Scale and Location**
[●]   Roads   [●]   Pan
[●]   Railroads   [●]   Zoom In and Out
[●]   Airport   **Identification**
   Land Ownership   [●]   Identity
   Chemical Sites   [●] **Hypertext**
[●]   Chemical Name   [●] **Hyperlink**
[X]   Amount   [●] **Animation**
[X]   State   **Spatial Modeling**
[X]   Concentration   [■]   Map Query
[X]   Distance to End Point   [■]   Buffer
   Populated Places   [■]   Proximity
[●]   Schools   [■]   Spread
[●]   Care Facilities
[●]   Large Employers
[●]   Apartments
[●]   Sports Arena
[●]   Hospitals
   Environmental Location
[●]   Parks
[●]   Greenways
   Census Data | [X] | **Illegal** |
[●]   Population | [■] | **Potentially Illegal** |
[●]   Race | [●] | **Legal** |
[●]   Income
[●]   Others

Table 2. Geographic Data and Interactive Functions Considered for Internet Map.

Dymon, U. J. 1994 Mapping - The Missing Link in Reducing Risk Under SARA II. *Risk: Health, Safety and Environment* 5:337-349.

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Peterson, M.P. 1997 Cartography and the Internet: Introduction and Research Agenda. *Cartographic Perspectives* 26. pp. 3-12.

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Use and Users of Maps on the Web

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Accessibility and actuality are presented here as the real benefits of the WWW medium for the dissemination of geospatial information through maps. In addition, the Web allows different modes of using web maps that address different map use goals. An argument is made that a great deal of web map use research will be required to develop more effective cartographic tools to better serve the needs of the users. Part of this research will have to be directed towards the characteristics of the web map users and the nature of their questions. Currently, we are witnessing a significant diversification of the user profile combined with an exponential growth of the total number of Internet users worldwide. The global distribution of the Internet is still very uneven, but there are now signs that the geographical anomalies will be somewhat reduced in the years to come. There are a number of other problems and limitations with which users are confronted in their use of maps on the web. However, the Web already is the major medium for the dissemination of maps and it has a great potential for further growth. But, this growth will have to be accompanied by cartographic research.

INTRODUCTION

I n our discussions about maps, there is sometimes confusion about the designations *use* and *user.* In some cases, we refer to the producers who use maps to disseminate geospatial data, for instance through the World Wide Web (WWW). In a similar way, website designers may *use* a clickable map as an interface to the information residing on the site, be it geospatial or not (*URL 1*). When reference is made to the user, cartographers normally have in mind the person who is actually using the maps (including, perhaps, maps as interfaces) to find answers to the essentially geographical questions they have. This is also the perspective from which this paper has been written, concentrating on web map use in a rather broad sense.

What is considered here is the entire process of using the Web to retrieve geographic information that is, or can be, transmitted by cartographic means. The geographic data may already come in the form of ready-made cartographic displays or the maps may still need to be constructed based on user input. Thereafter, the users may actually use the maps thus generated to obtain the information required.

"What is considered here is the entire process of using the Web to retrieve geographic information that is, or can be, transmitted by cartographic means."

While looking for answers to their geographical questions, WWW users may not be searching for a particular map, but may be offered a map display as a possible answer to a more general question like: "Where can I find a Chinese restaurant?" The Dutch version of the Yellow Pages (*URL 2*) offers the users, in addition to the address and other textual information and perhaps fully unexpectedly for the user, a map ("Toon Kaart" = show map) with the locations of all Chinese restaurants in the region specified; or a map showing the location of the selected restaurant; or even (if the business was willing to pay for it) a map (next to a textual description) showing the route to the restaurant selected from the place where the user is staying. In this case, the user was only looking for a place to eat and was not specifically asking for a map.

Based on these initial observations, the purpose of this paper is to shed more light on some aspects of map-use processes on the Web, as well as on the users themselves. It starts with presenting the real benefits to the user of the WWW medium for the dissemination of geospatial data by means of maps. The next section provides examples of different modes of using web maps in relation to different map use goals. Here, map use research is suggested that would help to develop more effective cartographic tools to better serve the needs of the users. The section on *user profiles* deals with the questions: "Who are they?"; "How many are there?"; and "What is their global distribution?" Some quantitative data on the use of maps on the Web are presented next. The last paragraph before the conclusion summarizes some of the problems and limitations web map users are confronted with in practice.

". . . the purpose of this paper is to shed more light on some aspects of map-use processes on the Web, as well as on the users themselves."

WHY HAVE WEB MAPS?

Compared to a medium like CD-ROM, the real advantages of the new WWW medium for the dissemination of geographic and cartographic information may be summarised under two main headings: *accessibility* and *actuality*.

A user with access to the WWW has, in principle, access to an enormous wealth of information from his or her PC. Information, including web maps, is easily accessible through user-friendly web browsers, 24 hours a day and not hindered by political and geographical boundaries. Through the hyperlinking interface, users also have limitless access to much more information than could ever be carried on a single CD-ROM. The Web can provide a quick answer to many geographical questions. Users also do not have to buy a CD-ROM, nor do they have to worry about installing the CD-ROM on their computer. Through the WWW, scanned copies of rare historical maps may be made accessible to users. The originals of these maps may only be available in one or a few map libraries in the world with perhaps very restricted access because of their fragile condition (*URL 3*). The accessibility of the medium also creates possibilities for public participation and collaborative cartographic visualization, for instance, in physical planning procedures (Krygier, 1999). Another aspect of accessibility, and a big advantage to the user, is that much of the information on the WWW is still available free of charge, given suitable hardware, software and an Internet connection.

One of the most serious problems of traditional cartography was to keep maps up-to-date. Due to the lengthy production process, sometimes a paper map was only made available to the users years after the initial data collection. By that time some of these outdated maps were already of limited use. With the introduction of electronic mapping, the production process could be speeded up somewhat, but the problem of actuality remained. A new edition of a route planner on CD-ROM will not be published every month, and even if it were, users would not be willing to buy a new version that often. The WWW, however, makes it possible to supply the users with up-to-date geographic and cartographic information. Good examples of this are web sites that include up-to-date weather maps (*URL 4*) or web maps showing real-time traffic information related to road construction work and traffic congestion (*URL 5*). Ultimately, the limit to the speed of revision is the speed of the data transfer through the Internet. A step further is to make real-time predictions of traffic conditions available to the user. The University of Duisburg in Germany, for instance, has created a computer simulation model by which traffic flows are predicted on the basis of measurements of current traffic intensities (*URL 6*). A next step would be to incorporate this kind of up-to-date information in the route planners that are available on the Web. A last example of the unprec-

". . . the real advantages of the new WWW medium for the dissemination of geographic and cartographic information may be summarised under two main headings: accessibility *and* actuality*."*

edented potential of the WWW to provide really up-to-date information by means of web maps is presented by sites that keep users informed of recent developments in news and sports, such as websites that inform people at home about the actual position of boats participating in sailing races. The positions of the boats are recorded by means of GPS techniques and are continuously plotted on sea charts that can be consulted on the Web. During the first ten days of the Route du Rhum 98 sailing race, more than 5 million maps of the race were distributed through the web in this way (Baumann, 1999).

These are all examples of new possibilities for a new medium to supply (almost) real-time geographic information by means of web maps. But, geographic information that is somewhat less dynamic (e.g. tourist maps or topographic base maps) may now also be supplied to the user in a more up-to-date form than ever before. It may be expected that users will become more discriminating in this respect and that they will lose their confidence in websites that are not kept up-to-date.

MODES OF USING WEB MAPS

Figure 1 shows the classification of web maps that has been undertaken for the book by Kraak & Brown (2001). The subdivision made at the lowest hierarchical level of this classification (view-only versus interactive interface and/or contents) is made from the perspective of the web- map user.

Another way of looking at the various ways of using web maps is to consider map use goals as positioned in the so-called "map-use cube," originally conceived by MacEachren (1994) (see Figure 2). Maps, including the maps generated in WWW sessions, may occupy any position in the three-dimensional space defined by the cube's axes, depending upon what a user does with the map and for what purpose. MacEachren and Kraak (1997) recognized four map use goals that are positioned in the cube: to explore, to analyze, to synthesize and to present information. However, in principle, web maps may also occupy other positions in the cube, depending on the typical use characteristics.

The static view-only scans of existing paper maps occupy a position close to the *present* ball in the cube. Many of these maps can still be retrieved through the Perry-Castañeda Library Map Collection site (*URL 7*). Typically, they were designed for a wide group of users and for a general purpose. Dynamic equivalents of these view-only maps are also available through the Web (*URL 8*). They may occupy the same position in the map-use cube, depending on their use.

As the Web typically is a medium for private use, many cartographic sites can be found near the base of the cube. Through these sites, maps may actually be created by an individual user to suit his or her private needs. When these possibilities for online map creation are limited to the selection of an area, a projection method, switching layers of map details on and off, and the design of the symbols representing these details, including the selection of colors, we are dealing with medium interactivity and the presentation of known geographical data relations (*URL 9*). This implies a position near the middle of the bottom side at the back of the

"Another way of looking at the various ways of using web maps is to consider map use goals as positioned in the so-called 'map-use cube' . . ."

". . . maps generated in WWW sessions, may occupy any position in the three-dimensional space defined by the cube's axes, depending upon what a user does with the map and for what purpose."
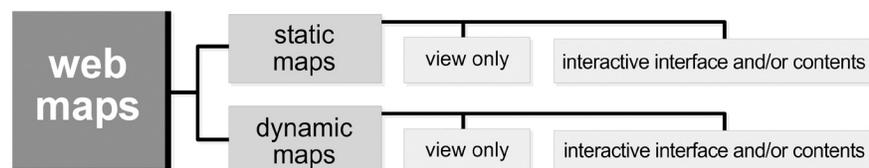

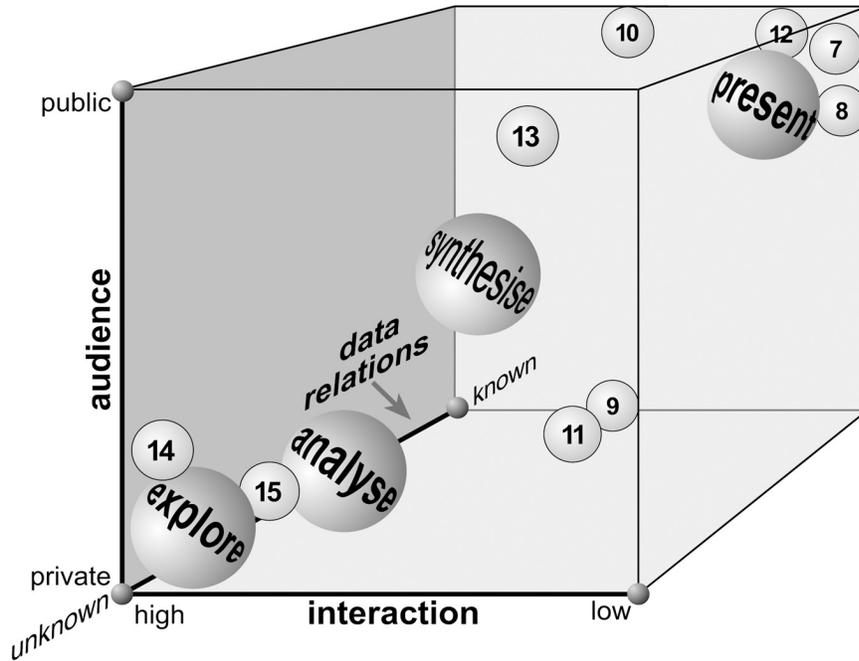*Figure 1. Classification of web maps (source: Kraak & Brown, 2001).*

Figure 2. Goals of map use arrayed in the map use cube (source: MacEachren & Kraak, 1997). For illustration purposes, some of the examples (URLs) that are mentioned in the text have been positioned in the cube as well.

cube. In a sense, clickable maps or hypermaps for public use may also be regarded as a kind of moderate interactive map, occupying a high position near the back of the cube (*URL 10*). In other interactive maps on the Web, users may change the area portrayed through panning, or the scale through zooming (*URL 11*), and some user-friendly sites even allow the user to change the orientation of the map display (e.g. North or destination at the top of a route map).

The *presenting knowns* to *revealing unknowns* axis of the map use cube also reflects different conditions of map use through the Web. On the *presenting knowns* end, users know exactly what geographical information they want and often what map on which website supplies that information to them. For example, the site of the Dutch High-Speed Line Project (*URL 12*) contains maps showing the routes of the railway line. These maps may also be positioned close to the *present* ball in the map use cube. On the front side of the cube, we may find the Web surfers who may not know exactly what they are looking for and browse, for example, through one of the atlases on the Web. For instance, the Lycos World Atlas (*URL 13*) may be positioned somewhere near the middle/right of the top of the front side of the cube.

Currently, in web cartography, as in cartography in general, lots of interesting developments are taking place in the left hand bottom front corner of the map-use cube. This is the position of exploratory cartography: map use in the private (revealing unknowns) and high human-map interaction corner of the cube. Because of further developments in the client-server architecture, it becomes ever more possible for users of web maps to explore and really interact with certain geospatial datasets, while making use of modern cartographic visualization techniques in order to gain insight into these unknown datasets. In such cases, it may be possible to manipulate (e.g. classify) the data, choose different cartographic representation methods and visually compare the resulting map displays.

". . . it becomes ever more possible for users of web maps to explore and really interact with certain geospatial datasets, while making use of modern cartographic visualization techniques . . ."

As such, online visual exploration may be followed by downloading the geospatial data for analysis locally. In this respect, there are some interesting examples on the Web relating to the exploration of census data. The CIESIN DDViewer can be used to calculate statistics and explore the 220 demographic variables from the 1990 US Census (*URL 14*). In the United Kingdom, the KINDS Service Pages (*URL 15*) provide various search and visualization tools for national spatial data sets. The Cartographic Data Visualiser (CDV) (Dykes, 1998) and Descartes (Andrienko *et. al.*, 1999) are examples of the software used for online interactive cartographic visualization. Further developments may be expected at this side of the map-use cube, as the WWW environment is well-suited for interactive visual exploration.

"... the WWW environment is well-suited for interactive visual exploration."

THE NEED FOR RESEARCH

With all these map use goals, the extremely important question is whether the maps that appear on the display screens during or after a WWW-session really are as efficient and effective as they could be. That is, do the users always get an appropriate answer to the geographical questions they have posed?

As cartographers have always done, web map designers must also take into account the purpose of the map and the needs and characteristics of its users. And, in view of the current potential for users to produce their own maps, this requirement also holds for the design of the cartographic tools offered to the users, as well as for the design of the web site's user interface.

One problem is that we hardly know anything about how people use web maps, or more generally, how people use the WWW to retrieve geographical information. In addition, we also do not know enough about who is using web maps. The user profile is becoming more and more diverse (see next section) and we need to know more about the different needs and different characteristics of the different user groups. In any case, the users themselves would certainly be helped if it could be made clearer which websites meet their requirements.

"One problem is that we hardly know anything about how people use web maps, or more generally, how people use the WWW to retrieve geographical information."

To some extent, the required web-map use research is not different from map-use research that has already been (and still has to be) executed in other map-use environments (van Elzakker & Koussoulakou, 1997). For example, the answers to questions like when, why and how people are using maps in the exploration of geographical data are as much needed with stand-alone GIS as with WWW user environments. Likewise, the results of research into the perception properties of visual variables (including the new 'derived' and 'dynamic' ones) as applied to cartographic symbols are relevant in all circumstances in which maps are displayed on monitor screens. Knowing more about the specific backgrounds and characteristics of users, and which affect their ability to perceive and/or to comprehend the geographical information inherent in the map (e.g. age, previous education, existing knowledge and experience), would also be relevant for the design and development of cartographic tools for the Web.

"Some aspects of map use may ... be very specific to the WWW-environment and will have to be investigated separately."

Some aspects of map use may, however, be very specific to the WWW-environment and will have to be investigated separately. For example: What are the typical characteristics of the web search and surf process in which answers are sought to various geographical questions that are provided through maps? What is the role of the user interface in this process? What are the consequences of the volatility of the medium that is used by rather impatient users? And do the web maps generated by the users themselves actually provide the information required, or do they give

cause for misinterpretations? Finally, what is the quality and reliability of the geographical information transferred through cartographic displays on the WWW?

In view of the very recent rise of the new medium, it is not surprising that, so far, hardly any web map use research has been executed. As usual, technical developments precede usability questions. However, a start has been made with investigating how maps are being used on the Internet. Examples are the work of Harrower *et al.* (1997) and the extensive customer survey and online user feedback option on the website of the National Atlas of the United States (*URL 16*, click the "Atlas Feedback" button) (also see Wright, 1999). Peterson (1997) also mentions the web map-use research associated with the development of the Alexandria Digital Library (*URL 17*). At this site, map use is being studied by examining the log files of web sessions. These files contain information on the types of maps that are accessed, how long they are viewed, what map is viewed before and after, and where the user clicks on the map. This kind of work should be followed by many more investigations of the use and the users of maps on the Web, so as to be able to develop more effective cartographic tools to better serve the needs of the users.

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There is a need to know more about who is using which maps on the Web and for what purpose. This need is becoming more and more pressing as the population of users is expanding and map-use goals are diverging. In 1997, we also did not know much about the use and users of web maps. However, we did know that the group of people who actually made use of the Internet was not very diverse at that time. Therefore, three years ago it was possible to state (van Elzakker & Koussoulakou, 1997) that the group of users of maps on the WWW could be defined as relatively young (15 to 40 years of age) males in Western countries with a high level of education, with an interest in science, technology and/or computers and with access to the Internet. Also, in view of the specific characteristics of the WWW medium, they were sometimes considered as a completely new generation of map users who were interacting with map displays in entirely different ways than 'traditional' map users. But still, because of the rather limited group of people actually connected to the Internet, it was not so difficult, in theory, to identify web map purposes and to adjust the cartographic web tools to the needs and characteristics of its potential users.

USER PROFILES

". . . the population of users is expanding and map-use goals are diverging."

There has been a significant change in the web user profile since 1997. User data are made available (not always free of charge) through several websites (e.g. *URLs 18, 19* and *20*). These data show that the Internet now plays a role in all levels of education and is becoming more and more common in every home and business. In the United States, most users now access the Web from home, whereas they primarily did it from work in the early days (Kehoe *et al.*, 1999). Peterson (1999) reports on an investigation of people planning to get Internet access: almost half of them have only a high school education or less; and 58% of them make less than US$50,000 a year. The use of the Internet is democratizing, although significant segments of society still have not made it onto the information highway. International Data Corp. (IDC) expects that 62% of all adults in the United States will have Internet access by 2003 (CyberAtlas, 1999a). In the first quarter of 2000 in the US, the number of women online surpassed that of men (CyberAtlas, 2000a). At the same time, adults 55 and older represent the fastest-

"The use of the Internet is democratizing . . ."

growing group of US Internet users (CyberAtlas, 2000b). For older people, the advantage of accessibility (as discussed above) is perhaps even more important than for younger people.

At least part of the world will undoubtedly follow the American example and demonstrate similar changes in user profile in the years to come. For instance, many European countries are catching up rapidly. As a consequence, there will be more and more different users of web maps with different needs and requirements. Some of these potential web map users may be regarded as 'new' users in the sense that maps now are much more accessible to them, and before they would normally not have considered buying GIS software. The Internet will make it possible for them to really interact with maps for the first time, so that all kinds of individual geographical problems may be solved much more efficiently and effectively than ever before. All this means that more and more attention should now be paid to adjusting the cartographic websites to specific user groups. For instance, the nature of the user interface and the possibilities for interaction cannot be the same for primary school children as for geoscientists exploring a geospatial dataset.
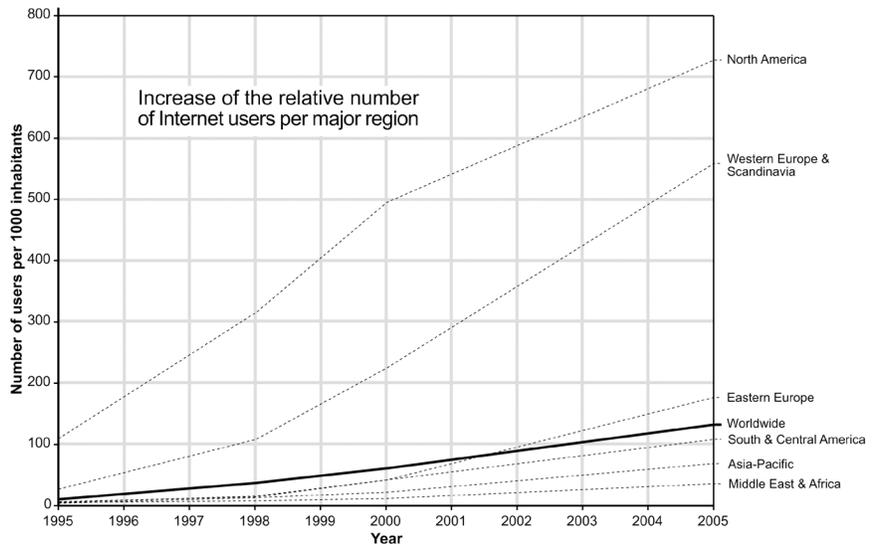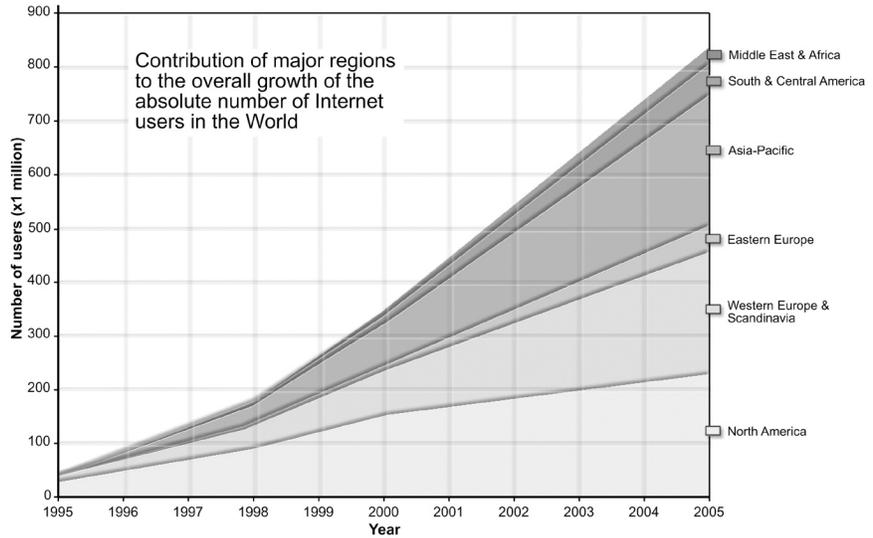
". . . more and more attention should now be paid to adjusting the cartographic websites to specific user groups."

Figure 3. Worldwide Internet users 1995-2005 (sources: URL 21 & 22, *December 1999 & May 2000).*

It is not only a matter of a user profile that is becoming more and more diversified; the number of users of the Internet and people with access to the WWW is also still growing exponentially. A November 1999 estimate arrived at 259 million Internet users for year-end 1999 (Cyber-Atlas, 1999b), while a September 2000 estimate put the number at 374.9 million Internet users for the entire world for year-end 2000 (CyberAtlas, 2000c). Internet users are defined here as individual adults over 16 years old with weekly usage in their business and homes. The numbers are said to be 15-30% higher when occasional Internet users are included. Supposedly, the numbers would also increase if the use at schools and, for instance, in public libraries and cybercafés would be included. In any case, the number of users will grow rapidly in the years to come, particularly in regions with current low penetration levels (see Figure 3). At the same time, it should be realized that the number of Internet users expressed as a percentage of the total population of the world (see Figure 4) will still be rather low, even five years hence (*URL 22*: 13% in 2005). This is mainly a matter of the global diffusion of the Internet. By year-end 1999, for instance, 40% of the total world Internet users still lived in the United States. This figure will decline to 25% by the end of 2005 (*URL 22*).

In our understanding of web maps and the dissemination of geo-spatial data, we not only want to know who the users are and how many there are, but also where they are. Figures 3 and 4 already give an indication of the number of users in the major regions of the world. In absolute terms, North America will remain the leading region for Internet users in the years to come, but the other regions are growing at a faster rate. Very interesting developments are taking place in some of these other regions, like the Cyberjaya project in Malaysia, stimulated by Prime Minister Mahathir. Cyberjaya is a digital city with a so-called e-government that uses no paper and exchanges all information through the Internet (*URL 23*).

Figure 5 shows the percentage of the population with access to the Internet by country. In this map, the different surface areas of the territorial units (in this case countries) have an unwanted effect on the perception of the global diffusion of the use of the Internet (larger countries tend

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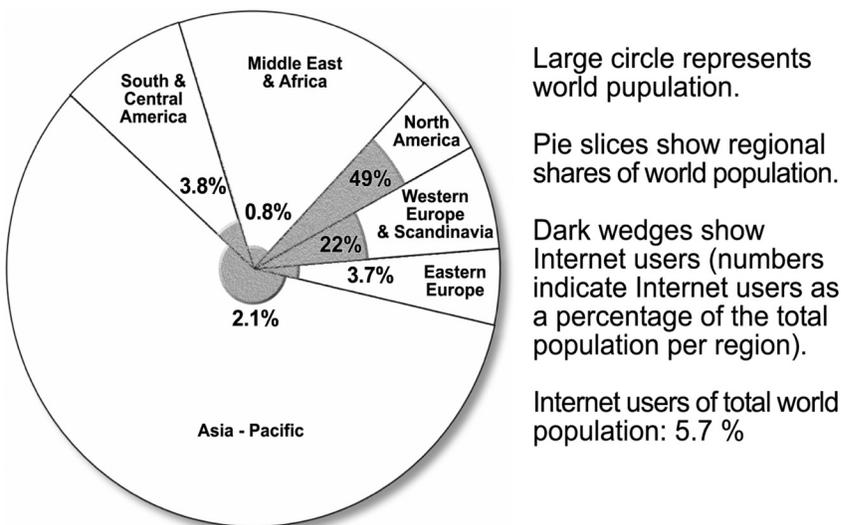

Figure 4. The portion of the world's population that uses the Internet, forecast for year-end 2000 (source: URL 21*, December 1999) (diagram conceptualised by UNDP, 1999).*
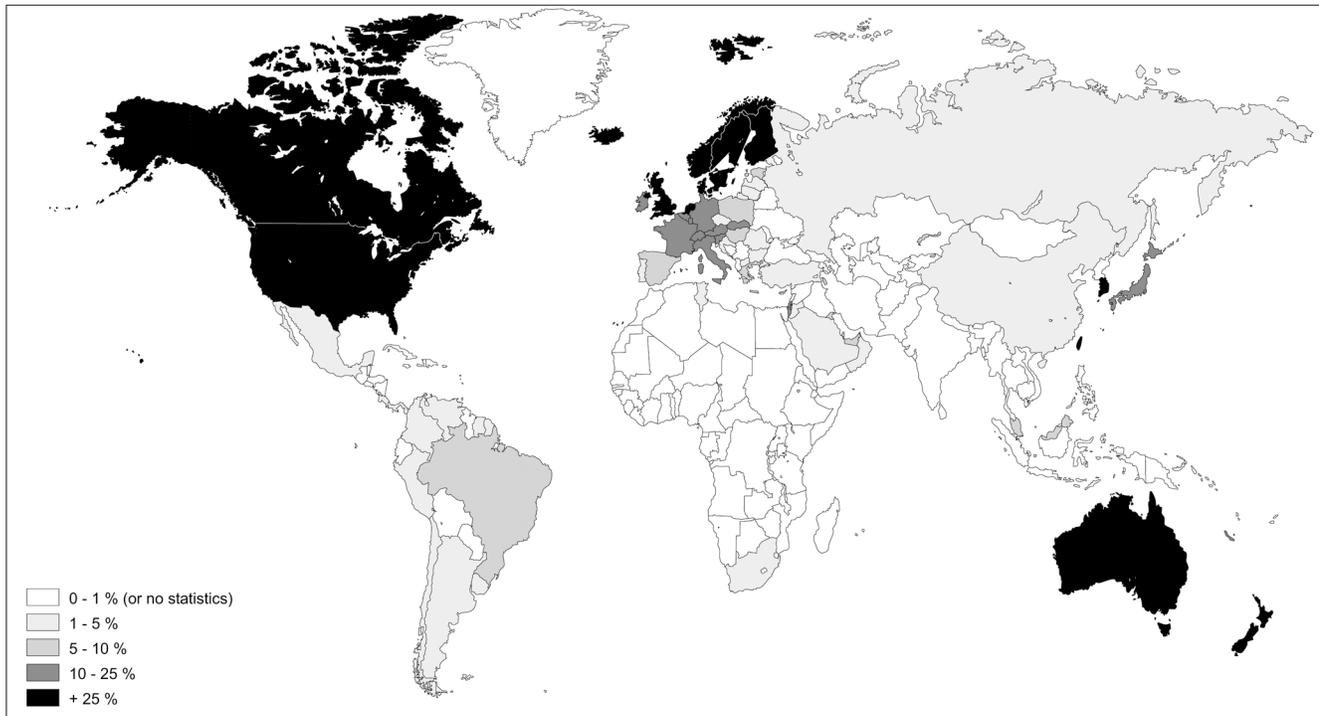
Figure 5. Number of Internet users as a percentage of the total population by country, 2000 (source: URL 24 *and CyberAtlas, 2000c).*

"While all nations are connected now, the uneven distribution of Internet users . . . and, consequently, web map users is striking."

"It is sometimes argued . . . that the globalization that is partly brought about by the Internet is elite-based and at the same time leads to increasing global – and social – inequality . . ."

to dominate, although their surface areas are not related to population numbers).

Therefore, Figure 6 is included here to show the absolute numbers of Internet users by country (using the same data sources as for Figure 5). The top 15 nations with the most Internet users at the end of 2000 are represented by means of separate proportional circles. All other countries (with less than 5 million Internet users) are put into classes. Together, the Top 15 nations account for about 82% of the worldwide Internet users. While all nations are now connected, the uneven distribution of Internet users (see Figure 6) and, consequently, web map users is striking. Factors that are mentioned (e.g. by Hargittai, 1999) to explain this uneven distribution are: economic wealth, level of education, English language proficiency, government policies (e.g. political or religious freedom, freedom of competition leading to differences in Internet access pricing) and existing telecommunication, computing and power facilities. In looking at Africa as a whole, for example, the low number of Internet users is not very surprising, if only because of the low literacy rates and the low number of fixed telecommunication (telephone) connections. And, it should also be realized that the Internet connectivity is often limited to one or two large cities within the countries (Press *et. al.*, 1999). It is sometimes argued, therefore, that the globalization that is partly brought about by the Internet is elite-based and at the same time leads to increasing global – and social – inequality (UNDP, 1999).

On the other hand, every country in Africa is now connected to the Internet (*URL 26*). Technical progress, in particular a rapid introduction of less vulnerable wireless means of telecommunication, may mean that the dissemination of maps and geospatial data through the WWW could contribute to the further development of this part of the world as well. In some African countries there are already more mobile telephones than
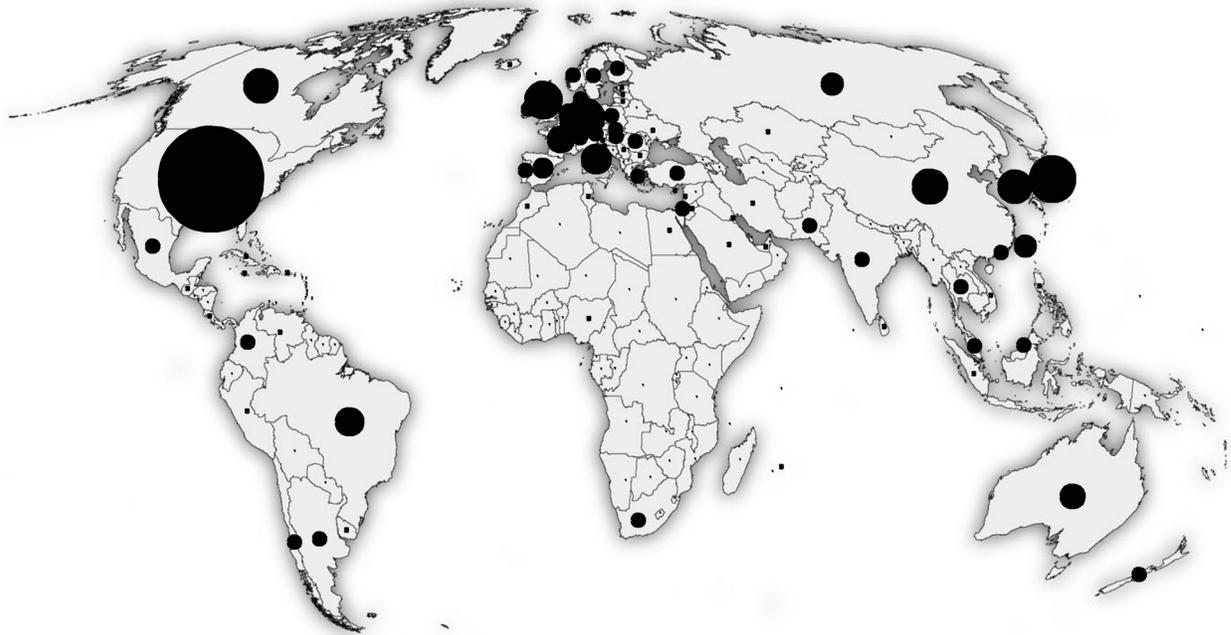
Internet users

·   200 - 50,000

▪   50,001 - 500,000

●   500,001- 5,000,000

Top 15 nations (x 1 million)

● Spain 5.2	● France 9.0	● China 15.8
● Netherlands 5.4	● Brazil 10.6	● United Kingdom 17.9
● Taiwan 6.5	● Italy 11.6	● Germany 19.1
● Russia 6.6	● South Korea 14.8	● Japan 26.9
● Australia 8.1	● Canada 15.2	
		● United States 135.7

Figure 6. Number of Internet users by country, 2000 (source: URL 24 *and CyberAtlas, 2000c).*

fixed telephone connections, and soon it will be possible to have access to the Web through a mobile Internet (Stähler, 1999). In Europe, as in Africa, the penetration of the Internet is very unequal at the moment. The contrast between Western and Eastern Europe (see Figure 3) may not be surprising. There is also, however, a contrast between Northern Europe, where Sweden, Norway, Denmark, Finland, Iceland, The Netherlands and the United Kingdom all have more than 30% of the population with access to the Internet, and Southern Europe, where some Mediterranean countries (Greece, Spain and Portugal) have less than 15% of the population using the Internet (see Figure 5). In the Asia-Pacific region, Japan, China, South Korea, Australia and Taiwan already belong to the Top 15 nations in Internet use (Figure 6), and this will become the largest Internet region by 2005 (Figure 3). The growth in the number of people with Internet access in a country like China is exponential. Depending on the Internet policy of the government, and in view of the enormous number of people living in this country (1.25 billion), China may rise in the Top 15 rapidly. And this will also have consequences for the number of maps generated through the WWW.

"The growth in the number of people with Internet access in a country like China is exponential."

WEB MAP USAGE

". . . with the introduction of the Internet and the WWW, we have witnessed an enormous increase in the number of maps that are actually produced and used."

". . . in 1998 over 5 million web maps were interactively and dynamically created during 10 days of the Route du Rhum sailing race . . . "

"MapQuest . . . is consistently mentioned as the number one web map-site in the world . . ."

In the past decades the need for maps has increased enormously in all parts of the world, as a consequence of, among other things, the growing number of geospatial relationships, greater human mobility, and more physical planning problems brought about by a more intensive use of land and water. It still remains to be seen what influence the exponential growth of the Internet, the corresponding increase in the time people will and may spend at their network stations, and the resulting global-ization will have on the intensity of geospatial relationships and the related need for maps and geodata. In any case, there will be a need for maps of cyberspace. And, because of a better accessibility and actuality of web maps, the medium may also generate a greater interest in maps of all kinds (even paper maps!). It should be noted that with the intro-duction of the Internet and the WWW, we have witnessed an enormous increase in the number of maps that are actually produced and used. In quantitative terms, the Web now has become the major medium for the dissemination of maps.

In the previous section, estimates were provided on total numbers of Internet users. Much data are also collected on the numbers of 'hits' on websites, for these data are used to attract advertisers or to assess how much a website can charge for advertising banners. The only problem is that these data are not made readily available because of the competition between commercial websites and because the data have now become a property, handled by separate and independent companies (Peterson, 1999). At the same time, there are many web-map sites that do not adver-tise and do not keep a record of the number of people that access their site, or use their maps (Peterson, 1997).

MediaMetrix keeps up some rankings of websites that are hit by most users (*URL 26*). The rankings show the actual number of total users who visited the website once in a given month, whereby all unique visitors are unduplicated (only counted once). In the rankings, search engines, Microsoft sites and Amazon.com are at the top of the list. The highest specific web-map site, MapQuest (*URL 27*), is listed as number 38 on the March 2000 ranking with 5,572,000 different users (compared to rank 49 in November 1999 with 3,754,000 users). However, rankings like these do not give an indication of the total number of web map-users nor of the total number of web maps actually retrieved, generated or downloaded. For instance, maps are also an important means of information dissemi-nation for sites like The Weather Channel (*URL 28*), listing as number 27 on the MediaMetrix ranking with 7,598,000 different users in March 2000 (November 1999: rank 39 with 4,677,000 users). But, we do not know how many of these users actually used maps to get information on the weather, how often they came back to the site, how many maps they used each time, nor how effective the maps were in providing the wanted informa-tion.

In October 1998, only 10.4% of the 3291 respondents of a WWW user survey (Kehoe *et al.*, 1999) said that they never looked for a web map; 41.4% accessed maps less than once a month; 32.2% monthly; 14.7% weekly and only 1.3% accessed maps daily. Assessing the total abso-lute number of web maps that is produced and used is a very difficult task for reasons mentioned above. However, use data are available for some specific websites. And these data are sometimes very impressive. For example, as already mentioned above, in 1998 over 5 million web maps were interactively and dynamically created during 10 days of the Route du Rhum sailing race (Baumann, 1999). On average, there were 200,000 hits per day on the race's website. So, on average 2.5 maps were generated during each WWW session. MapQuest (*URL 27*) is consis-

tently mentioned as the number one web map-site in the world, or, as Crampton (1998) states, the biggest mapmaker in history. According to a MapQuest employee, there were 75.4 million maps drawn on the Map-Quest site in November 1999 (Gebb, 1999). This would translate to 2.5 million maps a day or 1,750 maps a minute on average (and it would be much higher during peak hours). In November 1999, the MapQuest site had 16.6 million user sessions (cf. the figure of 3.7 million *different* users counted by MediaMetrix, as mentioned above). And this means that, on average, some 4.5 maps were generated during a user session. Map-Quest is a very popular site, offering various functionalities and a lot of useful geographic information. However, perhaps the speed and ease of information retrieval are at the expense of the quality of the cartographic design. As a consequence, we may doubt their effectiveness. Web map designs that are better adjusted to the needs and characteristics of their users may lead to even higher hit rates, and stimulate growth in the overall popularity of maps as carriers of geographic information over the Web.

"... there were 75.4 million maps drawn on the MapQuest site in November 1999 ... This would translate to 2.5 million maps a day or 1,750 maps a minute ..."

On the basis of information derived from selected sample sites like these, Peterson (1999) estimated that approximately 40 million web maps in total are used per day world-wide. This is a four-fold increase of the estimate he made in 1997. An even more dramatic growth of web map usage may be expected as a consequence of the predicted exponential growth of the overall number of Internet users.

For users, some limitations of web maps are not directly related to the WWW, but are a consequence of the computer nature of the medium (as opposed to traditional paper maps), such as limited portability, difficulty in manipulating the map (folding, turning, drawing or measuring on it), and limited display size, resulting in fewer possibilities for overview. In addition, screen and color resolution usually limits the amount of detail present on a monitor screen map. In these respects, paper media such as atlases still have some inherent advantages.

PROBLEMS AND LIMITATIONS

"For users, some limitations of web maps are not directly related to the WWW, but are a consequence of the computer nature of the medium (as opposed to traditional paper maps) ..."

Another problem is that the creators of web maps do not have full control over the final appearance of these maps. Although they are stored in platform-independent formats (e.g. GIF, JPEG or PDF), they do not appear exactly the same for every user. The effects of the cartographic designs may differ greatly depending on the various output configurations used. Even when considering only PCs (and not the new Internet appliances like set-top boxes for online digital TV), there will be differences in the users' browsers and operating systems (which handle colors in different ways, for instance) and in the quality (e.g. resolution) of their graphic cards and display screens (e.g. LCD or CRT in different sizes). In addition, users are able to personally adjust their displays for resolution, contrast, brightness and color balance.

"Another problem is that the creators of web maps do not have full control over the final appearance of these maps."

A further problem is that some websites are not kept up-to-date regularly, causing users to lose confidence in these sites. What may be even more important is that, in practice, there are considerable limitations to accessibility. These limitations may be listed under the following headings:

"A further problem is that some websites are not kept up-to-date regularly ..."

- Finding web maps and geodata
- Language
- Accessibility for everyone?
- Web maps and geodata for free
- Internet access, and
- Speed of data transfer

Many users of the web will have problems analogous to "drinking from the fire hose" (van Elzakker & Koussoulakou, 1997), i.e., finding the maps or geodata they need on the information-rich, but disorganised, WWW. A related problem is the volatility or continuity of the information: what appears in a site today might be gone tomorrow.

Language also plays an important role in accessibility. Misspelling (e.g. of geographical names) may cause difficulties in finding the required web maps or geodata. And, although the Web is not limited by political boundaries, the worldwide dissemination of maps and geodata may be hindered by language. English is the dominant language on the WWW (*URL 29:* 86.55% of the web pages are in English), while only around 10% of the world's population understands this language. Besides, it should be remembered that some 22% of the world's adult population is still illiterate (UNDP, 1999).

Indeed, the WWW is not yet accessible to everyone. Even in societies with a literacy rate of (almost) 100%, certain social classes do not have access to the Internet. Figures 3, 4, 5 and 6 show that there are substantial geographical anomalies too. It seems that access is currently limited to people or areas with a certain economic wealth, a certain level of education and computer skills, (English) language proficiency, a favorable government policy, and the necessary equipment. Economic factors alone are perhaps the most important explanation for limitations in web access. An important point to remember, however, is that access to maps through the web is far greater than access to maps on paper, even for people who have limited access to the Internet.

Accessibility is fostered by the web through the availability of free geodata and web maps, although this may lead to problems with quality. However, pay web sites are proliferating, and getting web maps and geodata for free is actually an illusion. A web-map/geodata user must have access, and this now means having a powered computer with a modem connected to a telecommunications network. In addition to this hardware (and some software), the user, or his or her organization, has to pay for the telephone costs and/or an Internet provider. In some places, e.g. in developing countries, these costs are relatively high, but in other countries these costs are lower in order to attract as many new Internet users as possible. It also means that Internet access is still limited to places with a connection to a properly functioning, fixed telecommunications network, i.e. at home or at work. Therefore, obtaining maps and geodata through the WWW while away from one's base is not currently widespread. However, technology is developing rapidly, and it may be expected that the mobile (wireless) Internet will be commonplace within a few years.

Finally, a current limitation to accessibility is the speed (and reliability) of data transfer over the Internet. For users, speed is one of the biggest problems in using the Web (Kehoe *et. al.*, 1999) and often it is the very advantage of a medium like CD-ROM for the dissemination of atlases, route planners, maps and geodata. The Internet Weather Report™ (*URL 30*) shows the performance of the Internet by means of animated maps for various parts of the world. The animations are based on time sequences and they show that the speeds of data transfer vary throughout the day. For example, the Internet is fast in Europe during the morning hours while most Americans are still asleep. But, of course, the speed also strongly depends on the technology available to each user, not just his or her own PC and the speed of the modem, but, for instance, also the capacity of the local telephone, ISDN or cable networks. Web maps and geodata usually come in large files and it may take a long time to retrieve or down-

"Many users of the web will have problems . . . finding the maps or geodata they need on the information-rich, but disorganised, WWW."

". . . the worldwide dissemination of maps and geodata may be hindered by language."

". . . the WWW is not yet accessible to everyone."

". . . getting web maps and geodata for free is actually an illusion."

"For users, speed is one of the biggest problems in using the Web . . ."

load them from the Web. Therefore, they are prone to the World Wide *Wait* syndrome of the many users who are rather impatient and unwilling to wait for maps to download. If technology did not advance, the problem would become bigger and bigger, because of the exponentially increasing use of the WWW. The reliability and speed of the Internet are, however, constantly improving, and it may be expected that many new technological developments will further increase the bandwidth and the speed of data transfer. Indeed, some people argue that speed is not a technical but an economic problem: the solutions are there, as long as the user is willing to pay for them.

"... some people argue that speed is not a technical but an economic problem: the solutions are there, as long as the user is willing to pay for them."

CONCLUSION

Despite all the problems and limitations, it may be postulated that there is great potential for the further growth in the use of maps on the Web. There will always be a need for maps and the success of a site like MapQuest promises to increase map use along with the exponential growth in the number of Internet users. This growth is in great part due to the advantages of acessibility and actuality. However, further growth of web map use also depends on improvements in the effectiveness of web maps and cartographic visualization tools on the Internet. And, for that, more research into web map use and web map users will be required.

NOTES

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This paper is based on research that accompanied the development of two chapters for a book on 'Web cartography: developments and prospects', edited by M.J. Kraak & A. Brown, and published in October 2000 by Taylor & Francis (London) (ISBN 074840869X). These chapters (on use and users of web maps, respectively) contain many more references to sample websites plus sections on how to find and retrieve maps and geodata on the Web, economic aspects and web maps in geospatial data infrastructures. The sample websites and illustrations are kept up-to-date on the site that accompanies the book (http://kartoweb.itc.nl/webcartography/webbook/).

URLs

URL 1   The website of ITC's Division of Geoinformatics, Cartography and Visualization <http://www.itc.nl/carto/>
URL 2   Dutch Yellow pages <http://www.goudengids.nl/>
URL 3   Historical maps Bremen University <http://gauss.suub.uni-bremen.de/>
URL 4   Radar simulation precipitation in the Netherlands <http://weerkamer.nl/radar>
URL 5   Real-time traffic congestion map of Athens <http://www.transport.ntua.gr/map/>
URL 6   Prediction of traffic flows <http://www.traffic.uni-duisburg.de/>
URL 7   PCL Map Collection <http://www.lib.utexas.edu/Libs/PCL/Map_collection/Map_collection.html>
URL 8   Deaths from cholera in London, 19th July to 2nd October 1866 <http://www.geog.qmw.ac.uk/gbhgis/gisruk98/index.html#cholera>
URL 9   Make your own map <http://www.aquarius.geomar.de/omc/make_map.html>
URL 10   Clickable maps <http://www.britannica.com/bcom/eb/article/single_image/0,5716,367+bin%5Fid,00.html>
URL 11   Limited interactivity <http://www.lonelyplanet.com/dest/>

URL 12 Dutch High-Speed Line Project <http://www.hslzuid.nl/hsl/uk/intro-uk.html>

URL 13 Lycos World Atlas <http://versaware.atlaszone.lycos.com/>

URL 14 CIESIN Demographic Data Viewer <http://plue.sedac.ciesin.org/plue/ddviewer/>

URL 15 KINDS (Knowledge Based Interfaces to National Data Sets) <http://www.kinds.ac.uk/kinds/>

URL 16 National Atlas of the USA <http://www.nationalatlas.gov/>

URL 17 Alexandria Digital Library <http://www.alexandria.ucsb.edu/>

URL 18 Matrix Information Directory Services <http://www.mids.org/>

URL 19 IDC <http://www.idc.com/>

URL 20 UK Internet User Monitor <http://www.fletch.co.uk/content/monitor/method.html>

URL 21 Computer Industry Almanac, Inc. Internet users by region <http://www.c-i-a.com/199908iu.htm>

URL 22 eTForecasts Internet user forecast by country <http://www.etforecasts.com/products/ES_intusers.htm>

URL 23 Cyberjaya project in Malaysia <http://www.cyberjaya-msc.com/>

URL 24 How many online <http://www.nua.ie/surveys/how_many_online/index.html>

URL 25 African Internet connectivity <http://www3.sn.apc.org/africa/>

URL 26 MediaMetrix Top 50 <http://www.mediametrix.com/usa/data/thetop.jsp>

URL 27 MapQuest <http://www.mapquest.com/>

URL 28 The Weather Channel <http://www.weather.com/>

URL 29 Inktomi WebMap <http://www.inktomi.com/webmap/>

URL 30 The Internet Weather Report™ <http://www.mids.org/weather/>

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Webcams, Interactive Index Maps, and Our Brave New World's Brave New Globe

Intermittent video supplied by a webcam affords near-real-time images that can approximate the dynamic scenes of full-motion video. As map supplements, webcam images offer readily interpreted on-the-spot reports of traffic flow, crowdedness, cloudiness, scenic beauty (or ugliness), and other directly observable aspects of the physical and human landscapes. And as easily interpreted cartographic point symbols, webcam images offer a range of visual variables, including size, numerousness, texture, rate of change, and value. Readily integrated with the maps, photographs, other images and the narrative text of electronic atlases and atlas-like websites, webcam images depend upon maps in two ways: locator maps provide the spatial context without which many webcam images have little meaning, and index maps help viewers identify places for which webcam images are available. As a medium for monitoring landscapes and watching people—with or without the subject's awareness and acquiescence—the webcam is symptomatic of electronic cartography's newfound capacity as a technology of surveillance.

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INTRODUCTION

A mong the defining characteristics of multimedia cartography is the integration of maps with text, statistical graphs, diagrams, photographs, and sound. Although all five categories of non-cartographic media can promote understanding of a map's symbols or patterns, photographs of familiar or easily interpretable features afford the most efficient link between a real landscape and its cartographic representation. A staple of printed world and regional atlases designed for general audiences, complementary photographs are abundantly apparent in electronic atlases, in which still photos and video clips often consume the bulk of CD-ROM memory. Emergence of the Internet as the primary mode of multimedia mapping has accorded photographic imagery an even greater presence through the webcam, which affords a ground-level perspective of traffic, weather, or tourist attractions, as well as sustained, real-time monitoring of public space here or abroad. This paper examines the operation, limitations, brief history, and cartographic role of the webcam, and argues that these video viewports are symptomatic of electronic cartography's newfound capacity as a technology of surveillance.

"Emergence of the Internet as the primary mode of multimedia mapping has accorded photographic imagery an even greater presence through the webcam . . ."

WEBCAMS AND CARTOGRAPHY

In its simplest and most common implementation, a webcam is an image file—let's call it *ourcam.jpg*—stored on a webpage and displayed on the viewer's computer by a line of HTML code that looks like

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<img src="ourcam.jpg">.
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Page layout instructions tell the viewer's computer where to place the picture on the screen, and the webpage's server refreshes the image by downloading the file's current contents at a fixed interval, which might

"The picture changes as the image file is refreshed with a new scene recorded by a digital camera . . ."

*"'CoffeeCam' (*www.cl.cam. ac.uk/coffee/coffee.html*), as it is often called, eliminated the frustration of climbing several flights of stairs only to find the carafe empty."*

"Cartwright (1997) proposed the webcam as a "reality link" to provide the "ground truthing" without which some viewers have difficulty comprehending cartographic animations and other visually complex geospatial multimedia."

be as short as a fraction of a second or as long as an hour. The picture changes as the image file is refreshed with a new scene recorded by a digital camera, captured by a video card and converted to a GIF or JPEG image, which is fed to the host server (Nemzow 1998, 26-46). Setups vary widely, and few webcams approach the Internet TV standard of full-motion video (Kotis, Lambert and McGregor 1999). Although some webcam sites offer a more or less continuous stream of live but jerky video images, others require the user to update the image manually, by clicking on a command phrase or the picture itself. Image quality varies less markedly, with the typical webcam presenting landscape-oriented color snapshots comparable in resolution and screen size to a QuickTime or RealPlayer viewport.

Web lore recognizes Cambridge, England, as the webcam's birthplace. In 1991, scientists at the Cambridge University Computer Laboratory rigged up a video camera, a frame grabber, and a networked computer to monitor the communal coffee pot in the Arup Building's Trojan Room (Stafford-Fraser 1999). 'CoffeeCam' (*www.cl.cam.ac.uk/coffee/coffee.html*), as it is often called, eliminated the frustration of climbing several flights of stairs only to find the carafe empty. Webcam technology blossomed in the mid 1990s, when inexpensive electronic cameras like the Connectix QuickCam (now produced by Logitech) fostered an upsurge of timely electronic photographs as well as numerous new websites catering to tourists, outdoor sports enthusiasts, and voyeurs (Krumenaker 1996). Among the latter websites is the JenniCam (*www.jennicam.com*) project of web pioneer Jennifer Ringley, who serves up snapshots from cameras strategically placed throughout her apartment (Tanaka 1999). For $15 a year JenniCam "members" can have their screens refreshed every minute, while "guests" may update only once every 15 minutes. Less risqué is KittyCam (*www.kittycam.com*), which offers free glimpses every two minutes of an elegant, long-haired black cat adopted in 1995 by the employees of Joint Solutions Marketing, a California consulting and design firm (Fredrickson 1998; Marder 1998). The following year the company bought a QuickCam—to photograph for the cover of an Apple Computer catalog. With the cover shot out of the way, employees installed the camera in the conference room and connected it to the firm's website. The resulting 'TableCam' was predictably boring, but someone suggested relocating the camera to focus on Kitty's favorite chair. The new theme proved remarkably popular— KittyCam averages two thousand visitors a day—and the company set up a separate website to commemorate its feline partner and feral cats in general. In summer 2000, the website began offering a variety of 'Kitty' merchandise, including the Kitty Mug, a Kitty Mousepad, and Kitty Coasters.

Among the earliest cartographic references to webcams is Bill Thoen's April 1996 column in *GIS World*. Thoen, who operates a GIS-oriented bulletin board, observed a growing use of webcams to promote tourism, warn of traffic congestion, and illustrate temporal phenomena like plant growth and bacterial decay. The following year, in a paper on "New Media and Their Applications to the Production of Map Products," William Cartwright (1997) proposed the webcam as a "reality link" to provide the "ground truthing" without which some viewers have difficulty comprehending cartographic animations and other visually complex geospatial multimedia. Particularly promising are interactive webcams, designed to pan, tilt, and zoom under the user's control. More recently, Cartwright (1999) listed webcams with games interfaces as "hybrid tools" useful in enhancing the cognitive accessibility and

informativeness of Internet cartography.[1] And Fraser Taylor (1999), a cartographer with an early interest in Web technology, echoed the importance of webcam-based links to reality in "edutainment" (educational entertainment) multimedia.

Webcams, I will argue, have a wider role in electronic cartography. At the comparatively minute, local level, for instance, webcam images can serve as point symbols—and in some cases direction-specific point symbols—providing qualitative or quantitative information about places. At a broader level, webcams are a relatively conspicuous element of cartographic surveillance, a mode of map use concerned more with control and manipulation than with learning and understanding. Webcams also address the conventional didactic and explanatory functions of atlas illustrations, albeit with a very timely and often dramatic twist. And because webcams exist at discrete points on the earth's surface, index maps storing their locations are important to users interested in spatial knowledge or surveillance. Equally pertinent are comparatively large-scale maps pinpointing the locations of individual webcams within their immediate neighborhoods. This multifaceted complementarity of maps and webcams suggests a duality in which webcams enhance our appreciation of mapped phenomena and maps help users locate relevant webcams.

"At a broader level, webcams are a relatively conspicuous element of cartographic surveillance, a mode of map use concerned more with control and manipulation than with learning and understanding."

WEBCAMS AS POINT SYMBOLS

The notion of webcam images as point symbols is not as farfetched as it might seem. Although I have yet to find a literal example, the small size of most webcam images would let a single map provide the geographic framework for a simultaneous display of multiple webcams. Figure 1, concocted by copying and pasting approximately simultaneous images from a traffic-monitoring website, illustrates what I mean. The icons are webcam images for various points along Interstate Highway 66, in northern Virginia. I found them on the Virginia Department of Transportation's HighwayNet (*www.highwaynet.com*), one of a growing number of traffic-monitoring websites (Lyons and McDonald 1998). VaDoT uses the website to promote its concern with traffic safety as well as help motorists avoid congested areas. Although pictorial images smaller than an inch or so wide are difficult to comprehend on both screen and paper, a regional map that allowed users to pan and zoom could support the website's ultimate collection of 110 webcams in the Washington, D.C. area. (In mid-August 2000, 25 cameras were in operation, and a FAQ page promised a fully operating system with 110 cameras in the near future.) Because the webcam can point in the

"The icons are webcam images for various points along Interstate Highway 66, in northern Virginia."
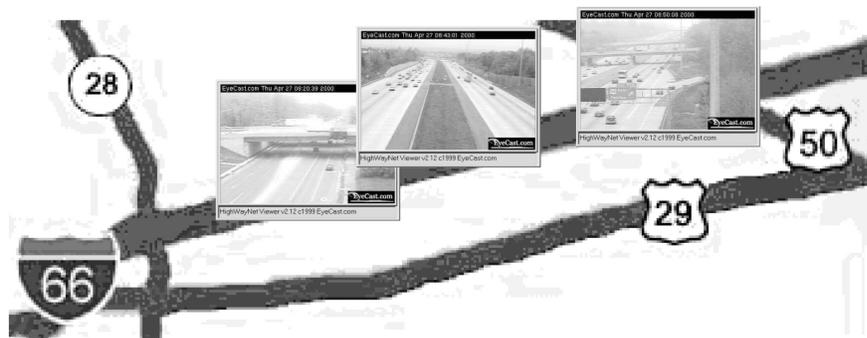

Figure 1. Hypothetical map uses webcam images as cartographic point symbols to describe approximate camera location as well as road conditions along Interstate 66 between Routes 28 and 50 in northern Virginia. Compiled with webcam images on the Virginia Department of Transportation's traffic camera website (www.highwaynet.com).
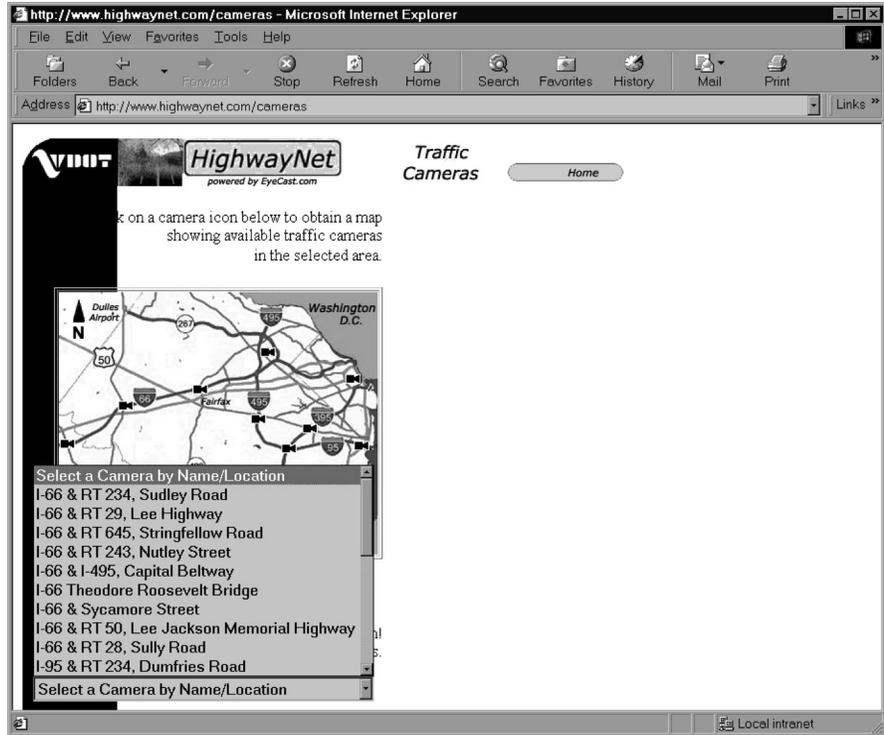
Figure 2. Virginia Department of Transportation's website provides a list of webcam locations as a pop-up menu atop an area map showing sections of highway with more detailed cartographic menus, as shown in Figure 3.
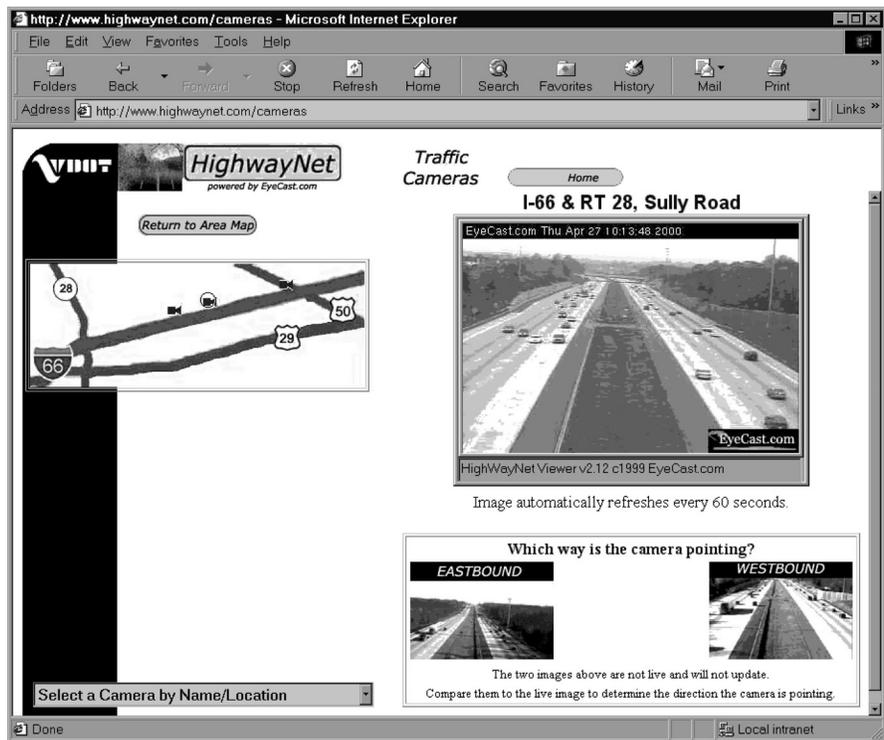
Figure 3. Webcam (right) shares the screen with a detailed index-map excerpt (left) on which camera-like icons show webcam locations. Faint circle surrounding the center icon marks the camera's location. Pair of example views below the webcam image helps the viewer identify direction in which the camera is pointing.

opposite direction, sample east- and westbound images (lower right in Figure 3) are needed.

Virginia's traffic website displays its webcam links in two ways. A pop-up menu offers a scrollable list of locations, as shown in Figure 2, and a two-level hierarchy of index maps identifies camera locations with clickable camera-like icons as shown in Figure 2 (partly obscured) and in Figure 3 (at the more detailed level). By contrast, the LIVE Camera Shots website of Montgomery County, Maryland's Department of Public Works and Transportation provides motorists on the opposite side of the Potomac with a list of clickable labels identifying intersecting roads and arranged by area or route (as in Figure 4). Because a geographically sequenced list of links is a crude topological map of sorts, webcams function as point symbols even though the user cannot simultaneously view their respective scenes. In principle, linear lists of clickable point symbols are similar in structure to the American Automobile Association's TripTiks, Amtrak's route maps for individual trains, and other route-specific cartographic narratives.

Traffic-flow websites illustrate the webcam's role as a quantitative point symbol. In showing the number of vehicles along a particular stretch of highway, the webcam offers a readily interpreted representation of traffic density and congestion (Figure 5). And if a rapid refresh rate allows multiple snapshots of moving vehicles, the webcam describes flow velocity as well as traffic volume. What's more, by allowing the viewer to count quickly the number of lanes that are open and moving freely, the webcam reveals the road's innate capacity as well as temporary constrictions caused by accidents or construction. In general, traffic webcams offer viewers four quantitative cues akin to the map author's visual variables (e.g., MacEachren 1995, 270-276): lanes of traffic, which reflects the road's

". . . webcams function as point symbols even though the user cannot simultaneously view their respective scenes."

". . . traffic webcams offer viewers four quantitative cues akin to the map author's visual variables . . ."
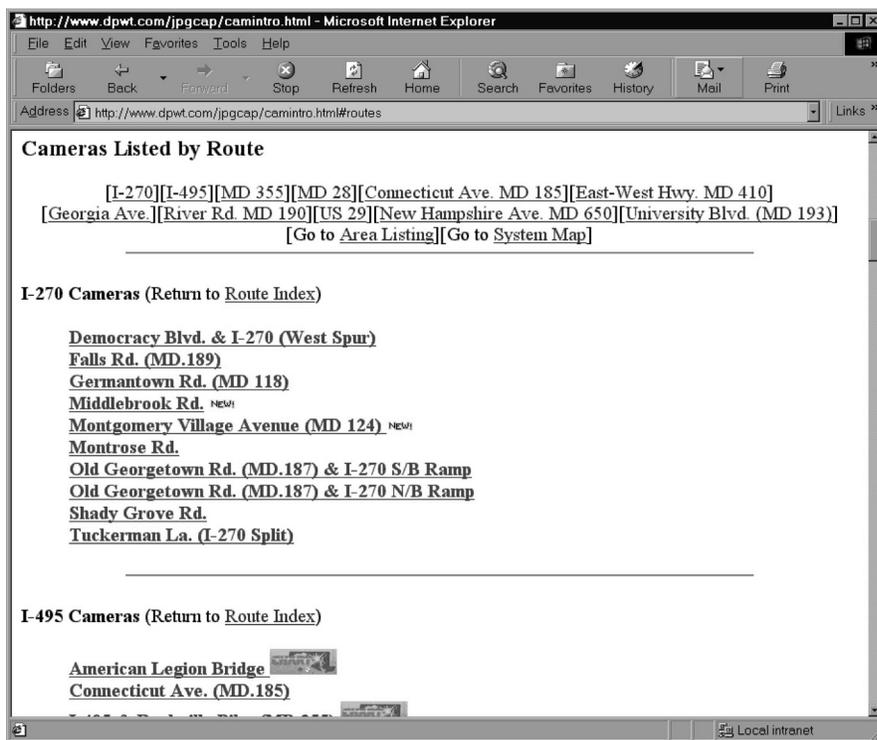

Figure 4. On its LIVE Camera Shots website (www.dpwt.com/jpgcap), Montgomery County, Maryland's Department of Public Works and Transportation offers motorists a linear list of webcam links, organized by route.
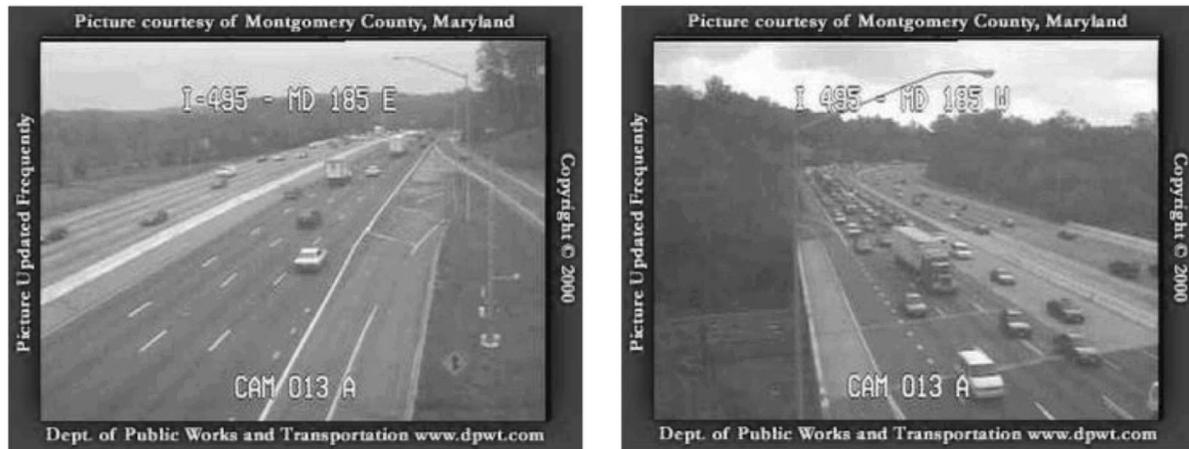
Figure 5. Webcam monitoring of Washington, D.C.'s Capital Beltway (I-495) at Connecticut Avenue shows different traffic conditions at 10:30 am (left) and 5:28 pm (right) on Wednesday, April 27, 2000. Note reversed camera orientations, to avoid direct sunlight.

functional width or *size*; the overall *numerousness* of vehicles, which indicates density of traffic and likely congestion; the *texture* or spacing of vehicles, which can reveal either the frustration of stalled traffic or the risk of a rear-end collision; and average speed, a dynamic variable that David DiBiase and his colleagues (1992) call *rate of change*. Although machine vision technology could convert each of these four cues into a number (Michalopoulos and Samartin 1998), the webcam affords a more direct, readily interpreted view of traffic flow than the comparatively abstract symbols with which conventional maps represent numerical estimates. Differences in the height and orientation of individual cameras thwart exact comparisons of webcams at different locations, but viewers familiar with the website and local highways should have little difficulty comparing routes and avoiding tie-ups.

Traffic websites are not the only examples of webcam images serving as quantitative point symbols. Webcams monitoring beaches, recreation areas, and business districts afford visual assessments of crowdedness based on the numerousness of people, not vehicles, and cameras at websites for surfers portray (or at least suggest) the height of waves. For an example, visit Gary's Surf Cam (*www.netsurfing.com/surfcam*) for hourly photos from Surfside, Texas, and links to forecast maps showing wave height and predominant wave direction in the Gulf of Mexico.

At weather and tourist websites, where sunshine is a key concern, webcams employ another quantitative visual variable, *value*, which registers cloud cover in addition to obvious seasonal and diurnal effects on solar radiation. Like most other imaging instruments, webcams respond readily to visible light, and few cartographic symbols employ value as effectively as sensors able to contrast the bright backgrounds of clear, sunny days with the less inviting scenes of overcast or stormy skies. However difficult the exact comparison of different locations, weather webcams offer viewers a quick check on sunshine and visibility as well as a qualitative assessment of the presence and type of precipitation. And full-disk and continental cloud-cover images (Figure 6) transmitted every quarter or half hour from geostationary meteorological satellites—perhaps the ultimate webcams—extend the analogy even further. In this latter case, though, cartographic processing clarifies the raw images by adding appropriately projected coastline symbols.

"Although machine vision technology could convert each of these four cues into a number . . ."

"Webcams monitoring beaches, recreation areas, and business districts afford visual assessments of crowdedness . . ."
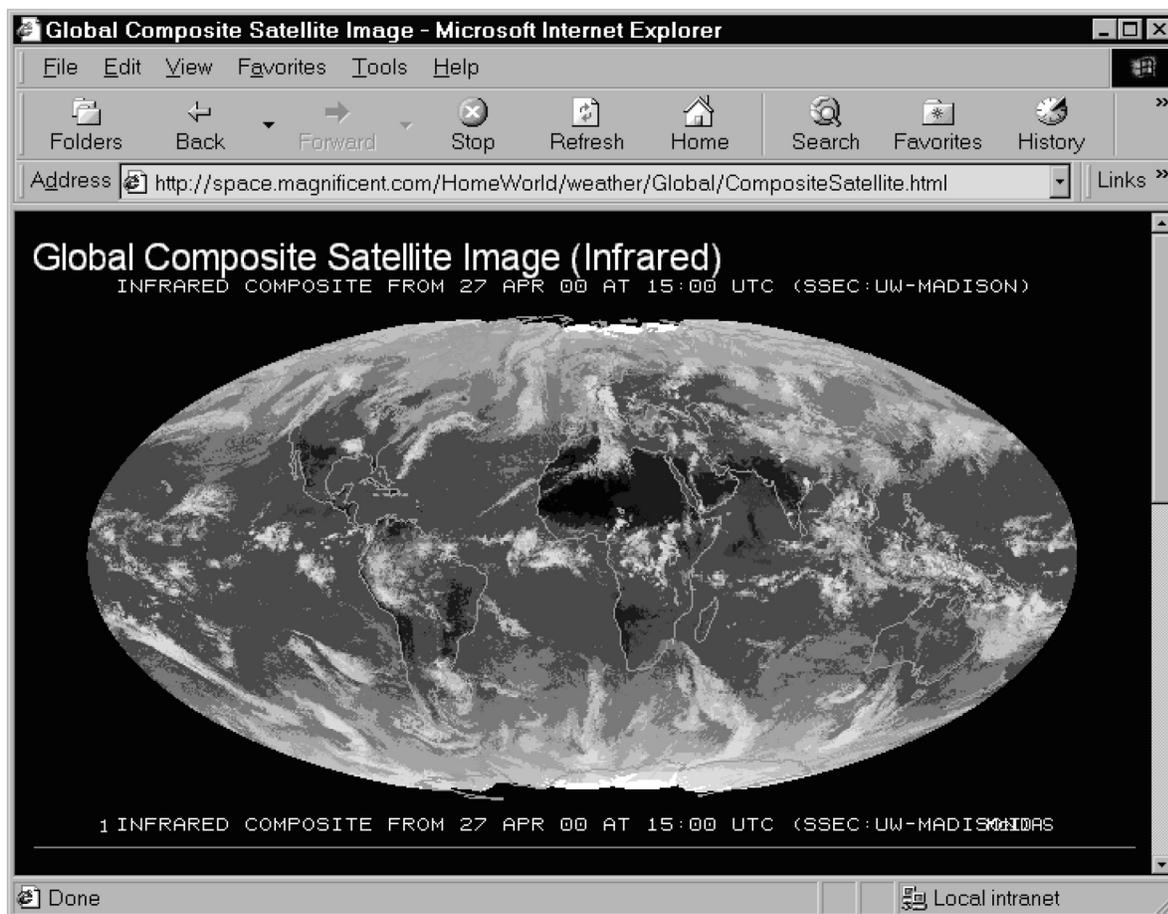
Figure 6. Composite of three transformed infrared satellite images prepared by the Space Science and Engineering Center at the University of Wisconsin—Madison.

Although weathercams and surfercams often blur distinctions between the qualitative and the quantitative, webcams as point symbols are more likely to highlight differences in kind than differences in amount or intensity. Indeed, powerful, often highly emotive contrasts in shape and hue underlie the popularity of webcams, which can capture the beauty of a sunset or pristine beach as well as the ugliness of a garbage dump or encroaching strip mine. As cartographic elements, webcams exemplify the map's prowess in communicating a selective, if not biased view of reality. A tourist website thus points its camera toward a historic home or spectacular seascape, rather than an overflowing trashcan or the impatient queue in front of a public toilet. In the same self-promoting vein, an environmental group would surely focus on a manufacturing plant's smokestack or polluted stream rather than the well-landscaped administration building or the new sport utility vehicles in its employee parking lot. Although webcams afford 'reality links' and 'ground truthing,' viewers must be wary that maps, photographs, and webcams, particularly in combination, can present a purposefully selective, highly rhetorical landscape narrative.

This caveat applies to interactive as well as fixed webcams. Viewers allowed to turn and tilt the camera are constrained nonetheless by a fixed pivot point chosen (one might assume) to afford multiple views, good or bad, that support the site owner's position. As developers of game software have demonstrated, interactivity can be seductively

"As cartographic elements, webcams exemplify the map's prowess in communicating a selective, if not biased view of reality."

engaging—and the key to making virtual and on-line environments believable (Houser and DeLoach 1998). Engaging the viewer's attention and prolonging the session can make the experience both memorable and believable.

WEBCAMS AS ATLAS ILLUSTRATIONS

As educators and authors of school atlases are well aware, maps and photographic images are inherently complementary. Learning, after all, depends upon a variety of devices, among them writing, pictures, and various diagrams, including maps, which excel at describing relative distances, geographic shapes, routes, patterns of distribution, and landscapes in general. But because many maps are collections of abstract geometric symbols, carefully chosen photographs can provide a useful bridge between the symbol and the viewer's experience. A map on which small colored circle identifies a city as a tourist mecca is less effective than the atlas or guidebook that depicts a landscape of attractive scenery, intriguing landmarks, comfortable inns, and inviting restaurants. And it's easier to appreciate a map of tropical farming if images of rice paddies and toiling peasants are nearby. If a webcam's link to a particular map symbol is especially strong (as in Figure 3), the symbol-photo pair clearly qualifies as a 'self-describing symbol,' defined by Suzette Miller (1999, esp. 57-58) as carrying its own description and requiring no map key (except perhaps to show the camera's location and orientation).

". . . carefully chosen photographs can provide a useful bridge between the symbol and the viewer's experience."

William Cartwright and Michael Peterson (1999) have remarked that the world atlas is perhaps the quintessential metaphor for multimedia cartography. Microsoft's Encarta Interactive World Atlas 2000 illustrates their point with a display engine that can integrate maps with pictures on the fly (Jacso 1998). The atlas's Multimedia Map is an interactive globe, which the viewer can rotate as well as enlarge or shrink. To the left of the map, a menu offers a choice of themes: people, places, landscapes, agriculture and industry, animals, and "all." As the viewer moves the mouse pointer across the map, three or four small rectangular frames in the vicinity become active (Figure 7). These frames, which contain thumbnail photos of the chosen variety, are roughly a centimeter tall on my monitor. In each frame Encarta cycles through a set of different pictures, which describe scenes in the vicinity. A highlighted border around the closest frame invites the viewer to launch a small window with a larger view, a verbal explanation of the scene, and a series of thumbnail images, which can be enlarged and viewed as a slide show. (Elsewhere within its main menu, the atlas offers a number of video articles describing various aspects of an area's culture, economy, or landscape.)

"William Cartwright and Michael Peterson (1999) have remarked that the world atlas is perhaps the quintessential metaphor for multimedia cartography."

An embedded web browser links the user to a dedicated website (*encarta.msn.com/ewa*), which serves as an alphabetical index of place-specific directories for retrieving a vast variety of images too numerous and demanding for a pair of CD-ROMs. Although few of the websites indexed have their own webcams, many sites' own links often point directly or through a 'search' function to other local websites with webcams. Closer integration of the atlas software with the browser—the Justice Department's Anti-Trust Division not withstanding—would allow webcams to support an interactive display similar to the atlas's Multimedia Map. However intriguing, this design relies on high-capacity bandwidth connections and, perhaps more problematic, depends upon a suitable variety of predictably reliable webcams. Darkness is less troublesome because stored images (or indoor alternatives, perhaps) might compensate for the inevitable limitations of outdoor webcams in parts of the world temporarily on the dark side of the circle of solar il-

Figure 7. Excerpt of pop-up photo images from the Multimedia Map in Microsoft Encarta Interactive World Atlas 2000 illustrates a potential use of webcams in a real-time interactive world atlas.

lumination. In any event, a fuller integration of webcams with world and regional atlases seems inevitable when improved bandwidth makes the CD-ROM atlas obsolete.

Webcams depend on maps in two fundamental ways: to help users find a camera relevant to their needs and to describe a camera's location and perhaps its footprint or viewshed. As the Virginia highway webcam in Figure 3 demonstrates, a sectional map might play the role of both locator map and map index, whereas a less detailed map covering the entire area (Figure 2, partly hidden by the pop-up menu) is little more than a cartographic index for the website's ten multi-camera locator maps. This hierarchical, two-tiered organization is useful if not essential, given the modest resolution of computer monitors and the complexity of describing sophisticated multi-camera websites.

WEBCAMS AND THE MAP INDEX

     Montgomery County, Maryland's trafficams illustrate a somewhat different approach. To help viewers find the most suitable camera, the LIVE Camera Shots website supplements its route-oriented lists of camera locations with a clickable county index map (Figure 8) linked to four regional index maps describing dozens of cameras located along principal streets (Figure 9). The latter maps provide a more detailed geographic frame of reference than their Virginia counterpart (Figure 3). Individual webcam images are presented without an adjacent locator map.

"Webcams depend on maps in two fundamental ways: to help users find a camera relevant to their needs and to describe a camera's location and perhaps its footprint or viewshed."

     Inadequate index and locator maps are a deficiency of many geographically useful webcam directories. Sites lacking a cartographic index as well as locator maps include AfriCam (*www.africam.com*), an ecotourism website with links to 14 cameras in African national parks, and the Live Weather Images (*www.weatherimages.org*) website's worldwide listing of several hundred "weather and tower cams." Although the seriousness

Questions/Comments? Contact our [Webmaster]

Click on an area to zoom in to camera locations.

FREDERICK COUNTY

MONTGOMERY COUNTY

HOWARD COUNTY

GERMANTOWN GAITHERSBURG

270

ROCKVILLE

SILVER SPRING / BETHESDA

POTOMAC

495

495

PRINCE GEORGE'S COUNTY

VIRGINIA

WASHINGTON D.C.

Figure 8. Clickable countywide index map provides links to four comparatively detailed index maps showing traffic webcam locations in different sections of Montgomery County, Maryland.
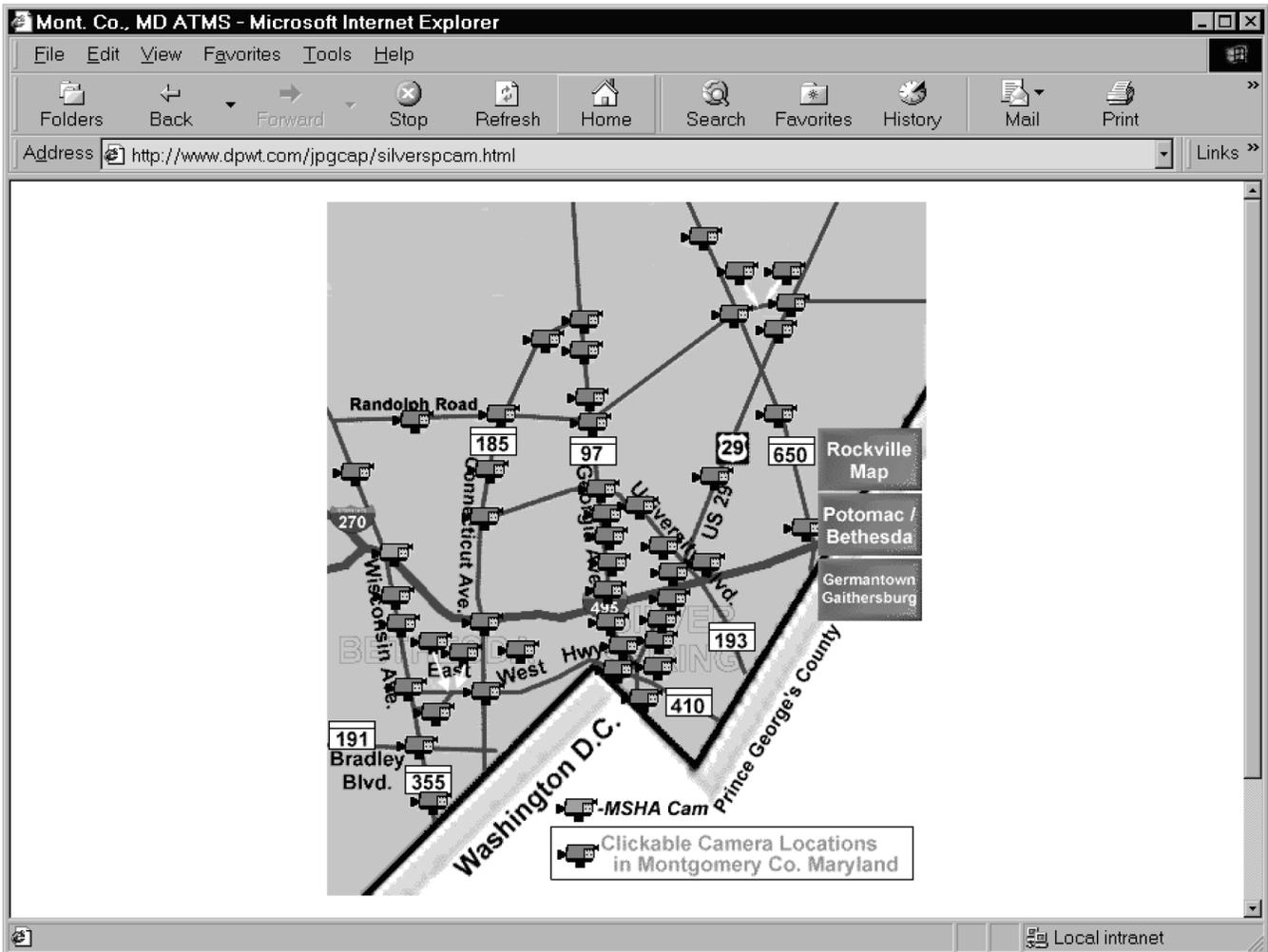
Figure 9. Detailed index map pinpoints traffic camera locations in the Silver Spring section of Montgomery County, Maryland.

of missing index maps is easily exaggerated—most surfers or weather enthusiasts, I suspect, are content to find a camera only vaguely representative of a particular coast or country—the lost opportunity to impart geographic knowledge is unfortunate. By contrast, the World Map of Live Webcams (*dove.mtx.net.au/~punky*) makes effective use of a two-tier clickable index map that identifies cameras temporarily out of service and offers the picture of a globe suitably turned to show areas currently with daylight (Figure 10).

Although index maps (when offered) seem suitable, locator maps are almost always vague about the area covered by the camera. As with index maps, additional information might prove unnecessary if not useless for most viewers. Traffic websites, for which location is indeed relevant, communicate camera locations effectively with a combination of words, highly generalized maps, and directional keys, while tourist websites, not intended for wayfinding, need nothing more than a well-chosen view and a verbal description.

However adequate the design of most webcam index and locator maps, none that I encountered is as detailed as a map published a couple of years ago in *The Atlantic Monthly* (Reeder 1998). Compiled by University of Kentucky geographers Matt McCourt and Carl Dahlman, the map described the assumed footprints of more than 70 surveillance cameras in a three-block section of Midtown Manhattan. Innovative symbols illustrated each camera's range and differentiated fixed cameras from dome-housed cameras able to pan. Although none were webcams, the map was a pow-

"Although index maps (when offered) seem suitable, locator maps are almost always vague about the area covered by the camera."

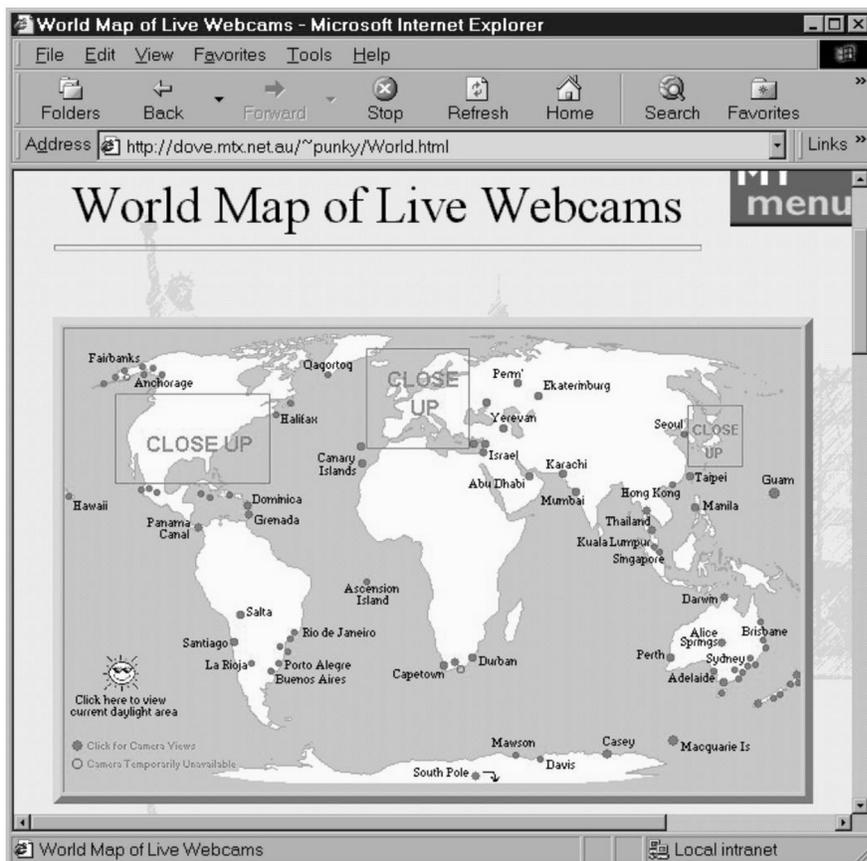WEBCAMS AND THE CARTOGRAPHY OF SURVEILLANCE

Figure 10. Primary cartographic index of the World Map of Live Webcams, a clickable Australian directory with more detailed index maps for the United States, Europe, and Japan.

erful rhetorical statement of the threat of security cameras to personal privacy in public places.

The *Atlantic* map suggests an ominously Orwellian scenario in which similar symbols are the key elements of an interactive, hierarchical directory to a web of surveillance cameras throughout our business districts, neighborhoods, and parking lots. The technology is straightforward, and the cost is not beyond the pocketbook of an electorate overcome with fears similar to those of Manhattan building owners. What better way to warn off villains than to suggest the steady stare of electronic eyes with which anyone—surely someone somewhere, anywhere—might be watching. With millions of little brothers (and little sisters) watching, who needs Big Brother?

Were I a postmodern critical theorist, this would be my cue to invoke the Panopticon, a late-eighteenth-century invention of British philosopher Jeremy Bentham as well as a favored emblem of the late Michel Foucault and kindred spirits who write of the "panoptic gaze" of the "panoptic state" (e.g., Staples 1997, 27-29; Whitaker 1999, 32-48). Bentham proposed a prison that kept prisoners under constant scrutiny with a one-way viewport through which an unseen "inspector" could (if he chose) monitor an inhabitant's every move at any time. However fashionable among postmodern theorists and privacy advocates, Bentham's impressively intriguing diagram seems as useful a concept as the equally naïve drawings of nineteenth-century flying machines that wouldn't fly and were never built. Even so, strident proponents of the Panopticon hawk dire warnings laced with blatant technological determinism, and one recent writer includes the webcam in his list of threats to personal privacy (Garfinkel 2000, 110-112). It's possible, I concede, but hardly likely. Other monitoring systems are more efficient, and other threats to personal privacy—GPS-based location tracking and signal-intelligence monitoring networks with automatic speech-to-text conversion come readily to mind—are more intriguing if not more plausible.

That said, it's equally clear that twenty-first century cartography will be very much a cartography of surveillance, capable of monitoring a broad range of threats, environmental and military as well as criminal, and posing ethical dilemmas no less daunting than the problems of genetic cloning explored in Aldous Huxley's prescient 1932 novel *Brave New World*. Webcams and their cartographic directories will no doubt have at least a minor role in geographic surveillance, perhaps with much the same collective clout as personal and community webpages touting news and entertainment. No less intriguing than the Panopticon is the prospect of millions of avid geoexhibitionists, proud of or embarrassed by their surroundings and clamoring for the attention of a mass audience of curious cartovoyeurs.

"The Atlantic *map suggests an ominously Orwellian scenario . . ."*

". . . it's equally clear that twenty-first century cartography will be very much a cartography of surveillance, . . ."

NOTES

1. Oddly Cartwright and co-author Gary Hunter (1999, 268) do not mention webcams by name in a list of distributed information for "the Literate Traveler." Even so, their list includes a variety of web-delivered pictorial information, including photographic collections, broadcast television, and Real Audio Web television.

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A New Technology for Interactive Online Mapping with Vector Markup and XML

As Internet cartography matures from static map images to interactive and animated maps, and embraces extensive GIS functionality, the limitations of presenting Web maps as image files become obvious. In this paper, a new technology for Internet cartography is demonstrated that uses direct vector rendering in a browser to create highly interactive virtual maps from distributed sources of geographic data. This technology is made possible by the advent of XML (eXtensible Markup Language) and XML applications for 2D vector rendering such as VML (Vector Markup Language) and SVG (Scalable Vector Graphics). AXIOMAP – <u>A</u>pplication of <u>X</u>ML for <u>I</u>nteractive <u>O</u>nline <u>M</u>apping – is a Web map publishing kit and a customizable virtual map interface that allows for the display and manipulation of multiple point, line and area layers, database query, choropleth mapping, hyperlinking, map labeling and annotation. To render maps in a Web browser (Internet Explorer 5, in the current version), AXIOMAP generates VML shapes "on the fly" from XML-encoded geographic data that can physically reside on different servers. A thin client-side solution, AXIOMAP provides for better interactivity than traditional map server-based approaches. The paper explains the functionality of AXIOMAP, the technology behind it, and presents several applications. A free version of the software can be downloaded from <u>www.elzaresearch.com/landv/</u>.

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INTRODUCTION

Within mainstream online mapping technology, servers generate maps as pictures in one of the standard raster graphic formats supported by graphical web browsers. Interactivity is accomplished by delivering an updated map image in response to user requests. Examples of the Internet map server technology include multiple web mapping sites powered by ESRI's ArcView IMS, MapObjects IMS, or ArcIMS [ESRI, 2000], MapInfo's MapeXtreme and MapXsite [MapInfo, 2000], etc.

This typical architecture has an important advantage of being able to accommodate almost any client graphic browser (since client requirements are minimal) and provide access to significant GIS functionality and large databases residing on a server. However, as noted in Andrienko and Andrienko (1999) and Stynes et. al. (1996), such server-side solutions place severe restrictions on map interactivity. Additional technical limitations include:

(1) Changes, even minimal, to a currently displayed map require a "round-trip" to the map server, resulting in lower update speed and increased network load, especially with large images (a common solution therefore is to keep the image size small);

(2) Since each "map picture" has to be generated by the map server, scalability in terms of number of simultaneous users becomes an important issue. Efficient scalability solutions exist but they tend to be expensive; and

(3)   Cumbersome object identification on a raster image and loss of visual quality during zoom are common.

At least the first two technical limitations of this mainstream model have important social implications. Organizations and companies willing to provide efficient interactive web mapping should be able to afford powerful servers and a high bandwidth uplink connection. Combined with the high cost typical of the map server software itself, this leads to a large number of producers and users of geographic data being excluded from interactive map publishing. The mainstream technology reinforces a de-facto *"digital mapping divide"* where global, regional, and municipal powers still determine which data are collected and shared with the public. Neighborhoods and communities, non-profit agencies and small companies, as well as organizations that rely on common hosting services to publish their Web pages, still have limited means of making an impact on how geographic information is collected and presented, and hence on decision-making processes that may affect them directly. Interestingly, this situation in Internet cartography echoes the concerns expressed earlier by Harley [1988] and Wood [1992]. The technology described in this paper provides an affordable way for communities to transform static maps into highly interactive documents which have the potential of being subversive, dynamic, and more culturally and politically charged.

Various client-server and client-side technologies for online mapping provide an alternative to the "picture case" described above (following the terminology from the OpenGIS "Web Map Server Interface Specification" [Open GIS Consortium, 2000]). Client-side solutions typically are implemented in Java, ActiveX or with the help of various specialized browser plug-ins for handling vector graphics. Mapping software is either pre-installed on the client computer, or is downloaded each time along with map information. Large download size for software (1 MB on average, as noted by Kendall, 1999), the possible incompatibility with a client computer, and the potentially large size of data files to be transmitted over network are the major drawbacks of this solution. However, manipulating vector data on the client side allows for enhanced interactivity and performance advantages due to a reduced number of server requests. Excellent examples of this technology are given by the CIESIN's Demographic Viewer [CIESIN, 2000] and the Descartes system [Andrienko and Andrienko, 1999] developed as Java applets, GeoMedia Web Map [Intergraph, 2000] and AutoDesk MapGuide [Autodesk, 2000] which require special plug-ins. Compared to these examples, the technology described in this paper represents, in a sense, a "thin" client as it relies on vector rendering and XML capabilities of the browser and does not require any Java/ActiveX applications or plug-ins, either pre-installed or downloaded with the data.

The choice of a Web mapping architecture depends on many factors. These include bandwidth, price, graphic quality, interactivity, and the server and client-side compatibility considerations mentioned earlier, as well as the needs of a particular online mapping application. If most user requests expect a new set of geographic features to be displayed each time on the client-side (mapping the vicinity of a user-specified address, driving directions, etc.), the advantages of client-side caching of vector coordinates are minimal or non-existent. If user requests repeatedly ask for a map with the same or similar geographic features, re-using vector geometry information already cached on the client can lead to significant performance and interactivity gains in atlas and thematic mapping applications

"The mainstream technology reinforces a de-facto **"digital mapping divide"** *where global, regional, and municipal powers still determine which data are collected and shared with the public."*

"The technology described in this paper provides an affordable way for communities to transform static maps into highly interactive documents which have the potential of being subversive, dynamic, and more culturally and politically charged."

with a relatively large amount of attribute data. For such applications, a vector-based client-side solution appears more appropriate, especially since most graphic browsers provide automatic caching mechanisms that speed up access to recently used data.

With the advent of XML and XML-based vector graphics languages, a new and interesting mechanism for client-side vector mapping became possible. The Vector Markup Language as implemented in Internet Explorer 5 allows for encoding and scripting of inline graphic primitives in standard HTML files, and vector rendering in a browser without any special plug-ins or large software downloads. The project described in this paper implements this latest trend in the form of a light client-side interactive mapping system called AXIOMAP: Application of XML for Interactive Online Mapping [ELZA Research, 2000].

The following section reviews the emerging XML-based standards for representing and rendering geographic data, followed by a functional description of AXIOMAP in the second section. Applications of AXIOMAP, as well as its potential as a user front-end for a distributed mediated GIS are discussed in the last section.

EMERGING WEB STANDARDS FOR GEOGRAPHIC DATA

Recommended by W3C [W3C, 1998a], XML (eXtensible Markup Language) emerges as the new *Lingua Franca* for data interchange on the Web. It provides for semantic tagging of hierarchically-organized semi-structured data (i.e. data with changing structure, omissions and repetitions—which is often the case with geographic data). XML files are editable text files, and provide a flexible platform-independent format for exchanging information between heterogeneous systems over the Internet. Most database vendors already support or plan to support XML. In the realm of computer mapping and GIS, the interest towards XML is also growing, with major vendors such as ESRI, MapInfo, Intergraph, Oracle, CadCorp, LaserScan etc. starting to offer XML solutions as part of their Web GIS suites (company web sites and private communication).

Within the Open GIS Consortium, a focus on XML has been expressed, for example, in defining Web map server capabilities in XML [Open GIS Consortium, 2000], and representing the OGIS simple features [Open GIS Consortium, 1997] in the form of Geography Markup Language (GML). While the system described here was developed prior to release of GML drafts, it adheres to similar principles. AXIOMAP uses a simplified DTD (Document Type Definition) to represent geographic feature collections as XML documents. Geographic features are exported into XML from a desktop GIS (ESRI's ArcView 3) and rendered in a browser as VML shapes. Compared to current GML DTD which is tuned to platform-independent storage and exchange of geographic data, the AXIOMAP DTD is tuned to efficient VML rendering of interactive maps (as discussed in the next section). However, recasting GML files in AXIOMAP DTD, and vice versa, appears straightforward with XSLT [W3C, 1999] as the DTD differences are not dramatic.

A very important recent development for Web cartography is a number of XML-based languages for 2D vector graphics proposed to the World Wide Web Consortium (W3C). Among them, the Vector Markup Language (VML), Precision Graphics Markup Language (PGML) and, most recently, the Scalable Vector Graphics (SVG) formats provide a mechanism for encoding and scripting graphic primitives for rendering in a browser. PGML (derived to a large extent from Postscript) and VML (with a simpler rendering engine) exist as W3C proposals, while SVG [W3C, 2000], a joint development of the two teams initially behind VML

"A very important recent development for Web cartography is a number of XML-based languages for 2D vector graphics proposed to the World Wide Web Consortium."

and PGML, is close to becoming a W3C recommendation (at the time of writing).

VML [W3C, 1998b] is implemented in Microsoft's Internet Explorer 5 and is the graphics interchange format within the Microsoft Office 2000 suite. In contrast to VML, using SVG currently requires a special viewer. Several SVG viewers have been developed [IBM, 2000; CSIRO, 2000], and a browser SVG plug-in has been recently released by Adobe [Adobe, 2000]. With further adoption of vector graphic formats in browsers and the development of export mechanisms from popular GIS into these formats, VML and SVG have the potential of making a revolutionary change in the way geographic information is displayed and used on the Internet.

AXIOMAP: OVERVIEW OF THE TECHNOLOGY

The AXIOMAP system (ELZA Research, 2000) consists of two modules. The first module is an ArcView extension for converting ArcView themes into XML files conforming to AXIOMAP DTD. The second module is a map viewer application written in Javascript, with the use of browser DOM (Document Object Model) and Cascading Style Sheets. The entire package can be downloaded from http://www.elzaresearch.com/landv/.

To publish a particular interactive map on the Internet, one needs to create a set of XML files by running the ArcView extension, and copy them, along with the map viewer, to a Web server. The XML files contain geometric (vertex coordinates of features), attribute and rendering information for each map layer. In addition, the ArcView extension creates a project organization file with names, locations and rendering styles of all layers registered to the map, and general map rendering instructions (map title, extent, annotation, projection, coordinate translation scheme, several GUI elements for the initial map view, etc.). When creating the collection of XML files, a map publisher specifies:

"With further adoption of vector graphic formats in browsers and the development of export mechanisms from popular GIS into these formats, VML and SVG have the potential of making a revolutionary change in the way geographic information is displayed and used on the Internet."

- **Rendering** style or symbol for a layer. By default, rendering styles are carried over from ArcView projects. However, the styles can be easily changed in a standard text editor by editing the XML files that contain rendering information.

- A variable to be used for **labeling** features. In the map viewing application, the feature labels can be turned on or off, or permanently attached to any part of the map. Feature labels (for thematic maps—along with attribute information) also appear as the user positions the mouse pointer over a feature.

- An optional variable containing **URLs** of pages to be opened when a user clicks on a particular map feature. The URLs can point to local or remote documents, or represent database requests, e-mail instructions, etc.

- **Location** of XML files representing a theme. The files for each layer can physically reside on a local computer or on one or several servers. In a distributed computing environment this ability allows one to maintain and update cartographic layers individually, thus ensuring that information displayed on a map is as current as possible.

- **Grouping** of different variables for effective presentation in the interface. This feature allows map publishers to provide user access to a large number of variables and themes from a relatively compact interface (in the example available at http://www.elzaresearch.com/landv/demo5/main.htm, users have access to 300 thematic

variables and 200 point layers describing physical conditions of buildings and streets in a neighborhood).

- **Color scheme** of the map viewer interface**.**
- **Language** of the interface and system messages. Currently, AXI-OMAP supports English, Spanish, French, Russian and Chinese languages (all language-specific information is stored in yet another XML file, so changing a language requires translation of only this file).
- **Coordinate system**. Spatial data can be converted from any coordinate system in ArcView into XML. However, distance buffers around point features will be enabled only for themes in UTM or latitude/longitude coordinates. For these coordinate systems, cursor position will be displayed in meters or decimal degrees respectively.

The structure of XML files ready to be served as an interactive map is shown in Figure 1. Each map resides in a separate folder containing at least an XML file with project organization information, metadata description, and a standard frameset and program calls. XML files for individual layers can reside in the same directory, or anywhere on the Web, as referenced from the project file.

Each XML file representing a particular layer contains coordinate strings for geographic features in this layer. For example, XML files for area layers represent a list of area records each of which contains the area ID, name and strings of vertex coordinates for polygons that compose the area. For the base area layer, area records can be linked to one or more attribute datasets also possibly residing on different servers as XML files. A fragment of an XML document with geometric information about San Diego neighborhoods is shown in Figure 2.

For the sake of rendering efficiency and small file size, feature coordinates stored in XML files are encoded as integer values with one or two more significant digits than maximum pixel resolution of a display. For example, with typical screen resolutions up to 1600 pixels, coordinate encoding in four-to-six significant digits provides enough visual quality during zooming. The coordinate translation scheme contained in the map
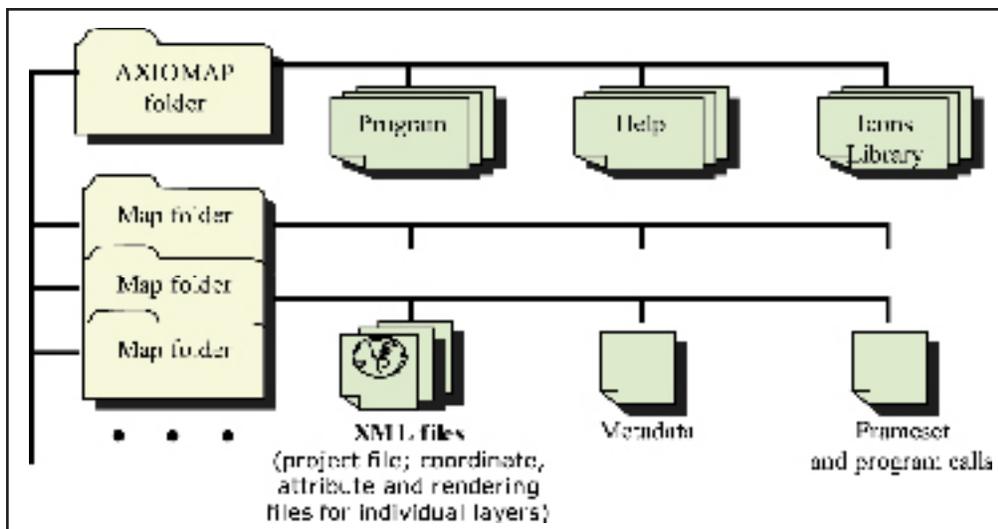
"XML files for individual layers can reside in the same directory, or anywhere on the Web, as referenced from the project file."

Figure 1. File organization of the AXIOMAP interactive map viewer.

```
<?xml version="1.0" encoding="iso-8859-1"?>
<rs>
<r><name>Horton Plaza</name><URL>horton.htm</URL><labelpos>41.46,77.51</labelpos>
<c>5076,1540 4986,1540 4895,1539 4803,1539 4715,1539 4622,1539 4534,1538 4534,1641
4534,1745 4534,1856 4622,1856 4711,1856 4800,1856 4893,1855 4984,1855 5075,1854 5075,1749
5076,1646 </c></r>
<r><name>Gaslamp</name><URL>gaslamp.htm</URL><labelpos>44.60,83.00</labelpos><c>5162
1013 5084,1057 5083,1116 5081,1222 5079,1326 5079,1433 5076,1540 5076,1646 5075,1749
5075,1854 5167,1854 5257,1855 5257,1750 5259,1647 5260,1541 5262,1434 5262,1328 5263,1222
5263,1013 </c></r>
. . .
```

Figure 2. A fragment of an XML document with information about two San Diego neighborhoods. Each neighborhood has a label (name), label position, an optional URL, and a list of coordinate pairs.

project file allows the re-computation of these numbers into approximate geographic coordinates "on the fly."

The second part of the AXIOMAP system is the viewer application which represents a DHTML client allowing users to construct multi-layer map presentations and control various aspects of map appearance. The viewer (its snapshot is shown in Figure 3), though less than 50K in size (less than 38K if the left frame of the viewer is pre-generated), allows users to:

"The second part of the AXIOMAP system is the viewer application which represents a DHTML client allowing users to construct multi-layer map presentations and control various aspects of map appearance."

- Perform instant choropleth mapping using datasets from different servers (controlling number of intervals and classification method). Users can also construct new variables as arithmetic functions of existing variables belonging to different datasets, and map them;
- Display/hide multiple point, line and polygon layers; label geographic features. These operations (as well as choropleth mapping) are accomplished without page refresh or map redraw, which enhances the user interaction experience. Particular map layers are fetched from Web servers only if they are requested by the user;
- Display, analyze and save attribute information for any object or a group of selected objects;
- Construct simple and incremental queries (based on multiple variables) and map query results;
- Navigate any map by zooming and panning, with user-defined zoom parameters. For better visual perception, different elements of map display are scaled in proportion to the zoom level. For example, the size of point symbols changes logarithmically with the zoom level;
- Connect with Web sites, databases, or local pages associated with geographic objects;
- Analyze proximity of various objects to one another, by drawing circles of specified radii and color, anywhere on the map;
- Control the position and content of the legend and annotation information; and
- Print out map documents along with accompanying statistical tables.

Several applications utilizing VML for map rendering on the Internet have been developed already [Gaborit, 2000; Geotask AG, 2000; Ground-
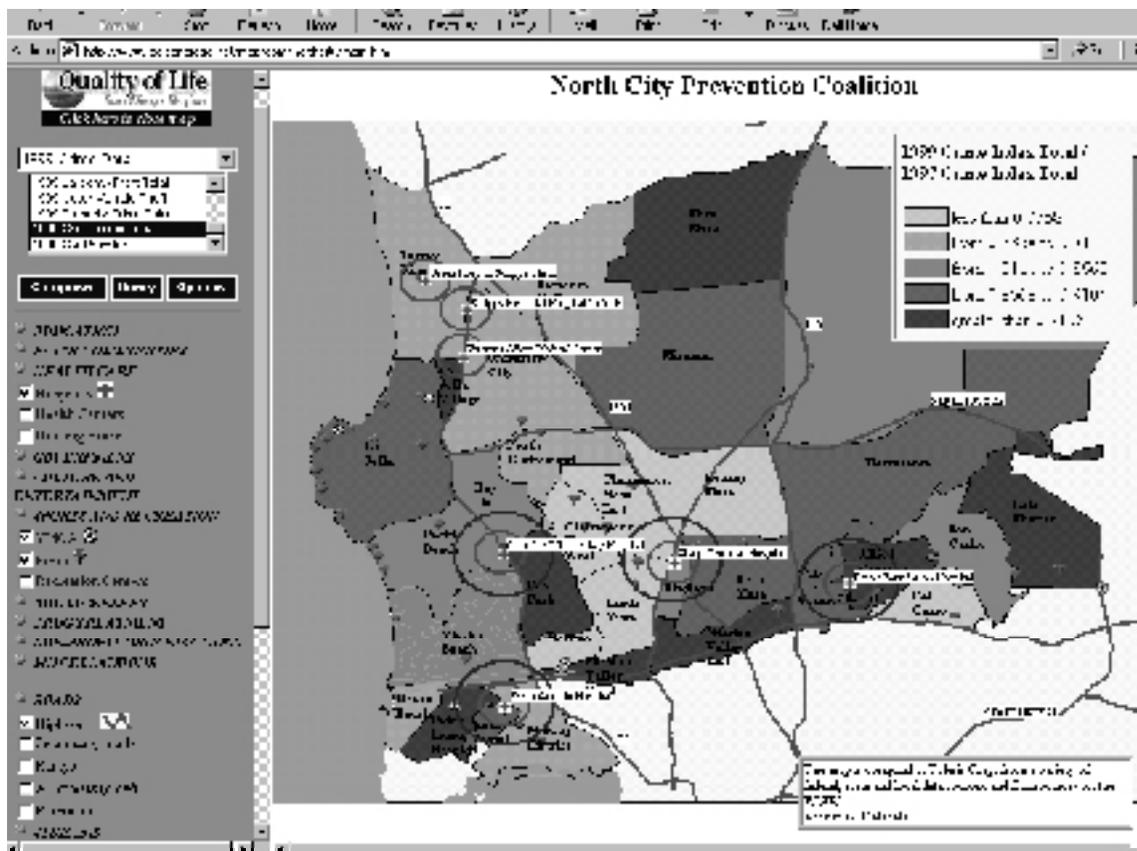
Figure 3. A snapshot of the AXIOMAP map viewer (data from the San Diego Quality of Life project).

control, 2000; XYZ Systemas, 2000]. A particular feature of AXIOMAP is that graphic elements, in VML format, are generated and displayed in a browser client "on the fly." An example of a VML fragment generated from the XML fragment in Figure 2, is presented in Figure 4. A dynamic virtual map represents a "layered cake" of VML snippets which can be individually created and manipulated, rather than a physical VML document. This reflects the difference between two architectures for Web vector mapping, named the "graphic element case" and the "data case" (or the "feature case") in the already cited OpenGIS document [Open GIS Consortium, 2000]. In the "graphic element case," graphic primitives of a vector map are pre-built or generated on a map server and sent across the network to the rendering client. In the "data case," server activity is limited to simply fetching data files on user requests, so that vector coordinates travel across the network and get converted to graphic primitives on the client side. The second approach, in our experience, provides for more latitude in defining interactive functionality of a web map, and results in smaller file sizes and easier attribute manipulations. With this architecture, implemented in the AXIOMAP viewer, meaningful and efficient user interaction with vector map data in the browser can be accomplished with much more modest computational resources compared to both "picture" and "graphic element" cases.

Since AXIOMAP works on the client side, it can be served from any Internet or Intranet server (in fact, it can even be used without a Web server). This flexibility comes at a price, however: for AXIOMAP to work, the client browser must support XML/VML (i.e. it has to be Internet

"With this architecture, implemented in the AXIOMAP viewer, meaningful and efficient user interaction with vector map data in the browser can be accomplished with much more modest computational resources compared to both "picture" and "graphic element" cases."

```
<html xmlns:v="urn:schemas-microsoft-com:vml"><head><style>v\:* { behavior:
url(#default#VML); }</style>
. . .
<v:shape id="a1" class=z style="left:0;top:0;width:11590;height:7547" fillcolor="#FFFF99" strokecol-
or="#000000" strokeweight="1" u="horton.htm" title="Horton Plaza" path="m5076,1540l
4986,1540 4895,1539 4803,1539 4715,1539 4622,1539 4534,1538 4534,1641 4534,1745 4534,1856
4622,1856 4711,1856 4800,1856 4893,1855 4984,1855 5075,1854 5075,1749
5076,1646xe"/><v:shape id="a2" class=z style="left:0;top:0;width:11590;height:7547"
fillcolor="#FFFF99" strokecolor="#000000" strokeweight="1" u="gaslamp.htm" title="Gaslamp"
path="m5162,1013l 5084,1057 5083,1116 5081,1222 5079,1326 5079,1433 5076,1540 5076,1646
5075,1749 5075,1854 5167,1854 5257,1855 5257,1750 5259,1647 5260,1541 5262,1434 5262,1328
5263,1222 5263,1013xe"/>
. . .
<div class=label style="top:75.51%; left:39.46%;">Horton Plaza</div><div class=label
style="top:81%; left:42.6%;">Gaslamp</div>
```

Figure 4. Fragments of the VML file generated by the AXIOMAP viewer from the XML document in Fig. 2.

Explorer 5), or – in the most recent cross-browser version - an Adobe SVG plug-in must be installed on the client side. While currently such client requirements limit the universal usability of this approach, standardization efforts on the side of W3C (especially as regards Web vector graphics, XML, DOM and ECMAscript) must improve the situation. At the same time, the AXIOMAP approach makes publishing interactive maps on the Web extremely simple, and provides for enhanced user interaction with map content.

APPLICATIONS

AXIOMAP features and flexibility made it a useful instrument in a range of projects. The two examples below describe a research testbed for spatial information mediation being developed within the MIX (Mediation of Information using XML) project of the San Diego Supercomputer Center, and a community mapping portal developed as part of the Quality of Life in San Diego project. In the first example, AXIOMAP works as a user front-end on top of server software that generates XML files in the process of responding to user queries. In the second example, AXIOMAP is used as a stand-alone viewing and analytical interface to multiple point, line and area layers stored as XML files.

"The goal of the spatial mediator system is to give a user the ability to issue a single query to access multiple heterogeneous geographic sources, retrieve different pieces of the result, and seamlessly assemble these pieces into a composite response."

AXIOMAP within MIX: interactive mapping of spatial query responses

The goal of the spatial mediator system is to give a user the ability to issue a single query to access multiple heterogeneous geographic sources, retrieve different pieces of the result, and seamlessly assemble these pieces into a composite response. Several earlier publications have focused on technical aspects of this wrapper-mediator framework for logical integration between geographic information sources [Gupta et al., 1999, 2000; Zaslavsky et al., 2000]. Figure 5 shows the general architecture of such a framework.

In this system, user requests are formulated from a web map interface (such as AXIOMAP) and sent to a *mediator*. The mediator generates a query evaluation plan, decomposes the request into small fragments and dispatches them to the appropriate sources of geographic data and services. The data and services, in turn, are "wrapped" into conversion software (a *wrapper*) that translates request fragments into the language of a particular source (a sequence of Avenue instructions in our
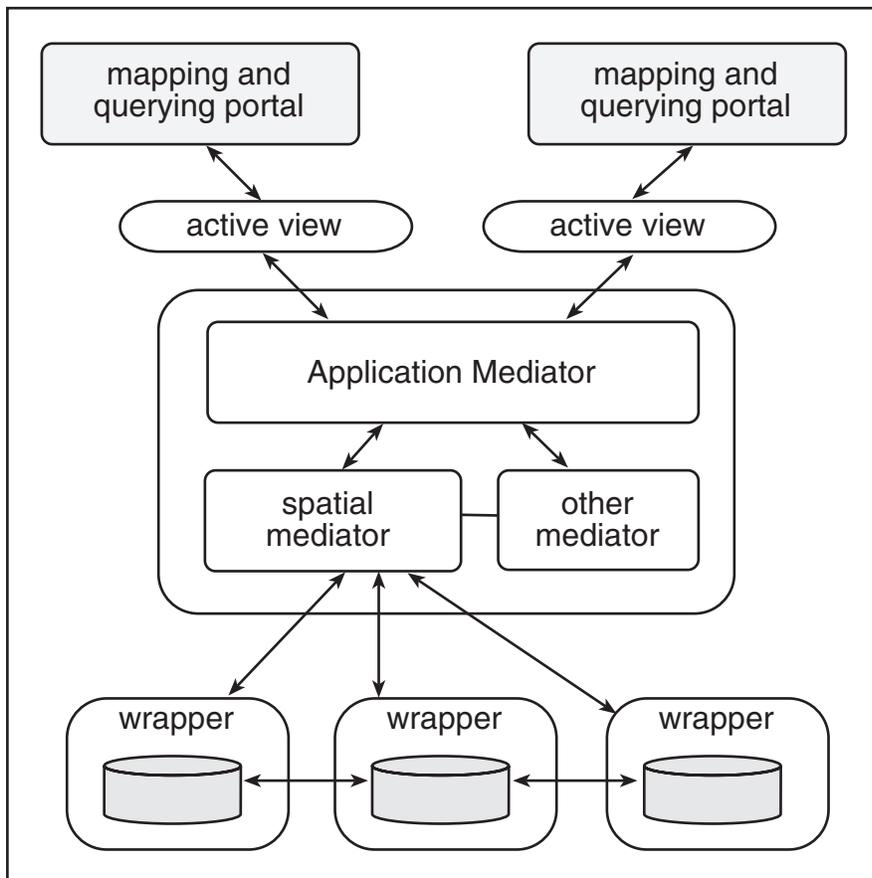
Figure 5. The architecture of a system of mediators and wrappers for heterogeneous information integration.

experimental wrapping of ArcView sources, for example). The sources process the scripted requests and return the query results to the user as XML files. In our case, the source wrappers generate XML files from geographic layers requested in a query, within the spatial extent of the query result. At the same time, the mediator generates an AXIOMAP project file referencing the locations of these newly-generated XML layers. The AXIOMAP viewer then opens the project file and presents it to the user as a layered virtual map that can be further manipulated and analyzed interactively.

As an example, consider the following hypothetical spatial query:

Find neighborhoods in the North Coastal part of San Diego with median household income over 50K, without recreation facilities (recreation center, YMCA), and crossed by an interstate highway.

Generating an evaluation plan for a query like this, posed against a series of heterogeneous spatial data sources, is described in [Gupta et al., 2000]. In our example, suppose source A contains a layer of San Diego neighborhoods with accompanying census information, source B has a digital map of interstates, and source C provides point layers for recreation facilities. Responding to the query, source wrappers generate XML files for each of the layers requested in the query (in our case, the neighborhoods layer is generated at source A as *a.xml* and *b.xml*, the interstate layer is *l0.xml*, and the point layers are expressed as *p0.xml* and *p1.xml*). In addition, one of the source wrappers (the last one in the query evaluation

"Responding to the query, source wrappers generate XML files for each of the layers requested in the query."

plan) generates query results as an *f0.xml* file. The mediator then generates a project file, a fragment of which is shown in Figure 6.

As a response to the query, the user can see the map interface shown in Figure 7. Initially, only the result of the query is displayed on the map, but the user has the option of turning on other layers referenced in the query. Additionally, the user can generate thematic maps, add buffers and labels, and use other AXIOMAP viewer capabilities to further customize the map.

```
<layer layertype="base"><source>http://www.sourceA.com/a</source>
 <v><name>1990 Census Data</name>
 <source> http://www.sourceA.com/b0</source></v></layer>
<layer layertype=»line»>
 <source> http://www.sourceB.com/l0</source><id>0</id>
 <name>Interstates (Source B)</name>
 <color>#ff0000</color><width>2</width></layer>
<layer layertype="point">
 <source> http://www.sourceC.com/p0</source><id>0</id>
 <name>YMCA (Source C) </name><icon>p0.gif</icon></layer>
<layer layertype="point">
 <source>http://www.sourceC.com/p1</source><id>1</id>
 <name>Recreation Centers (Source C)</name><icon>p1.gif</icon></layer>
<layer layertype="foregr">
 <source>http://www.sourceA.com/f0</source></layer>
```

Figure 6. A fragment of a project XML file generated by the spatial mediator for the sample query.
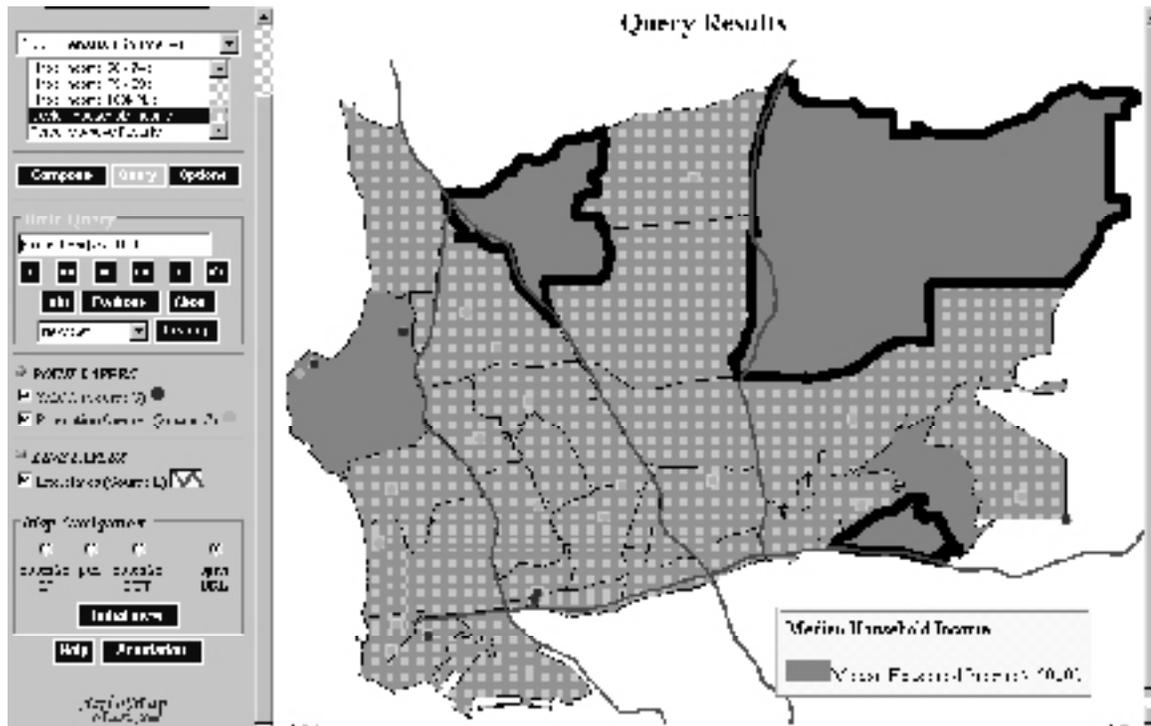

Figure 7. AXIOMAP user interface, with query results generated by a spatial mediator. The query results are shown as a black outline against other layers in the query.

AXIOMAP in the San Diego Quality of Life (QOL) Project

The San Diego Quality of Life Project is the core activity of a public partnership (including state and county agencies, foundations, universities, and non-profit organizations) with the mission to empower local communities through information sharing, development of QOL indicators and tracing their dynamics in each neighborhood, and statistical analysis and mapping of QOL indicators in a form accessible by community members. One of the main distribution channels for the QOL interactive maps and warehouse data is a special Internet community portal being developed by non-profit Telesis Corp. [Telesis, 2000]. From this portal, community users can access a wealth of information about their neighborhoods, including 11 interactive maps of San Diego Community Collaboratives (as in Figure 3), as well as more detailed community mapping projects. Each Quality of Life map enables community users to develop choropleth maps of about 300 variables (demographics, housing, ethnic and income composition, occupation and employment, land patterns, crime, forecast data from a local planning agency, etc.) and any arithmetic combinations of these variables, and display three dozen line and point layers (roads, hospitals and recreation centers, parks, drug treatment centers, government agencies and non-profits, churches and community centers, libraries and museums, etc.). The Quality of Life maps are accessible from the QOL web portal at www.qolsandiego.net.

For several key problem areas, a complete physical inventory of the neighborhoods was conducted, where about 200 types of point objects indicative of the quality of life conditions were recorded with a GPS-enabled mapping system. The recorded locations included areas with graffiti, drug paraphernalia, broken glass and trash, as well as the physical conditions of each building (see http://www.elzaresearch.com/landv/demo5/main.htm). With these data, never before available in the form of an online interactive map, communities can support policies focused on local police protection and school security, home improvement funding and substance abuse prevention activities, etc.

"Each Quality of Life map enables community users to develop choropleth maps of about 300 variables (demographics, housing, ethnic and income composition, occupation and employment, land patterns, crime, forecast data from a local planning agency, etc.) and any arithmetic combinations of these variables, and display three dozen line and point layers (roads, hospitals and recreation centers, parks, drug treatment centers, government agencies and non-profits, churches and community centers, libraries and museums, etc.)."

CONCLUSION AND OUTLOOK

Compared to server-side mapping architectures, XML encoding and rendering of geographic information gives a different response to the tradeoffs of online mapping, emphasizing dynamics, interactivity and interoperability for geographic data. At the same time, direct XML-based vector rendering in a browser avoids the often "heavy" Java/ActiveX/plug-in client-side solutions, thus remaining within the realm of what is typically called a "thin" client.

Since AXIOMAP manipulates vector coordinates and attributes of geographic features within a browser, this technology appears to be especially suitable for dynamic and animated user-driven map presentations, making use of dynamically extended graphic variables (*moving*, *rotation*, *oscillation*, *pulsing* – as in Holmberg, 1994). Additional research issues emerging from this experience include the development of virtual maps from distributed and independently maintained data sources, and analysis of novel online map publishing paradigms, as well as the social implications of online mapping.

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cartographic techniques

Desktop Hachure Maps from Digital Elevation Models

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Introduction

A classic cartographic technique for representing three-dimensional topography on a two-dimensional map involves the use of hachures. A fine line or hachure is generally drawn in the direction of steepest topographic gradient. Hachuring across an area creates tonal variations throughout the map. These tonal variations are a form of analytical hillshading, creating a three-dimensional representation of the topography. Such hillshading can employ vertical or oblique lighting techniques to create such effects.

Hachures display quantitative measures of the topography's slope and aspect. The slope is the angle from horizontal of the steepest topographic gradient, while the aspect is the azimuthal angle from north measured in the clockwise direction. Because hachures are quantitative repre-

sentations of these components of topography, rules have been established for the construction of such graphics. The general rules vary depending on whether the hachure is part of a large-scale or small-scale map, and whether a theoretical vertical or oblique lighting is used to illuminate the hachures.

Large-scale hachure maps with vertical illumination effect

Major J.G. Lehmann in 1799 was the first to systematically represent the terrain with hachures. He used lines oriented in the aspect direction with the thickness of the line proportional to the slope. The resulting maps proved especially useful for construction of large-scale topographic military maps (Robinson et. al., 1995). Increasing the hachure thickness with slope was named "slope hachuring" and can be equated to analytical hillshading with vertical illumination.

Imhof (1982) outlined five rules for the creation of slope hachures for large-scale maps:

1) Hachures follow the direction of steepest gradient
2) Hachures are arranged in horizontal rows
3) Hachure length corresponds to the local horizontal distance between assumed contours of a certain interval
4) Hachure width is thicker for steeper slopes
5) Hachure density remains constant throughout the map area.

All of the above rules should be obeyed when constructing large-scale hachure maps with vertical illumination. To create hachures with the appearance of oblique illumination, rule five is modified. To create hachures for a small-scale map, defined

by Imhof (1982) as smaller than 1:500,000, more rules are relaxed to allow what Imhof calls a freer graphic portrayal.

Large-scale hachure maps with oblique illumination

Oblique illumination of hachures produces "shadow hachures." Varying the thickness of hachures on illuminated versus shadowed slopes creates modulations in tone associated with oblique illumination. Hachures on illuminated slopes are thinned to create this effect. This violates Imhof's fifth rule, but gives a strong impression of the third dimension, especially in mountainous areas. The 'Dufour' maps of the mid-1800's are particularly striking cartographic representations of mountainous large-scale topography (Figure 1). One drawback of shadowed hachure maps, as Imhof (1982) points out, is that thinner shadow hachures on illuminated slopes can be misinterpreted as flatter topography.

Yoeli (1985) developed computer algorithms that would allow the user to create large-scale hachures from digital elevation data. This system obeys Imhof's rules, and can be used to create slope or shadow hachures. The construction of hachures with Yoeli's algorithms is based on digital contours, with beginning points of hachures selected at a given horizontal interval along contour lines. The resulting hachure maps do an excellent job of portraying topographic features on large-scale maps.

Unlike Yoeli, our methodology is designed to produce small-scale hachures. In relaxing some of Imhof's rules, we were able to arrive at a simple procedure. Yoeli, in obeying all of Imhof's rules to create large-scale hachures, was required by the nature of the problem to create a much more complex design processes.
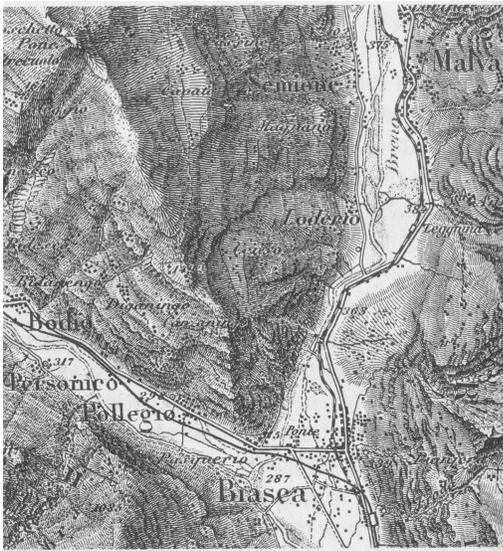
Figure 1. A portion of a large-scale topographic map using obliquely illuminated hachures to represent topography. (From Sheet 19 [1858], Switzerland, 1;100,000, the "Dufour map.")

Small-scale hachure maps with oblique illumination

Small-scale hachure maps do not readily comply with the five rules outlined by Imhof (1982). Unlike large-scale hachure maps, which are derived based on the contour's structural elements, small-scale maps appear more free-form. Most of these small-scale hachure maps are obliquely illuminated.

In this paper, we outline a methodology for creating small-scale hachure maps with oblique illumination directly from a Digital Elevation Model (DEM). As with most small-scale hachure maps, we violate Imhof's rules 2 and 3, but obey all of the other rules. We use a grey background with black and white hachures to render oblique illumination while obeying Imhof's rule 4. This tonal method is similar to that used by Tanaka (1950) in creating an obliquely illuminated contour map of a portion of Kyushu, Japan. We refer to the map resulting from our method as an illuminated hachure map.

Location, Data Source, and Software

We have created an illuminated hachure map that covers a portion of the Cas-cade Mountains of western Washington state. This area includes the volcanoes of Mt Adams, Mt. St. Helens and Mt. Rainier. This landscape lends itself to hachure map-ping with its frequent vari-ations in slope and aspect.

The source data for this map are a 3-arc second Digital Elevation Model (DEM) from the United States Geological Survey (USGS). The DEM is a square grid with cells measuring 92 m. The DEM was derived from an elevation model produced by the Defense Mapping Agency from source data at a 1:250,000 scale.

We used ESRI's ArcView Version 3.2 for Windows software to create our illuminated hachure map from this DEM. Because it was necessary for us to manipulate grids, we also used the ArcView Spatial Analyst Version 2.0 for Windows extension. In this paper, we outline all ArcView operations and list equivalent commands for ESRI's ARC/INFO Version 7.2 software with the GRID module. Other Geographic Information System (GIS) software that can manipulate and display grids and spatially referenced points could be adaptable to our methodology.

Methodology

To produce a small-scale obliquely illuminated hachure map, we created a point theme from the DEM that contains both slope and aspect data. We oriented the ha-chures using aspect data. Next, we created oblique illumination with both slope and aspect data. We used aspect data to divide point

data into illuminated and non-illuminated hachures. In addition, we used the slope data to vary the thickness of individual hachures. We present a step-by-step guide to our methodology below.

The first step was to aggregate grid cells of the 92 meter DEM to create a 277 meter DEM using a mean value of the nine contributing grid cells. This aggregation was necessary to create an attractive and legible hachure map at our selected scale. We aggregated the grid by cutting and pasting a short script in ArcView Help (under *Aggregate*, then *Example*). In the ARC/INFO GRID module, use the *Aggregate* command.

In order to make illuminated hachures, it is necessary to have both slope and aspect information. We calculated slope and aspect grids for the aggregated DEM using the *Derive Slope* and *Derive Aspect* items under the *Surface* dropdown menu. We converted these floating point grids to integer grids, a step necessary before they can be converted to point themes. To do this, we used the *Map Calculator* under the *Analysis* menu. The calculation dialogue box prompts for a grid theme (slope or aspect), and then an operation to apply to this theme. In this example, we used the arithmetic *Integer* operation, which truncates the floating point aspect or slope number. In the ARC/INFO GRID module, use commands *Slope*, *Aspect* and *Int* to perform the same operations.

Next, we converted slope and aspect grids into point themes. We used a sample ArcScript from the ESRI website (www.esri.com). The *Raster to Vector Conversion* script, written in Avenue by Kenneth McVay, converts a grid to a point theme. We gave unique attribute field names to slope and grid values in the point themes. In ARC/INFO, use the command *Gridpoint* to convert a grid to a point coverage.

Figure 2. A small-scale hachure map of the Cascade Mountains of Washington state with illumination from the northeast. The scale is 1:450,000 and north is to the top of the page. Mt. Rainier is near the north edge and central. Mt Adams is in the southeast corner and Mt. St. Helens is in the southwest corner. The Cowlitz River valley cuts through the central portion of the map.

We joined the slope and aspect themes in ArcView based on location. To perform a spatial join, the table of one theme is the source, the other is the destination. We select the *Shape* field in both tables. We use the *Join* button or the *Join* option under the *Table* dropdown menu to combine attributes into

a single table. The resulting spatial join for two point themes will write all attributes from the source table to the nearest point in the destination table, making all slope and aspect information available in one theme. No command exists in ARC/INFO to perform a spatial join, but the same result could be achieved through a series of commands or a script. One option would be to *Buffer* one point coverage, then *Intersect* it with the other.

We used aspect values to orient hachures in the direction of steepest slope. The convention for rotating point symbols in ArcView is counterclockwise from north, while the convention for aspect angle is clockwise from north. As such, we multiplied the aspect value by -1. The modified aspect values define the direction in which hachures are drawn. We specified this variable as the *Rotation Field* in the *Advanced* option of the legend editor for the point theme. In ARC/INFO's ArcPlot module, rotate the hachure with the *Markerangle* command.

We used both aspect and slope values to create the illusion of oblique illumination. We separated points representing hachures in the illuminated and non-illuminated direction into two new themes. We selected an illumination azimuth of 45°. Then we selected all points with aspect values within 90° of the illumination direction (original aspect range -45° through 135°) and saved these to a new theme. These are the illuminated hachures, which we displayed as white arrows. We saved all other points to a second theme. These are the non-illuminated hachures, which we displayed with black arrows. We made the background gray so that both black and white hachures are visible.

We enhanced the illumination effect by varying arrow thickness with slope. In this example, we chose three classes of slope: the

first from 2° to 4.6° was drawn with a 6 point arrow, the second from 4.6° to 7.2° with an 8 point arrow, and the third from 7.2° to the maximum slope, 17.4° with a 10 point arrow. Because hachures generally do a poor job of representing gently sloping topography, we did not include any hachures with slopes below 2°.

Discussion

The resulting hachure map is presented at a scale of 1:450,000 in Figure 2. The hachures generally represent the topography in an accurate and easily interpretable manner. Black and white hachures on gray remove the ambiguity of slope steepness associated with some shadow hachure maps. The use of arrows further eliminates any confusion that could arise from bi-directional lines in determining azimuth in topographically complex areas.

Our process obeys three of Imhof's five rules of hachuring. Hachures follow the direction of steepest gradient, as in nearly all hachure maps. Hachure width is thicker for steeper slopes, made possible with oblique illumination by using black and white arrows on a gray background. Lastly, hachure density remains constant throughout the map area, except in areas of slope less than 2°. This result follows from using a regular grid as the source data. Although hachures are evenly spaced, the subtle changes in orientation (1° of aspect) and the small size of the hachure produces a map we believe has the free-form look associated with small-scale hachure maps.

Figure 2 includes some small areas of hachures within a larger white area with slopes less than 2°. These isolated areas of hachures have often been excluded in hand rendered hachure maps. If it is desirable to eliminate these hachures, the offending points can be select-

ed by location and deleted from the GIS point themes.

Lastly, we stress that the hachure map here is a generalization and does not fully exploit the data in the DEM. One generalization was the aggregation of the DEM from 92 to 277 meters, a step necessary for clarity. Also, an analytical hillshading of the data would show more detail of landscape than this hachure map. One example of this is the Mt. St. Helens caldera, discernible with analytical hillshading of the 277 m DEM. The transition from shaded areas used in hillshading to linear point symbols used in hachuring is a generalization inherent in the hachuring process.

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Estimating the Size of a Large Map Collection or How I "Lost" 200,000 Maps and Still Kept My Job

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"The Cartographic Information Center ('Map Library') in the Department of Geography & Anthropology, is the largest university map library in the nation. Its more than 500,000 maps and photographs rank LSU 10th among all U.S. map libraries." This statement from the pamphlet *Louisiana State University Facts '93*, was repeated in the community information section of the Baton Rouge telephone directory and was also repeated to this map librarian by his barber.

This article will briefly trace the growth in the number of maps reported as held in the LSU cartographic Information Center to illustrate how much these figures were inflated over the years. Next, this article will present the methodology used to establish a statistically sound estimate of the map holdings and will propose a set of standards for estimating the size of a large map collection.

The boastful statement that opened this article has been repeated often enough to be regarded as factual by people outside of the map library profession. Within the profession, it has been regarded with skepticism long before this librarian became associated with the LSU Cartographic Information Center. Although LSU has reported its holding statistics to the map library guides and directories

since 1954, this statement does not appear in the professional map librarian literature. Interestingly, the "facts" reported in the opening statement were drawn from several sources that appeared over a span of nine years. The claim that Louisiana State University has "the largest university map library in the nation" appears to be derived from the second edition of the *Guide to U.S. Map Resources* published in 1990. In this source, LSU heads the list of the largest geoscience libraries with 400,000 maps (Cobb 1990, p. xii). Another table in the *Guide* lists LSU as fifth among all U.S. map libraries after the Library of Congress, the National Archives, Harvard, and the University of Wisconsin (Cobb 1990, p. xi). According to the *Guide,* LSU was the fifth largest map library in the nation and the third largest university map library. The "fact" in the original quote claiming that Louisiana State University is tenth among all U.S. map libraries dates from the Winter 1981 issue of *Library Trends* (Stevens 1981, p. 528). The figure of 500,000 maps and aerial photographs in the opening statement does not appear in either the 1990 *Guide* or the *Library Trends*, but it can be attributed to two 1986 publications (Cobb 1986, p. 61; Wolter 1986, p 349). The wild fluctuation in the number of maps reported between 1981 and 1990 raised doubts about their accuracy. This map librarian was suspicious of the conveniently round figure and began searching the Cartographic Information Center files for proof to substantiate the figure.

No such proof was found. In fact, the last recorded count of the map holdings is now over forty years old. Apparently, all reported figures since January 1958 were unsupported guesses. Thus, the following question arose: How significantly have the reported LSU map collection figures been inflated since 1958?

In Table 1, the rounded figures prior to and including 1958 are based on actual map counts. The large increase between 1954 and 1955 resulted from the transfer of the Army Map Service collection from storage in the main library to the map library and the acquisition of 5000 maps from the Library of Congress. The corresponding average annual acquisitions rates for these years are also based on actual counts. In contrast, the figures from 1968 to 1990 are unsupported guesses. The annual acquisition rates listed after 1968 are inferred from the increase between reports. As can be seen, once the figures ceased to have a statistically sound basis they began to soar to unrealistic levels. Further, the inferred annual acquisition rate for the years between 1981 and 1985 is an incredible 23,750 maps per year. This rate is two and a half times the number of maps acquired by the Cartographic Information Center in one unusual year, 1996, as the result of participation in the Library of Congress Geography & Map Division Summer Special Project.

Although the reported number of maps dropped inexplicably in 1990, by 1995 the most commonly quoted figure for the number of maps held in the Louisiana State University Cartographic Information Center was 500,000. Since this figure could not be substantiated, this map librarian resolved during the summer of 1996 to either confirm or refute its validity by conducting a systematic estimate of the map holdings.

Methodology

The Cartographic Information Center map collection is housed in 129 flat five-drawer cabinets, 39 vertical two-drawer cabinets, 830 pamphlet boxes, 13 large corrugated cardboard boxes, 10 classroom map carts as well as various other storage containers. All of the materials are stored in

the 2414 square foot map room. Because only a small fraction of the map collection is cataloged, and counting each individual map would be impossible, a method had to be developed to produce a statistically sound estimate of the number of maps.

The *Federal Depository Manual* provides a list of conversion factors to translate linear measurements of collections to numbers of items (GPO 1993, p. 93). The map conversion factor is given as 200 flat sheets per two inch deep drawer. A quick calculation using the supplied conversion factor yielded 1000 flat maps per five-drawer cabinet or 129,000 maps in the Cartographic Information Center's flat map cabinets. Since this rough estimate yielded a number significantly less than the reported 500,000 figure, it was realized that there were either 371,000 maps in the remaining storage containers, the conversion factor was too generalized, the 500,000 map figure was completely fanciful, there must be many unaccounted maps checked out to the faculty, or a combination of all of these factors was at work. Obviously, a more reliable estimate could be made.

The collection estimation project consisted of four parts: the Preliminary Survey, the Characterization Survey, the Measurement Phase, and the Estimation Phase. Prior to starting the project, a map room floor plan was drawn to facilitate the work and to chart the project's progress.

The Preliminary Survey's goals were to identify the storage areas that contained maps and to identify which map storage areas would have to be manually counted. Each drawer, box, or other type of storage container was opened for inspection. As a result of the Preliminary Survey it was realized that using the Government Printing Office conversion factor would

Year	Number of Maps	Annual Acquisition Rate
1954[1]	15,700	not reported
1955[2]	59,040	2,010
1958[3]	68,757	3,015
1968[4]	180,000	11,000
1976[5]	300,000	15,000
1981[6]	325,000	5,000
1985[7]	420,000	23,750
1986[8]	500,000	80,000
1990[9]	400,000	-25,000

[1]Goodman 1954
[2]West 1955
[3]West 1958
[4]Carrington 1970
[5]Carrington and Stephenson 1978
[6]Stevens 1981
[7]Carrington and Stephenson 1985
[8]Cobb 1986
[9]Cobb 1990

Table 1. Reported Cartographic Information Center Collection Size.

produce an inaccurate estimate since the collection contains many diverse material formats which are housed in many different storage container types. Although the GPO conversion factor would not suffice for the whole flat drawer collection, the Preliminary Survey indicated that the collection could be broken down into more specific homogeneous storage areas, each with its own conversion factor (Allen 1996, p. 14). The generalized areas of homogeneous map collections, such as a topographic series, in a similar storage method were grouped together and plotted on the floor plan. The term "density groups" was coined to reflect the assumption that a uniform density of maps per linear measurement existed throughout the group of storage containers. The density groups would be more precisely defined and delineated during the Characterization Survey. Areas of heterogeneous collections, such as city plans, were designated for manual counting. Further, it was

found that 53 of the 645 flat map drawers did not contain maps and were excluded from the next survey. One hundred and sixteen drawers contained heterogeneous collections that required manual counting.

The Characterization Survey's goals were to determine the number and nature of the density groups and to determine the appropriate conversion factor for each density group. In order to achieve these goals, the remaining 466 flat map drawers and the other storage areas were again inspected to determine a more accurate spatial extent of each density group. Further, the general density group descriptions from the Preliminary Survey were refined to be more precise. A total of forty-one density groups were characterized including the following examples: flat historic nautical charts, folded current nautical charts, captured foreign maps from the World War II era, recent 1:50,000 scale topographic maps of Mexico, 8x11-inch

film negatives, full sized coastal survey chart film negatives, folded U.S. Geologic Survey topographic quadrangle maps stored horizontally, folded U.S. Geologic Survey topographic quadrangle maps stored vertically, and plat maps. Making the density groups as specific as possible would be essential to achieving an accurate final estimate, thus collections of maps that might have easily been grouped together if the storage areas had not been inspected were further refined into separate groups. For example, within the Army Map Service collection the following more specific density groups applied:

Maps stored flat, one stack per drawer

Maps stored flat, two stacks per drawer

Maps stored folded, one stack per drawer

It can easily be seen that the difference in the number of maps per linear unit in the last two groups would be roughly a factor of two while the difference in storage method in the first two groups could be addressed by measuring both stacks.

Additionally, the Characterization Survey identified two density groups that covered large storage areas that would present special problems when determining their conversion factors: the U.S.G.S. topographic quadrangle maps and the U.S.G.S. thematic maps. Although these two groups were heterogeneous, they were too large to consider manually counting the maps. Further, since they comprised a large percentage of the collection, they warranted the extra effort to accurately estimate their contents. A standard linear conversion factor could not be determined for the U.S.G.S. topographic quadrangle maps for two reasons. First, the maps were stored vertically which would have required removing 1,997 folders from the drawers and placing them on a flat surface for measur-

ing. Second, the folders contained a mix of flat 15-minute quadrangle sheets and folded 7.5-minute quadrangle sheets. In order to avoid removing the folders and to account for the presence of flat and folded maps, it was decided to use the vertical map folder as the conversion factor unit.

Since the number of maps in each folder varied depending on the alphabetical range assigned to the folder, the number of editions of each sheet, and the number of copies of each edition, it was best to calculate the average number of maps per folder. The maps in a random sample of five percent of the folders (100 folders) were counted. The resulting conversion factor for this density group was 19.5 maps per folder applicable to 75 vertical map drawers. Two vertical map drawers contained historic Louisiana quadrangle sheets with a higher percentage of 15-minute quadrangle sheets while one drawer contained a set of unfolded 7.5-minute planimetric maps. The maps in these three drawers were counted manually in order to have accurate figures for later requests for preservation funds.

The density group containing the U.S.G.S. thematic maps in manila sleeves was a smaller problem than anticipated. The thematic maps are stored vertically in 619 pamphlet boxes. Since the pamphlet boxes were all the same type with a uniform interior width (7.5 centimeters), the pamphlet box was used as the conversion factor unit. Again, five percent of the boxes (32 boxes) were sampled and the average number of maps per box calculated.

While calculating the average number of thematic maps per box it became evident that standards defining what would be counted as one map had to be established. These standards were later expanded and applied to the counting of the heterogeneous collections. Since many of the manila

map sleeves contained multiple thematic map sheets and text parts, the contents of each sleeve in the sampled box were removed and examined. A four sheets series that fit together to form one map image was counted as a single map. Sheets that depicted the same area but with different themes were each counted as one map. A single sheet that contained multiple smaller maps was counted as one map. The accompanying text was not counted. The conversion factor for the U.S.G.S. thematic map density group was 19.3 maps per pamphlet box.

Since the remaining density groups contained maps that were stored horizontally, determining the appropriate conversion factor was a simple process. A standard method of determining a linear conversion factor is to measure a given unit, such as a centimeter, against a homogeneous stack of map sheets and then count the number of sheets per centimeter (Allen 1996, p. 14). Samples from several stacks or from different heights of the same stack may be taken and averaged together for a more accurate conversion factor. This method introduces possible error due to differential compression of folded maps at various heights in the stack, an inaccurate ruler reading, or if the stack is compressed by the sampler.

Determining an accurate conversion factor would be crucial to achieving an accurate final estimate. In an effort to eliminate these inaccuracies, a micrometer was used to measure the one-centimeter sample. The micrometer was set to the English unit equivalent of one centimeter (.3937 inch) and its thimble was secured with tape in order to ensure the same measurement on all samples. A representative stack of maps was removed from the drawer, placed flat and adjusted until the sheets were flush on one edge of the stack. The flush stack edge was

moved until about one centimeter of the stack protruded from the edge of the cabinet top. The instrument was held vertically as its anvil was aligned on the bottom map sheet. As the micrometer was slid towards center of the map stack, the spindle forced out any sheets that did not fit within the one-centimeter opening. The sheets that remained in the micrometer were counted to provide a conversion factor unbiased by compression or by an inaccurate ruler reading. When sampling folded maps, the maps were sampled from the double edge opposite the fold. Some representative conversion factors for the different map types in the density groups are listed in Table 2.

As can be seen from the list, there is a wide range of conversion factors for maps stored horizontally. Further, the conversion factor is influenced not only by the sheet thickness, but also by map condition due to use, applied backings, and folding methods.

During the Characterization Survey it was observed that the map folders within the drawers ranged from thin brown wrapping paper to thicker kraft paper to tagboard folders. Further, these housing materials would contribute to the linear measurement of the map stacks. In order to eliminate both inflating the measurement and the need to remove all of the maps from the folders during the Estimation Phase, the housing material conversion factor, devised to account for folder thickness, would be subtracted from the linear measurement of the maps during the Estimation Phase. Again, the micrometer was used to determine the number of folders per centimeter by measuring the double edge opposite the fold. Since the thin paper folders were closer in thickness to an individual map sheet, it was decided to treat them as map sheet in the 60 to 70 sheets per centimeter range. The housing mate-

rial conversion factors for the most common folders were:

tagboard folders - 4 per centimeter

kraft paper - 4 map sheets per folder

brown wrapping paper - 2 map sheets per folder

Measurement Phase

The linear measure of the map stacks within the density groups, whether the maps were stored in drawers or boxes, was a simple task. All measurements were taken by one staff member to ensure consistency. The maps that were stacked were measured by placing a thin metal strip in the center of the top of the stack. The metal strip was than adjusted on the stack until it protruded from the edge of the stack and rested parallel to the bottom of the storage container. Next, a ruler was placed with its edge flat on the storage container bottom while the ruler's graduated edge was lined up perpendicular to the metal strip. The measurement was read from the bottom edge of the metal strip to the nearest millimeter. In the drawers where the map folders were spread

out horizontally and overlapping, the folders were temporarily gathered into a single stack for measuring. Folded maps were measured from the edge opposite the fold to correspond with the micrometer's position during the conversion factor measurement. After the linear measurements were taken and recorded, the number and nature of the folders in the drawer were also recorded. The linear measurements from all storage containers in the density group were totaled, as was the number of folders.

Estimation Phase

The project's Estimation Phase was a simple math exercise. The formula for calculating the estimate for each density group depended on the nature of the map folders. If the density group contained tagboard folders, the product of the housing material conversion factor and number of folders modified the linear measurement. If the density group contained paper folders, the product of the appropriate housing material conversion factor and number of folders modified the number of sheets (see Appendix A).

Topographic Series	Condition	Conversion Factor
Denmark 1:20,000 scale	Pristine	67 per centimeter
Germany 1:25,000 scale	Worn	43 per centimeter
Korea 1:50,000 AMS series L751	Pristine	57 per centimeter
Java 1:25,000	Linen backing	24 per centimeter
Mexico 1:50,000	Slightly used	64 per centimeter
U.S.G.S. quadrangle maps	Folded once	34 per centimeter
U.S.G.S. quadrangle maps	Flat	77 per centimeter
Navigation Chart Series	Condition	Conversion Factor
NIMA aeronautical	Folded as shipped	3 per centimeter
NOAA nautical	Folded once	33 per centimeter
NOAA intracoastal	Folded as shipped	1 per centimeter

Table 2. Representative Conversion Factors for Different Map Types.

Validity checks on the estimation method were performed on estimates from a large and a small density group. The Java 1:25,000 scale topographic series served as the small group validity check. The Java map series that was housed in tagboard folders totaled 7.8 cm., and contained five folders. When these values and the appropriate conversion factors were inserted into the formula, an estimate of 181 maps resulted (see Appendix B). By actual count, the group contained 200 maps, illustrating that the estimate was almost ten percent short of the actual number.

The Mexico 1:50,000 scale topographic series served as the large group validity check. Coincidental with the collection estimation project, a sheet-level database of the maps in the collection depicting Mexico was completed. A database search returned 2674 map records in the series. Measuring the maps in their paper folders resulted in 42.1 cm. of maps and materials. The measurement included the 89 brown wrapping paper folders. When these values and the appropriate conversion factors were inserted into the formula, the result was an estimate of 2642 maps (see Appendix C). The low margin of error, 1.1 percent, is heartening, but is equally as suspicious as the conveniently round collection size estimate.

Standards

The standards established to guide the collection estimation project were intended to ensure consistency in what maps were included in the estimate and how the included sheets were counted as a single map. Thus, the standards can be divided into those defining maps within the project's scope and those defining a single map for estimation purposes.

The maps excluded from the survey were:

Electronic products
Class sets
Maps owned by the faculty but stored in the library
Maps bound in folios
Maps intended for distribution
Index maps
Photographic copies of maps if the original map was also present

Examples of maps included in the survey were:

U.S. National Atlas separate sheets
Drafts of original cartographic work by the faculty
Duplicate sheets of the same edition

The standards for the definition of a single map sheet were:

Multiple sheets that fit together to form one map image counted as one map
Maps printed on both sides counted as one map
Overlays to transparencies counted as one map
A single sheet that contained multiple smaller maps counted as one map
Sheets that depicted the same area but with different themes each counted as one map

Results

When the estimating and counting was completed and the subtotals were added, the estimate stood at 277,971 maps in the Cartographic Information Center on September 1, 1996. This statistically sound estimate became a benchmark that could be adjusted by all subsequent acquisitions and deselections. Thus, the estimated current holdings after three years of adjustments is approximately 289,000 maps.

At the project's conclusion, this map librarian reported the revised collection holdings estimate to the

Geography & Anthropology Department Chair and emphasized that the new estimate contradicted the figure touted by the university. Further, that unless the department faculty had established individual map library annexes in their offices that accounted for the missing maps, the Cartographic Information Center had just "lost" 200,000 maps. Without hesitation, the Department Chair accepted the new estimate and endorsed reporting the revised estimate. Additionally, this map librarian kept his job. Currently, the Department Chair no longer boasts to prospective students and faculty that the Cartographic Information Center is the largest university map library in the nation. Instead, he is pleased that the Geography & Anthropology Department readily accepted losing its claim to being the largest university map library in the spirit of academic and professional honesty.

Conclusion

In general, the collection estimation project proved that it is possible to produce a statistically sound estimate of a large map collection size. Further, the project illustrated that the estimate's validity depended on consistent and accurate measuring and sampling as well as faithful adherence to the standards and definitions. Specifically, the validity check performed on the large and small density group estimates revealed that the estimation method worked well for large homogeneous map groups, but it was probably more efficient and accurate to simply count a very small homogeneous map group.

In reality, the age of electronic map images and geographic information systems capable of generating many permutations of maps and displayed data in response to a patron request, has rendered the collection holdings statistic obsolete. For example, any attempt to

estimate how many maps can be created from the maps and data in a GIS package is similar to trying to estimate how many poems can be generated from the words in a dictionary.

There will be paper map collections until the day that all maps are stored electronically and all patron requests can be served by generating a map on request from a GIS station. As long as there are map librarians and library administrators, they will want to know the size of their paper map collections, and until all map collections are cataloged to the piece level, estimates will be used to determine the size of map collections. This article has presented one method to estimate the size of a large map collection. It can be used to establish a statistically sound estimate to serve as a benchmark that can be modified by future changes in the collection. The adjusted estimates can serve as reliable estimates of a collection's size until a collection is completely cataloged. It may be another forty years before the Cartographic Information Center's collection is retrospectively catalogued. Until then, this map librarian can honestly say with pride, "The Cartographic Information Center ('Map Library') in the Department of Geography and Anthropology, is the largest map library in the state with more than 289,000 maps."

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**Appendix A
Estimation Formulas**

Tagboard folders:
Linear Measure - (Total Folders X Housing Material Conversion Factor) X Density Group Conversion Factor = Total Maps

Paper folders:
(Linear Measure X Density Group Conversion Factor) - (Total Folders X Housing Material Conversion Factor) = Total Maps

**Appendix B
Calculating the Number of Java 1:50,000 Scale Maps**

8.8 cm − 5 folders X $\underline{\text{1 cm.}}$ X $\underline{\text{24 maps}}$ = Total Maps
 4 folders 1 cm

By performing the calculation, the conversion factors cancel out the units until only the desired unit remains:

8.8 cm − 5 folders X $\underline{\text{1 cm}}$ X $\underline{\text{24 maps}}$ = Total Maps
 4 folders 1 cm

(8.8 cm − 1.25 cm) X $\underline{\text{24 maps}}$ = Total Maps
 1 cm

7.55 cm X $\underline{\text{24 maps}}$ = 181 Maps
 1 cm

Appendix C
Calculating the Number of Mexico 1:50,000 Scale Maps

42.1 cm X $\underline{67 \text{ maps}}$ − 89 folders X $\underline{2 \text{ maps}}$ = Total Maps
                1 cm   1 folder

By performing the calculation, the conversion factors cancel out the units until only the desired unit remains:

42.1 cm X $\underline{67 \text{ maps}}$ − 89 folders X $\underline{2 \text{ maps}}$ = Total Maps
                1 cm   1 folder

2821 maps − 89 folders − $\underline{2 \text{ maps}}$ = Total Maps
                             1 folder

2821 maps − 178 maps = 2642 Maps

The Bodleian Library, Oxford, United Kingdom

Nick Millea
Map Librarian, Bodleian Library
November 2000

Introduction

The Bodleian Library is the largest university library in Britain, holding in excess of six million books and housing one of the World's principal cartographic collections, amounting to around 1,200,000 maps and 20,000 atlases, along with rapidly growing numbers of CD-ROMs, digital datasets and cartographic software.

The Library, named after its founder, Sir Thomas Bodley, opened in 1602, and has been serving its readers from all over the World ever since. http://www.bodley.ox.ac.uk/mh/facts/facts20.htm

The map collection consists of maps from all parts of the globe, with topographic and thematic maps dating from medieval times to the present day. In addition to maps and atlases, the Map Room holds a comprehensive collection of gazetteers and guide books, which accompany around 6,000 books and 220 journal titles im-mediately accessible to readers on the Map Room bookshelves, with subject matter concentrating on geography, cartography and travel. Mapping produced by overseas national surveys worldwide can be consulted in the Map Room, ranging from commonly available Western European and North American output to more recently accessible Eastern European material.

As a library of legal deposit, the Bodleian assumes not only a university-wide role, but also a national and international one as a result of the wealth of its holdings. Deposit of Ordnance Survey (OS) material has resulted in an almost complete collection of OS mapping being held in the Library (Ordnance Survey itself was bombed in the Second World War, so their own collection is far from complete). Current British legislation requires a full environmental audit for any new building development being undertaken anywhere in the country, so the Library's virtually complete geographical *and* historical record of landscape change has enabled the Bodleian to provide a commercial service to land use consultants. Full details can be found in the 'Site Surveyors' section at: http:// www.bodley.ox.ac.uk/guides/maps/

Brief history

Sir Thomas Bodley founded the Library to serve "the republic of the learned," and encouraged his contemporaries to enrich it with gifts of money and books. His agreement with the Stationers' Company of London in 1610 was a fore-runner of legal deposit legislation, as a result of which the Bodleian came to acquire British publications in ever-increasing quantities. The result of almost four centuries of building the collections is a veritable treasure trove of library materials.

Further major cartographic acquisitions included the arrivals of Richard Gough's collection of maps in 1809, and more recently the Todhunter Allen collection in 1987. During the late eighteenth century, most of the county maps then being published in Britain were claimed by the Library, while the nineteenth century saw the commencement of the unbroken deposit of Ordnance Survey mapping.

A purpose-built Map Room was opened in the New Bodleian Library in 1946, prior to which the Library had no special provision for the consultation of maps. There is accommodation for fifty readers, in addition to the card catalogue of maps, which currently contains around 250,000 entries, while map records are steadily being made available on-line in OLIS, the Oxford Libraries Information System.

The Map Room has an established staff of five, together responsible for its day-to-day running, including all aspects of reader service, acquisitions and cataloguing. In addition there are at present three staff dedicated to the commercial land use consultancy service and another two working

full-time on a collaborative retrospective cataloguing conversion project, 'Mapping the World.'

Library users

Reader constituencies differ considerably in scope. There are: the academic users, based within the University using maps to further their research; the commercial users, wishing to identify land use change; those planning expeditions or holidays to distant locations; the genealogists; those researching boundary disputes – be they legal teams working on international boundaries, or private individuals examining footpath routes passing their houses; that particularly British phenomenon – the railway buff, studying the changing locations of stations and sidings; and the historians of cartography, keen to exploit our sizeable antiquarian holdings.

Antiquarian mapping

The antiquarian (pre-1850) collection is considerable, including the ca.1360 "Gough Map" (pronounced "Goff") – the oldest surviving road map of Great Britain. http://www.bodley. ox.ac.uk/guides/maps/mapcase. htm
Some other notable holdings are the Todhunter Allen collection; portolan charts; numerous (primarily English) estate plans, for example the Laxton Map of 1635; the Agas map of Oxford (1578), and Hamond's map of Cambridge (1592).

The Todhunter Allen Collection
http://www.bodley.ox.ac.uk/ hef-proj/

This collection consists of over 700 items of cartographic significance, illustrating the development of British cartography through almost three centuries. It was col-

lected by Hugh Todhunter and was bequeathed to George Eldred Allen who in his turn increased it significantly.

There are 113 county atlases on England and Wales, dating between 1617 and 1885. They are made up of maps of individual counties that were usually published separately. As a result, the make-up of individual atlases varies depending on the state of the maps going into it. It is this variation in state and edition that makes the Allen collection so important. Some of the atlases are present in a variety of states - some of which are unique. In several cases the atlases are the only copies available in a public collection.
Also in the collection are county maps, mostly from the late eighteenth or early nineteenth centuries. About one third of these are large scale, giving more accurate description of life and landscape in the individual county than the earlier small scale maps.
Further parts of the collection include two sets of the first edition one-inch Ordnance Survey maps, and thematic material such as railway, canal, road and geological atlases.
A cataloguing project was undertaken in two phases, initially listing all the items in the collection with a view to making a catalogue available in hard copy in the future, and then transferring this information onto the Library's on-line catalogue, OLIS. http:// saturn.olis.ox.ac.uk

Geographical Information Systems

The Map Room offers its readers the chance to work with Geographic Information Systems (GIS). A site licence for MapInfo Professional enables educational users to create customised maps for academic purposes. Interest

in GIS seems to cross disciplinary boundaries, with training sessions offered to Library users every Tuesday morning according to demand. More information is available under 'Digital mapping' at: http://www.bodley.ox.ac.uk/ guides/maps/infofrme.htm

Digimap

The Digimap service, co-ordinated by EDINA at the University of Edinburgh, began life at the Bodleian as a two-year trial which brought digital Ordnance Survey map data, via a web interface, directly to University members. This trial service was withdrawn in December 1999, making way for a new national service, launched on 10 January 2000. The University of Oxford is one of over forty Higher Education Institutions which have signed up for a new five-year agreement, delivering five OS datasets to anyone currently teaching, researching or studying at the University. The datasets available are: Strategi®, Meridian™, Land-Form PANORAMA™, Land-Line. Plus®, and the 1:50,000 Place Names Gazetteer (which will be available from March 2001).
Some of the projects undertaken using Digimap have included: air pollution monitoring; externality fields produced by Tottenham Hotspur Football Club; feeding Cromwell's New Model Army; and habitat use by farmland bird species. Further information on Digimap can be found at: http:// edina.ac.uk/digimap/

Copying of maps

In line with UK Copyright law, photocopying and photographic reproduction of mapping material is limited to items over seventy years old, and is subject to conservation requirements. For visitors to the Library, photocopying is usually completed within two

working hours, but photography is likely to take considerably longer. http://www.bodley. ox.ac.uk/dept/imaging/

Mapping the World

This project's aim is to open up a major under-used resource for research in a wide range of disciplines by targeted series-level cataloguing of post-1850 overseas mapping. Led by Oxford, a group of seven UK universities (Birmingham, Cambridge, Edinburgh, Imperial College, London and Manchester) are collaborating, with funding received from the Research Support Libraries Programme available until July 2002. The plan has been to facilitate remote access to key materials by converting map library catalogue records, which traditionally have been held on cards and accessible only to researchers visiting the seven participating libraries in person.

The seven participating sites hold a wealth of maps in their collections, with a combined total of over 800,000 post-1850 overseas maps, described on around 150,000 catalogue cards. Collection sizes vary from Imperial's 7,500 geological maps, to Oxford and Cambridge's 300,000 sheets each. Thus, 'Mapping the World' is seen by the participating institutions as the first stage in a longer term aim to provide electronic access to all their map collections. http://www.bodley. ox.ac.uk/users/lmh/rslp/index. html

Admission

Use of the Map Room is open to anyone holding a valid Bodleian Library Reader's Card. Details of admission procedures and application forms can be found at: http://www.bodley.ox.ac.uk/guides/admisfrm.htm

General information

The Map Room is located on the first floor of the New Bodleian Library on Parks Road. The 'Getting Here' section of the Map Room homepage has more details: http://www.bodley.ox.ac.uk/guides/maps/infofrme.htm

The Map Room's opening hours are:

Monday – Friday: 09.00-19.00
Saturday: 09.00-13.00

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World Directory of Map Libraries

The 4th edition of the World Directory of Map Collections, compiled and edited by Olivier Loiseaux of the National Library of France, on behalf of the Section of Geography and Map Libraries was launched at the International Federation of Library Associations annual conference in August 2000. It has been issued in the series, IFLA Publications as No. 92/93.   This

fourth edition lists 714 collections from 121 countries. Generally collections with fewer than 1000 maps were excluded unless they were in a national library or national archive or represented the only map collection for a country. The entries are arranged alphabetically by the English name of the countries, followed by the English form of the city name. When there was more than one collection in a city, the entries are arranged alphabetically by the institution name. Data are presented by institution name and address including fax and e-mail addresses; person in charge of the collection; history of the establishment of the map collection; number and categories of staff employed; the area occupied by the map collection; size of the collections; nature of the collection such as, subject specialization, chronological coverage; special collections; bibliographic control; reference services; lending services; copying services; storage equipment; conservation; and publications. This 550+ page volume is available from K. Saur Verlag, ISBN:3-598-21818-4.

The International Federation of Library Associations and Institutions (IFLA) is an independent international non-governmental association whose purpose is to promote international understanding, cooperation, discussion, research, and development in all fields of library activity. Within IFLA, the Section of Geography and Map Libraries is an international forum to promote and coordinate the collection, storage and access to geographic and cartographic information. The section's objectives are to initiate projects and studies, the findings of which are published in the form of technical monographs, occasional papers, standards, cataloguing rules, manuals, directories, bibliographies, newsletters etc.

book reviews

Recent Atlases of Mortality in the United States: A Comparative Review

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Atlas of Cancer Mortality in the United States, 1950-94. by Susan S. Devesa, Dan J. Grauman, William J. Blot, Gene A. Pennello, Robert N. Hoover, and Joseph F. Fraumeni, Jr. Bethesda, Maryland: National Cancer Institute, September 1999. NIH Publication No. 99-4564, softcover. 360 pp., maps, graphs, tables, references, appendices.

    Atlas of Respiratory Disease Mortality, United States: 1982-1993. by Jay H. Kim. Cincinnati, Ohio: National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, August 1998. DHHS (NIOSH) Publication No. 98-157, softcover, vii, 75 pp., maps, appendix.

    Women and Heart Disease: An Atlas of Racial and Ethnic Disparities in Mortality. by Michele L. Casper, Elizabeth Barnett, Joel A. Halverson, Gregory A. Elmes, Valerie E. Braham, Zainal A. Majeed, Amy S. Bloom, and Shaun Stanley. Morgantown, West Virginia: Office for Social Environment and Health Research, West Virginia University, December 1999. ISBN 0-9665085-1-3, softcover, xiii, 239 pp., maps, graphs, tables, index.

    Following rapidly on the heels of the publication of the *Atlas of United States Mortality* (Pickle et al. 1996) and the first edition of the *Dartmouth Atlas of Health Care* (1996), disease and mortality atlases have become a growth industry in the fields of public

health and medical geography. The utility of small area disease mapping has captured the attention of clinicians and health researchers interested in evidence-based practice and outcomes management (Gundersen 2000). Three recent national atlases of mortality from specific diseases provide an opportunity for a comparative review of purposes, methods, disease mapping strategies, approaches to data visualization and statistical comparison, methods of print and interactive presentation, and overall effectiveness. In contrast to Walter and Birnie (1991), this review does not provide an empirical analysis of the characteristics of each atlas. Rather, as the three atlases represent very different approaches in a number of respects, and point out several areas where methodologies continue to evolve, the contents and features of each atlas are briefly described, followed by a comparison of their salient features.

Atlas of Cancer Mortality in the United States, 1950-94

Cancer mortality atlases have evolved into a separate subject heading in the disease atlas genre. The present atlas is the fifth American offering from the National Cancer Institute; previous publications covered mortality by county for 1950-69 (Mason et al. 1975), mortality among nonwhites for 1950-69 (Mason et al. 1976), mortality among whites for 1950-80 (Pickle et al. 1987) and among nonwhites during the same time period (Pickle et al. 1990). The data for this latest atlas are derived from national death certificate files, and are based on underlying cause of death. The heart of the atlas is a series of maps, in 262 pages, showing age-adjusted mortality rates by US counties and separately by State Economic Areas (SEAs), separately by gender and race (white and black), for all cancers and for

each general site or body system (37 in all). Furthermore, separate maps show the patterns for the periods 1950-1969 and 1970-1994. The enterprising reader, calculator in hand, may determine an expected total number of maps (perhaps 2 x 2 x 2 x 37) and come up short. One reason is that certain cancers are gender-specific. Additionally, data on black cancer mortality are provided only for the period 1970-1994, and only by SEA, and for certain cancer sites black mortality was not high enough to generate statistically meaningful maps (i.e. sparse data for cancer of the testis, salivary glands, thyroid gland, among others). Additionally, county level maps are presented for only half to two-thirds of the cancer sites (more for white females than for white males). Even with these exclusions, the authors present a wealth of statistical data on cancer mortality.

    The authors provide an abbreviated discussion of methods, as well as a section describing the results, overall and by cancer site, of the mapping exercise. Here we learn, for example, that the 1970 U.S. standard population was used, with direct age adjustment across 18 five-year age groups, and that Atlas Pro and Atlas GIS for Windows software were used to create the maps. While some statistical analyses and comparisons are provided, the national maps do not show statistical significance. Rather, each map shows the areal units (counties or SEAs) classified across age-adjusted rate deciles, using a familiar color scheme ranging from full intensity red for those areas in the highest decile, to full intensity blue for those areas in the lowest decile, with eight gradations in between; areas with sparse data are shown in gray. Areas with sparse data were defined as: a) observed cases less than six, b) less than twelve and not statistically different from the national rate, or c) expected cases less than six and

not statistically different from the national rate.

The atlas is available in three forms: this softcover edition, currently obtainable at no cost from the National Cancer Institute, and two websites (accessed by pointing your browser in version 4 or greater of Netscape Navigator or Microsoft Internet Explorer to http://www.nci.nih.gov/atlas/mortality.html), one static and one dynamic. It is unfortunate that the authors failed to include the website address in the printed version, but enterprising readers should be able to find it through use of their favorite search engine. The Atlas On-Line web-based application provides everything contained in the printed version of the Atlas. This includes not only the color maps, but also the databases, text, and related graphics files. Users interested in accessing the underlying data for each map can obtain this information here. The second application enables the user to create maps from the underlying database, with flexibility in determining the number of data ranges and colors, and zoom in and out capability. The potential set of maps appears to be limited to those included in the printed version of the Atlas. The dynamic application continues to evolve, and readers are encouraged to log on and examine its technical aspects while viewing some of the cancer mortality maps that can be created.

Strengths of this atlas include its consistent manner of presentation, omission of extraneous detail, and presentation of age-adjusted rates rather than classifications based on inferential statistics. Weaknesses include the rather long time intervals displayed (1950-69 and 1970-94), failure to smooth the age-adjusted rate data prior to final map presentation, and reliance on underlying rather than multiple cause of death information for identification of cancer cases. This latter issue varies in significance with the site and type of cancer under study.

All in all, the authors are to be commended for the creation of a comprehensive atlas, one that will prove highly useful in focusing attention on spatial variations in the incidence of cancer mortality across the United States.

Atlas of Respiratory Disease Mortality, United States: 1982-1993

The second atlas under review provides maps of respiratory disease mortality across the United States. The conditions studied derive from a variety of ICD-9 rubrics, including tuberculosis, sarcoidosis, lung cancer and pleural malignancy, pneumonia, chronic obstructive pulmonary disease, asthma, hypersensitivity pneumonitis, asbestosis, silicosis, several forms of pneumoconiosis, byssinosis, and several other conditions. Data were obtained from national vital statistics sources, for calendar years 1982-1993, focusing on deaths among individuals 15 years and older. Age-adjusted rates were calculated using the 1980 U.S. standard population, across four age groups (15-34, 35-54, 55-74, 75+), and mapped by health service areas (HSAs), aggregated from counties, as defined by NCHS (1991). Data for each disease are based on underlying or contributing cause of death. There are no maps displaying patterns by gender and race, nor was this reviewer able to find any discussion of potential variations in mortality for any of these conditions by these characteristics. Two maps are presented for each disease: 1) age-adjusted, classed in five strata, and 2) compared to US rate as a rate ratio, with no confidence intervals or p-values. On each map, the five strata represent the following centiles of the distribution of values: lowest 10th, 10-30th, 30-70th, 70-90th, and highest 10th. For each rate ratio map, rate ratios were calculated by dividing the age-adjusted rate for each HSA by the U.S. rate. HSAs with fewer than 20 deaths for any given cause are shown double-hatched to warn the reader that rates are based on small numbers of cases, but shaded according to the category in which the actual value falls. The age-adjusted rate maps use a brown to yellow scale with gray for the lowest category, while the rate ratio maps use a dark green to lime green scale, also with gray to show HSAs where the rate ratio is less than 1.00. Each pair of maps is accompanied by an abbreviated discussion (never more than one page) of known and suspected occupational and environmental risk factors, with selected references for each disease. The atlas concludes with appendices showing the boundaries of the health service areas and their names. Readers who wish to determine which counties fall into each HSA will need to consult another source document (Makuc et al. 1991).

Strengths of this atlas include its concise approach and national perspective, with two maps and a page of text summarizing the information for each respiratory disease. The author is also to be commended for his restraint, in an era of p-values and tests of statistical significance, for not presenting any maps showing HSAs with rate ratios statistically different from the national rate. Weaknesses are more numerous, and include the limited discussion of statistical and cartographic methods, concerns about the methods used to calculate the rate ratios (especially the failure to account for race and/or gender differences in respiratory disease mortality), and the manner of graphical display (choice of intervals, decision to show rates and rate ratios with cross-hatching even when these are unstable estimates).

Given the relative infrequency of deaths associated with several

of these diseases, one wonders whether this national atlas should have been produced. The time period studied makes it difficult to compare these maps with other disease atlases. Another concern is whether mortality from respiratory diseases is adequately captured using underlying, as opposed to multiple, cause of death codes. While this point has been studied for some of the diseases in question (Davis et al. 1992), it may pose issues for some of the less common illnesses mapped here. Although NIOSH may have plans for an interactive web-based application using the data presented in this atlas, there is no mention of this made anywhere in the text. Although not referenced, the entire contents of the atlas can be downloaded as pdf files, from http://www/cdc/gov/niosh/98-157pd.html. Generally speaking, while this atlas is useful to the interested reader, compared to others (i.e. Pickle et al. 1996) it is substantially less comprehensive and statistically detailed.

Women and Heart Disease: An Atlas of Racial and Ethnic Disparities in Mortality

The third atlas reviewed here focuses on women and heart disease mortality, explicitly examining gender-specific race/ethnic differences from a national and state perspective. While the previous atlases were from the National Cancer Institute and National Institute of Occupational Safety and Health (a unit of the Centers for Disease Control and Prevention), respectively, this work is the product of a collaboration between staff at the National Center for Chronic Disease Prevention and Health Promotion at the Centers for Disease Control and Prevention and the Office for Social Environment and Health Research at West Virginia University.

    This atlas utilizes mortality data

from national vital statistics for 1991-95, analyzed primarily across counties, focusing on women 35 years and older. Heart disease mortality cases were identified using underlying cause of death classified by the ICD-9-A (nosological coding system for United States death certificates used from 1979-1998) to codes 390-398, 402, and 404-429. The atlas includes several national maps using counties as units of analysis, showing demographic patterns from the 1990 Census, official population projections, and other sources. A series of national maps show smoothed age-adjusted heart disease death rates by county for each race/ethnic group (all women, American Indian and Alaska Native, Asian and Pacific Islander, black, Hispanic, and white women), with counties classed into quintiles and areas with sparse data shown in gray. These six maps provide the only national perspective on heart disease mortality among women; all maps in the atlas from that point on provide intra-state data. For each state, there are two pages, each with up to three maps at the county level within the state. The number of maps depends on the race/ethnic distribution of women in each state.

    This atlas provides a focused, deliberate, highly professional presentation, with a text that both outlines all weaknesses of which the authors are aware and carefully describes all methods employed. One major concern has to do with the series of maps for each state. Maps show heart disease mortality by race/ethnic group for all women, white, black, Asian and Pacific Islander, Hispanic, and American Indian and Alaska Native women. For each state, counties are classed into quintiles based on the distribution of age-adjusted rates for that state and race/ethnic group. This facilitates comparisons across counties within race/ethnicity, which may have been the authors'

primary goal. However, it renders comparisons across states more problematic, although there are national maps included in the atlas. Another way to do this would have been to determine quintiles across all counties in the United States, so that the colors on each race/ethnicity-specific map would represent the same age-adjusted rate interval across all state maps.

    The authors are currently finalizing a companion volume on male heart disease mortality forthcoming late in 2000.

    The atlas is also available in a downloadable version, at http://oseahr.hsc.wvu.edu or http://www.cdc.gov/nccdphd/cvd/womensatlas.

Comparison and Comment

The three atlases examined here all focus on national patterns of disease-specific mortality, yet each takes a different approach to the analysis and display of statistical data in map form. The heart disease atlas focuses explicitly on counties as units of analysis, while the cancer atlas provides maps both by county and by SEAs, and the respiratory disease atlas provides maps by HSAs. Each of the atlases focuses on mortality defined by underlying cause of death, and all utilize the direct method of age-adjustment. Two of the atlases (cancer, heart disease) also provide gender- and race-specific maps, while the respiratory disease atlas does not. The years for which data are mapped differ widely among the three atlases. The atlases also differ as to manner of data display, with the heart disease atlas focusing on quintiles based on the rates displayed in each map, the cancer atlas similarly using deciles, and the respiratory disease atlas using five strata based on centiles. In contrast to the *United States Atlas of Mortality* (Pickle et al. 1996), only one of these atlases (respiratory disease)

includes maps based on statistical comparisons between each area and the United States as a whole. A general discussion of the appropriateness of maps that make statistical inferences, with standards or guidelines for their creation and dissemination, from the multiple perspectives of environmental epidemiology, cartographical methods and spatial analysis, public health, and mass communications, is clearly in order. Comparison of results from atlas to atlas would be enhanced by the adoption of a single standard population for age adjustment, and by the use of the same age groupings in computing adjusted rates.

Disease atlas designers should give some thought to the potential of indirect age-adjustment as a technique for presentation of small area variation in mortality and disease. The recent *Atlas of Leading and 'Avoidable' Causes of Death in Countries of Central and Eastern Europe* (Józan and Prokhorskas 1997) provides an interesting contrast to the methods used in these three atlases.

Statistical and cartographic methodologies for small area analysis are evolving rapidly, with new techniques and critiques of older as well as recently proposed approaches appearing continually. Thus it comes as no surprise that these atlases employ differing methods, and we can be sure that as these reports are updated with more current data, experiments with newer methods will continue. Medical geographers and environmental epidemiologists must cautiously balance the complexity of statistical methods with the interpretability of the final product to the public audience. None of these atlases provides the final answer, but we can be sure that the presentation of the maps included in each will allow researchers and members of the public to frame more questions. And that, in the final analysis, is the ultimate pur-

pose of an atlas of mortality rates or disease incidence.

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Air Apparent. How meteorologists learned to map, predict and dramatize weather.

By Mark Monmonier
University of Chicago Press, Chicago, 1999.
$27.50 (cloth)
ISBN: 0-226-53422-7
309p.

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A nation with an entire cable television channel devoted to the weather must be considered obsessed. This concise little volume speaks to our national weather addiction and illustrates the development of the cartographic images we seek out daily in newspapers, television, and on the Internet.

In *Air Apparent*, Monmonier continues in the style of his earlier books *How to Lie with Maps* and *Maps in the News*. *Air Apparent* is an amply detailed yet readable account of weather, climate and meteorological cartography. Arranged nearly chronologically, each chapter explores a topic or aspect in the development of weather maps, as we know them today.

Though weather observations had long been made and recorded the idea for locating the observations on a map was slow in developing. Although we take for granted the rendering of meteorological symbols on a map, the first genuine weather map was probably not created until 1816. Through the first several chapters Monmonier traces the history of the science of meteorology and the conceptual combination of maps and weather observations. The associated development of weather symbols and cartograph-

ic conventions, such as isobars and wind direction arrows progressed over decades and centuries, finally merging in the 1800s. In addition to these cartographic innovations, the author includes discussions of some of meteorology's important controversies such as the discoveries surrounding the understanding of storm systems and the reluctant, at least in the US, adoption of the concept of warm fronts and cold fronts. Continuing from observations to rudimentary forecasting, the author emphasizes the importance of the telegraph for the timely transmission of weather observations required for predictions and the progression of weather forecasting from a primarily military, defense science to an agrarian, domestic science.

The early 20th century saw the first regularly published current weather charts of the Northern Hemisphere and the more regular inclusion of weather maps in newspapers. Thus, weather information began to reach a broader audience; first through print publications, then television, and now the Internet. As Monmonier notes, printed maps tend to be simple and clear while television and Internet maps have the added advantage of animated symbols. The author brings the book up to date with chapters on recent technological developments. High performance computing and mathematical refinements enable more sophisticated forecasting, with satellite meteorology and weather radar adding new dimensions to the suite of meteorological tools. Through these chapters, Monmonier manages to explain highly technical concepts and systems, such as Doppler radar and NEXRAD, in comprehensible terms that even the technologically challenged will understand. Another chapter addresses climate, including fundamentals such as precipita-

tion, temperature extremes and climate classification as well as the modern concerns of global warming and ozone depletion.

The final chapter focuses on cartography. As Monmonier observes, meteorology is inherently cartographic, yet little attention is paid to the theory and practice of map-making. Likewise, historians of cartography have given meteorological maps little study. With this chapter the author, at least, begins to correct those oversights.

Air Apparent ends on a positive note. Weather forecasting is more accurate and prescient than ever, and advances in theory and technology should carry our understanding even further. Concerning the display and dissemination of these data, Monmonier envisions a future with interactive and animated charts and maps responding to short-term and long-term conditions and expectations.

Since the weather is a topic of common interest, *Air Apparent* is sure to appeal to a general audience while providing a manageable overview of the subject in only 309 pages. Additionally, Monmonier has an unusual talent for writing books that both casual readers and experts will appreciate. His thorough research is evident in the annotated endnotes. The index is well constructed and complete and an appendix includes a series of URLs. His choice of illustrations complements the text and the black and white maps, in particular, nicely highlight many salient points. A chapter on air-quality, dispersion and hazards is rather oddly placed but the information is pertinent to the overall topic and the author has clearly given it much thought, having already published a book on the subject of disasters.

In all, *Air Apparent* is just what we have come to expect

from Mark Monmonier, a well-researched and readable account of an area of cartography that has not previously been well examined. This book will be an excellent addition to most libraries and the collections of both cartographers and meteorologists.

Barrington Atlas of the Greek and Roman World.

Richard J.A. Talbert, ed. Princeton, NJ: Princeton University Press, 2000. xxviii pages, 102 plates, [ ] pages. ISBN 0-691-03169-X; $325.00. Two-volume *Map-by-Map Directory* (ISBN 0-691-04962-9) $150.00

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The publication of the *Barrington Atlas of the Greek and Roman World* is an event that has been awaited by classical scholars for over one hundred years. Only one other publication has attempted to comprehensively display the physical landscape of the Greek and Roman world, *Atlas of Ancient Geography Biblical and Classical* by William Smith published between 1872 and 1874.[1] In 1980, members of the American Philological Association (APA) realized that projects then underway were not going to successfully meet the need for basic reference maps supporting classical studies and that older materials were becoming increasingly less accessible. In 1988, after little further forward movement by the APA, Richard Talbert was asked to take on the task of providing the focus and driving force to successfully compile and complete the publication of a reference atlas. Talbert set five goals for the project: to involve the cartography firm and publisher early in development process; to develop plans that

could be completed in the foreseeable future at a reasonable cost; to create a single, bound atlas ample in size but not unwieldy; to comprehensively cover depictions of ancient landscape configurations; and to create maps that could be used by readers not necessarily well versed in map interpretation. Donnelly Cartographic Services (later Geosystems and MapQuest.com, Inc.) and the Princeton University Press were involved early to establish the format and style of the atlas. In 1990 a specimen map prepared by Donnelly Cartographic Services, which became the "Byzantium" map in the atlas, received the "American Congress on Surveying and Mapping Certificate of Merit, 1990 Map Design Competition, Best of Category: Series Maps and Charts." Setting a goal of foreseeable completion in combination the goals for comprehensiveness and a single-volume accessible atlas drove design and coverage. Maps were prepared that follow a common format with a unifying symbol style, method of elevation depiction, and a minimum of different scales.

More than 200 individuals were involved in the preparation of the atlas, preparing base maps, compiling data, reviewing maps and directory entries, and editing. Base maps were developed from standard United States Defense Mapping Agency/National Imagery and Mapping Agency products, Joint Operations Graphics, Tactical Pilotage Charts, Operational Navigation Charts and Global Navigation Charts. Compilers were specialists already well acquainted with the regions that they were asked to cover; compilers were to use existing sources, not to become involved in new, extensive research efforts. Each of the plates includes attribution to its compilers, as none of the work in the atlas is anonymous or done by the collective, and the date that it was submitted to the project

by the compiler. The maps were anonymously reviewed by classical scholars who were not otherwise connected with the project. Funding for the project, more than $4.5 million, came from a number of different sources including the Barrington Foundation, the American Philological Association, the National Endowment for the Humanities, and the University of North Carolina, Chapel Hill.

"The purpose of each map is to offer an up-to-date presentation of the significant physical and cultural features of the area covered, within the relevant time frame, exploiting all available historical, epigraphic, and archaeological data." The *Barrington* could well be the *Times World Atlas* for the Greek and Roman world. The volume includes 99 topographic maps on 175 pages plus three additional overview "sketches." There is an extensive amount of introductory material that places the atlas into an intellectual context, describes how the atlas was prepared, and assists the user in making the best use of the maps. A 44-page gazetteer section containing 24,249 feature names found on the maps, including multiple names for some features, concludes the volume.

The maps are at four different scales, 1:5,000,000, 1:1,000,000, 1:500,000 and 1:150,000. Most of the maps are double-page plates. Relief is shown by gradient tints and, depending on scale, shading or contours. The smallest scale is used for the seven regional "overview maps" that open the map portion of the atlas. The areas covered by the overview maps are large regions, some of which had contact with the Greeks and Romans but were not strictly part of the Greek or Roman worlds: Mare Internum, Fortunatae Insulae, Hibernia-Scandinavia, Asia Occidentalis, Arabia-Azania, India with Sri Lanka, Asia Orientalis. Six geographical sections follow: Europa Septentrionalis, Hispania-

Libya, Italia, Graecia-Asia Minor, Syria-Meroe, and Pontus Euxinus-Persicus Sinus-Bactria. The maps in these sections are at either 1:500,000 or 1:1,000,000; the larger scale is used for maps of the "core" classical world while the smaller is used for maps of the peripheral classical world. Three maps in the six geographical sections, Attica, Rome and vicinity, and the Bosphorus, are at 1:150,000. The final three maps, the overview "sketches," show the provinces of the Roman Empire at three specific times, the death of Trajan (A.D. 117), from the Verona List (circa A.D. 303-324) and according to Hierocles (late 5th century to early 6th century, A.D.). These three maps are the only maps in the entire volume with a specifically assigned time period. All of the other maps show a variety of overlapping time periods by using color coding of the feature name or by underlining the feature name.

The *Barrington Atlas* is not the typical "textbook" classical history atlas that includes coverage of physical, political, economic, cultural, military, and religious features or events. The focus of the *Barrington Atlas* is strictly the physical (topographical) world as it probably appeared during the classical period much in the same way that the *Times Atlas of the World* focuses on the physical aspects of today's world.

The *Barrington Atlas* is a solid volume. Its binding is scholarly in appearance and sturdy enough to stand up to years of use. The pages lay flat when opened and little, if any, information will be lost to the gutter on double-page maps. The color scheme used for the gradient tints is similar to the *Times Atlas of the World,* but not as saturated, with a traditional progression from green at lower elevations through yellow to rosy browns at higher elevations. Contour lines are light gray allowing feature names to "float" above the landscape

for easy reading. There is a nice control of foreground and background. All maps include a ratio scale statement plus a barscale. The maps do not feel cluttered, and it should be easy for novice map users to find the specific sites they seek. The symbol key appears only once in the volume, at the beginning of the map section on the verso of the fold-out map of the Mediterranean Sea. The extra thickness of the folded page makes is easier to find the legend than it would be on a single thickness of paper. The introductory material is clearly presented and includes some interesting information normally not found in atlases, a description of the compilation and production process plus a map-by-map listing of base maps used. Much of the introductory material should be required reading for first-time atlas users; it places the atlas in both an intellectual and historical context and alerts the reader to some of the constraints placed on the atlas and its contributors.

The atlas is accompanied by a "Map-by-Map Directory" CD-ROM. Each map has a section that includes introductory material, a listing of all of the place names on the map with codes for the source material used by the compiler, and a bibliography. The introductory material provides a geographical overview of the area covered by the map and will include discussions of problems encountered and decisions made during compilation. The place name list displays grid location, feature names including variants, period of occupation, modern name, and appropriate supporting reference works. Adobe Acrobat Reader 4.0 with Search, version 4.05 is included on the CD and is required to not only view the files but to make full search capability use of the indexed files. The basic version of Adobe Acrobat 4.0 will open files for viewing but is not

able to search across files. Instructions on using the "Map-by-Map Directory" are also included on the CD. The navigation between files is facilitated by a PDF file of the table of contents with links to the individual chapters, working much in the same way as a paper index with hand-turned pages. The "Map-by-Map Directory" is a necessary supplement to the atlas because it includes the names of features that are given only reference numbers on the maps. Alternatively, the same information can be viewed in the separately available two-volume printed version of the directory. The PDF files on the CD-ROM duplicate exactly the pages of the printed volumes except for some errors in an abbreviations list which are acknowledged in the FAQ at the Ancient World Mapping Center web site and were corrected between the production of the CD-ROM and the printed directory.

Hammond's *Atlas of the Greek and Roman World in Antiquity*[2] is the atlas most similar to the *Barrington* because it includes maps that focus on the physical/political world in addition to maps that target specific events, time periods, or activities. The *Hammond* indexes more than 10,000 sites, slightly less than half of the number included in the *Barrington*. It includes maps of wars and battles, cities, trade and invasion routes, and the spread of Christianity, none of which can be found in the *Barrington*. The *Hammond* includes little explanatory text, and all of the maps are in shades of brown. This contrasts greatly with the extensive introductory material at the beginning of the *Barrington*, the explanations that accompany each map in the map-by-map directory, and the chromatic range of the gradient tints on the *Barrington's* maps.

There are two textbook atlases titled *Atlas of the Classical World*, one edited by Talbert[3] and the

other by Michael Grant.[4] Neither one has *Barrington's* dedicated focus on classical landforms and extensive feature names. Although both have gazetteer sections, their focus is on specific places, events, historical figures and time periods not on the topography and, indirectly, the connections made possible or hindered by topography. Because the *Barrington Atlas* does not include many maps targeted on specific figures or time periods, the novice classical scholar may be best served by using the *Barrington* side-by-side with one of the more common textbook atlases, and seasoned scholars will enjoy the security of the robust scholarship that underlies the entire volume.

Work on the atlas continues with communication via the Web. The Ancient World Mapping Center has been established at the University of North Carolina at Chapel Hill "to promote cartography and geographic information science as essential disciplines within the field of ancient studies." The website (http://www.unc.edu/depts/awmc/) includes a FAQ for the atlas and soon will make available a Web form for critiques and corrections to the atlas. There are also a number of links to classic world-related sites and maps derived from the *Barrington Atlas* which can be downloaded in PDF format. The *Barrington Atlas of the Greek and Roman World* will not become stale or dated as long as the Ancient World Mapping Center exists.

Although expensive, the *Barrington Atlas of the Greek and Roman World* should be considered an essential purchase for libraries supporting classical studies programs. Devoted classical scholars with room in their personal libraries for a large volume may also want to have this instant classic readily at hand. The additional purchase of print "Map-by-Map Directory" is not strictly necessary as the CD-ROM version is bundled with the

atlas but the print may facilitate more in depth study, especially where computing equipment is not easily accessible. The atlas will appeal to novice and senior scholars but also might find a fringe audience of novelists and poets who are looking for place names rooted in history but with an ambiance of timelessness.

Richard J.A. Talbert, "Mapping the Classical World: Major Atlases and Map Series 1872-1990," Journal of Roman Archaeology 5 (1992): 5-38.

Nicholas G.L. Hammond, ed. *Atlas of the Greek and Roman World in Antiquity*, Park Ridge, NJ: Noyes Press, 1981.

Richard J.A. Talbert, ed. *Atlas of Classical History*, New York: Macmillan, 1985.

Michael Grant. *Atlas of Classical History*, 5th ed. New York: Oxford University Press, 1994.

Government Printing Office (GPO)

Robin Haun-Mohamed of the Government Printing Office (GPO) told the Council that GPO will distribute 28.2 million items in Fiscal Year 2000. GPO distributed 382,000 maps in FY 1999. GPO is entering its fifth year of transition from paper to electronic items. The

amount of fiche, paper, and CD-ROMs is down. GPO is attempting to eliminate multiple-formatted products, but these are reviewed on a case-by-case basis. The DRGs are available on-line through Microsoft Terraserver. The topos are available on-line via TopoZone (www.topozone.com).

Robin reported that in March she had met with representatives of the Bureau of the Census. They discussed the responsibility for long-term access to Census electronic products. Currently, these products are using Acrobat or Hewlett Packard Graphics Language (HPGL).

The National Wetlands fiche and new web site were discussed. The revised and improved National Wetlands Maps that had been done for GPO a couple of years ago were formatted wrong by the vender, and thus not distributed. Council indicated that if they could be made available on the web, they would not need to be photographed again. Similar versions are available on the web at: http://wetlands. fws.gov/

Robin asked the Council a series of questions: 1) What is the impact on libraries when mapping is online? 2) How do we use online spatial/cartographic data? 3) Do we download things, save things, archive them, or do we go back to the original source material each time? 4) Do we handle electronic map needs in the library or do we send our users someplace else? 5) Do we use the airport charts, obstruction charts, approach charts, etc.? 6) What will be the impact if the USGS Open File Reports go online only?

Council members each, in turn, answered as many of these questions as applied to them.

Government Printing Office (GPO) Map Cataloging

Vi Moorehouse from the GPO Cataloging Unit made a few comments to the Council. She said that there are over 200 map libraries, of which an estimated 40% are run by professional map people. GPO is concerned about the remaining 60%. Vi expressed a desire that the map library community would provide guidance to those who are uninitiated in map cataloging.

Vi told the Council that their map cataloging backlog is "almost nil." At this point, USGS topos are being cataloged using two different dating methods. One is in the edition statement. If the edition statement is not available, the date is added at the end of the title. The Forest Service-USGS maps are being listed under I 19:81 instead of A13.28. She also indicated that USGS is very receptive to requests to place something online, such as Open File Reports.

Vi discussed a problem with encoding of GPO's new BIBCO records. BIBCO requires that the encoding level in the fixed fields be left blank (like LC). The result is that records are being displayed in OCLC as LC originated, instead of GPO. Thus, it is not possible to identify GPO/BIBCO records in the OCLC title index listings.

National Ocean Service (NOS)

The National Ocean Service (NOS) was represented by Fred Anderson, the Deputy Director of the Office of Aeronautical Charting and Cartography, and Howard Danley, the Deputy Chief of the Navigational Services Division of the Office of Coast Survey.

Fred reported that Aeronautical Charting and Cartography (AC&C) will be moving to the Federal Aviation Administration on October 1, 2000. They will stay in their current facilities in Silver Spring, Maryland. AC&C prints and distributes NOAA and NIMA charts to the public. Aeronautical charts will remain in the Federal Depository Library Program. Libraries should contact AC&C's

Distribution Office in Riverdale, Maryland for catalogs and other promotional information to give to patrons. The FAA has not made a decision about AC&C printing and distributing Nautical Charts. Fred noted that the printing of aeronautical and nautical charts fit together well. There is a 28-day cycle for aeronautical charts and the nautical charts fill in the printing gaps. The distribution computer system has been fine-tuned and AC&C can start shipping aeronautical and nautical charts directly to the depository libraries, rather than going through GPO. The libraries should be getting these products faster--before the effective date of the charts. For future digital aeronautical charts, AC&C does not want to use copyright or user fees. They want to avoid a CRADA because that would create a monopoly and would be outside the Federal Depository Library Program.

Howard Danley reported that they don't know what will happen with printing and distribution of nautical charts when AC&C goes to the FAA. They have a Cooperative Research & Development Agreement (CRADA) for print on demand for nautical charts. Nautical charts have a life of 1-2 years. Commercial ships have to keep their charts corrected by hand from updates that are published in *Notices to Mariners*. Until 1969, the charts in the warehouse were hand corrected until shipped. Nautical charting agencies in the rest of the world still hand-correct the charts before shipping. Print-on-demand will allow more up-to-date charts to be distributed. A print-on-demand trial of forty charts of the New York Harbor area will be undertaken by a company called Vomela in St. Paul, Minnesota. There is a continual update of the digital files and the base information can be changed in two to three weeks. The print-on-demand copies would have an added value and cost more. They could be

produced in custom editions with special marginal information for commercial users or recreational users. They could be printed with or without Loran. NOS wants to test the viability of these higher cost charts.

Currently, raster digital nautical charts are produced under a CRADA with Maptech. The company has a web site, www.maptech.com which has views of the charts available online. The regular CD-ROMs cost about $200 each. They have a Professional Series CD for $500 each. These come with an e-mail update service. Updates are received by e-mail and the charts are updated when the CD is run. The updated charts can be saved to the hard disk or a floppy disk or only the updates are saved so that the updated charts are displayed on the screen when it is called up. NOS is working to have these Professional Series CD charts certified by the Coast Guard for the carriage requirements for use in navigation for ships of more than 1600 tons.

Vector nautical charts are being developed by NOS. By the end of the year, vector charts of the 40 largest United States ports should be available. Ships should be able to navigate using the vector charts with GPS. NOS has a demo of the area near Valdez, Alaska. Had these charts been available, the Exxon Valdez would have received six audio warnings before it ran aground. The NOS home page has images of the nautical charts at 100 dpi. These should be small enough so they cannot be used for navigation, but provide customers with an idea of coverage.

For now, NOS will continue with both print-on-demand and lithographic copies in parallel. When the price of the print-on-demand copies comes down, maybe the lithographic copies would be dropped. The print-on-demand copies would be copyrighted and would not be in the Federal Depository Library Program.

Library of Congress Geography and Map Division (LC G&M)

John Hebert, the new Chief of the Geography and Map Division at the Library of Congress spoke to the Council before lunch. John worked in the Library's Hispanic Division before moving to Geography and Map. He announced several staffing changes. Betsy Mangan will be retiring in the Summer. Betsy has been with the Division for over 30 years. John hopes to hire an assistant chief and someone to take over the reins of the cataloging unit. Al Herman retired in the spring. The Division will be hiring a new Administrative Officer. Currently, the Division is in good shape as far as staffing—the push for materials in the American Memory Program has helped.

The Division continues to bring in a large number of materials through purchases, the State Department Program, and the copyright program. Recently, the Division received a gift including 6 of the 18 known maps by Lafayette's cartographer. The Division is starting to make arrangements to acquire maps from Cuba.

Last summer, LC implimented a new Integrated Library System (ILS)—Endeavor. It has been a trial at times. NIMA also installed Endeavor, so the two organizations are working out agreements to share data. While NIMA has never used the MARC format, they have cataloged each individual sheet of the various map series. Conversely, LC catalogs using MARC, but has not individually cataloged the sheets to its various series (numbering over 2,000,000 sheets). Once LC acquires the individual sheet information from NIMA, they will hire contract workers to bring the records up to LC standards.

The National Digital Library Program is entering its 5th year. The Library is reviewing the Program and deciding whether it should remain in the departments (like G & M) or consolidate into one system-wide office. The Division has completed scanning their collection of panoramic maps of the US, and continues to add these types of maps as they acquire them. They have also completely scanned two atlases including one by Ortelius. New categories include railroad maps, Civil War maps, Revolutionary War maps, and maps of the Spanish and Portuguese world from before 1600. The maps in the various categories are being derived from the cartobibliographies compiled at LC. The Civil War scanning project was begun in November 1999. The Revolutionary War maps will start soon. Spanish maps will start in the Fall. The Division entered a contract in 1998 with Sanborn to scan their maps. The project has been halted due to a dispute over copyright. LC is allowing Sanborn access to 250,000 maps that are in the public domain, but Sanborn wants to add a copyright statement to the scanned images. LC feels that anything made before 1923 is in the public domain. Also, the Division is currently exploring a cooperative project with the State of Virginia Library and West Point to scan maps of the cartographers of the Confederacy. Other proposed scanning projects include the U.S. county atlases from the 1800's, land ownership maps, and maps of Eastern Europe from the late 1800's. Printed copies of the scanned maps are available through a company in Seattle — www.museumarchives.com. John believes that a print-out of a panoramic map will cost about $40.

Gary Fitzpatrick has received funding to hire two people in FY 2001 and two more in FY 2002 to do GIS in the Division for Congress. Essentially, they will create GIS maps on demand for Congres-

sional members.

The Council inquired about the LC Summer Project. John was very interested in doing it. Despite concerns about the cost of housing, he indicated that LC would be unable to provide funding toward housing. However, he encouraged everyone to write letters to him requesting information and expressing interest in the Summer Program. He indicated the Philip Lee Philips Society might be able to help.

The Division has initiated weekly talks by staff members. The topics are chosen by the speakers and the talks are intended to build bridges of understanding within the Division, and to let others know what they are doing.

National Imagery and Mapping Agency (NIMA)

Jim Lusby addressed the Council for NIMA. He works in the National/Civil Agencies Customer Operation Branch. There are Customer Operations liaison officers and technicians stationed worldwide. NIMA products meet the needs of civil, national, and law enforcement customers. Their products helped support the USGS Environmental Crisis Support efforts such as Hurricane Mitch, and the Colombian earthquake. Working with the Secret Service, NIMA has supported security efforts during the Papal visit to St. Louis, the Energy Conference in Houston, and the World Bank Meeting in Washington.

The digital products that NIMA has available are on their web site: www.nima.mil/geospatial/products/DTED/dted.html

Through agreements with other countries, NIMA will soon be distributing available topographic maps at a scale of 1:50,000, 1:100,000, 1:250,000, and cities at various scales of the following countries: Vietnam, Cambodia, Laos, Somalia, Tanzania, Uganda,

Bolivia, Dominican Republic, Haiti, Belize, Honduras, Guatemala, El Salvador, Nicaragua, and Costa Rica. Once printed, depository libraries who have chosen to receive NIMA topographic maps will get a full set (or as many as are available) of each country.

In summary, Jim made three points. 1) There will be Digital Nautical Charts (DNCs) which are vector images. These are not yet finished. There is a replacement for the Digital Chart of the World, it is the Vector Map Level 0 which consists of four CD-ROMs. 2) There will be a vector map of the world at Level 1 detail but only of selective countries. 3) NIMA is moving toward providing foundation-feature data electronically. They want to provide the data and have others do the hardcopy mapping. The data will be continuously updated. There are no concrete plans to archive the data, but they are talking about it. NIMA hopes to phase out printed products by 2010.

Census Bureau

Robert Marx, Chief of the Census Bureau's Geography Division, and Tim Trainor, Chief of the Cartographic Operations Branch spoke to CUAC about developments at the Census Bureau. They gave the Council a TIGER bookmark that had lots of useful URLs for Geography Division web sites.

They began their talk with new developments for Census 2000. The term Block Numbering Areas (BNAs) will not be used any more; just Census Tracts and Census Block Groups, although not all of these have been developed with local authorities. Formerly, there was a required minimum population of 1000 in order to constitute a Census Designated Place (CDP), but now there will be no minimum population requirement. CDPs are closely settled and named, although unincorporated communities. The Census works with

local governments to decide which blocks make up a CDP. Block numbers will now be 4 digits with no suffix; this style of number will be available first with the P.L. 94-171 data release shortly before April 2001. Census blocks are the smallest area of land defined by line features on census maps. ZIP Code Tabulation Areas (ZCTAs) are approximately the same as USPS ZIP Code service areas and have been developed to address difficulties in mapping USPS ZIP Codes. ZIP Codes are assigned to routes or points, and technically aren't area features. ZCTAs will be done at the 3-digit level for large areas that don't have housing units (because ZIP Codes in these areas are as yet undefined by the US Postal Service).

In contrast to the predominately black and white paper products from 1990 and earlier, Census 2000 will have an emphasis on electronic map products, in color, with paper products available on demand. Electronic media will include the Internet, CD-ROM, and DVD-ROM. Plotter formats will include Adobe Acrobat Portable Document Format (PDF) and Hewlett Packard Graphic Language (HPGL). Examples of CDs being produced are the Congressional District Atlas, Census Mapper, and PL 94-171 Redistricting Data from the Census 2000 Dress Rehearsal. Digital format has advantages in the areas of more efficient storage, ease of selecting and choosing a map, and retaining the ability to print. Census's standard plotter is an HP DesignJet 1050C, which produces color or black and white output at 600 dots per inch and includes 80 megabytes of RAM and a 2 gigabyte hard disc. The Acrobat files will have thumbnails and geographic area names will be searchable.

Customers will still be able to order paper products from the Census Bureau. Cartographic products will be available a month

before the PL 94-171 data and should cost the same as in 1990 ($5 a sheet for a printed map). Boundary files in Acrobat (PDF) will be downloadable to the public, but not the HPGL plotter format; the latter can be purchased on DVD.

Examples of paper products that will be available for purchase are large-format reference maps, such as Government Unit Block Maps, Census Tract Outline Maps, and State/County Outline Maps. After 2000, State/County Metro Areas, Urbanized Areas, and Congressional Districts maps will be available, as well as Public Use Microdata Sample Products (PUMS). Corner Point Files, based on map sheet coordinates, will be provided for large format maps only.

P.L. 94-171 paper products will be available by March 2001, HPGL files by April, and Acrobat files in May. The Governmental unit maps will be available on paper in May 2001, in HPGL in June, and in Acrobat in July. Other reference maps will follow later in 2001.

For those needing to manipulate electronic files, generalized boundary files will be available from the Census Bureau's Geography Division cartographic boundary file web site (http://www.census.gov/geo/www/cob/) in some standard GIS formats: ArcView shape files, ArcInfo export format files, and ASCII. The TIGER/Line-file discs will continue to be available as they have been for those who need to translate street and boundary files into GIS formats. Files will come with FGDC compliant metadata.

U.S. Geological Survey (USGS)

Rea Mueller spoke to the Council concerning USGS issues. The Survey serves a variety of disciplines including geologic, cartographic (i.e., National Mapping Division), hydrologic, and biologic. They are moving onto the web in all areas, including data, electronic publica-

tions, status graphics, GNIS, geography, and National Biological Infrastructure. Search and access tools include GLIS to identify and order materials, and Earth Explorer (from OHIOVIEW funding that contains Landsat and Corona).

Map lists will continue to be put online. These will show the version-date rather than the current-ness-date. The version date is the latest date, and will be in the lower right-hand corner of the paper topographic map. New editions of the paper indexes will combine map indexes (the green books) and map lists (the information in the old brown books or white state map lists) onto one sheet. While the printed map lists will only show the version date, the online map lists give both version and currentness dates. Map reference codes will be added to the index sheet. Maine is the prototype for this series, with North Carolina in the works. The Mineral Resources Data System (MRDS) and the Minerals Availability System/Minerals Industry Location System (MAS/MILS) databases are available in electronic format on CD-ROM-DDS-52.

Terraserver offers maps on the web. The DRG's are available for all of the U.S. except Alaska. The DOQ's are still not complete for the entire U.S.

Rea told the Council about a new information program that may be accessed by calling 1-888-ASK-USGS. One of the option buttons on the toll-free number is "Talk to the USGS Library Information Desk." The new web site (http://ask.usgs.gov) will have information on water, hazards, and biology.

The thematic map series are changing. The "I," "HA," and "Circum-Pacific" map series will continue to be produced, and be sent under a single depository number. Other series are complete and the final numbers are: C-146, OM-227, OC-148, GP-1016, MR-96,

and GQ-1804. A few maps in each series are still in progress, and will be sent when completed. The MF series may be saved but only in electronic form.

Progress continues on the online version of the *National Atlas*, which may be viewed at www.nationalatlas.gov/. The project is progressing with the cooperation of eighteen federal agency partners. Some new maps include a shaded relief map, and an earthquake map. *The National Atlas* has an interactive browser and connects with the TerraServer which allows patrons to view aspects of a local area.

Several trends were noted in USGS map production and distribution. There will be more cooperative partnerships. USGS maps will likely continue not to fall under copyright. Future revision of the topographic maps will focus on top-selling quads and on maps produced in cooperation with other agencies.

U.S. Forest Service (USFS)

Betsy Banas from the US Forest Service, Washington, D.C. Office spoke to the Council about some new mapping activities. Mapping for the Forest Service historically was done from regional offices. But in 1975, the Forest Service began to consolidate mapping with the establishment of the Geometronics Service Center in Salt Lake City. As technology has evolved, the Center has become increasinly involved in geospatial activities: providing geospatial data, services and training in addition to traditional mapping. In 1999, Geometronics Service Center was renamed the Geospatial Service and Technology Center (GSTC), to better reflect its new mission.

The production of the "Single edition" series of maps continues. These are produced to the specifications of the USGS 1:24,000 scale topographic quadrangles

with Forest Service information as well. Several years ago, the Forest Service entered into an agreement with USGS to produce, in accordance with USGS standards, the quads covering the Forests. Consequently, the Forest Service is in the process of updating a large number of topo maps, and plans to keep their revision cycle on a tighter schedule than would otherwise be possible if USGS were responsible for their update. Five years is the ideal, but realistically it can be as much as 15 to 20 years. Quads in areas of frequent change are revised more frequently.

Until recently, the Forest Visitors' Maps have been available for purchase only from the individual forests themselves. But, the Service has entered into an agreement with USGS such that USGS will sell and distribute Forest Visitor Maps through their vendor network for participating Forests.

In October 1999, President Clinton called a halt to all construction of Roads in unroaded Forest areas. This (the Roadless Initiative) is a conservation effort to protect endangered species and promote biological diversity. An environmental impact statement will be done on 54 million acres. GIS has been an essential tool in this process. Numerous product-specific maps have been generated which display information from a variety of geospatial and tabular files. The data provides information regarding inventory of roadless areas, road status, fire risk, and forest health. These can be viewed at: www.roadless.fs.fed.us.

National Park Service (NPS)

Tom Patterson from the National Park Service Division of Publications at the Harpers Ferry Center spoke to the Council regarding mapping of the National Parks. Lands under Park Service stewardship cover most States and Territories, including Alaska, Hawaii,

American Samoa, Guam, the Virgin Islands, and Puerto Rico. The Harpers Ferry Center staff of four cartographers provide visitor-orientation mapping for the 379 parks in the system. The cartographic program at Harpers Ferry Center is unique among Federal agencies for its strong emphasis on graphic design.

The National Park Service web site receives approximately 850,000 hits per day. Within that site, the Harpers Ferry Center's web site is the 10th most popular web site in the NPS. There were 4.7 million hits on the Harpers Ferry site last year.

There are approximately 500 maps in the Division of Publications inventory, 99% of which are digitized. Of the digital inventory, 80% are on the web. The remaining 20% are still waiting to be printed before they are placed on the web. Vector map files are available in both Adobe Acrobat (PDF) format and Adobe Illustrator (AI) format. With the release of Adobe Illustrator 9.0, maps will be posted in PDF format only, since the PDF and AI formats will merge. Shaded relief images, which are used as placed art backgrounds within vector maps, are published on the web only in gray scale. Well over 100 shaded reliefs are loaded on the web page as 200 dpi JPEGs. There are no plans to scan historic park maps.

Tom presented new maps of Mt. Rainier; Crater Lake; Channel Islands (with digitally-generated bathymetry); Buck Island Reef in the Virgin Islands (he noted that it was a challenge to show the reef bottom with traditional cartographic methods, so they incorporated aerial photography); an oblique view of the Grand Canyon; California Trail; a guide to Fort Larned, KS (using 3D technology for the landscape details, including buildings and trees); and Fort Davis, Texas.

(letter from the editor continued)

in common? What can they talk about?

What they talk about, of course, is the advantage of each medium for conveying information. The map on paper is more portable, has a higher resolution and can be larger. No, the map on paper is less portable than map distribution through the web because there is a limit to how many maps you can carry with you, and maps on paper do not offer the advantages of interaction and animation. And so it goes.

So, does size matter? Size, of course, is just the latest argument against the use of computers for the display of maps. It used to be that computers could not be used to produce maps on paper because they could not draw lines well enough or could not produce shadings with the proper gradations. In essence, the computer could not produce an acceptable cartographic product. OK, so now it can. But, the computer monitor is still an unacceptable form of display because, well because, it's too small and we cannot convey broad geographic patterns in a small area. Besides, it doesn't have the fine resolution of maps on paper. And so it goes.

I have a sign on my office door that says: "If it's not on the web, it's not!". The statement tries to convey that even if something is real, if people can't see or experience it, in a very real sense, it doesn't exist. To millions of people, those maps of eastern Europe and Austria, although beautifully done, are not accessible and therefore not real. They don't exist. So, the argument is reduced to a choice of size or existence. Either we make big, "beautiful" maps that don't exist (to large numbers of people) or small maps that do. To be or not to be? I'll take existence.

Speaking of existence, this is my last issue as editor of *Cartographic*

Perspectives. I have been with the journal for nearly ten years, initiating an Editorial Board in 1991, serving as guest editor in 1997, and making the transition to editor in 1998. It has been truly gratifying to see the journal grow in these years in both size and status. Most rewarding of all is the amount of help that I've received from everyone involved in the production of *CP* – the Assistant Editor, Section Editors, and the entire Editorial Board. Let me extend my warmest thanks to all of these individuals, and to the guest editors who have given me the extra time to explore cartography outside of North America.

Michael P. Peterson
Omaha, Nebraska

CALL FOR PAPERS

XXI Annual Meeting of the
NORTH AMERICAN CARTOGRAPHIC
INFORMATION SOCIETY

Portland, Oregon
October 3 – 6, 2001

The NACIS Program Committee invites you to participate in this meeting by presenting a paper, poster, or exhibit, or planning a session, panel discussion or workshop. Computing facilities at the Portland State University will be available for workshops. The meeting will be held at the Downtown Portland Doubletree Hotel.
All cartographic-related topics are welcome.

Potential topics include:

- *Map librarianship, digital archives & databases*
  Map /atlas design & production techniques
  GIS data and map acquisition strategies
  On-line mapping, animated & interactive cartography
  Government agency cartography, Census 2000 mapping
  Commercial & free-lance cartography
  GI Science, GIS developments, Geographic visualization
  Mapping the West

For Papers: E-mail your 250-word abstract to the program chair, Jim Meacham, by May 15th. Please include your submission within the e-mail message, rather than as an attachment. List names and affiliations of all authors, and include phone and e-mail for the presenting author and specify equipment needs. We encourage student participation.

E-mail abstracts & questions to:
jmeacham@oregon.uoregon.edu
DUE May 15, 2001
Participants will be notified by June 15, 2001 of acceptance of their abstract.

For Exhibits or Posters: Contact Jeffrey McMichael at jmcmichael@gsu.edu by August 24, 2001 with exhibit/poster title, the names and affiliations of authors, and exhibit space needs.