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Maps as social constructions: power, communication and visualization

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Abstract: Two developments in cartography mark an epistemic break with the assumption that maps are unproblematic communication devices. These are 1) investigations of maps as practices of power-knowledge; and 2) 'geographic visualization' (GVis) which uses the map's power to explore, analyze and visualize spatial datasets to understand patterns better. These developments are key components of a 'maps as social constructions' approach, emphasizing the genealogy of power in mapping practices, and enabling multiple, contingent and exploratory perspectives of data. Furthermore, this approach is an opportunity for cartography to renew its relationship with a critical human geography.

Key words: cartography–critical geography relationship, geographic visualization, Harley, maps as social constructions.

I Introduction

Writing shortly after the second world war, Arthur Robinson, author of what was to become the standard cartography textbook of the next 40 years, observed that a 'revolution appears long overdue in cartography' (Robinson, 1952: 13). For Robinson, this revolution was based on introducing a more rigorous (scientific) approach to cartography, which would focus map design around map use or, as he described it, 'function provides the basis for the design' (1952: 13). Traditional concerns with map esthetics would be de-emphasized in favor of a functional account of how maps work.

Looking back from the beginning of the twenty-first century, it is now evident that cartography and mapping have changed even more than Robinson could know in mid-century. Although Robinson himself was instrumental in creating that revolution, recent developments in cartography have gone well beyond the model of maps as communication. This article describes these developments as an 'epistemic break' between a model of cartography as a communication system, and one in which it is seen in a field of power relations, between maps as presentation of stable, known information,

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and exploratory mapping environments in which knowledge is constructed.

These developments represent an opportunity for cartography to renew its relationship with critical human geography, which has characterized cartography as atheoretical, and is often suspicious of the technical as an instrumentalist rationality. For example, in his discussion of the production of space and the world-as-exhibition, Gregory (1994: 65) argues that proponents of GIS promote it as an abstract science and 'in so doing a rhetoric of concealment is deployed that passes over these configurations of power-knowledge in virtual silence', followed by a footnote to Goodchild and Openshaw (two 'GISers' who have, in fact, been very vocal (from contesting positions) about the relations of GIS and society). Gregory is certainly not wrong to want to deprivilege representation as 'an unproblematic reflection of the world' (1994: 75) but is himself unnecessarily silent about moves in cartography and GIS to do just this (as he would acknowledge). This article is therefore meant to give voice to cartography's nascent attempts to theorize representation and power relations, and to destabilize the correspondence theory of mapping practices. In so doing the goal is to re-establish a dialogue between cartography and critical human geography as a first step in a renewed relationship.

One approach to maps as representations and sites of power-knowledge is associated with writers such as J.B. Harley, Denis Wood, John Pickles, Michael Curry and Matthew Edney. Harley's work in particular has been influential; he wrote more than 20 articles during the 1980s and early 1990s (he died in 1991) on maps as practices and relations of power and knowledge, overtly appealing to the work of Michel Foucault and Jacques Derrida, a strategy that was a bold intrusion of poststructuralist theory into cartography's assumption of maps as communication devices. The timing of his contributions, his credentials as a historical geographer and his co-editorship (with his colleague, David Woodward) of the *History of cartography* project (six volumes, ongoing, University of Chicago Press), give him a unique position in the literature.

However, Harley's work was by no means complete when he died. Most importantly, he did not formulate a clear research agenda for how one might implement his theories in practice. In this article I suggest how a Harleian agenda can be developed, and how it might relate to Foucault's work on power relations; especially the spaces for the possibilities of resistance to cartographic power, which are largely ignored even by those in the Harley 'tradition.'

As a coda to this theoretical discussion, I provide a brief example of how geographic visualization ('GVis') may be the method to Harley's theory by discussing a three-dimensional interactive campus map which could be distributed on the Internet. Distributed mapping emphasizes multiple views and makes a good case study of the percolation of power relations.

Between them Harley and GVis challenge the prevailing picture of cartography as the communication of information from the cartographer to the map user. The 'representationalist' picture of mapping gives way to one in which maps are part of a general discourse of power, which both enables and abridges possibilities for people to act. Harley and GVis indicate that mapping should proceed through multiple, competing visualizations which are not created by a cartographer and transmitted to the user but made on the spot by the user acting as his or her own cartographer.

In other words, the search established by Robinson for the single optimal map

through ever-clearer methods of map communication is over. This article makes the case for an alternative landscape of cartography in which maps are recognized as social constructions. It concludes with an assessment of the common agenda which might be shared by both cartography and a critical human geography.

II Development of the map communication model in cartography

Consider the following statement made in a review of the discipline of cartography:

> The goal in 1950 was simply to make a map; in 1975, in theory, a map maker makes the map created by a cartographer who is supposed to be sensitive to the capabilities of his envisaged map reader. Corollaries of this view are a lessened concern for the map as a storage mechanism for spatial data and an increased concern for the map as a medium of communication . . . In communication the psychology of the map reader should set upper and lower bounds on the cartographer's freedom of design (Robinson *et al*., 1977: 6).

Here are contained most of the major principles of the map communication model (MCM). First, there is a clear separation between the cartographer and the user. Secondly, the map is an intermediary between the cartographer and the user. Thirdly, the map communicates information to the user from the cartographer. And fourthly, it is necessary to know the cognitive and psychophysical parameters of the map user's abilities to comprehend, learn and remember information communicated by the map. This last point was repeatedly emphasized by Robinson and other cartographers from the 1950s on and represents a major contribution to the discipline. According to Andrews, the MCM has 'fostered the development of a philosophical and conceptual framework in cartography . . . [it is] responsible for dramatic shifts in cartographic methodology, research and map design' (1988: 185).

Prior to Robinson cartography was in fact less rigorous and less concerned with the user. Indeed, the map was considered the end result in itself and it is only in the second half of the twentieth century that attention was paid to such things as expert–novice differences, the child's understanding of maps, how people learn and remember maps, and so on. The goal of communication is clarity, and the user's expertise and familiarity with the map is an important factor in achieving clarity. Here then was a research agenda for cartography under the MCM: map design based on user testing.

Although Robinson performed very little psychological map testing himself (although see Hsu and Robinson, 1970), by the 1970s the MCM was the predominant paradigm in cartography (Robinson and Petchenik, 1977). There were two other factors which led to this. Geography during the 1950s and 1960s was going through a process of formalization, that is, the quantitative revolution. In particular the discipline was strongly influenced by books like *Models in geography* (Chorley and Haggett, 1967), which included a chapter from cartographer Christopher Board on 'maps as models' (Board, 1967). Board provided a clear theoretic link between Robinson's scientific impetus and developments in systematic geography. Finally, there was a rise of research in cognitive cartography, especially early work such as the UC Santa Barbara school (for a review, see Golledge and Stimson, 1997). Much of this work adopted a correspondence theory model of representation which imbued the map as a record of the landscape (to which 'distorted' mental maps could then be compared).

Under the MCM the goals of cartography are to produce a single, optimal (best) map, which presents information clearly, and which is based on known factors of map use.

By contrast both the Harleian approach and geographic visualization question these four goals:

- The goal of a single map is superceded in visualization environments which provide multiple presentations of the data, animations or rich interactivity.
- The goal of producing the 'best' map is undermined by the Harleian–Foucauldian identification of maps as sites of power-knowledge. Judgements of 'best' arise from privileged discourses which subjugate other cartographic knowledges (the nonscientific, the local, the populist or cartographies of resistance).
- *Presentation* is de-emphasized in favor of *exploration* of data; maps are transient (neither printed nor saved, but created and erased many times over) rather than near-permanent. This has implications for the map archive.
- The cartographer–user dichotomy is also conflated when users are their own cartographers, especially in web-based online mapping.

In the next two sections I shall discuss these challenges to the map communication model provided by Harley and GVis.

III Contemporary challenges to the map communication model

> Political language – and with variations this is true of all political parties, from Conservatives to Anarchists – is designed to make lies sound truthful and murder respectable (Orwell, 1968 [1946]: 139).

As George Orwell noted in his enduring essay 'Politics and the English language', political language does not simply communicate human ideas, but is used to further particular interests. During the 1980s and 1990s cartographers began asking whether there was an analogous politics of representation of maps and mapping: can maps be usefully considered as politicized documents, that is, as documents formed within a discourse? To be sure, this was quite a leap; if any 'theory' was to be found in cartography at this time, it was safely located in the map communication model, or in structural accounts of the map as a semiotic system.

Nevertheless, Harley began to trace out the relationships of political interests, power, and the hidden agendas of maps: the 'second text within the map' (Harley, 1989: 9). This point of view does not seek to remove entirely the communicative process from maps, but it is a far more subtle reading of cartography. For Harley, maps do not communicate so much as provide a powerful rhetoric, and therefore can be critically examined as texts themselves. In this section of the article I wish to examine Harley's work as the conceptual component of my argument. I argue that Harley did not complete his project or go far enough and therefore it is necessary to sketch out a research agenda which begins with but importantly moves beyond Harley. One possibility, suggested here, is more fully to engage the work of Foucault, and to couple that with insights gained from the emerging field of geographic visualization.

1 Maps, power relations and communication

a Harley's retheorization of cartography:

> *Student*: Now then, over here we have a map of the entire world. You see there? That's Athens.
> *Strepsiades*: That, Athens? Don't be ridiculous. Why, I can't see even a single lawsuit in session . . . but where's Sparta?
> *Student*: Sparta? Right over here.
> *Strepsiades*: That's MUCH TOO CLOSE! You'd be well advised to move it further away.
> *Student*: But that's utterly impossible!
>
> Aristophanes, *The clouds* (*c*. 423 BC)

The humor in this scene from Aristophanes' anti-Socratic comedy lies in the dim-witted Strepsiades' confusion between symbol and reality. It is as if by redrawing the map Strepsiades could move the old enemy of the city of Sparta to a safer distance, or that the map would show the notorious Athenian lawyers scurrying to court. Unlike the semiotician Alfred Korzybski who famously proclaimed that 'the map *is not* the territory' (1948: 58), Strepsiades has a child-like vision of the map as somehow synonymous with the environment. On the other hand, the map is not completely divorced from the territory either. As Korzybski (1948: 59, emphasis in original) went on to say: 'A map *is not* the territory it represents, but if correct, it has a similar structure to the territory, which accounts for its usefulness. If the map could be ideally correct, it would include, in a reduced scale, the map of the map; the map of the map, of the map; and so on, endlessly'. The question then becomes: what is the relationship between the map and the territory if it is not the territory itself and yet is of it? Put another way, this is a key component to one of the abiding questions of the twentieth century: what is the nature of language (and symbol systems in general) and how does it represent?

Harley's approach to this question arose from his career in the UK as a historical geographer, where he began to find that maps were such important source materials that he turned his attention to studying them *qua* maps. During the 1970s Harley developed several research projects which would prove to be very influential in the history of cartography: a systematic account of research in the field which emerged as the *History of cartography* and a retheorization of cartography to account for the way in which maps acted as agents for the normalization of power relations.

To pursue these projects Harley moved in 1986 to the University of Wisconsin–Milwaukee and the American Geographical Society Map Collection (initially catalogued by J.K. Wright in 1923, and moved from New York City to Milwaukee in 1978). At the AGS collection, Harley established the Office for Map History which has responsibility for the long-term projects and exhibitions mounted using the collection.

Several of his projects with the AGS capture Harley's interests at the time (Varanka, pers. comm.): Amerindian maps, the Columbian Encounters project (Harley, 1990a; 1992b) and Renaissance mapping for the *History of cartography* volumes. To some degree this work was inter-related in that it seeks to document the power of mapping in subjugating populations, as well as the territorial power struggles arising when different populations encounter each other. The AGS sponsored much of this work for traveling exhibitions; for example, the 'Maps and the Columbian encounter' (Mark Warhus, curator) appeared at the Newberry Library, Chicago, and other locations after Harley's death (Akerman, 1992).

In addition to this empirical research, Harley began to examine in more detail the question of how a map represents its territory through a remarkable series of contributions challenging cartography's communication-orientated theoretical assumptions (1988a; 1988b; 1989; 1990a; 1990b; 1992a; 1992b). As defined by the International Cartographic Association (ICA), a map is 'a symbolized image of geographical reality, representing selected features or characteristics'. The ICA's definition endorses this representationalist model (Belyea, 1992). Cartography textbooks also make it very clear that one should match the symbol to the referent; for example, use *discrete* symbols (e.g., choropleth maps) to show *discrete* data such as sales tax rates, and *continuous* symbols (e.g., isarithmic maps) to show *continuous* data such as temperatures. This relationship is often codified as the 'visual variables' – a set of map graphic building-blocks which match spatial phenomena.[1]

In a seminal article on 'Deconstructing the map', Harley (1989) sketched out an approach designed to challenge the primacy of the map as communication by focusing on relations of power and textuality. In a revised version of the article he wrote: 'Cartography has never been an autonomous and hermetic mode of knowledge, nor is it ever above the politics of knowledge. My key metaphor is that we should begin to deconstruct the map by challenging its assumed autonomy as a mode of representation' (Harley, 1992a: 232, not in Harley, 1989). Harley here appeals to the 'crisis of representation' familiar to critical human geographers, by destabilizing language, fragmenting the subject and politicizing our relationship to the 'other' (e.g., maps of the Columbian encounter). In short, maps are social constructions. The map is not objectively 'above' or 'beyond' that which is represented; nor can one track back from the representation to some ultimate object, knowledge or mind. One of the important implications of this is that, according to Harley, we should accept maps as rhetorical devices which dismantle the 'arbitrary dualism' (1989: 11) of propaganda versus true maps, or scientific versus artistic maps. Harley here echoes Foucault's 'dividing practices' which constitute subjects as either mad or sane, sick or healthy, criminals or 'good boys' (Foucault, 1982: 208).[2] These dividing practices are the result of a discourse of power-knowledge.

Wood and Fels (1986) had earlier explored the idea of the map as a narrative in an essay influenced by the work of the French structuralist Roland Barthes (1972). For Barthes, semiotics could be extended to account for any system of signs, including travel guides, food, fashion and so on. These 'mythologies' are sign systems which 'naturalize' (make natural) their way of representing, but which are actually ideological moves which could be critically examined.[3] For Wood and Fels, and in turn for Harley, scientific maps, by privileging accuracy and technical authority, promote their naturalization as well as forming a dividing practice of scientific and nonscientific maps, but in doing so 'contain a dimension of "symbolic realism" which is no less a statement of political authority than a coat-of-arms or a portrait of a queen placed at the head of an earlier decorative map' (Harley, 1989: 10). By itself, this idea is neither terribly new nor exclusive to those labeled poststructuralist or postmodernist. In 1942, J.K. Wright anticipated many of these points when he wrote: 'The trim, precise, and clean-cut appearance that a well drawn map presents lends it an air of scientific authenticity that may or may not be deserved . . . every map is . . . a reflection partly of objective realities and partly of subjective elements' (p. 527).

Novelists and writers have also explored the destabilization of the map as representation. In addition to Aristophanes, Lewis Carroll (1988), Luis Jorge Borges (1964) and

Umberto Eco (1994) have played with the idea of a map at a 1 to 1 scale, i.e., actually coextensive with the land it represents. A map at this scale pushes to the limit the Korzybski-like separation of map and territory.[4]

However, what all these accounts lack, and what Harley provided with his 'deconstruction', is an account of the power relations of mapping, and the map's agency as discourse. In other words, a theorization of representation in the history of cartography. To do this, Harley's 1989 article pursued three routes of investigation:

1) Eliciting the 'rules of cartography,' which was meant to encompass both the well-known rules for the technical production of maps and the lesser known rules for the 'cultural production' of maps. This route was inspired by the 'archaeological' work of Michel Foucault which sought to examine the formation of the archive, that is the rules of formation of statements: what are 'its modes of appearance, its forms of existence and coexistence, its system of accumulation, historicity, and disappearance' (Foucault, 1972: 130)?
2) Interpreting maps as texts, inspired by the work of Jacques Derrida and Roland Barthes. For Harley, maps are socially constructed texts, and as such can be interpreted in multiple ways, have contradictions and fragmentations, and cannot be traced back to a sovereign mind or subject.
3) Maps as practices and relations of power-knowledge. Harley considered two areas of power: that which was exercised by map patrons (monarchs, ministers and the state) over or with cartography for their own ends, or 'external' power; and the power exercised by cartographers themselves which is 'embedded in the map text' (1989: 13), or 'internal power'. For this route Harley again turned to the work of Foucault.

Thus for Harley the deconstruction of mapping was a heterogeneous amalgam of approaches. One aim was to reinterpret mapping as a nonpositivist endeavor. Maps are situated in a particular set of (competing) interests, including cultural, historical and political; maps can be understood by what they subjugate/ignore/downplay (what he called the silences and secrecies – Harley, 1988b); and the way to interpret maps is not as records of the landscape but tracing out the way they embody power (in creating/regenerating institutional power relations such as serf/lord or native/European) and are themselves caught up in power relations, i.e., are not innocent (map deconstruction). In sum: 'Deconstruction urges us to read between the lines of the map – "in the margins of the text" – and through its tropes to discover the silences and contradictions that challenge the apparent honesty of the image' (Harley, 1989: 3).

How successful was Harley's project? To some degree, this must be judged not just on the popularity of his arguments (although he is probably one of the better known workers outside the discipline) but on how well he provided a viable research agenda. Deconstruction might reveal what the map was not (i.e., innocent, scientific, optimal), but what is left to say about what the map is? Here we face several obstacles.

Firstly, Harley's work is sadly incomplete due to his death when only 59 (just three years after the article which brought to the fore the Foucauldian notion of power-knowledge in maps – Harley, 1988a). For the practical implications of his theoretic work, we are limited to his last, unfinished writings (e.g., Harley, 1992b).

Secondly, Harley often failed directly to engage with the primary theoretical texts of Derrida and Foucault, displacing them in favor of secondary works. This has led Harley sometimes to misunderstand their work, or more precisely to fail to note differences between his position and those of Foucault and Derrida. For example, as Belyea (1992) notes, Harley's argument depends on two notions which were rejected by Foucault: that there is a unitary 'author' (e.g., of a map) which Foucault was at pains to deny in *The archaeology of knowledge* (1972) and his early courses at the Collège de France; and that power can be separated into external or internal sources (e.g., 'relations of power are not in a position of exteriority with respect to other types of relationships . . . but are immanent in the latter' – Foucault, 1978: 94). To this we can add Foucault's denial that power and surveillance are inherently negative or exclude the possibility of resistance (Foucault, 1997).[5] Only in true domination is there no possibility of resistance: 'where there is power, there is resistance' (Foucault, 1978: 95). What Harley would have made of these insights is hard to say, but they do point to the need to supercede Harley's position. In this case, it may be more fruitful to speak of a *distributed* user/agent relationship in cartography, especially in relation to geographic visualization, where users are their own cartographers (e.g., in distributed mapping via the Internet).

Finally, Harley offers no *practical research agenda* or critical framework which would subsume his empirical and theoretic work, although the larger *History of cartography* project is certainly consistent with that ethos (Edney, pers. comm.).

b A Harleian research agenda: It is therefore necessary both to start with and go beyond Harley if we are to proceed with the strategy of maps as social constructions. In this section I sketch a working research agenda for cartography, one which is theoretically informed and empirically grounded, and which will therefore renew its relationship with a critical human geography. This agenda consists of two major thrusts and one critical implication.

1) Provide a social history or anthropology of maps and mapping as contingent and contesting representations, that is, maps as social constructions.[6] This would understand map history as evolutionary, but not as a progression to better (because more scientific or accurate) maps; a cartography without 'progress' (Edney, 1993). This approach seeks to 'denaturalize' the map: 'the intention is to break through the shell of objectivity with which our culture has surrounded the map in order to expose and then study the map for what it is: a human practice' (Edney, 1996: 188). The advantages of such an approach are that one avoids privileging certain forms of maps as better because they are more scientific (i.e., more accurate). It also allows us to stop worrying about map objectivity (as in the case of propaganda maps) and to accept intersubjectivity instead; that is, a model of right and wrong (an ethics) which is contingent on society, culture and history, not on foundationalist knowledge. Finally, and critically, a wider appreciation of the diversity of cartographic forms is possible, not solely those which correspond to reality 'the best'. Are there more cartographic forms which have not yet reached prominence? As I shall suggest in the conclusion, one promising candidate is online or distributed mapping.

By positioning maps within their societal power relations, a richer account of their purpose could be provided. Furthermore, this interpretation can be extended to contemporary digital cartography, distributed mapping and GIS in the context of their

relations to society. In this view, the critical issues of the digital divide or differential access to digital resources (and more importantly knowledge of their operations) as well as the larger concern for the ethics of mapping are included. This extension goes well beyond Harley's core area of the history of cartography, but is supported by work he planned to do with John Pickles on the ideology of the map.

Suggested research questions:

- The question of the unity of authorship and discourse destabilized by Foucault in his *Archaeology of knowledge* (1972). Under what circumstances is a map authored? Are either the traditional maps-are-by-individuals or poststructuralist maps-are-cultural productions satisfactory accounts?
- The question of map readership. Or actually the question of the cartographer/user where the user makes his or her own map. Are maps (e.g., on the Web) a writerly text in Barthes' sense?
- The social history of accuracy. How do notions of accuracy vary with time? What is accuracy's role in establishing the primacy of Enlightenment cartography? Are there particular moments when accuracy was especially privileged, or where lack of accuracy has led to a deprivileging?
- Who has access to online mapping (maps on the Internet) and who does not? Further, who is knowledgeable and who is not? Can an ethical geography intervene (Crampton, 1999a)?

2) Document the power of the map by tracing out the genealogy of power discourses, that is, how maps are strategies and relations of power-knowledge. These discourses establish the environment in which we as human beings act; sometimes opening up new possibilities and sometimes abridging them in what Foucault called the 'disciplining' of a population. As Harley observes: '[t]hose who raise questions about . . . how [maps] act as a power-knowledge in society . . . are not merely trying to rewrite history. They are also alerting us to the present' (1990b: 12). It is noticeable that one of the implications of this Foucauldian position (a history of the present) is that it turns our emphasis to the production of the subject by the map rather than to explications of the map's meaning. In geography an obvious parallel is the production of nationality and space by cartographic partitioning, for example, in Bosnia (Crampton, 1996).

Harley's bipartite division of 'external' and 'internal' sources of power is ultimately too crude. We can add other aspects such as the silencing power of maps (Harley: 1988b), for example, how the map contributes to disempower constituencies such as the poor (Yapa, 1996) or, for example, differential access to GIS, the Web and online mapping (Crampton, 1999a), or how the map speaks for others by subjugating knowledge.

Suggested research questions:

- How do maps work to produce knowledge? What is the discourse of cartography?
- What would a full account of power relations in mapping look like? Is such an account sufficient/necessary/possible?
- What is the relative status of these categories? For example, is silencing a separate order of power relations (i.e., to disempower rather than empower)?
- What are the resistances to power? What strategies of cartographic opposition are

possible either with maps (Wood, 1992, especially Chapter 5) or against their disciplining tendencies (Edney, 1996)?
- Are power and surveillance necessarily negative? Although this is a common assumption, it was never held by Foucault.

3) One emergent implication of Harley's work is to emphasize the importance of multiple perspectives and multiple maps. By contrast to the communication model which identifies a single optimal map (one which communicated the ideas and knowledge of the cartographer most clearly to the map user), in a Harleian agenda, polysemy and multiplicity are preferred. As I shall emphasize in the next section, the best candidate for the production of multiple maps is geographic visualization, which overturns the communication model by promoting exploration rather than presentation, contingency rather than finality.

It is noticeable that this Harleian agenda is markedly concerned with ethics and justice. It is also remarkable how he has shaped the intellectual terrain; not just in the *History of cartography* project, but in his ethical concerns (e.g., Monmonier, 1991), his validation of theory (Delano Smith, 1996; Edney, 1996; Jacob, 1996), and the relationship of technology and society (e.g., the NCGIA Initiative on GIS and Society). In the next section I wish to provide a coda to this theoretical discussion via the emerging area of geographic visualization.

2 Maps as visualizations: geographic visualization (GVis)

a Defining visualization: Geographic visualization (GVis) refers to the ability of maps, graphics and images to make visible spatial relationships. As such one of its primary objectives is the very geographical desire to find spatial patterns in the data. To some extent, visualization is what cartographers have been doing all along in the sense of making aspects of the world visible, but there are important differences. Geographic visualization also refers to the added capabilities of interactive mapping software such as rotating the data in three dimensions, adding or stripping away data layers during data exploration, or querying the map interactively. As MacEachren (1992: 101) points out, 'visualization is foremost an act of cognition, a human ability to develop mental representations that allow geographers to identify patterns and to create or impose order'. There is thus a sense that GVis allows different kinds of questions to be asked in geography. Because it emphasizes data exploration (a process) over data presentation (a product), it cannot be encompassed by the map communication model. GVis is a questioning or sense-making activity, compared with the MCM, which is an answer-delivering model.

The differences between visualization and traditional cartography can be captured using the concept of 'cartography cubed' (C^3) (MacEachren and Fraser Taylor, 1994). Cartography cubed is a method of understanding different kinds of uses of maps. The 'cube' contains three dimensions: private–public, high interactivity–low interactivity and, revealing knowns–exploring unknowns (see Figure 1). Traditional cartography has emphasized public use, low interactivity and revealing knowns, while visualization emphasizes private use, high interactivity and exploring unknowns.

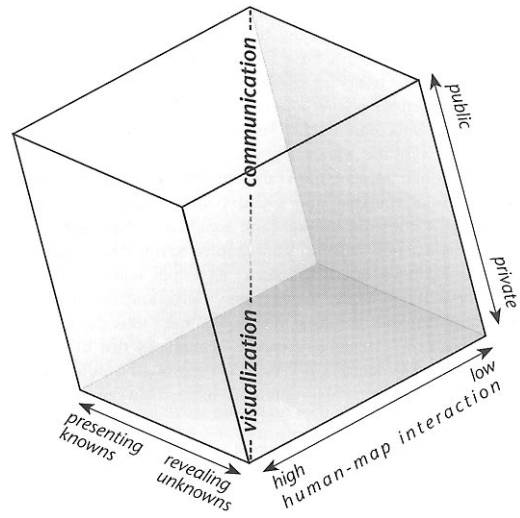

Figure 1 The concept of 'cartography cubed,' emphasizing the continua of private–public, exploring unknowns–presenting knowns and high interactivity–low interactivity
Source: Reprinted from MacEachren and Fraser Taylor (1994: 6) with permission from Elsevier Science

The tripartite division of cartography with its emphasis on data exploration was an extension of the work of DiBiase, who in turn applied the 'exploratory data analysis' (EDA) of statistician John Tukey. In DiBiase's original conception, map usage went through various stages, with only the last being seen by the public (i.e., being published). These stages were exploration–confirmation–synthesis–presentation.

It is noteworthy that the published maps we are used to seeing only represent the last of these four stages. Data exploration, generation and confirmation (or disconfirmation) of hypotheses, and synthesis of these hypotheses are 'hidden' processes of map use (i.e., they are private), but which are nevertheless extremely critical. It is these processes of which GVis consists.

b A practical example of GVis: GVis can be illustrated with work done on a digital three-dimensional visualization of community and city-size spaces such as GMU-3D constructed by John Simmons (Crampton, 1999b). In GMU-3D a fully interactive and navigable environment (a university campus) is presented in true three dimensions (i.e., multiple 'z' values at each x, y location). The visualization is populated with human 'avatars' (computer representations of people) with whom one can interact, as well as trees, roads, buildings and clickable flags or information points (Figure 2).

As one moves through this environment it is apparent there is no single 'optimal' perspective, and in fact one is induced to explore the dataset. For example, as a new student to the campus, one enters the environment by calling it up over the World Wide Web. Interactivity is available immediately. Viewing a long-distance view of the campus the user rotates the view to the desired orientation, zooms in (changes scale) and navigates along pathways to the desired building (e.g., the Registrar's Office). The user

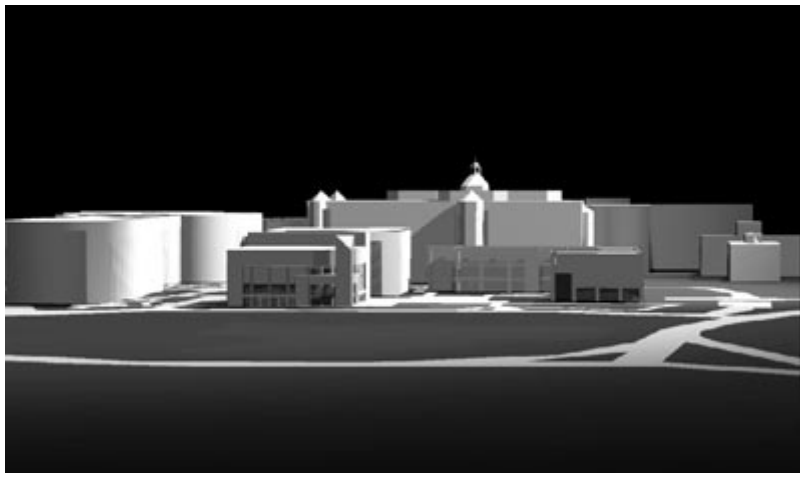

Figure 2 GMU-3D, an interactive navigable environment
Source: John Simmons. Used with permission

can then enter the building and is presented with a floor plan which is directly queryable (Figure 3).

The 3D environment is multiscalar and multipurpose. Because 3D environments are believed to be more easily understood than either 2D article maps or 2D interactive representations, a range of possible users and applications is possible, depending on the datasets implemented. In addition to students, physical plant engineers could use it to locate active Ethernet jacks in a building, parking lots can be queried for available spaces, lighting can be remotely controlled, disabled access indicated and so on. However, one need not 'do' anything in the environment; one of the lessons of virtual environments is that people from disparate spatial locations like to gather to chat for recreation or education. These discussions can be facilitated by being in the 'appropriate' virtual environment (e.g., classrooms for classes, the bus stop for ordinary conversation).

Production of 3D GMU was done in VRML (Virtual Reality Modeling Language) in order to reduce file size so that bandwidth would not prevent the environment being distributed over the Internet. To render the landscape large scale, base maps of the campus were 'extruded' to obtain the layout of the buildings. This produces featureless cubes and so architectural details then have to be added from design plans and photographs of extant buildings from multiple positions. For much of this data it is necessary to generalize and simplify it heavily to reduce bandwidth. Finally, where specific detail is needed, the virtual geographer will create texture maps for added verisimilitude (e.g., crenellations or towers).

IV Tying it all together: renewing cartography's relationship with geography

We have seen how the main underpinnings of contemporary cartography are going through a transition, or epistemic break. One of the arguments of this article is that this

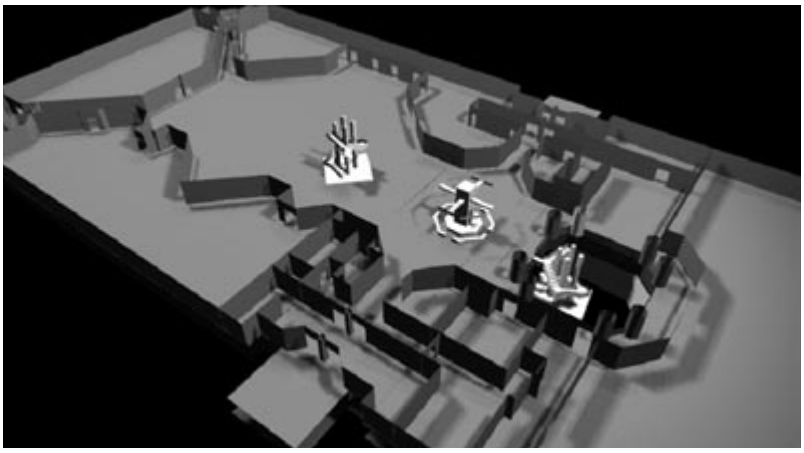

Figure 3 Interior of building in GMU-3D
Source: John Simmons. Used with permission

transition represents an opportunity for cartography to renew its relationship with geography by establishing commonalties of interests. In this final section I outline a series of research questions which could be jointly addressed by the disciplines of cartography and geography. This list is by no means meant to be all-inclusive, nor anything but the perspective of one person. All that can be offered is that they provide an echo of how cartography and geography may find spaces of resistance to surveillance, to see the opportunities as well as dangers of visualization (that is, to decry 'logics' of technology), to emphasize the social construction of cartographic knowledge rather than a system of communication, and to engage the implications of distributed mapping.

1 Convergence of spatial technologies

One issue in common is that of a convergence of the major applied mapping practices: digital cartography, remote sensing and GIS (Crampton, 1998). This convergence is especially noticeable between cartography and GIS. The convergence is happening for several reasons: the development of GVis by cartographers, which results in queryable, interactive maps; and the traditional use of GIS to make user-defined maps based on queries. A logical step from here is to integrate scientific visualization methods with GIS (Cook *et al*., 1997). Perhaps the most dramatic emerging technology is the integration of visualization, knowledge discovery in databases (KDD or data mining) and distributivity via the Internet (MacEachren *et al*., 1999). This type of integration of spatial analysis tools and guided querying of multiple archives (e.g., of separate climate databanks at different federal agencies) is very useful if done transparently to the user, who may access from a highly distributed set of locations. In the USA, the Digital Libraries Initiative (DLI) aims to put a cartographic interface on such georeferenced data. With a DLI the user can search for images, maps or other environmental data and

metadata via a cartographic front-end on the Internet. The best known digital library of spatial data is the Alexandria Digital Library (Buttenfield, 1999). However, like all powerful tools, geographers need to recognize the implicit power-knowledge structures, and how they may be used to cross-match and cross-reference data on individuals (Goss, 1995).

2 Hypermedia forms and distributed mapping

The second issue is that cartography and GIS are both emerging as major capabilities on the Internet. Distributed mapping is still at an early stage; nevertheless, it is likely to provide many new and exciting capabilities for geographers. How might political action be enabled or retarded by the distribution of information about political strategies or faster access to knowledge about resistance groups (the Zapatista in Mexico, or the nearly year-long congressional block on the results of Washington, DC's vote on medical marihuana usage)? Will access to the 'other' deconstruct nationalism or stereotyping, e.g., in the classroom? Access here may include pictures of the environment, live chats, exchange of news, as well as maps. Indeed, distributed maps are dissimilar from traditional static maps in that they link information from various sources and provide a user-defined environment. The information may be in many forms (maps, images, sounds, video and text) which may be connected via hyperlinks into a multimedia database; in other words, a hypermedia environment (from the Greek *huper* – over, beyond). Here it is not the map which is the focus, but the mapping environment as a whole (a process, not a product). Because the environment is interactive, the user in large part (although not entirely) determines what information is to be displayed, at what stage, at what scale and in what context (i.e., with what other information). It is in this sense that we talk about 'user defined' mapping (Crampton, 1999b). Finally, how might the very idea of the 'map user' be challenged by synchronous, distributed, interactive access to spatial data?

3 The geography of virtuality

A third issue needs to be separated out, and that is the new online spaces which these mapping environments themselves are creating. These mapping environments, often featuring photo realistic three-dimensional spaces, which might best be understood as new virtual worlds or 'cybergeographies' can themselves be mapped and used, or understood as quasi-geographical spaces with their own communities, spatial relations (e.g., centers and peripheries) flows and interactions. This is the new 'geography of virtuality' (Crampton, 1999a).

A question of interest to geographers is to what extent virtual geographies replicate or differ from physical geographies (Batty, 1997; Taylor, 1997; Dodge, 1998). This question is especially pertinent in an era of globalization where physical distances are supposed to be becoming extinct (Cairncross, 1997). For example, global financial markets are now described as 'free of distance' with international investments and back offices separated physically, but in intimate contact across telecommunication lines. It is likely that many will want to resist this death of distance through a renewed discussion of time–space compression, or a more optimistic vision of civic participation

(Light, 1999) or transgression of national boundaries. What, then, are the cartographies of cybergeographies (Kitchin, 1998)? For example, a notable feature of many virtual spaces is the degree to which they replicate traditional physical spaces, complete with costs of distance. These similarities raise interesting questions about the persistence of spatial relations and the importance of physical space as a metaphor even in a virtual world. If physical spatial relations are inevitably duplicated in virtual worlds, what does this mean about the centrality of geography in human life?

4 Issues of ethics

Many of the issues proffered here have implicit questions of ethics. In the case of information, for example, a balance is required between access and protection of personal privacy. As much as the Internet establishes new geographies of access, it also brings with it the probability of increased surveillance. Geography has in the past two or three years seen a resurgence of interest in ethical issues, very much including the possibilities of resistance to surveillance. In addition, and very substantively, there are cartographies of colonialism and postcolonialism, the recovery of subjugated knowledges and the questioning of how a mapping knowledge–practice becomes a science – an ethics of cartography.

These four issues constitute the start of a renewed relationship between cartography and a critical human geography, not this time in commonalities of spatial analysis, but maps as social constructions.

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Notes

1. Standard cartography textbooks which discuss the visual variables include Robinson *et al*. (1995: 319–21, 476–78), Dent (1999: 76–79 where they are labeled 'symbol dimensions'), Slocum (1999: 22–25, 243–44) and MacEachren's primer (1994: 15–34, see also p. 54ff.). Dent (1999: 77) says, for example, that '[t]here is a logical (and traditional) correspondence between geographic phenomena (point, line, area, and volume) and the employment of symbol types (point, line, area)'. Slocum (1999) notes challenges to the map communication model, but adopts it anyway, while Tyner (1992) actively promotes it.

2. It is contested to what degree Harley worked from the primary texts of Foucault or Derrida, and to what degree he worked from secondary texts. Belyea (1992) makes a largely successful case for the latter as part of her argument that Harley did not fully embrace Foucault or Derrida. Yet Harley's approach must be understood as one of bricolage: using handy ideas he found lying around for his questioning of maps, and that he was as likely to drop at the next moment. Belyea also argues that Harley maintained an orthodox understanding of the map as an image of the landscape, a position Harley would probably have agreed with, even as he questioned it.

3. In later work Barthes (1972) moved away from his earlier structuralist work to a more post-structuralist concern with the inter-relatedness of all texts ('intertextuality') and their potential for multiple interpretations depending on the reader's route through the text ('polysemy'). See also Edney's (1996: 188) comments on 'denaturalizing' the map.

4. Eco actually develops Borges' grand conceit by writing a mock feasibility study of how a 1 to 1 map could be constructed under certain conditions, e.g., that it be a map and not a ground-hugging plaster cast, or a transparent sheet through which one could view the actual territory or an atlas with partial pages, and so on. Like Korzybski, Eco concludes the enterprise is impossible because a true 1 to 1 map would have to contain itself (i.e., a map of the map, of the map, etc.).

5. In this interview from late in his life, Foucault is careful to clarify his understanding of power. He opposes the 'states of domination that people ordinarily call "power" ' (Foucault, 1997: 299) with a different concept of power as strategic relations or games of strategy, 'a set of procedures that lead to a certain result, which, on the basis of its principles and rules of procedure, may be considered valid or invalid, winning or losing' (p. 297). 'Power is not evil. Power is games of strategy' (p. 298), and 'in power relations there is necessarily the possibility of resistance because if there were no possibility of resistance . . . there would be no power relations at all' (p. 292). Mediating between these two levels are 'technologies of government' (p. 299) or practices of the self and of freedom, an ethics of the concern for self as a way of reducing domination as much as possible. These ethics of the care of the self were the subject of his last series of books on the history of sexuality, of which Volume 1 (Foucault, 1978) also treats power in some detail.

6. Harley (1989: 8) comments: '[r]ather than working with a formal science of communication . . . our concern is redirected to a history and anthropology of the image . . . [a]ll this, moreover, is likely to lead to a rejection of the neutrality of maps, as we come to define their intentions rather than the literal face of representation, and as we begin to accept the social consequences of cartographic practices.' This is a good summary of key implications in his work.

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