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Representations in an Electronic Age: Geography, GIS, and Democracy

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> The slow, uneven decline of these interlinked certainties, first in Western Europe, later elsewhere, under the impact of economic change, "discourses" (social and scientific), and the development of increasingly rapid communications, drove a harsh wedge between cosmology and history. No surprise then that the search was, so to speak, for a new way of linking fraternity, power, and time meaningfully together. Nothing perhaps more precipitated this search, nor made it more fruitful, than print-capitalism, which made it possible for rapidly growing numbers of people to think about themselves, and to relate themselves to others, in profoundly new ways (Anderson, 1983, 36).

Defining GIS

Defining geographic information systems (GIS) is not a straightforward matter. Even the use of the term "GIS" can be problematic. "GIS" refers to geographic information systems in the plural, yet "GIS" is often used as an acronym for a single system. Some writers choose to refer to "GIS systems," as a system of systems, while others have resorted to terms like "GISers" to refer to those with some strong commitment to GIS as a disciplinary enterprise.

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GIS itself has a poorly developed archive and virtually no critical history of its own production, a fact recently emphasized by Coppock and Rhind [...]:

> A variety of information indicates that the field of GIS has expanded rapidly in recent yea
> and agencies would certainly help. As yet, however, few organizations have given any thought to formalizing the history of their involvement in GIS and at least one major player (Ordinance Survey{…}) has refused to let its detailed records be examined by external researchers (Coppock and Rhind, 1991, 21).

Moreover, the definition of GIS varies depending upon who is giving it, and whatever definition we do give it is likely to change rapidly as digital spatial data and computer graphics spread rapidly into engineering, medical, earth science, design, planning and other fields.

Central to each of these possible definitions is some relational system of spatial information handling and representation. GIS is a special case of information systems in general, in which information is derived from the interpretation of data "which are symbolic representations of features" (Goodchild et al., 1991, 10). The designation GIS is also "frequently applied to geographically oriented computer technology, integrated systems used in substantive applications and, more recently, a new discipline" (Maguire et al., 1991, 12), to the mapping of information using digital technology (Newell and Theriault, 1990, 42), or to any kind of automated geographic data processing (Clarke, 1986).

These competing definitions are reflected in differences in interpretations of the central principles of GIS. Maguire et al. (1991, 13-4) suggests three such undergirding principles: that GIS focuses on the cartographic display of complex information; that GIS is a sophisticated database system; and that GIS is a set of procedures and tools for fostering spatial analysis. However, "the recent origin and rapid rate of progress has not been conducive to the analysis and definition of GIS" (Maguire et al., 1991, 9). Part of the reason for this is said to be the commercial nature of commodity, which leads sellers and developers to produce a "great deal of hyperbole and rhetoric" and to offer conflicting advice and information. Part of the reason has to do with the ways in which GIS has developed within different disciplines and research contexts (in agriculture, botany, computing, business, photogrammetry, geology, zoology, surveying, engineering, and geography), for each of these field puts its own peculiar stamp on the claims it makes for GIS. Thus, "together these factors (those mentioned above plus others) have conspired to obfuscate an issue which has never really been satisfactorily discussed or analyzed in any detail" (Maguire et al., 1991, 10).

Two of the central defining characteristics of all geographic information systems are the role of digital electronic data and the production of electronic special representations of those data: GIS is a product of computers in particular and of electronic information technology more generally. When we turn to such electronic media, to what objects do we turn? Do we turn to objects themselves, the artificial

neural networks that facilitate data entry, capture, and reproduction? Do we turn to the speed with which new devices allow us to operate and communicate? Do we turn to new forms of representation that are allowed and disseminated by new devices and apparatuses? Or do we turn to new practices that are not intrinsic to the new media, but are permitted and facilitated by them: technologies of the body, of the social, of the economy, by which bureaucratic, business, or military functions (and others) can be extended effectively across new territories with effects that previous technologies did not permit? I think we must admit than in our enthusiasm and confusion, we refer to all of these at once; that is, that (like geographic information systems themselves) the new electronic media produce multiple overlapping effects with which it is analytically and politically difficult to deal.

GIS thus operates at several levels and the term "GIS" refers to several distinct types of object: a research community that transcends disciplinary boundaries; an approach to geographic inquiry and spatial data handling; a series of technologies for collecting, manipulating, and representing spatial information; a way of thinking about spatial data; a commodified object that has monetary potential and value; and a technical tool that has strategic value. Academic developers and users of GIS have a tendency to focus primarily on the technical and organizational issues raised by the use of electronic information and imaging. But because of the high cost of its development and use, GIS has emerged above all as a tool and product that changes the ways certain groups and organizations operate. That is, it is a technology (like all technology to one degree or another) closely tied to the concrete material and ideological needs and interests of certain groups. As such, it is an important element in changing social relations in market economies; in producing new demands, commodities, and forms of domination in the workplace; in developing new systems of counting and recording populations; in defining, delimiting, and mapping space and nature; and in providing new tools and techniques for waging war. In each of these domains GIS is part of a contemporary network of knowledge, ideology, and practice that defines, inscribes, and represents environmental and social patterns within a broader economy of signification that calls forth new ways of thinking, acting, and writing.

Despite this ambiguity and the absence of coherent definition, the development and adoption of these new information and imaging technologies is increasingly being referred to as a revolution − almost Maoist in form − in which new technologies succeed each other in ever shorter periods of time, and as a result of which speed of interactions is increased, unit costs are reduced, and new methods are applied to old (and new) problems. Already "projections for the 1990s indicate that projected the GIS field will grow by as much as 35 to 40 percent, based on projected sales of GIS-related hardware, software, and services" (Huxhold, 1991, 12), and boosters are already proclaiming the emergence of a new profession, the GIS profession. But in this emerging profession the question "Is a geography degree the ticket to GIS success?" (Huxhold, 1991, 20) is posed alongside the questions "What is the GIS profession, what does it take to be a part of it, and what does it pay?" (Huxhold, 1991, 22). As Maguire et al. (1991, 17) point out, "GIS are clearly big news" and "it is not fanciful to

suggest that by the end of the century GIS will be used everyday by everyone in the developed world for routine operations." What is not yet clear is, what forms of change and what kinds of distortion will result from these patterns of adoption if the discipline strives to retain a central role in [the] emerging "profession"?

GIS is a set of tools, technologies, approaches, and ideas that are vitally embedded in broader transformations of science, society, and culture. These contexts are wide-ranging and as yet little studied in the literature surrounding new mapping and analytical technologies including GIS. But the questions are gradually being raised in the broader contexts of mapping generally (Hall, 1993; Harley, 1990, 1989, 1988a, 1988b; Pickles, 1992b, 1991; Smith, 1992; Wood, 1992), virtual reality (Rheingold, 1992; Wooley, 1992), and cyberspace (Benedikt, 1991; Crary and Kwinter, 1992; Penley and Ross, 1991).

[…]

[The] complex of technologies [electronic media, cyberspace, virtual reality, new disciplinary practices] has been poorly defined within a language and framework that weakly reflects its impacts on issues such as individual autonomy, privacy, access, systems of governance, marketing strategies, and military tactics. We are, that is, entering a potential new phase of ways of *worldmaking* for which we desperately need new ways of *wordmaking* (see, e.g., Luke, 1993; Olsson, 1992; Pred and Watts, 1992; Ronnel, 1989).

The task of definition in this sense is too important to be left only to experts. As GIS enters into the fields of public policy, regional planning, business, the military, and private lives, its effects are wide-ranging and the issues its application raises are important. However, with notable exceptions, such as the resignation from [the United States] Congress in 1987 of Congressman George Brown in protest against the almost exclusive use of satellite technology for reconnaissance purposes and the fact that a ban existed on public discussion of the issue (Barry, 1992, 571), the development and application of GIS have rarely been treated as having serious political and social implications. Moreover, for the most part, GIS users themselves have failed to address these wider contexts of practices and meaning within which their own activities are located.

Thus, it would be wrong to see new informational databases as merely efficient counting machines. The effort that has gone into their development and production signals a broader restructuring of the economy of information within which they are put to use. In this sense, the recent thrust to develop and diffuse institutional and professional foundations for these new technologies and tools also signals the wider instantiation of this new economy of information in society − an economy of accounting, recording, archiving, overlaying, cross-referencing, and mapping information. If we are to seriously engage in disciplinary and social roles played by GIS, it must be contextualized within broader (and in some ways more dynamic and problematic) developments in representational technology generally.

The Technology and Its Possibilities

Insofar as it has enlarged our vision of how data and information can be linked in new and interesting ways, GIS has brought about far-reaching and significant changes within scientific research, public and private agencies, and the disciplinary structure of geography. Like the market-oriented communications and information systems that are currently gaining ground within liberal democracies, GIS technologies and programs of research and teaching are being sold to the geographic profession and to the broader public "on the promise that it will enlarge people's choices and increase control over their lives, that is, that it will be both liberating and empowering. This emerging order is the product of two major processes: technological innovation and convergence, and 'privatization'" (Murdock and Golding, 1989, 180).

In *Mapping the Next Millennium: How Computer-Driven Cartography Is Revolutionizing the Face of Science*, Hall (1993, 8) suggests that, fueled by new facts and new systems of instrumentation, 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, and that this redefinition requires a rethinking and broadening of our conceptions of maps and mapping:

> With stunningly precise new instruments of measurement developed over the last half century and with the tremendous graphic powers provided by computers over the last two decades, everyone from archaeologists to zoologists has been able to discover, explore, chart, and visualize physical domains so remote and fantastic that the effort involves nothing less that the reinvention of the idiom of geography (Hall, 1993, 4-5).

Part of this redefinition involves the corporation of technically precise methods. These methods encourage concern for the "perfect GIS" in which the base map would be accurate and geodetically correct, data would be available in compatible forms and formats, the GIS would be maintained and current, and all sorts of information − from state boundaries to 3-D models of grocery stores − would be included (Abler, 1993, 132; Keating, 1992, 32). The integration of the technology of accurate location − in this case an integrated GIS/GPS (Global Positioning System) − would permit an improved geography to be developed, a three-dimensional representation (a geography in depth) accurately pegged to the material world around us. The modeling of human and environmental interactions in this new global geography and "global geography machine" will be possible if GIS is tied to GPS, and mapping is rescued to the accurate representation of the materiality of the earth and to the accurate determination of position (Abler, 1993).[2]

[2] For a critique of the assumptions behind this view of mapping, see Wood (1992).

Abler's (1993) discussion of GIS/GPS exemplifies the current concern for data and accuracy at the core of data collection and management techniques. But such claims also have the effect of directing the attention of geographers away from the broader field of spatial representations with which the new global imaging systems have already being merged, specifically the world of virtual, not "real," realities. Ted Nelson (1992, 158), in contrast, has argued strongly that "our world becomes increasingly virtual, as its appearance departs more and more from depending on the structure of physical reality." And this notion, it seems to me, captures more effectively the spatiality of GIS − a virtual space of data manipulation and representation whose nominal tie to the earth (through GPS and other measuring devices) is infinitely manipulatable and malleable. The Newtonian world of Abler's GPS/GIS fusion, although technically necessary, seems a skeletal form compared to the virtually chaotic, complex worlds of fractal space, hypertext, and GIS.

In this new world of cartographic experimentation, technology generates its own appropriate concepts of scale:

> My approach is to try and get people to *drop* human scale completely. And when they think of something, they go into *that* scale. If you're going to think of galaxies, you've got to be galaxy-like{…}If you don't expand yourself to that scale, I think it's hopeless (Interview with Alan Dressler, Aug. 28, 1989, in Hall, 1992, 5).

Digital spatial data and GIS permit the infinite manipulation of data layers, the construction of an infinite sequencing of new views on the data landscape, new angles of view, multiple overlays, and correlations of spatial data landscapes. Space and data have become fully manipulatable in this virtual environment.

One of the more popular recent expositions of this wider perspective is David Gelernter's (1992) *Mirror Worlds or The Day Software Puts the Universe in a Shoebox … How It Will Happen and What It Will Mean. Mirror Worlds* is a popularized introduction to the goals and visions underpinning the development of virtual worlds, but it provides a useful point from which to view the epistemological assumptions and social claims within this broader field of virtual spatial realities. *Mirror Worlds*

> 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 hag 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 trapped inside a computer − where you can see and grasp it whole" (Gelernter, 1992, 3). These images "engulf some chunk of reality" [...] and the mirror world "reflects the real one" [...]. "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" (Gelernter, 1992, 6).

How is this to happen? How will the "place" of the 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 see traffic density on the streets, delays at the airports, the physically 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 ion 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. 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 focused 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 its budget? Leave a software agent behind (Gelernter, 1992, 16-7).

The elaboration of new virtual worlds and spatial images extends our own world and thinking about that world in remarkable ways. In this context, GIS is merely one part of a larger tradition of digital data handling and spatial representation. Part of this wider tradition includes multimedia and hypertext. Mark Poster (1990) has perhaps provided the most thorough theorization of the new revolution in visualization brought about by new electronic information systems, but it is in the work of G. P. Landow (1992) that poststructuralist ideas are brought directly to bear on an interpretation of multimedia and hypertext. For Landow, critical social theory promises a way of theorizing hypertext, and hypertext embodies and tests theories of textuality, narratives, margins, intertextuality, and the roles and functions of readers and writers. In Roland Barthes's term, hypertext produces "writerly" texts that do not dominate the reader and insist on particular readings, but instead engage the reader as an "author" and insist upon the openness and intertextuality of the text − that is, its openness to other texts and readings.

> When designers of computer software examine pages of *Glas* or *Of Grammatology*, they encounter a digitalized, hypertextual Derrida; and when literary theorists examine *Literary Machines*, they encounter a deconstructionist or poststructuralist Nelson. These shocks of recognition can occur because over the past several decades literary theory and computer hypertext, apparently unconnected areas of inquiry, have increasingly converged (Landow, 1992, 2).

Such information-handling and imaging technologies place the visual at the very center of the known, and raise important questions about the nature of the image. As Walter Benjamin (1968, 233-4) has shown us, there are important differences between the image produced by the camera and the image produced by the painter:

> The painter maintains in his work a natural distance from reality, that cameraman penetrates deeply into its web. There is a tremendous difference between the pictures they obtain. That of the painter is a total one**;** that of the cameraman consists of multiple fragments which are assembled under the new law.

With the emergence of spatial digital data, computer graphic representation, and virtual reality, the law has changed again. The principle of intertextuality common to both hypertext and GIS directs our attention to the multiple fragments, multiple views, and layers that are assembled under the new laws of ordering and reordering made possible by the microprocessor. Some have even suggested that virtual reality signals the end of photography as evidence for anything, or that virtual representations will produce illusions that will be so powerful it will not be possible to tell what is real and what is not real.

Such claims are deeply disturbing and at root problematic. Nonetheless, GIS and informatics do open virtual spaces for "real" social interaction, new communities of dialogue, and new interactive settings for which we currently have only poor language and no architecture. The electronic airways are, in this view, interpreted to be foundational for the reemergence of a civic culture, a community of dialogue, and a global village. They are also the potential source of new powers for marginalized groups to whom traditional media have been inaccessible. In this view, the electronic airways and systems of informatics provide a potential source of counter-hegemonic social action, and GIS − as a specific form of data handling and imaging − offers a diverse array of practical possibilities. In both cases (the resurgence of civic culture and the potential for counter-hegemonic action) informatics are seen as a potential liberator of socially and politically marginalized groups, and thus a source of democratizing power for these newly networked groups. If information is power in this sense, and if community is built through dialogue, then information permits both to emerge for those who would otherwise have no voice and no space for collective action.

Uses of communication systems for politically progressive purposes and for the defense of speech against totalitarianism have recently taken on a character of mythic proportions, as users extol the progressive uses of fax machines by students in China during the 1989 Democracy Movement, or the use of e-mail by those opposed to the coup against Gorbachev to maintain contact with each other and the outside world (Penley and Ross, 1991, viii). Like Pancho Villa, who captured the trains and used them to attack government troops and gain access to the very heart of the cities during the Mexican Revolution, new informatic democrats and revolutionaries are eulogized as examples of progressive power, and as counterexamples to the more widespread business, state, and military uses of the technology.

Even though the funding for research and development of the hardware and software used in GIS and other imaging systems has come primarily from business, state, and military sources, advocates of the progressive potential of information and imaging technologies argue that access is hard to deny, networks are quite difficult to control information is readily accessible and used by individuals and groups with limited budgets and expertise, and the ability to use the technology in depth permits groups like environmental organizations to counter claims by polluters about their environmental impacts, by developers about likely effects on groundwater, and so on. In this view, GIS enables communities to make better decisions by providing access to more and better information. It provides more powerful tools for local planning agencies; it offers exciting possibilities for data coordination, access, and exchange; and it permits more efficient allocation of resources and a more open rational decision-making process.[3]

Epistemological Inertia and the New Imperial Geography

> It is not fanciful to suggest that by the end of the century GIS will be used everyday by everyone in the developed world for routine operations (Maguire et al., 1991, 15).

The discussion in the previous section detailed elements of a socially and critically engaged role for GIS. It is built largely on the claims of proponents of GIS and informatics generally about the possibilities inherent in the technology and/or the use of the technology. Not all geographers have been happy to accept any of these claims made by GIS users, and in this section I ask whether such claims are sustainable given questions about the underlying assumptions, ontology, and politics of GIS and its use. If we determine that all these claims are not sustainable, do we know what a critical use of GIS and imaging technologies would require? If the claims between GIS

[3] Of course, all these matters are contingent on the types of regulatory framework that emerge to govern development, property rights, access, and so on.

users can be sustained, what should be the relationship between GIS and critical science, and what effect would such a situation create for critical studies of geography, particularly in those branches of the discipline (and of many other disciplines) where "the positivist assumptions embraced by GIS have long since been jettisoned" (Lake, 1993, 404)? Can we transform GIS and other imaging technologies to make them compatible with the premises and commitments of critical science? Or can we rethink our understanding of the new information and imaging systems in ways that will allow their productive potential to be deployed in new ways?

The self-understanding of GIS itself can be readily observed in the two-volume *Geographical Information Systems* (Maguire et al., 1991). This publication − the most thorough synthesis and analysis of GIS to date − is a vast compendium of the history, principles, tools, and methods of GIS: an encyclopedia and handbook for GIS, a marker of the state of the field at the present time, and a workbook for teachers and student to deepen their awareness of the field. Maguire et al.'s text provides the first solid support for the claim that GIS is entering into a new phase and approaching the possibility of creating a separate discipline − a claim made by the editors of the book (particularly in the Introduction) and boosters within the commercial sphere (such as *GPS World)*. Indeed, the work reflects the emergence of strong research agendas within GIS over the past two decades, as well as the close integration of academics, public, and commercial developers and users of GIS.

This book is also a marker of another aspect of disciplinary history. It is perhaps the most comprehensive statement to date of a branch of geographic scholarship that has systematically pursued a vision of the geographic, with an epistemology and belief in method quite different from that pursued by large parts of the rest of the discipline. While within geography and the social sciences generally the period from the 1960s to the 1990s saw the emergence of new paths and principles, which − from the critique of objectivist science in the 1970s to the impacts of postmodernism and poststructuralism in the 1990s − have transformed the central questions and approaches of the discipline, the epistemology and method that underpins GIS emerged in the 1960s under the auspices of positivist and empiricist versions of science and reemerged as a result of the collaboration between, and a revitalization of, spatial analysis, cybernetics, and computer developments of the 1970s.

Taylor's (1990, 211-2) trenchant critique of GIs as the new imperialist geography suggests that GIS has emerged as a two-part strategy on the part of unreconstructed "quantifiers" who have "bypassed" the critiques levied against the empiricism of spatial analysis, and at the same time have captures the rhetorical high ground of a progressive modernism (or naïve postindustrialism) by readily accepting the switch from knowledge to information:

> Knowledge is about ideas, about putting ideas together into integrated systems of thought we call disciplines. Information is about facts, about separating out a particular feature of a situation and recording it as an autonomous observation {…}. The positivist's revenge has been to retreat to information and leave their knowledge problems − and their opponents − stranded on a foreign shore. But the result has been a return of the very worst sort of positivism, a most naïve empiricism (Taylor, 1990, 211-2).

In this (re)turn the geographical is defined as the study of anything that is spatial[4]:

> GIS is a technological package that can treat any systemic collection of facts that are individually identified spatially. These facts may be medical statistics, remote-sensing images, crime files, land-use data, population registers or whatever. In terms of the package, spatial patterns can be produced irrespective of what the information is about {…}. Such quantifiers can be produced a maverick geography dealing with crime one week, bronchitis the next, and so on (Taylor, 1990, 212).

The colonizing aspirations of such claims and such an approach are − as Taylor points out − transparent. Many GIS users undoubtedly see these claims as exaggerated at best and false at worst, or, as Openshaw (1991) has argued, they represent reductionist assertions and derogatory and confrontational language, "knockabout stuff" that emerges from a reactionary desire to protect a particular system of order and power. Thus, for Openshaw, the crisis to which Taylor points is redefined as "contrived" and should be replaced by a notion of "creative tensions" between at times complimentary, at times competing, but equally productive, intellectual projects. Openshaw [...] describes the possibilities of GIS:

> A geographer of the impending new order may well be able to analyze river networks on Mars on Monday, study cancer in Bristol on Tuesday, map the underclass of London on Wednesday, analyze groundwater flow in the Amazon basin on Friday. What of it? Indeed, this is only the beginning (Openshaw, 1991, 624).

According to Openshaw [...], this new-order geography needs GIS in order to "put the pieces of geography back together again to form a coherent scientific discipline." He continues:

> It would appear then that GIS can provide an information system domain within which virtually all of geography can be performed. GIS

[4] For the critique of paradigmatic thinking and an argument for post-paradigmatic science, see Pickles and Watts (1992).

> emphasizes an holistic view of geography that is broad enough to encompass nearly all geographers and all of geography. At the same time it would offer a means of creating a new scientific look to geography, and confer upon the subject a degree of currency and relevancy that has, arguably, been missing (Openshaw, 1991, 626).

This imperialist, reductionist, and technicist view of GIS (and geography) is further illustrated in Martin's (1991) *Geographic Information Systems and Their Socioeconomic Applications*.[5] The book is important because it is one of the few to explicitly address the role of GIS in socioeconomic applications, and because it does so explicitly from an understanding of GIS as a spatial analytic and applied science. Martin begins with a discussion of the absence of any clear theoretical structure guiding the developments of GIS, and argues that "to an outsider GIS research appears as a mass of relatively uncoordinated material with no core theory or organizing principles" (Martin, 1991, 44). In order to overcome this absence of theoretical work, Martin defines "spatial data" and "geographic data" by using definitions developed for spatial analysis in Abler, Adams, and Gould's 1971 volume *Spatial Organization of Society*: "spatial data" is a general term used to refer to measurements that relate objects existing in space at any scale, and "geographical" date is a term used to refer to data relating to objects in the range of architectural up to global scales. Geography is the analysis of objects and patterns in space (not, coincidentally, exactly the subject matter of GIS), or as Martin (1991, 45) says, quoting Abler et al. (1971), "Almost any substantive problem a geographer tackles can be fruitfully considered as a problem of describing accurately and explaining satisfactorily the spatial structure of a distribution." Martin builds upon and revitalizes − as the basis for a theory of GIS − these theoretical concepts of space and geography, but he does so in a away that they remain disengaged from any consideration of the broader discussions and theoretical debates that have transformed the discipline in the past 20 years, and even from those efforts that sought to rethink concepts of space within spatial analysis (see, e.g., Gatrell, 1983). These debates about the nature of space, spatial objects, and what constitutes geographical objects [is] ignored here in the interest of reconfiguring "theories of GIS" in terms of purely abstract spatial objects and the relations between them.

Representing the natural and social world is, in this view, only a technical problem: analog models or real maps of the real world provide a model that is "an 'accurate' representation of the world and … embodies the spatial relationships necessary for the solution of any particular problem" (Martin, 1991, 48). In an attempt to ground the special category of representation that deals with socioeconomic phenomena, Martin turns to the theory of maps and lays out the traditional cartographic model of the relationship between the real world and the map as a model of the real world. In this model, "the cartographer's task is to devise the very best

[5] This discussion of Martin is based on Pickles (1992a).

approximation to an 'ideal' transformation involving the minimum information loss" (Martin, 1991, 45).[6] In struggling with the problem of representation, martin resolves the matter by recourse of a traditional positivist interpretation of maps, in which the relationship between reality and image is an unproblematic one of representation, and error is merely a result of lack of technical skill or unintentional distortion (for a wider discussion of this model of cartography, see Pickles, 1992b). The result is a book that represents (in spite of its clarity and careful definition, among other strengths) the kind of theory of GIS that leads geographers to argue that GIS can be seen as a form of unreconstructed (or only partially reconstructed) spatial analysis operating with the assumption derived from a positivist tradition. Its concepts and epistemology of space, objects, and reality are taken directly from the spatial analytic tradition. Martin argues for a straightforward observer epistemology and a view of theory as definition. To this spatial analytic tradition are added computers, power, and flexibility. But many of the old problems remain. This is reflected in Martin's conception of the socioeconomic application for which GIS is particularly well suited:

> Unlike a road intersection of a mountain summit, we are rarely able to define the location of an individual simply by giving their map reference. This has far-reaching implications: socioeconomic phenomena such as ill health, affluence, and political opinion undoubtedly vary between different localities, but we cannot precisely define the locations of the individual which make up the chronically sick, the affluent or the *politically militant*. If GIS are to be used to store and manipulate such data, it is crucial that much care is given to ensuring that the data models used are an acceptable reflection of the real world phenomena (Martin, 1991, 5, emphasis added).
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> GIS may become invaluable to the efficient functioning of organizations (Martin, 1991, 40).
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> The growth of these data and their use in relation to socioeconomic phenomena has become known as "geodemography." Many organizations, including health authorities, retailers, and direct-mail

[6] Several conceptions of representation and reality underpin this understanding of "socioeconomic applications." GIS is concerned with the representation of spatial data. Such representational practices are made distinct by the "ways in which data are organized in GIS to provide a flexible model of the real world" [...]. These new computer-generated representations − "virtual maps" − are distinct from "real maps" in that they offer a greater degree of flexibility [...]. Martin does stress the filtering effect of this representational act, suggesting that all remotely sensed images are but poor representations of the real world [...], and that classification systems may bear little relationship "to the 'real world' classes of land cover which we hope to discover"[...]. The "real" here is that which is naturally given in unmediated form: a land surface to be captured as a raw image to be classified [...]. The task of the GIS user is to represent and manipulate a model of geographic reality as accurately as possible (Martin, 1991, 8, 13, 21-3, 27).

> agencies have become very interested both in the description of geographic locations in terms of their socioeconomic characteristics, and the identification of localities containing people of specific socioeconomic profiles (e.g., poor health, high disposable income, etc.) (Martin, 1991, 41).

The prospect of socioeconomic application of GIS permitting efficiently functioning organizations such as insurance companies to develop "geodemographical" insurance rate schedules based on identification of zones and localities of risk, the targeting of civil rights groups (the "politically militant") for particular police or vigilante attention, or the extension of direct-mail solicitation to exact market targeting based on recorded purchasing and general expenditure records (already a reality, or course), seem actually to be applauded in Martin's eagerness to "sell" to the reader the potential socioeconomic applications of GIS. Martin takes as unproblematic what has become naturalized practice within the GIS community. Thus, for example it is difficult to distinguish between the unabashedly boosterist claims of the academic Martin from the unabashedly boosterist claims of the business authors in the October 1991 issue of *GIS World* which lauded the role of "GIS in Business" (Francica, 1991; Maffini, 1991) with fluffy articles dealing with socioeconomic applications ranging from real estate, energy delivery, agribusiness, tourism, and communications (Dangermond, 1991), to the insurance industry (Runnel, 1991), to retailing (Moloney and Dellavedova, 1991), to market areas analysis for car dealerships (Clark, 1991), to fleet management (Barry, 1991), to delivery services (Heivly, 1991), to direct marketing (Moncla and McConnell, 1991; Cook and Plumer, 1991), to telecommunications (Gusso and Lasala, 1991), to fast food location strategies (Kirchner and Thomas, 1991).

In writings concerned with the spatial and economic applications of GIS the absences and silences are particularly instructive. Whole domains of praxis within which GIS might make some contribution are elided, and Martin (and much GIS) remains silent about them. Instead, the gaze of the strategic planner, the commercial manager, or the military strategist is presented as an appropriate application − this is the kind of technocratic myopia that led Gunnar Olsson from 1972 on to charge that spatial analysis was an inherently conservative form of analysis (Olsson, 1974, 1972). In this myopic vision, there is rarely room for insurgent GIS, or for GIS socioeconomic applications other than those that permit us to gain greater levels of clarity and control over the social and economic domain.

Moreover, Martin (as do many others writing about GIS) fails to ask questions about current trajectory of GIS research and practice. No attention is given to the question of the scale and cost of technology and its relation to the specific types of socioeconomic application. No reference is made to the growing amount of Third World literature on pc-based GIS for local action groups, or the use of computerized databases to monitor and control polluting state enterprises in centrally planned economics, or to the flourishing of disparate efforts by progressive GIS users to develop networks of local, small-scale systems to provide information that challenges

corporate and statist interest that Martin seems to see as major users of "socioeconomic applications."

Martin's book typifies a strong thread in the emergence of GIS as a disciplinary discourse and social practice. The book represents only an implicit and indirect picture of the representational economy emerging within the contemporary GIS and its relationship with an economy of control. In this economy, socioeconomic applications are aimed at organizational efficiency and control of geographic territory (be it the jurisdiction of a health, police, or military authority, or the market area of retailers or direct marketing agencies). Implicit is the view that if date and technology availability permit the manipulation of spatial data for particular ends, then the ends themselves are justified (or of no concern to the geographer). Missing is any analysis of the ethical and political questions that emerge as GIS institutions and practices are extended into socioeconomic domains. That Martin's book is intended to be a text on the socioeconomic applications of GIS for students and GIS users (like the bulk of texts dealing with GIS), but lacks any treatment of ethical, economic, and political issues, raises serious questions about the possibility for the emergence of critically and socially responsible behavior within the particular episteme and its associated practices.

Like Martin, GIS authors more generally have grounded their analyses in terms of value-neutral observation, science as the mirror of reality, and theory and the product of data collection and testing, and have not chosen to engage in disciplinary and social theoretic debates of the past two decades that address the intellectual, social, political, and technological impacts of this form of instrumental action. In speaking about planning and applied geography, Robert Lake (1993) explicitly ties the development of GIS to this "resurrection" of a rational model of planning and a positivist epistemology:

> The unrelenting embrace of the rational model by planning and applied geography is not adequately described merely in terms of the tenacity and inertia of convenient and familiar practices. The rational model has been actively resurrected and rehabilitated by the ascendance of Geographic Information Systems to a position near or at the core of both planning and geography (Lake, 1993, 404).

Lake's claims that positivist epistemologies have been resurrected and rehabilitated can, I think, be sharpened even further. While it is certainly the case that many critical theorists in geography see in GIS a rehabilitation of positivist epistemology, from a different perspective it is clear that positivism was never forsworn, nor was the critique of positivism seriously engaged by GIS scholars. Empiricist and positivist assumptions continued to ground spatial analytic work throughout the 1970s and 1980s, and they were not seriously challenged either by the turn of behaviorist and behavioral geographies in the 1970s or by the turn away from analytic traditions toward humanism and subjectivist epistemologies in the 1980s (see Pickles, 1985, 1986). Instead of a thorough engagement with the epistemological debates that emerged in the

social sciences in the 1970s and 1980s, or with the linguistic turn in the 1980s, geographers working in the field of GIS merely sidestepped into the research tradition of artificial intelligence, whose heritage of cognitive simulation and semantic information processing provided a compatible intellectual and professional home for work on automated cartography and GIS software.[7]

From this perspective, it becomes clearer why Lake's (1993, 405) review of the literature finds few publications on the part of GIS proponents that consider the epistemological, political, and ethical critiques of positivism, or any serious engagement with what he terms the "fundamental disjuncture growing at the core of the disciplines." That disjuncture is perhaps even more severe than Lake suggests. Such attempts to ground geographic research methods (and for Openshaw, 1992, to ground geography as such) in automated date handling seem to many GIS critics strangely distanced from contemporary theoretical debates about geographical method, epistemology, and ontology. In the 1980s, human geography developed strong critiques of the reductionist ontology of spatialism and turned to questions of contextual knowledge; contingency and necessity; society, space, and nature; the (social/political/gendered) construction of space; and the production of scale − each of which in various ways problematized the dominance of natural science methodology in the study of social phenomena, and raised questions about the underlying ontology of objects, location, and application on which spatial analysis was predicated. Lake's disjunction is, in this sense, grounded in a fundamental epistemological divide between positivists and postpositivists [between those that think human knowledge is founded on certainty and those that think of it as based on conjecture], between Kantians [those who follow the theories of Kant] and those who heeded the extended debates generated by the linguistic turn and the interpretive turn, and − as Derrida has coined it − between those whose feet are firmly planted in the soil of logocentrism [western cultural ways of understanding] and the metaphysics of presence, and those who have taken on board the implications of the critique of logocentrism and ontotheology [belief in existence of original being without need of experience]. The former claim to stand on the critical tradition of empirical science, while the latter calls for a critical theory that engages the logic of limits, the marginal, and the liminal [intermediate, transitional]; that overturns many of the epistemological assumptions on which such a science can be built, and that locates a new understanding of power at the heart of claims to knowledge (Derrida, 1976; Norris, 1987).

> Perhaps more troubling is the likelihood that consideration of these issues will be even further obscured by the popular momentum, technological complexity, and sheer scale of financial investments represented by the ascendency of GIS. Once that investments is made,

[7] See Dreyfus (1992) for critical reflections on this issue, Fontaine (1992) for an uncritical example, and Dobson (1993, 1983), Pickles (1993), and Sheppard (1993) for reflections on this issue in geography.

> the focus is more likely to turn to expanding applications that to reconsidering philosophical foundations (Lake, 1993, 405).

Brian Harley, (1990, 8) has made exactly this point in his review of contemporary computer cartography: "We can glimpse here that unconscious process of myth-making, though which the invention of a progressivist positivist past is used to justify a progressive positivist present."

From Saber-Rattling to Engagement

> The essence of technology is by no means anything technological. Thus we shall never experience our relationship to the essence of technology so long as we merely conceive and push forward the technological, put up with it, or evade it. Everywhere we remain unfree and chained to technology, whether we passionately affirm or deny it. But we are delivered over to it in the worst possible way when we regard it as something neutral; for this conception of it, to which today we particularly like to do homage, makes us utterly blind to the essence of technology (Heidegger, 1977, 4).

GIS technology has, from its early days, been big business. Currently it is huge business, and the scale and scope of this business is not hidden in the market place. The power of data handling now means that GIS and related data handling and imaging systems have become central elements in demographic and infrastructural accounting systems; international, national, and regional monitoring and management projects, business organizations, design activities; and military weapon and strategic planning. Since electronic information technologies provide more information and faster access across broader spans of space, they are presumed to be technologies that are liberating. Such a mythos of public benefit accruing from the *ability* to gain access to new and broader forms of data, and to represent this data spatially in a wide array of images, has been instrumental in the adoption of the new telematics within universities, planning agencies, environmental bodies, and the corporate and business world.

Given these goals, why is it that parts of the geographic profession display such distrust of the developments in GIS and remain skeptical about the motives, potential value, and political consequences of its adoption?

If the modernizing impulse of electronic technology is interpreted by some as liberating − as creating new opportunities for civil society to forge "communities" of correspondence, such as through the emergence of computerized e-mail networks and bulletin boards within universities and large corporations − others are more sanguine about the rationalizing effects of such modernizing technologies. The new systems of knowledge engineering raise many questions about freedom, civil society, and

democratic practice, whether, for example, from a Marxian analysis of the differential impacts of technology adoption across race, class, and gender, a Weberian interpretation of technological modernization as part of a broader rationalization of social life, a Habermasian critique of instrumental rationality and the colonization of the lifeworld, or a Foucaultian account of the normalizing effects of new power/knowledge practices embedded in the discursive and nondiscursive practices of computerization.

As Hall (1993, 369) reminds us, "Reading a map represents a profound act of faith. Faith in the mapmaker, in technologies of measurement, (and the science that underlies them), in the idea of the map − space in what we like to call the real world." Yet the map and map-maker have often been implicated in profound acts of betrayal:

> With centuries of distance and historical hindsight, we can see that error and bias, exploitation and colonialism, self-serving centrism and ecological harm can so easily be read into the subsoil of old maps and that they may as well be listed with symbols and explained in the legend [...].
>
> In would be foolish to ascribe that unspeakable tragedy (the Great Dying of the New World brought about by Spanish conquest) … to the maps that chartered the New World; but it would be equally foolish to ignore the intricate weave of social and cultural nerves that connect discovery, exploration, and mapmaking. The map is the game board upon which human destinies are played out, where winning or losing determines the survival of ideas, cultures, and sometimes entire civilizations (Hall, 1993, 370-1).

Hall (1993) is refreshingly clear-sighted about the exciting possibilities of new maps and their inherent dangers:

> Every map presages some form of exploitation {…}. Geopolitics, after all, is impossible without a cartographer, and that exercise of control over a distinct domain marks a watershed in political power, confirming the notion that maps are not merely pictures of the world, but depictions of a world that can be shaped, manipulated, acted upon [...].
>
> Map historian J. B. Harley refers to cartography as the "science of princes," and it is a characterization that applies to modern mapmakers as well. From the expenditures financed by Spain and Portugal in the fifteenth century to experiments sponsored by the National Science Foundation last year, there exists a tradition of what might be called "mercenary geographers." In the context of contemporary science, the term strikes the ear harshly; but in the context of the history of exploration and mapping, there is compelling and overwhelming evidence that "explorers," terrestrial and intellectual, must align their

> professional and personal ambitions with wealthy and powerful nations, which can afford the expeditions (or, in the modern analogue/idiom, the "experiments") that chart and stake a claim to new territories (Hall, 1993, 383-4).

Thus, Hall (1993, 387) asks, "Can we acquire modern map knowledge without … inventing and committing new, equally modern and unimagined cruelties?"

This question becomes even more pertinent with electronic systems of representation (such as GIS), where the pace and the scope of adoption, and the at times unsavory uses to which the information and technology has been put (and for which it was, in part, developed), have encourages only limited challenges to instrumental conceptions of the role of GIS in society (see, e.g., Pickles, 1991; Smith, 1992; O'Tuathail, 1993). But, as GIS has become − along with hypertext, multimedia, and other complex, multilevel computer database and imaging systems − an element in the extension of accounting systems and the servicing of new needs and responsibilities on the part of public and private agencies, it becomes crucial to ask how these technologies impact on the ways in which people interact with one another.

Despite the apparently pressing nature of these issues, discussion of the social impacts of GIS has been limited mainly to an internal analysis of technique and practice. Little external evaluation and critique has been developed. Where this has occurred, the heat and emotion surrounding issues of reallocation of funding, redirection of teaching and research programs, and competition between GIS and other areas of the discipline have tended to result in angry polemic, instead of thoughtful, strong theoretical engagement.[8] Of course, since the personal, institutional, and social stakes are high, this is not unexpected. The development and adoption of new information technologies, and the rise of new ways of doing things, do not occur without struggle. Each new technology, insofar as it was widely adopted, must be situated within existing norms, practices, and discourses, or new norms, practices, and discourses must be created. This is no less true for the electronic media of remote surveillance and multiscale mapping technologies that lie at the core of GIS.

The discussion of GIS in geography seems to have taken one of two tacks. Either GIS is interpreted from within the ranks of the practice itself, in which case interpretations reflect a concern for questions of methods and technique. Or geographers have become advocates of GIS − the new "space cadets." Yet many seem unwilling to discuss the destabilizing effects of GIS of even the most pertinent recent debates about the sociospatial dialectic, power/knowledge, and the constitution of social and political subjects. Instead, much discussion takes the form of unreflective GIS advocacy and an almost unevangelical need to proselytize about the geographical nature of GIS. Objectivist epistemology and a pragmatic politics combine to reject any

[8] See the polemics in Openshaw (1992, 1991) and Taylor and Overton (1991).

broader theorization of the consequences of this form of knowledge production and management.

In what ways can a social theoretic understanding transcend these polar positions, and how we can speak about this technology without presupposing the ontological and epistemological assumptions on which GIS is founded? […] [T]he question is not only about the internal possibilities and constraints of GIS, but about the reconfigurations of social, economic, political, and disciplinary life that the emergence of electronic technologies like GIS are creating. However, on of the central difficulties in developing a critical social theory of GIS is the refusal of GIS users to distinguish between empirical and technical claims about objects, practices, and institutions, and the discourses within which particular claims about objects, practices, and institutions, and particular claims to truth, are made. That is, concepts, practices, and institutional linkages remain largely unproblematized, naturalized as normal and reasonable ways of thinking and acting.

The language in use in GIS itself is instructive. In the words of GIS exponents and practitioners the new electronic technologies permit the rapid and extensive *surveying* of *new and more complete sets of data* at great *speed*, decreasing cost, and greater *efficiency.* The *technological* changes that make these *advances* possible also permit the *standardization* and *manipulation* of a variety of discrete date sets to *yield* new *spatially specific* sets of information that can be *codified*, and even *commodified*. This *control technology* and *knowledge engineering* require special *skills, knowledge,* and *training.* The *output* is in great *demand*, students can find good *jobs*, and government, military, and business *applications* provide challenges for the university researcher.

These claims are made, however, in the almost total absence of any wider context of theorizing the changes in technology and social relations, of epistemology and theories of sciences, or of the processes of the production, representation, and dissemination of information within which these processes operate. As Foucault (1980) has so clearly demonstrated, the technics of the human sciences have arisen in conjunction with specific practices in the broader society:

> In a society such as ours, but basically in any society, there are manifold relations of power which permeate, characterize, and constitute the social body, and these relations of power cannot themselves be established, consolidated, nor implemented without the production, accumulation, circulation and functioning of a discourse. There can be no exercise of power without a certain economy of discourses of truth which operates thorough and on the basis of this association. We are subjected to the production of truths through power and we cannot exercise power except through the production of truth (Foucault, 1980, 93).

The task of a critical genealogy of power is to clarify the detailed practices that constitute the "history of the present," and to provide accounts of the emergence of new modalities of power (Fraser, 1989, 17).

GIS is just one of these new complexes of discourse, practice, and institutional ensemble, among many others, effecting changes in the modalities of power. As a cultural practice, instituted historically, its forms and effects are consequently contingent, ungrounded except in terms of other, prior, contingent historically instituted practices. In this sense, power is as much about the possibilities of modernization − the ways in which identity and differences are constituted − as about the exercise of influence and the formation of new iron cages. As social relations and new subjectivities are embodied, we need to ask how such identities are sustained, how power flows through the capillaries of society in particular settings, and what role new technologies of the self and of society play in this circulation of power. Foucault would have understood well our contemporary fascination with GIS, its "technologies of surveillance," forms of knowledge engineering, and commitment to the categorizing and normalizing of nature and social life.

In *The Consequences of Modernity* Giddens (1990) raised the question of modernity and trust: As more and more people live in situations in which they interact with disembodies institutions, their local practices are mediated by globalizing social relations, and their daily contacts are increasingly mediated by automated and computerized operations (the bank teller machine, automatic telephone answering machines, camera operated security systems, etc.); *facework commitments*, [...] "sustained by or expressed in social connections established in circumstances of copresence" [...] are replaced by *faceless commitments* [...] which depend upon "the development of faith in symbolic tokens or expert systems" [Giddens, 1990, 80] or abstracts systems [...]. The shifting balance between facework and faceless commitments and contacts is also a recomposition of the rules and practices that constitute social behavior. Thus, for example, the complex skills required to maintain civil inattention (the form of encounter that takes place between strangers in a community) are replaced by alternative systems of encounter, such as forms of uncivil inattention like the hate stare. The possibilities for deep-seated changes in the nature of social life are very real in such abstract systems where the nature of trust and interaction change.

Conclusion

> What, in a positive sense, made the new communities imaginable was a half-fortuitous, but explosive, interaction between a system of production and productive relations (capitalism), a technology of communications (print), and the fatality of human linguistic diversity (Anderson, 1983, 43).

In the debate about the nature, uses, and impacts of GIS in the hypermodern world of generalized information and communication, geographers have adopted a relatively limited range of critical positions. For many, GIS represents a reassertion of instrumental reason in a discipline that has fought hard to rid itself of notions of space as the dead and the inert, and, as Soja (1989) has argued, to reassert a critical understanding of the socioeconomic dialectic. For yet others, the debate about GIS is a nonissue (Clark, 1992). As I hope I have begun to show […], the emergence of GIS as both a disciplinary practice and a socially embedded technology represents an important change in the way in which the geographical is being conceptualized, represented, and materialized in the built environment. As both a system for information processing and for the creation and manipulation of spatial images, and as a technology which is diffusing rapidly through the apparatuses of the state and the organs of business, GIS requires a critical theory reflecting sustained interrogation of the ways in which the use of technology and its products reconfigure broader patterns of cultural, economic, or political relations, and how, in so doing, they contribute to the emergence of new geographies.

Along with the important critical task of assessing the impacts of GIS as tool, technology, and social relation, I have also tried to show how we need to think more seriously about the transformative possibilities that GIS offers. In regards to parallel developments in cyberspace, Heim (1992, 59) has argued that "cyberspace is more than a breakthrough in electronic media or in computers interface design. With its virtual environments and simulated worlds, cyberspace is a … tool for examining our very sense of reality." Whether and how this tool for manipulating and understanding both our world and our sense of the world is used, depends at least in part on the conceptual tools, critical frameworks, and linguistic codes we choose to mobilize by way of response.

[...]

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