Network Topologies and Virtual Place

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The use of terms such as "cyberspace," "electronic frontier," and "information superhighway" implies a project for geographers: the attempt to incorporate such innovative views of place within an ontological framework sensitive to geographical concerns. Combinatorial theory and structuration theory provide a basis for this incorporation. Just as places are dialectically related to social processes, so too are communication media. Similar factors related to the patterning of communication flows pertain in both cases. In particular, geographers can identify similar patterns of nodes (communicators) and links (communication paths) in places and in communication media. These patterns, or topologies, provide a set of opportunities and constraints for social interaction. When topologies in computer networks replicate the topologies in familiar places, certain elements of social structuration are shared, as well. This sharing, in turn, lends validity to claims about "virtual place" that can be quantitatively described, through combinatorial methods, to indicate the level of specialization in the topological form that has been replicated, and hence the significance of the replication. In light of such similarities, the political and social implications of computer networking are explored.
Key Words: virtual place, place, computer networks, structuration theory, media.

Vice President Al Gore described the U.S.'s planned interactive broadband network as "a network of highways, much like the interstates of the 1950s. . . . highways carrying information rather than people or goods" (Gore 1993). Science fiction writer William Gibson envisioned a global computer network as a "consensual hallucination" accessed through modems connected directly to users' brains: "A graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding . . ." (Gibson 1984:51). These two quotes serve to illustrate the most common way of thinking, talking and writing about computer networks: through metaphors that draw on spatial experiences such as driving down a freeway, walking through a building, or flying in a spacecraft. Collectively, I will call these "virtual-place metaphors."

Virtual-place metaphors are employed when the guidebook to America Online (AOL), a popular computer-network service, describes its "people connection" as consisting of a lobby and adjoining rooms. The lobby is a place that people "pass through, often on their way to some other destination," and occasionally "bump into an acquaintance, or sit there a moment to rest," while in the "rooms," the "conversations are more focused and the residents less transitory" (Lichty and Parks 1992:234, 237). Similarly, the Dean of the School of Architecture and Planning at MIT proclaims that:

> We are entering an era of electronically extended bodies living at the intersection points of the physical and virtual worlds, of occupation and interaction through telepresence as well as through physical presence, of mutant architectural forms that emerge from the telecommunications-induced fragmentation and recombination of traditional architectural types, and of new, soft cities that parallel, complement, and sometimes compete with our existing urban concentrations of brick, concrete, and steel (Mitchell 1995:167).

And Mitch Kapor and John Perry Barlow, founders of the Electronic Frontier Foundation (EFF), an organization of computer-network free-speech activists, declare that:

> Over the last 50 years, the people of the developed world have begun to cross into a landscape unlike any which humanity has experienced before. It is a region without physical shape or form. It exists, like a standing wave, in the vast web of our electronic communication systems. It consists of electron states, microwaves, magnetic fields, light pulses and thought itself (Kapor and Barlow 1993:1).

While these accounts deny some elements of traditional spatial relations, they simultaneously employ virtual-place metaphors: "telepresence," "soft cities," "landscape," "region."

If the use of virtual-place metaphors indicates that computer networks or their applications in-

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voke place experiences, this fact has important implications for the geographical interpretation of space and place, and it would seem that geographers should make some effort to respond. Claims that new media "destroy the geocode's key" (Mitchell 1995:10), similar to Meyrowitz's (1985) "no sense of place," are also intriguing in this regard, and prompt a response from geographers that is grounded in an understanding of the social function of place. But in what mode of geographical scholarship can we respond to such ideas? Since we are discussing *ideas and articulations* about place, humanist geography would seem to be the preferred approach. A humanist geographer would treat observations about computer networking, such as those quoted above, as symbols, metaphors, and images that help people understand their world, that is, as *geosophies*.

Geographers have previously treated geosophies as artifacts (or even "mentifacts," Zelinsky 1973), that is, as products of culture that can be re-presented in some artful fashion, sorted, classified, linked to historical cultural trends, and compared to other geosophies (e.g., Wright 1947; Glacken 1967; Tuan 1974, 1977; Sack 1980). When applied to discourses about computer networking, this approach produces interesting results, some of which I explore elsewhere (Adams 1997).

There are, however, limitations to the humanistic approach. First of all, it does not directly address topics that are perhaps foremost in many geographers' minds: what are the geographical effects of the diffusion and use of computer networks? How does interaction via "the Net" differ from face-to-face interaction and other forms of mediation? How is power mapped onto this new "space" and who benefits? Such questions motivate the authors of recent works such as *Telecommunications and the City* (Graham and Marvin 1996), *Collapsing Space and Time* (Brunn and Leinbach 1991), and *Understanding Information: Business, Technology and Geography* (Robins 1992). These works, however, either ignore virtual-place metaphors or present them in a rather cursory way, dismissing them as unrealistic and proceeding to get down to serious analysis, or using them to set a mood of excitement, then moving quickly to empirical details or theoretical interpretations that bear little relation to the virtual-place metaphors.

Here I plan to take up the challenge implied in the virtual-place metaphors not by treating them as artifacts but as a serious *ontological* challenge to geography. Accordingly I show how they can be incorporated within an existing ontological framework used in geography, that of structuration theory. I begin at the most basic level, below such distinctions as "information superhighway," with the basic equation underlying all of the virtual-place metaphors: a communication system is to communicators as a place is to inhabitants. In addition, since virtual-place metaphors imply a *mapping* of real places onto virtual places, terms such as "virtual café" and "virtual classroom" are probed for some nonarbitrary meaning. The primary challenge is to see if this meaning can be accomodated within models of reality that are both comprehensible to geographers and illuminating, models that fit the overall social role of computerized communication as well as its specialized forms—e-mail, World Wide Web, interactive computer forums, and so on. Specifically, I apply techniques of combinatorial mathematics and structuration theory to identify the structural characteristics of the two types of communication contexts—computer networks and places—and show their similarities. This approach leads to the confirmation of popular discourses that portray computer networks in terms of virtual place.

My objective is a step beyond: to understand how place simulations are constructed upon and out of three long-term sociospatial processes: the progressive stretching out of social relations across space (distanciation); the multiplication of exchanges of goods, ideas, and persons between distant parts of the world (globalization); and the related loss of the social and psychological importance of physically defined places (disembedding). In the Discussion and Implications sections, I link these issues to philosophical concerns about selfhood and the possibility of moral action in the face of globalization. Throughout, I use the common term "cyberspace" to indicate computer networks as an experiential realm and a social context. To indicate the places conventionally studied by geographers, I use the term "physical place."

Structures

Two notions of structure arise in our discussion. First is the structure of links and nodes in communication systems, expressed in terms of combinatorial theory, a branch of mathematics that allows combinations of elements in sets to be counted and compared. Through combinatorial theory, we can determine the probability that any particular structured combination—a "topology" of links—would be generated at random out of all possible topologies linking a given set of nodes under study. We can thereby gauge the degree of specialization manifested in a particular communication system. Through this descriptive technique, we find that the structure of some computer networks is measurably quite similar to that of certain physical places.

The second notion of structure is that of individual-society interactions formalized and described in structuration theory. From this perspective, places are not static objects, but rather dynamic systems of connections. People constitute place through daily life by externalizing knowledge, authority, routines, commitments, and beliefs, and they are simultaneously refashioned by the locales of sensation and action that they and others are constituting. The external sphere (society and space) acts upon the internal sphere (self and mind), which acts simultaneously on the external sphere. Social causes and effects, agency and structure, intertwine in an endless cycle. While Pred and Thrift deserve most of the credit for articulating this approach, Gregory's (1978) formulation is essential in recognizing "other" types of structure such as the kinship rules and symbolic (mythical) oppositions (as articulated in the structuralism of Levi-Strauss and Piaget). In a similar fashion, the structure imposed by walls, wires, and other methods of connecting and separating communication situations can be seen, in dialectical fashion, as both constitutive of and constituted by human agency.

If a place's role in society and individual life can be understood in terms of providing a stage or container for both internalization and externalization, then computer social contexts can be seen in the same way. If a place can be understood in terms of social relationships that are, fundamentally, links (communications) between nodes (people), then again places and telecommunication media provide a roughly equivalent function. The two notions of structure are in fact closely related, and their comparison permits the refinement of the concept of virtual place in the rest of the paper. I argue that virtual places of various kinds can be "mapped" onto the topology and social structuration of physical places and processes, and that conclusions about current transformations of social life can be drawn from this mapping.

A Combinatorial View of Networks

Let us begin by thinking of a "network" as any system of links and nodes, not just a system built of computers and telephone lines. The meanings of "node" and "link" in this model are dialectical. A *node* is a point at the end of a link or the meeting place of two or more potential or actual links; functionally, it is a sender or receiver of communication. A *link* represents a linear connection between two nodes; functionally, it involves a method, code, medium, and format of communication. In this discussion, links will be directional: one-way (either way) or two-way. So a "network topology" can be any particular arrangement of nodes and directional links. More technically, a network topology is a particular subset of all of the patterns possible out of a given set of nodes, 2 through n, and four types of link: (1) no link; (2) one-way: A to B; (3) one-way: B to A; (4) two-way: A to B *and* B to A. Given a certain set of nodes, links can be arranged in a number of different patterns, ranging from total connectivity, in which all nodes are connected directly to all other nodes by two-way connections, to total disconnection, in which none of the nodes are connected to any other nodes. Between these two extremes are a wide range of network patterns, including: dyadic structures, in which nodes are connected in pairs (by either one-way or two-way links); radial structures, in which a small number of nodes have high connectivity (links to many other nodes); branching structures, in which nodes are hierarchically organized according to their degree of connectivity, with flow generally "up" or "down" the hierarchy; structures with strong linear tendencies (one-way or two-way loops and chains); highly interconnected structures in which many nodes have high connectivity and many links are two-way; and many other patterns and combinations of patterns.

Pursuing the abstract notion of "network" a little further, we can show that a surprisingly large number of distinctive network patterns can be constructed from a relatively small number of nodes. For example, with four nodes connected in all possible combinations by directional links, there exist 4096 different network patterns. With five nodes, there exist more than one million different possible network patterns. In general terms, the number of possible link locations, L, between n nodes can be expressed as the sum of all numbers smaller than n:

$$L = \left[(n-1) + (n-2) + (n-3) + \ldots 1 + 0\right] = n \times \left(\frac{n-1}{2}\right)$$

where n is the number of nodes and where L is the number of possible link locations. The total number of different network patterns for n nodes is 4 (the number of possible "link conditions" for any possible link location) raised to the power L:

$$T = 4^L \qquad (2)$$

where T is the total number of different network patterns for L possible link locations. Thus for the previous examples, four nodes can be connected with $4^6=4096$ different network topologies (ranging from no links at all to two-way links between all four nodes and the other three), and five nodes can likewise be connected with $4^{10}=1{,}048{,}576$ different network topologies. This combinatorial method indicates that an incredible 4.7 sextillion (4.7×10^{21}) network patterns can be constructed using only nine nodes. Figures 1a–1e illustrate five of these patterns. The networks in Figure 1 are simply topologies but can be interpreted as archetypes of some familiar media systems: (a) bulletin board, (b) chain letter, (c) radio broadcasting system, (d) telephone system, and (e) conference. The rarity of any one of these patterns is indicated by one in 4.7 sextillion.

We might reveal more by characterizing these patterns as "specialized" rather than rare. While "rarity" implies the simple frequency of occurrence of a phenomenon, specialization indicates that the phenomenon is rare for a functional reason. In this case, the function is not external to the system but rather internal, that is, it is a structure dedicated to a particular organization of interaction. In human networks, the underlying specialization of communicative function leads to purposive construction and maintenance of certain types of networks for certain types of social interaction. Each communication topology is a functionally specialized product of reflexive and purposive activities over time. Likewise, in most cases, a communication technology is strongly associated with only a few topologies at most, indicating its association with particular organizations of agency. The essentially radial outward (from one node to many) pattern corresponds to

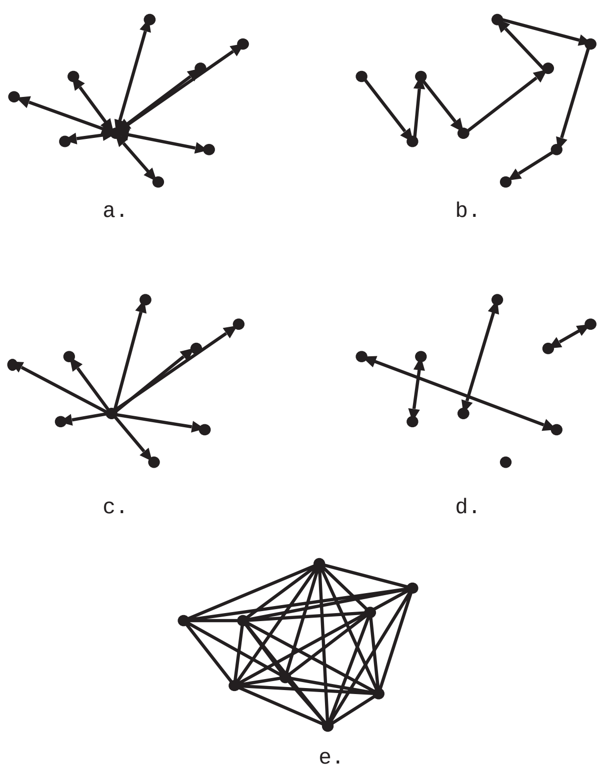

Figure 1. Five familiar topologies constructed of nine nodes and directional links: (a) two-way radial (bulletin board), (b) one-way linear (chain letter), (c) one-way radial (broadcast), (d) two-way dyadic (telephone), (e) maximally interconnected (conference).

radio communication, although, on rare occasions, a radio listener can be heard by other listeners (for example after winning a dial-in contest). Likewise, the dyadic character (nodes joined in pairs by two-way links) of the telephonic communication topology is not challenged by the technical possibility of telephone conference-calls. When we distinguish between communication topologies, whether in places or media, we are not simply identifying random differences and similarities such as exist among snowflakes, but rather similarities based on function. The ratio between a pool of similar topologies and all possible topologies measures this specialization quantitatively.

Topological diagrams are abstracted from the environments normally studied by geographers, hence physical space is not represented. These diagrams instead show social space. Since social space is variegated into such aspects as cognitive space, aesthetic space, and moral space (Bauman 1993), and is composed of agents with independent will, these diagrams, like architectural floor plans, are maps of possibilities rather than explanations of causes. Topologies do not determine specific interactions, but rather indicate a context for cohabitation, which imposes peculiar potentials and limitations on the various types of social interaction. We can now turn to the main topologies of cyberspace. Where a cyberspace topology is similar to the topology of a physical place, I will indicate the corresponding place as an "archetype."

(A) *Cybercasting* (radial/one-way topology): This arrangement supports communication from one or few to many. This is the topology of radio and television broadcasting. It is presently used for online magazine and newspaper text and for messages to users from the managers of computer networks. Architectural archetypes include the places used traditionally for ceremonial proclamations, lectures, and sermons: temples, churches, theaters, balconies, lecture halls, auditoriums.

(B) *File Search and Retrieval* (radial/two-way topology): This is user-driven information search and retrieval in which users extract text, images, or occasionally digitally recorded sounds from databases at central repositories or in other users' computers. Search engines and indexes installed at the central or peripheral nodes help locate the precise material needed by a user. Examples available online include the World Wide Web, wire-service reports, online encyclopedias, education resources, legal indices, and investment databases. Architectural archetypes of this topology are, most significantly, the library and other archives.

(C) *E-Mail* (one-to-one or one-to-few/one-way topology): This type of connection is now familiar. It resembles regular postal mail except that messages travel at a much faster rate, and sending mass mailings to all members of a group is easier and cheaper to accomplish. Network users can create their own lists or subscribe to mailing lists as a way to send and receive messages with persons in a group that is defined by similar interests. The main architectural archetype is the mailbox and the seclusion of the private room or office.

(D) *Computer Bulletin Board* (radial/two-way topology): This arrangement is called a Bulletin Board Service (BBS), or a newsgroup (on Usenet). It is topologically identical to file search and retrieval, except that the database that users search is also a repository of user's contributions. BBSs are generally related to a predetermined topic. Users interactively search the messages of others and leave their own inquiries, comments, and replies. This format is often used to advertise goods and services, and share advice and opinions. Its main benefit is that it creates a living archive of the thoughts of a group of people, which other people can access whenever it is convenient, to inscribe their own views and comment on others' inscriptions. An archetype is a bathroom stall with graffiti or, more elegantly, a rock with petroglyphs.

(E) *Computer Forum* (many-to-many, two-way): This arrangement is referred to, at times, as the "electronic auditorium," "chat room," etc. It involves real-time discussion among spatially separated participants, all of whom are logged on at the same time and view each others' contributions instantaneously. Users can "listen in" or contribute their own comments. All of those "present" see the same lines of text scrolling up their screens with contributions of themselves and others. A variation provides a "place" to gather and listen to an expert or celebrity. To reduce confusion, such contexts are sometimes divided into "rows" (audience groups), and people see only the communications in their own row plus a single speaker or speakers "on stage" for all of the rows (this arrangement is a branching modification of a radial, two-way topology). Architectural prototypes include the auditorium and central square, places that allow one to listen at intervals to a public speaker and also exchange comments with other listeners.

(F) *Multi-User Environments* (MUDs, MUSHes, MOOs, etc.): These contexts are like computer forums (many-to-many, two-way), but with textual descriptions automatically inserted by a computer program to narrate the experience of being in an invented place. Such simulations include descriptions of views ("ahead of you is a small troll seated on a flower-covered hill") and descriptions of the actions of other users ("Linda278 picks one of the flowers and offers it to you"). These are elicited from the central program by abbreviated commands such as: "pick flower, offer to PCAdams." The computer program also autonomously generates one or more characters who appear to take part in the game alongside the human participants (that is, text describes their actions as if they were other persons participating in the game), and contribute in interesting ways to the fantasy character of the situation. In multi-user dungeons (MUDs), the topology is the same, but the content reflects its derivation from role-playing games such as "Dungeons and Dragons." Users explore a dungeon or other fantasy environment, encounter monsters, wizards, elves, and other beings, seek treasure, and do battle. "MUSHes (multi-user shared hallucinations) and MOOs (MUD object oriented) are more fluid—they are virtual towns, or clubs, or cafés, or frontier lands, whose rules and personalities evolve over time" (Bennahum 1994:1). With the irony sometimes manifested in biological evolution (as with the transformation of dinosaurs into birds), electronic dungeons have evolved into electronic classrooms and cafés.

This overview of cyberspace indicates a diversity of social functions in the online world that is unparalleled in other communication media. Television, for example, carries a wide range of different types of content, but its situational repertoire is basically limited to a one-way, radial topology. Telephone conversations also vary in content, but they are nearly always based on a topology of two-way, "dyadic" communication between two nodes. The only communication medium that rivals the topological flexibility of computer networks is place itself.

The task of applying this overview and actually mapping electronic virtual places is complicated by several factors. First, a map of computer network space is ultimately irreconcilable with a traditional map of users at the locations in geographical space where they log on with computers. A gopher menu or Web browser may locate a database with presidential speeches next to a database with political commentary, while the two physical memory sites are in fact housed on university campuses at opposite ends of the country. Likewise, two computer users who live next door to each other may access "distant" parts of cyberspace in their spare time, one posting messages on a bulletin board devoted to astronomy while the other takes part in a "chat room" for basketball fans. The two spaces, cyberspace and physical space, touch at all points but are incongruent; what is near in physical space is often far in cyberspace, and vice versa. Nevertheless, the spaces bear a significant similarity.

The fragmentation of cyberspace into various topologies (A through F) mirrors the sociospatial segmentation of modern society (Tuan 1982) and the postmodern city (Davis 1990; Knox 1993). "Places" in cyberspace are not only multiple and diverse, they have developed their own social mores, customs, or "netiquette"; their own histories (complete with online weddings, births, and deaths); their own hierarchy of old and new "residents"; and diverse relationships to the surrounding geographic and virtual spaces (Mitchell 1995; Rheingold 1993; Turkle 1995).

A second similarity is that users of computer networks pass among various virtual places in complex ways, not unlike a driver or pedestrian navigating through city spaces. Let us imagine a hypothetical example. A user, HOGWILD@aol.com, logs on and e-mails a professor-friend, BSmith@unp.edu, to pose a question about acid rain.[1] BSmith responds later that day, "I don't know," but suggests that HOGWILD "drop in" on an electronic forum related to environmental issues. While searching for that forum, HOGWILD encounters a BBS with ongoing discussions on environmental issues, and a menu of FAQs (frequently asked questions) on environmental topics. In these databases, HOGWILD obtains both a short answer to the question about acid rain, and the electronic address (URL) of a rather long technical report on the subject. Rather than waste time online reading the latter document, HOGWILD tries to download it into computer memory to read at a later time. Running into problems in the attempt to download, HOGWILD goes to a "live online help" section, waits through a "line" of other users, and learns, from an interactive, real-time discussion with an expert consultant, how to download this particular type of file. A dozen others "listen in" to this advice while waiting in "line," and one or two of these persons makes a mental note of the outcome for future reference.

It is this combination of many topologies (radial, dyadic, highly interconnected, etc.) "in" a single medium that renders computer networks particularly interesting from a geographical standpoint. Diverse communication situations—each sustaining a different type of structuration, each segmented and contained, yet interconnected by easily accessible paths—make up the social environment in physical space that is normally studied by human geographers. The same description can be applied to the virtual places of the Internet.

If, as structurationists argue, place *is* process (Pred 1984b), then process can also be place; the implication of this processual similarity is that place indicates a process that might be divorced from material structure and location. While a virtual room is constructed of electricity, silicon chips, codes, and computer protocols, and a physical room is constructed of wood, plaster, vinyl, etc., the structure-agency dialectic may operate essentially the same way in either setting. To clarify this point requires a brief exposition of structuration theory.

Place, Communication, and Distanciation

While place is often defined in terms of location and boundaries, it is also definable in terms of contexts: physical and social structures that support communication. Some places, such as the church and the lecture hall, are physically designed and socially designated to support a radial topology of communication, with unidirectional links from one person to many. Other places, such as the confessional and the bedroom, are physically designed and socially designated to support two-way communication between two persons. Still other places, such as the "round table" and the town hall, support interactive communication among several or many members of a group. This aspect of place is indicated in the way place names reflect function: "round table" meetings can occur at square tables, and "the church" can mean either a built structure or a spatially dispersed institution. These linguistic habits indicate that communication topology can be detached from physical structure of place, yet remain tied to the concept of that place. If we map the structure of communication linkages in the form of a topology, we can see a pattern that may recall a familiar place, even when the links connect people in various remote locations.

Traditionally, place is an interweaving of communication and action. Such interweaving occurs in many distinctive ways, each defining different situations such as the bedroom and classroom, office, and market. Any of these may be an appropriate situation in which to "cut a deal," but the meaning of this social relation varies according to the topology in which it is embedded. For example, cutting a deal in the office eliminates external communication links, while doing so in the market leaves open the formation of adjoining links (i.e., conversations with passers-by). Topologies of communication are as essential to the existence and particularity of a place as its walls, furniture, paths, sight lines, scale, light, decoration, social institutions, and personal expectations.

Geographers have argued that place is defined by the communication acts that structure both personal activities and collective social processes (Tuan 1991; Pred 1990). Other scholars have shown that various modes of communication-in-place reinforce and reify the connection between place and social situation. Place sets the stage for spoken language as well as for the "silent language" of gestures and body position, and for various types of portable visual symbols such as clothing and privately owned vehicles (Hall 1959, 1983; Goffman 1959, 1974; Bourdieu 1984). Meaning is constructed in relation to the intersection of symbols and place, such that a particular word, phrase, symbolic act, or symbolic object may mean something different in one place than in another (Rommetveit 1981).

Individual choices and social processes therefore often appear to be consequences of the symbolic "power of place." This power in fact consists of social sanctions which, through the structuration of daily life, are tacitly transformed into sense of place. But whereas social power relations appear to be embedded in a place, the "power of place" is itself a social artifact embedded in communication processes. The social or cultural production of place can therefore be unpacked into several different levels of signification residing not in physical structures but in society and culture (Foucault 1970, 1979, 1980; Lefebvre 1991; Goffman 1959, 1974). The power that places have is therefore derivative of human actions and society. This fact is shown most clearly through structuration theory.

Structuration theory views people's lives as shaped by social structure, while people are nevertheless capable of exerting free will to shape that structure (Gould and Olsson 1982; Thrift 1983, 1985; Thrift and Forbes 1983; Pred 1982, 1984a, 1984b). As theory, structuration constructs a common ground between structuralism and humanism, between determinism and voluntarism. It can be summarized in terms of seven premises: (1) Social structures are not given, but rather are actively constituted by people through all of the activities of their lives. (2) Social structures do not simply limit what can be done or known, they also create opportunities for certain kinds of personal initiative, and facilitate the gathering of particular kinds of knowledge. (3) The connection between structure and agency is a dialectic of internalization-externalization through which people internalize rules, routines, and knowledge through socialization, and also, simultaneously, externalize rules, routines, and knowledge through their actions. (4) This internal-external dialectic is not a locked and inflexible loop. It is an open spiral in which people's reflexive monitoring of the outcomes of their actions and the actions of others leads to changes not only in actions but also in the resultant "structure," which constrains and enables further actions. (5) The internalization-externalization cycle takes material form at particular times and locations through the transformation of nature in response to people's knowledge, rules, routines, and beliefs. (6) Place is, consequently, a "historically contingent process" (Pred 1984b). Finally, (7) the impact of communication and transportation technologies on structuration has resulted in a progressive stretching out, or "distanciation" of the cycles of internalization and externalization through space, so that people are increasingly involved in the affairs of distant places, and people both sense and act, to an increasing degree, through technologies that "disembed" actions from places and reconstitute the geometry of physical space with the topologies of communication networks.[2] Premises six and seven are the most pertinent to questions regarding place in relation to communication topologies.

Place is (among other things) a setting for seeing the consequences of one's actions, a mechanism for "reflexive" (Giddens 1984) thought. Insofar as individuals and societies judge what has previously occurred as good or bad, place is a moral sphere. Distanciation (via new media or older means of spatial interconnection) can interrupt the operation of this function. One can (and often does) change one's actions in response to evidence of distress one has caused to others, but in the distanciated world, distress is often hidden by distance, and actions are easily divorced from their consequences in the minds of actors. Distanciation is of moral interest because it obscures the consequences of one's actions both near-at-hand and in distant places. For example, when I buy a piece of fruit in the distanciated market of the First World, I usually have little knowledge regarding the labor relations or the environmental impacts associated with the production of that fruit or of the location where it was grown. Yet my money subsidizes the labor relations and environmental impacts of growing that fruit. I help create the place of production. Symbolic products work in much the same way as material products: a television program, a book, or a Web page can assist in obfuscating and mythologizing distant places and people.

Furthermore, symbolic products of telecommunication are primary means of "disembedding," the removal of interactions from physical settings. Relations with the world outside the walls of the home once required movement, which involved access to various parts of the city (the printing office, the library, business offices, taverns) and hence movement through the spaces between. A wealthy citizen in a coach might turn away from the sight of a beggar, a derelict building, or a garbage dump, but these sights were inevitable components of the visual landscape, and could not entirely be ignored without cutting off economically, politically, or socially useful contacts. Place had a strong moral influence in regard to one's personal actions, as well; if one broke the rules of social conduct, the local community bore witness and would pass judgment. One consequence of modernization is that place, as a moral force, has dwindled in power. People are shielded by the anonymity of large cities and the consequences of their actions are often played out in distant places. Disembedding and distanciation reduce the moral efficacy of place, for better or worse, and leave people dependent on a trust born of ignorance (Giddens 1990). As computer networks contribute to this dynamic, potentially synthesizing something akin to place, they inject ambiguity into the moral condition of modernity. Before we can begin to explore that ambiguity, we must clarify the relationship between places and virtual places.

Places and Virtual Places

A virtual café constructed of lines of text scrolling up CRT screens on half a dozen computers spread around the country is a far cry from a real café in which people from a single town gather in small groups to converse over caffeine and biscotti. It seems a great leap of subjectivity to call the scrolling text a café. Nevertheless, the computerized communication situation may be objectively analogous to a "real" café insofar as it replicates a café topology and structuration process.

Places constitute communication networks through physical arrangements of barriers, bodies, and spaces, while computers constitute communication networks through signal flows and codes. Whereas location—defined in terms of precisely measured distances between points (relative location), or in relation to arbitrarily selected grid lines (absolute location)—is essential to the geographer's traditional view of place, it becomes merely one factor among several that define place in the late-modern or postmodern, networked world. As Richard Sclove observes, "[T]echnologies . . . represent an important kind of social structure. By 'social structure,' I mean the background features that help define and regulate social life" (Sclove 1995:89).

To be like a real café, a "virtual café" must consist of: (a) groups of two or more nodes highly interconnected among themselves to form clusters (as around tables), (b) which are loosely associated to form a larger network (the café), (c) which supports a certain amount of one-way communication ("eavesdropping") between clusters, as well as (d) the possibility of forming intercluster links (encountering friends), and (e) the

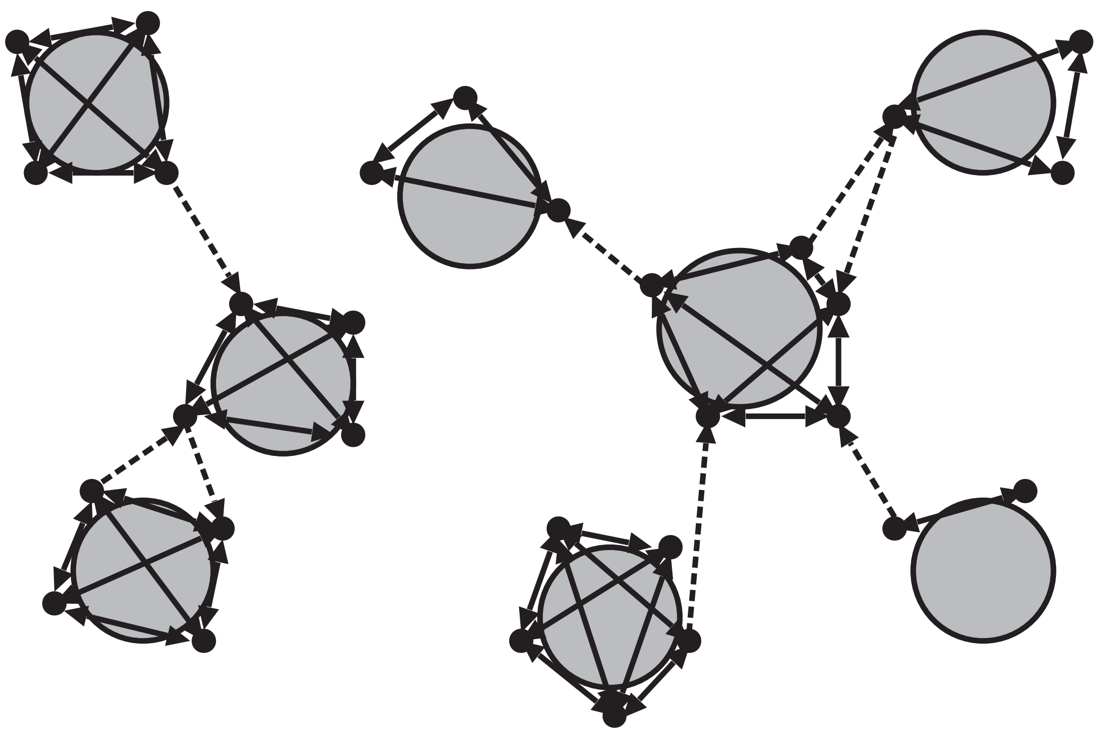

Figure 2. A café topology, consisting of clusters of highly interconnected nodes, with optional one-way (eavesdropping) links.

opportunity to switch clusters (move from one table to another) (see Figure 2). While much is lost in the "translation" from café to virtual café (such as smells of freshly roasted coffee, sounds of spoons clinking on cups and saucers, and steamy windows), in the way the term is currently used, the basis of its particular kind of structuration described here is preserved. Likewise, the concept of an "information superhighway" (interactive broadband system) implies the topology of a freeway—a long chain of primary links with subsidiary branching networks of secondary links (see Figure 3). And "virtual classroom" implies a radial pattern of two-way links with one node (the teacher) having high connectivity, and other nodes (the students) having low connectivity, mainly to the teacher (Figure 4).

One way to identify the degree of similarity between a "real" place and a corresponding computer-network "virtual place" is to describe both situations topologically, determine a set or "family" of topologies sufficiently broad that it includes both situations, then count all of the topologies in that family of topologies. We then divide this number by the total number of topologies with that number of nodes. If we recall the vast numbers of topologies associated with only nine nodes, it is clear that a classroom of forty students is mathematically capable of supporting enormous numbers of possible network topologies. We can calculate the specialization of the topological family including both the "real" and the "virtual" place in order to get a sense of the significance of a particular instance of "virtualization" through computer networks. A highly specialized family would indicate that an important social function has been retained in the social incorporation of the new technology.

Taking the nine-node "classroom" topology as an example, and supposing that the lines of communication are not always open to every student in the room (due to sleep, incomprehension, etc.) combinatorial analysis indicates that there exist 1467 radial patterns with 4, 5, 6, 7, or 8 radial links (we cannot have more than eight radial links with nine nodes) oriented between a high-connectivity (teacher) node and peripheral (student) nodes. A computer protocol that supports two-way communication between an instructor and a number of students, but does not include communication between the students, would also be of this type. Dividing this number into the total number of possible topologies with nine nodes, we find that the probability of producing such a

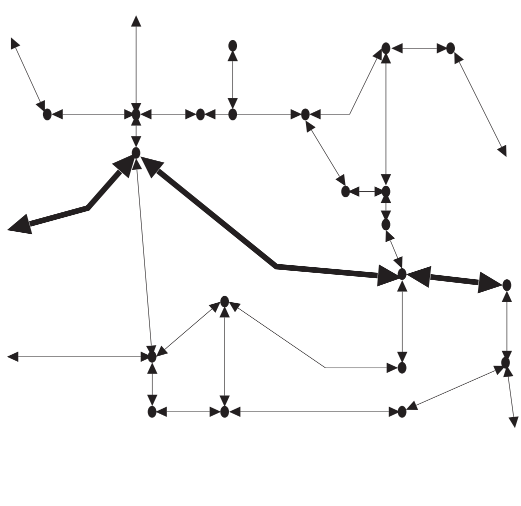

Figure 3. A freeway topology, consisting of a "backbone" of heavily used primary links attached to a fabric of subsidiary links.

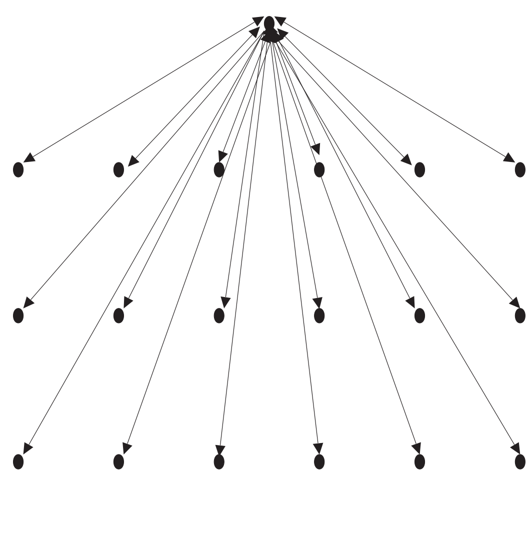

Figure 4. A classroom topology, consisting of two-way links between a single highly connected (teacher) node and many student nodes.

topology is one in 3.2 quintillion (3.2×10^{18}).[3] Even when we include variations in the number of participating students (4 through 8), this is nevertheless a highly specialized situation.

A more realistic "classroom" topology includes limited communication between students ("sharing" answers and comments about the instructor's clothes). The probability of creating a nine-node topology of *this* sort at random is approximately one in four quadrillion (4×10^{15}).[4] This is less specialized than the previous topology, but still quite specialized. This number serves much better as a basis of comparison, because it encompasses more of the entire range of situations we might call a "classroom." To call a computerized communication situation of this type a "virtual classroom" therefore represents an identification of topological similarity at a level of 1 in 4 quadrillion. In other words, if we associate *this* particular classroom of 4, 5, 6, 7, or 8 students with *that* particular "virtual classroom" of 4, 5, 6, 7, or 8 students (even if they differ from each other in number in that one has two students talking to each other and the other does not), our criterion of sameness (the pool of all 9-node classroom-topology situations with the possibility of interstudent conversations) is 1 four-quadrillionth of the size of the pool of all possible communication situations with up to 9 participants. Hence, the term "virtual classroom," defined topologically, is rather precise. In addition, the precision is higher for classrooms of a more typical size, since, as the number of nodes (students) increases, the total number of possible topologies increases faster than the number of topologies associated with a particular topological situation, and 9 students is at the low end of "real" classroom size.

To evaluate other "virtual place" claims, we similarly must select a family of patterns (e.g., the café topology) out of the total possible patterns and count the number of such patterns for a chosen number of nodes, leaving room for some likely variations within this pattern. We then divide by the total number of possible topologies with that number of nodes (Equation 2). Although this statistical method is relatively unsophisticated, it indicates that "virtual classroom" is an objectively verifiable situation.[5]

A topological similarity between a place and an electronic communication situation strongly suggests (but does not dictate) a similarity of social structure. For example, while the intrusion of computer networking into the classroom situation certainly creates novel problems and potentials for both students and instructors, it also may, by its topological nature, sustain the familiar social structuration associated with the classroom in conditions of spatial fragmentation. This arrangement allows the teacher to establish interactive communication with all students: to ask and answer questions, gather responses, offer clarifications, lecture, "hand out" assignments, and evaluate individual learning—in short, to teach.

A "virtual classroom" therefore creates the possibility of a classroom-type structuration among groups and in situations that rule out gathering in place. The question remains whether this reconstitution of place is a step forward or backward for pedagogy. It may well be the case that something intangible about bodily presence—instructors being near students in the physical container of the classroom—assists in the transmission of knowledge or the attitudes required for reflective and analytical thought. Alternatively, this technology may use distanciation and disembedding to overcome the isolation of rural school children, as in Wyoming's Big Sky Telegraph project (Rheingold 1993:244–49). In any case, a "virtual classroom," "virtual café," "virtual office," or "electronic highway" can be seen as a unique experiment in which the role of physical place in social structuration can be evaluated by removing place's defining role in structuration processes, while holding constant the basic communicational structure of the social situation.

Complicating this picture is the fact that each node (computer) is actually in a particular physical place. These locations of the computing equipment each have their own connections to structuration processes in physical space, and the network-supported structuration processes are not fully independent of the many physical places in which the nodes are located. But since the nodes can, and often do, move from location to location without affecting the topology of the "virtual place," and often cyberspace's "occupants" interact with no idea of each other's locations, we are justified in considering computer networks as "locales" of structuration in their own right. Doing so sheds light on the meaning of social processes and places. Still, it remains questionable whether network interaction and direct experience can be directly compared. Is virtual place "real" in its own way, or is it merely a clever simulation or illusion? On what is the agent act-ing in each of these realms? Is the agent in one realm the same theoretical entity as the agent in the other? Is cyberspace an appropriate "environment" in which to study social structuration, or is it merely a kind of game or puzzle for those infatuated with technology?

Cyberreality and the Senses

Writings on these questions usually follow Walter Benjamin (1986) and Jean Baudrillard (1983) in associating modern communication technologies with unreality. Benjamin argues that reproductions of artwork lack the "aura" of the original, while Baudrillard asserts that reproductions decline in reality through a "procession of simulacra," as the thing represented by a symbol or sign is lost or forgotten, and reality itself is thereby undermined. More specifically, Light (1996:128) argues that:

> The contemporary language of "virtual communities," "virtual pubs," and "virtual cafes," by describing digital spaces in terms of their physical antecedents, actively obscures the limited implications of computer-mediated communications for community that we can grasp today—outcomes that we can assess, shape, and modify.

Such arguments provide a needed antidote to the utopian images of techno-enthusiasts such as Alvin Toffler (1980), John Naisbitt (1982), and Newt Gingrich (1995), but they fail to problematize the concept of reality or address the ontological nature of virtual-place experience. In particular, we can ask if there is not something unreal about a place when it cannot be felt and its "occupants" cannot be touched, and whether that unreality interferes with the ability of computer networks (regardless of their topological characteristics) to support the constitution of social situations as "real" as those occurring in places. Every person becomes a participant in structuration to the extent that he or she is able to *sense* other agents and the environment that surrounds self and others. Accordingly, we should ask what importance, if any, we can attribute to the sensory differences between direct experience and computer network-mediated experience.

Reality is quite clearly contingent on the sensory modes through which humans apprehend their environments. Simulations are usually apprehended *as* simulations precisely because they do not present themselves to all the sensory modes in the same way as the original. For example, fake fruit looks like real fruit, but does not taste like real fruit. Simulated (virtual) place is most obviously a place without walls, furniture, and bodies that can be touched; it *looks* like a place but does not *feel* like a place. Tuan argues that a place "achieves concrete reality when our experience of it is total, that is, through all the senses as well as with the active and reflective mind" (Tuan 1977:18). Something experienced through all of the senses acquires a greater quality of realism than something sensed only through one sensory mode. As Tuan reminds us (1974:8), sight alone is not always trusted. This is indicated in Christianized cultures by the story of Christ offering himself to be touched by the doubting apostle. Here touch and sight confirm one another as measures of reality. Current trends in computer technology promise the diffusion within a few decades of interfaces that closely replicate direct experience through three or more senses (Rushkoff 1994), suggesting that the "reality as multisensory" model may apply in cyberspace. But we need not await this development to question the ontological premise that direct experience is more real than mediated experience.

We can think of many experiences in which a single sense is accepted as proof of reality. For example, when one enters a room and smells propane gas, the reality of a gas leak is accepted, and we do not flip a switch to confirm that we are in an explosive environment. Spoiled food initially discovered by smell is not subjected to further tests of reality. In fact, in everyday life, nearly all of what is apprehended in one sensory mode is taken to be real without resorting to other modes for verification. In addition, modernity accustoms people in countless ways to accept single-sensory phenomena as real. Modern landscapes are overwhelmingly visual, with signage and architecture designed for high-speed drive-by viewing rather than multisensory exploration. Not only is the visual sense dominant, but often it is reduced to the simple task of recognizing words (Venturi et al. 1986). Cities viewed through the windshield of a moving car are perceived as a stream of icons deployed on billboards and building facades. Countries attain reality in the minds of citizens through spoken and written symbols such as constitutions and history books, and through visual images such as flags and museum exhibits (Anderson 1983). Modern suburbs are essentially odorless, flavorless, and textureless compared to the residential environments of most of human history. Modern work environments, ranging from ultra-clean production rooms for silicon chips to the climate-controlled offices in which data is entered into computers and processed into reports and policies, are often sensorially impoverished in the extreme. A comparison between traditional food markets the world over and a modern supermarket reveals yet another realm in which sight has been given priority over the other senses. Likewise, even in recreational environments such as the gymnasium, swimming pool, golf course, and shopping mall, one finds far less richness of touch, smell, and taste than in the ad hoc recreational settings such as the forest, pond, pedestrian promenade, and fair of earlier eras.

As people and culture adapt to the sensorial impoverishment of modernity, they learn to accept as "real" much that is apprehended through only a single sensory mode. If the experience of physical landscapes seldom involves more than one or two sensory modes, it hardly makes sense to hold computers (or other media) to a standard of reality that is multisensory. Nor is it appropriate to dismiss the place-simulations of modern technologies on this account. Ironically, as the visual field of the computer screen is increasingly combined with high-quality speakers and CD-Rom to create a fuller sensory experience, the sensory "richness" of computer-simulated virtual places may even exceed that of many familiar settings of daily life.

Discussion

If we do, for the sake of argument or a thought experiment, take cyberspace to be a site of structuration separate from ordinary physical space and composed of "virtual places" functionally similar to certain corresponding physical places, what are the implications for the individual as consumer, citizen, and moral agent and for human communities made up of such individuals? At the root of social life in physical places lies the person. As citizen, consumer, or individual, the person is an individually and socially produced nexus of identity. In Western society, the person is also the primary site of rights that organize social life and constitute a moral order. While cyberspace does not create personal identity, its constitution of social interaction does allow identity to develop in certain ways that may provide a departure from precomputerized or extracomputerized modes of identity. Such new identities and their associated forms of political agency may be confined initially to cyberspace interactions, but as Sherry Turkle points out (1995), the novelty of computer networks as social contexts is so fundamental as to produce lasting changes in the self-concept of at least some users. These, in turn, resonate with other persons, including those who do not use computers. Donna Haraway (1985) uses the term "cyborg" (a hybrid organism that is part human and part machine) to indicate virtually any woman who works with modern technology, and the Dean of the School of Architecture and Planning at MIT believes "we are all cyborgs now" (Mitchell 1995:28). These comments convey the idea that the technology can affect the lives even of persons who do not consciously use or identify with it.

A primary characteristic of the cyberspace identity is the phenomenon of "cycling through" (Turkle 1995:177–209). This term indicates a person's ability to alternate quickly among several identities. Normal life involves distinct and separate social contexts: work and home, night clubs and classrooms, and so on. On networks, one may be flirting, setting up a business arrangement, joking with a friend, and taking advice from one's boss at virtually the same time. These social situations may occupy several windows on a screen, or one may "cycle" from one to the other in rapid succession. The closest analogy is speaking on the telephone to a business associate while lying in bed with a lover. While this situation would normally be experienced with some sense of cognitive dissonance—an uncomfortable feeling of confusion about one's identity—computer-assisted juxtaposition of social contexts through extensibility eventually becomes a pleasurable, even addictive, state of being (Turkle 1995). Place's traditional constitution of self is structured by time and space such that a person appears to be (and hence "is") one person at a time (an employee, then a parent, then a friend, and so on); cyberspace allows one to socially perform as several different persons at the same time. This shift from a sequential to a simultaneous mode of managing facets of identity implies that for all of the similarities between places and virtual places, the structuration process differs in regard to how it constitutes the self.

Another important characteristic of cyberspace that again indicates a different kind of structuration process is the mutability of online identity. In cyberspace, a woman can pretend to be a man, a fourteen-year-old boy, or, for that matter, an elf or an animal. The person's "appearance" in the form of text removes contradictory visual cues and simultaneously avoids the filtering mechanisms of published writing. People internally negotiate online and off-line identities as they "commute" between geographical space and cyberspace. While the masquerade ball is nearly forgotten in late modernity (surviving in the U.S. primarily as a yearly holiday, Halloween), it is revived on the computer, with the modification that the costumes in cyberspace are constructed of words, and therefore are created during, rather than before, the moment of interaction. In comparison to geographical space, there are relatively few barriers to access based on age, physical condition, gender, location, or physical appearance alone. Thus, the creation of virtual places suggests not only new potentials for coercive power (Gillespie and Robins 1989; Graham and Marvin 1996), but new opportunities for resistance as well. These observations are not intended in a utopian spirit. There are many "barriers" around cyberspace that prevent people from "commuting" in this way. Since the main requirement for participation in a network community is the ability to read and type, a primary barrier to network participation is illiteracy. Another barrier, for obvious reasons, is impairment of vision. A third, and most important, barrier is poverty, both individual and societal, which strongly affects the location of cyberspace's access nodes. Nevertheless, the cycling through and masquerade of cyberspace are politically charged with the power of inversion and juxtaposition, which, like the carnival, festival, or fair, upsets traditional social relations (Bakhtin 1984; Scott 1990; Stallybrass and White 1986; Manning 1983). Unlike previous forms of carnival, a form of "containment" is provided for this chaotic situation not by time (as in an annual festival), but by technologically assisted disembedding.

Cyberspace, particularly certain "places" such as MUDs and "adult" chat rooms, is a counterreality, an upside-down world, characterized by the inversion of identities, satire, excess, and humor. These elements of the carnivalesque threaten to spill over into everyday life, if not through collective action, then at least through consciousness. People "in" these virtual places externalize actions and ideas normally hidden, and they internalize new insights about the responses of others to these actions and ideas that would not otherwise be available, broadening their conceptions of self. New conceptions of self are evident in physical places as well as virtual places. Perhaps the best way to think of the connection between the two realms is in terms of commuting: people move between places and virtual places on a regular basis, and what is internalized in one kind of place may be externalized in the other. These differences in conception and expression of self may lead to radically new concepts of what is appropriate or "moral" behavior.

Implications

> It may be that understanding community depends above all on rejoining two concepts that have become strangely dissociated in our thinking—community and communication (Tinder 1980:18).

While the majority of societal discourses about computer networking are enthusiastic, a number of critiques of the new technologies have been launched from those on the left—both geographers and not—who generally maintain that computer networks are tools of capital that exacerbate economic disparities, strengthen powerful groups, desexualize the body and replace it with a disembodied gaze, promote violence, annihilate privacy, and continue the march of commercialization. Graham and Marvin, for example, argue that while computer network technologies are "likely to have diverse effects between different places, groups and organisations," in general, they "tend to offer freedom only to already powerful social groups," and "facilitate increasing control over space for powerful groups while creating new physical and electronic ghettos for marginal, low-income and disenfranchised households" (Graham and Marvin 1996:183, 193, 336). Ken Hillis associates computer networks with the luxurious self-deception of affluent, white culture: "Most of the world still struggles to attain the space to practise a subjectivity [that] a certain Western male bourgeoisie would discard as an outmoded Enlightenment commodity, content instead to face itself online, and tell itself collectively that it subsumes the larger totality, that its cartoon-like representation of the human and [the] spatialization of social relations are aesthetically complete" (1996:94). Gillespie and Robins argue that since uneven development is either necessary or inevitable within global capitalism, "new technologies are implicated in, rather than offer[ing] solutions to, uneven geographical development" (1989:15).

The issues raised in such critiques require both an empirical and a theoretical response. The empirical response would examine how groups at the "margins" of society, such as environmental organizations, peasant uprisings, and gay and lesbian associations make use of computer networks to carve out spaces of resistance. For these groups, computer networks may help overcome boundaries imposed by distance and location, enabling the formation of distanciated communities of interest. A politically marginal group that is also geographically marginalized in a border zone, or in an area far from the centers of power, may find that computer networks provide an easy means of disseminating news about their own suffering and the perpetration of injustices, as well as a means of locally mobilizing resistance and maintaining solidarity. Shannon O'Lear's (1997) study of e-mail in Russia and Estonia indicates that computer networking has facilitated grassroots organization in the Peipsi-Chudskoye Lake region and helped the inhabitants to resist capital exploitation and reduce water pollution. Oliver Froehling (1997) similarly finds that Zapatista rebels in the Mexican state of Chiapas were able to benefit from the Internet, despite their lack of direct access to computers, and did so in a way that used an international trade agreement as a public-relations weapon, putting globalization to work for the local goal of social justice. Barney Warf and John Grimes (1997) argue that computer networks support counterhegemonic (as well as hegemonic) communications, describing use of the Internet by environmental organizations, animal-rights activists, labor activists, women's organizations, gay and lesbian organizations, and others. Much more work needs to be done on such empirical issues, but this research suggests that neither technological determinism nor structural (Marxian) determinism can explain the complex interplay of structure and agency in the social space of computer networks.

The theoretical response is somewhat more complicated and requires that we supplement the earlier discussion of topologies with a moral theory related to social space. Adopting a framework of structuration that recognizes two different spaces, each with its own topologies of interaction and selves that migrate between virtual places and physical places, we obtain a new perspective on the processes of distanciation, globalization, and disembedding. But to understand what is most promising about cyberspace, we need to further expand our idea of social space.

Zygmunt Bauman (1993) argues that not one but three types of social space exist. Each type of social space transposes qualities of physical space such as near and far or closed and open, onto our experience of self and others. These three types are cognitive, aesthetic, and moral space, each of which is composed of affective "spacings," which differ "in their pragmatics and their outcomes." Cognitive space is constructed intellectually, and delineates our knowledge of others. Aesthetic space is the terrain of our interest in others, "guided by curiosity and the search for experiential intensity" (Bauman 1993:146). Moral space is the uneven distribution of felt responsibility or commitment to others.

The "stranger" provides the benchmark of each type of social space: a stranger in cognitive space is one about whom I know little and would prefer to know even less; a stranger in moral space is one about whom I care little and am prompted to care even less (Bauman 1993:167). In aesthetic space, attraction is traditionally an inverse function of distance, and therefore a stranger is one who is repulsive or of no interest. Relations between the types of social space are changing through time. For example, in Western culture, traditional canons of beauty interpreted difference in social station or ethnicity (from a white elite viewpoint) as aesthetic inferiority, and interest in "the other" as perversity (see e.g., Stallybrass and White 1986). An element of both modernity and postmodernity is a growing fascination with difference, whether naïve, as in the "noble savage," or nuanced, as in the postmodern celebration of diversity. This transformation of aesthetic spacings brings cognitive and aesthetic space into conflict: the other, a person of whom we know little, becomes alluring and fascinating, an ideal toward whom we reach out.

As Bauman amply illustrates, the layering of the three social spaces is inevitably marked by disjunctures. We may feel aesthetically interested in the suffering of certain persons while not moved to intervene if they are in distress. We may feel morally obligated to assist a person although our aesthetic delight in him or her has subsided. We may take great risks to assist persons of whom we know nothing, while we may neglect to assist persons we know quite well. Despite this lack of correspondence, cognitive, aesthetic and moral spaces do range in a roughly parallel fashion from one affective pole to the other, from those persons one knows little about, cares little about, and does not find pleasant to behold, to loved ones about whom one knows much, cares deeply, and generally takes delight in seeing, hearing, and holding. From a geographical perspective, Bauman's scheme of social space illuminates many of the relations between place's facets of social relations and meaning (see Sack 1997).

Epitomizing the tensions and disjunctures between moral space and the other spaces is the "ultimate aesthetic space" of modern mass media, where intimate and grisly details of the lives of strangers can be observed and even orchestrated, but they are "doomed to remain, happily, infinitely remote as subjects of action" behind a "glass screen to which their lives are confined" (Bauman 1993:178). This space, which Bauman calls the "telecity," is fraught with moral problems, particularly the fragmentation of families and society into "a closeness of monads, enclosed in the invisible, yet impregnable bubbles of their respective virtual realities," and a reduction of others to objects of amusement and pleasure (Bauman 1993:178–79). The problem is that telecommunication separates aesthetic and cognitive space from moral space. This amounts to an aestheticization of public space, which reduces persons to spectators and unwitting performers.

The motivation behind raising this concern is indicated by Stuart Corbridge. Corbridge (1993) argues, in effect, that we have a moral obligation to bring the geography of our moral space into correspondence with the geography of our cognitive space. He believes that we should extend our feeling of involvement not according to a distance-decay model of morality, but to wherever we know there is suffering. Insofar as the dynamics of globalization have intertwined our lives with those of distant strangers, we have a responsibility to assist them in times of distress. Presumably, the mode of communication by which we obtain knowledge of their suffering, in particular whether it is direct or mediated, is irrelevant to our own degree of moral obligation. Both Bauman and Corbridge would agree that enlargement of one's aesthetic space, without the concomitant extension of one's moral space, poses an ethical problem.

Yet every day we hear of famine, wars, poverty, and crime, and seldom respond by extending our assistance. We note the suffering of distant others but remain unmoved to assist them, whereas we might assist them if they were in our neighborhood. Television, radio, newspapers, and magazines bring the spectacle of suffering close in aesthetic and cognitive space but not in moral space. As our cognitive space is technologically expanded, we can potentially learn of more and more suffering. The idea of matching this cognitive/aesthetic expansion with an expansion of our moral space is overwhelming. We respond by shutting down our faculties of sympathy, viewing the suffering of distant others as a spectacle, with emotional involvement but without action, as if studying historical tragedies rather than current events. Alternatively, we respond by breaking the communication link; we turn off the TV or radio, put down the newspaper or magazine. We are faced with a choice: either willingly restrict the scope of our knowledge, or else systematically, and perhaps uncomfortably, place some persons who are cognitively familiar outside the scope of our moral commitment.

Part of the problem, though certainly not all of it, depends on the topology of the medium we use to access the world "out there." A radial, one-way topology, such as that of television or radio, is probably the most overwhelming. The information it provides is not filtered according to interest, and is not composed of two-way links that would support interaction. The audience can respond to a sense of overload only by breaking the link or shutting off its own moral sensibilities. Newspapers and magazines are somewhat more interactive: permitting the selective extension of one's cognitive space and hence supporting a more prolonged sense of commitment, but they too are essentially one-way media. Computer networking, whether in the form of the World Wide Web, electronic bulletin boards, e-mail listservers, or chat rooms, provides an even more selective setting for the extension of cognitive space. While their scope may be global, the virtual places on the Internet offer at least as much agency and involvement as the corresponding physical places. Furthermore, whereas it is possible to narrow the network-assisted view of the world to situations that do not threaten to incur a moral obligation, for example by simply corresponding by e-mail with successful friends and retrieving Web pages related to sports, undertaking what Brook and Boal (1995:ix) refer to as "another 'white flight'," it is equally possible to become committed through cyberspace to the concerns or members of a distanciated community, as indicated by the research of Froehling, O'Lear, Warf and Grimes, and others.

This suggests a new model of globalization, not the cancerous growth of a single social body directed by a monolithic government, a centralizing flow of capital, or centrally produced media "programming" (a word with ominous undertones), but rather a collection of comfortable "places" where one can simultaneously feel "at home" and work progressively along multiple routes of connection between diverse locations.

This cautiously optimistic model is tenable not because computers (or any technology) act on society in a certain way, but because they can provide new contexts in which people take action: virtual places of many sorts. My study can only indicate the possibility of mapping these places in a systematic way, but it suggests the implications of the *possibility* of such mapping: if some aspects of computer networking, like other modern technologies, threaten to immerse us in anonymity, powerlessness, and an immoral, aestheticized space, disembedding us from the place-based communities that once gave us a moral grounding, other aspects of computer networking evoke the possibility of something different: a social world that is global in scope and local in character.

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Notes

1. Flamboyant and colorful names are common in cyberspace, HOGWILD was chosen to indicate this fact. Another type of name common in cyberspace is the amalgam of first and last names, particularly for those in institutional settings. BSmith and HOGWILD were chosen at random and are not intended to indicate any real person.
2. I identify distanciation not simply in the realm of economic or institutional processes, as Giddens does, but also in familial relations, friendship, romantic attractions, neighboring, hobbies, and community formation.
3. Combinatorial theory simplifies this counting task. We first count all patterns in which one node is connected to four nodes, five nodes, six nodes, seven nodes, and eight nodes with outward-directed links. We can assume that however many patterns there are with *a particular* node at the center, the total number of patterns is nine times that number, since there are nine nodes that can be at the center, so we simply designate a node as the "teacher." If we count the possibilities with this node at the center, we then multiply by nine to obtain an accurate count of all possibilities. Beginning with four-link patterns, then adding the number of five-link, six-link, seven-link, and eight-link patterns (the last being only a single pattern, since there is one for each node), we have:

$$\binom{8}{4}+\binom{8}{5}+\binom{8}{6}+\binom{8}{7}+\binom{8}{8}$$

$$=\frac{8!}{4!\times 4!}+\frac{8!}{5!\times 3!}+\frac{8!}{6!\times 2!}+\frac{8!}{7!\times 1!}+\frac{8!}{8!\times 0!}$$

$$=\frac{1680}{24}+\frac{336}{6}+\frac{56}{2}+\frac{8}{1}+1$$

which gives us 163 possible outward-directed radial patterns with one node at the center. Multiplying by nine (since originally one node was chosen from nine and designated the "teacher" node), we have $163 \times 9 = 1467$ possible outward-directed radial patterns with any of nine nodes at the center. Finally, we divide this figure into 4,700,000,000,000,000,000,000 (4.7×10^{21}) (the total number of possible topologies with nine nodes) to find a probability of one in 3.2×10^{18} that such a pattern would be randomly generated, which is, alternatively, a measure of the specialization of the classroom topology.
4. For this calculation, I multiplied the 1467 possible radial topologies (calculated above) by the number of possible locations for one or two additional links. Thus, we have:

$$1467+\left[\binom{8}{2}+1467\right]+\left\{\binom{8}{2}\times\left[\binom{8}{2}-1\right]\times 1467\right\}$$

$1467 + 41{,}076 + 1{,}109{,}052 = 1{,}151{,}595$ possible topologies with 4, 5, 6, 7, and 8 radial links and 1 or 2 peripheral links between "student" nodes. Dividing this sum into 4.7×10^{21} (the total possible network topologies with nine nodes), we obtain a probability of 1 in 4×10^{15}.
5. For a detailed description of virtual classroom situations, see Bennahum 1994; Mitchell 1995:65–70; Rheingold 1993:245–51.

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