51. [Introduction] Surveillance and Capture

Two Models of Privacy

The police get search warrants to allow them to gather information about the people they suspect of wrongdoing—at least, on TV shows like *Law and Order.* If the judge doesn't think they have enough reason to suspect the person, the request for a warrant is denied. In a dystopia, however—the canonical example is that of *1984*—there is total surveillance. Information is gathered about everyone, and the analysis of this information is used to decide who to suspect. Visions of total surveillance have often been dismissed as pure fantasy. Enzensberger's essay (◊18) presents the standard objection: "The monitoring of all telephone conversations, for instance, postulates an apparatus which would need to be *n* times more extensive and more complicated than that of the present telephone system. A censor's office, which carried out its work extensively, would of necessity become the largest branch of industry in its society."

18

Michel Foucault's influential concept of *panopticism* presents a scenario in which this is not the case. Panopticism gets its name from a thought experiment about prison design from a time before electronic surveillance. In the *panopticon,* conceived by Jeremy Bentham, the prison's guards sit in a central tower, ringed by a building containing cells. The cells are constructed so that light shines through them, toward the tower. This "backlights" the inmates in their individual cells, making each prisoner's every move visible to a guard in the tower. The tower is constructed so that prisoners can never tell if they are being watched. As Foucault writes, "the major effect of the Panopticon" is "to induce in the inmate a state of conscious and permanent visibility that assures the automatic functioning of power. So to arrange things that the surveillance is permanent in its effects, even if it is discontinuous in its action; that the perfection of power should tend to render its actual exercise unnecessary; that this architectural apparatus should be a machine for creating and sustaining a power relation independent of the person who exercises it; in short, that the inmates should be caught up in a power situation of which they are themselves the bearers" (201). The inmates know that they may be monitored at any time, so they will act at all times as though they are being monitored, becoming their own surveillance.

This *surveillance model* of privacy, especially in the terminology of Foucault's panopticon, has been the dominant model for most discourse about privacy in the new media field. This model fails to highlight certain aspects of the technical elements of new media—glossing over ways in which the institutional practices of computer system design may be antithetical to privacy, as well as ways that the tools of computer science may be able to provide effective privacy-enhancing technologies.

> The Web's opportunities for creative self-surveillance have not been overlooked by the owners of autopanoptic Web cams, many of whom have been happy to broadcast video of their working and Web-surfing selves to the world.

In the essay reprinted here, Phil Agre grapples with the questions of institutional practice, presenting a different metaphor for privacy, the *capture model,* drawn from an awareness of the current methods of computer systems design. Following the standard computer science practices in order to design or deploy a new media system that captures (collects through effort) information about its use, privacy considerations inevitably arise. Agre also demonstrates that looking through the lens of capture can show us ways in which our activities are themselves restructured. Just as the inmate of the panopticon changes her behavior, internalizing her surveillance, so the "informated organization" internalizes capture—reordering behavior so that it is more amenable to capture models (which were likely developed under the fiction that they transparently represented the prior state of behavior).

The capture of private information is accelerating as computing becomes ever more integrated with our life processes and spaces, whether in the guise of Web forms, swipe cards, or the implanting of computers and tracking devices under the rubric of "ubiquitous computing." For this integration to be effective, the computer must "know" about the situation into which it is integrated. That is, the computer system must be designed to contain a model of the activities taking place. The standard computer systems design methodology is to analyze these processes in ever more fine-grained levels of detail. In the capture model, the more detailed the information, the more computational processes can analyze and augment the activity, and therefore the more potentially fruitful the results of introducing computing into the situation. The information provided through capture in systems development may have quite positive results, and—as is not the case with the surveillance model—is seldom considered as harmful to the party whose information is captured.

Agre's description of the capture model greatly contributes to understanding privacy issues, but as he emphasizes in this selection, the capture model does not render surveillance an outmoded idea. Different scenarios with implications for privacy are now playing out—some best understood through the surveillance model and some best understood as capture—in the use and development of new media.

In a further difference from the surveillance model, which imagines the results of all information collection destined for the central repository of a "Big Brother," the capture model understands information to go in many directions, and for many purposes. A delivery service may capture information about drivers, handlers, senders, receivers, the packages that pass through their hands, and the vehicles in which they are transported. A bank may capture information about tellers, borrowers, depositors, loan officers, and the money that (virtually) passes through their hands. An individual may use a handheld computer and personal information management (PIM) software to organize and categorize interactions with work, family, and friends. The capture model helps to explain, more clearly than a surveillance concept might, how the gathering of such information has benefits as well as privacy implications and work-restructuring implications, even if the individual in question is not continually under observation. A delivery driver may also use PIM software to schedule a deposit of money at the bank, and the three "captured" events (vehicle movement, PIM task completion, bank account activity) will not immediately be correlated, because the three pieces of information do not initially exist in the same context. Increasing correlation of this sort is, however, an acknowledged corporate goal.

Controversies over Web site cookies are one topic that has highlighted how the new media environment is filled with corporate attempts to build profiles of customers and other visitors from captured data—which are then used to target-market, and are sold and traded. Such tracking has generally been discussed in terms of "surveillance-style" monitoring of shopping activity. Web users aren't particularly happy about this, considered either way. Unlike many capture subjects discussed by Agre, neither users nor their employers see these actions, whether viewed as capture or surveillance, to be particularly beneficial. For example, the company DoubleClick received strong protest in response to its public plans to merge a large consumer database it had purchased with the information it has collected by serving advertisements (and cookies) on many Web sites. Such practices, however, are quietly continuing. The issue is hard to understand in terms of the "Big Brother" surveillance of *1984* or the self-surveillance encouraged by the panoptic model. It can be seen, instead, as the organization of personal information as a commodity. As Roger Clarke and others have explicated, such organization is objectionable not simply because we don't like calls from telemarketers, or because we like to keep some things about ourselves to ourselves. It is also objectionable because of the way we exist as social beings—managing our personae in the public world by deciding what to disclose, and to whom. Cookies don't simply threaten the security of our credit card data, they also compromise our ability to manage how we present and define ourselves.

Organizations such as the NSA acquire vast amounts of information about our society. The Echelon system, as the ACLU's *Echelon Watch* reports, monitors "as many as 3 billion communications everyday, including phone calls, e-mail messages, Internet downloads, satellite transmissions" in the United States, the United Kingdom, Canada, Australia and New Zealand. After such data is collected it is scanned for unusual flows, pre-defined keywords, or emergent patterns. The information found is used not only against targets chosen in advance (which reportedly include suspected terrorists and international charities, as well as foreign companies who are bidding for business against domestic ones), but also to *identify new suspects.* When "panopticism" is used to refer to this phenomenon, it is no longer referring to the knowledge of possible surveillance that leads to self-surveillance. It is *also* referring to attempts to actually create the total surveillance state of *1984.* While Enzensberger argued that such a total collapse of privacy was impossible, he made this argument from the perspective of human surveillance, writing before it was practical to employ computer analysis for processing massive amounts of intercepted communications.

A 1997 collection edited by Agre and Marc Rotenberg takes up the question of where privacy is headed in the online era. Privacy-enhancing technologies are one important area of development. For example, the widespread use of strong cryptography is one way of enhancing privacy—not because it would be strong enough to prevent the NSA or its counterparts from accessing the contents of a message in which they were particularly interested, but because their access would require the use of a certain amount of computer power, enough to make the continual monitoring of all intercepted messages, suspect or not, impractical.

Cryptography has been a primary example of how computers are not, as they have sometimes been characterized in the humanities, a force somehow by their design aligned with surveillance and authoritarianism. In the 1990s, as pro-cryptography sentiment grew, many governments actively opposed the use of strong cryptography by their citizens, at the least demanding "key escrow" or other measures to aid state surveillance. But as electronic commerce became increasingly important to visions of future economic growth, and as it became clear that only strong encryption would lead to consumers feeling comfortable about sending credit card data over the Internet, these government objections diminished.

The availability of cryptography is only an initial, tentative step. Encrypted email is now rare enough to draw attention, and infrequent enough for the government to open and search in its entirety, if it cares to. Only once the use of cryptography for new media communications has become as standard as the use of envelopes for paper communications will the easy ability of the government to violate privacy—whether considered as surveillance or capture—cease to hang over every electronic movement and data exchange. What will remain will be continual capture of private data by mega-corporations, tracking employees, customers, and passersby though every glimpse, transaction, and workplace activity. Already, corporations may monitor all casual conversation by users that passes through their software, and even do so under the shroud of legality. As of this writing, the Microsoft Instant Messenger license agreement specifies that all communications in that system are the property of Microsoft; the company may choose to do anything they like with them, including publishing them with attribution. In space, perhaps, no one can hear you scream. But in cyberspace, someone—perhaps the richest man on the planet—can indeed hear you, whether you scream, cry, or whisper, even in a "private" conversation.

—NWF

Further Reading

Agre, Philip E., and Marc Rotenberg, eds. *Technology and Privacy: The New Landscape*. Cambridge: MIT Press, 1997.

Agre, Philip E. *Computation and Human Experience*. Cambridge University Press, 1997.

Cornford, James. "The Virtual University Is . . . the University Made Concrete?," *Information, Communication, and Society,* 3(4): 508–525, 2001.

Clarke, Roger. "The Digital Persona and Its Application to Data Surveillance." *Information Society* 10(2): 77–92. April–June 1994.

Foucault, Michel. "Panopticism," from *Discipline and Punish: The Birth of the Prison,* trans. by Alan Sheridan. New York: Pantheon, 1977. From the French *Surveiller et Punir: Naissance de la Prison,* 1975.

Zuboff, Soshana. "Panoptic Power and the Social Text," chapter 10 of *In the Age of the Smart Machine: The Future of Work and Power,* 362–386, New York: Basic Books, 1988.

Original Publication
Information Society 10(2): 101–127. April–June 1994.

Surveillance and Capture

Two Models of Privacy

Philip E. Agre

1 Introduction

Ideas about privacy are, among other things, cultural phenomena. They are shaped through historical experience, they condition perceptions of newly arising phenomena, and they are reproduced or transformed in all of the same complicated ways as other elements of culture. Cultural ideas about privacy are particularly significant right now, given the rapid emergence of new technologies and new policy issues around privacy. In this paper I propose to contrast two cultural models of privacy:

> The "surveillance model," currently dominant in the public discourse of at least the English-speaking world, is built upon visual metaphors and derives from historical experiences of secret police surveillance.
>
> A less familiar alternative, the "capture model," has manifested itself principally in the practices of information technologists; it is built upon linguistic metaphors and takes as its prototype the deliberate reorganization of industrial work activities to allow computers to track them in real time.

These two models are not mutually exclusive. By emphasizing the contrasts between them, I hope to make evident their contingent nature. Privacy issues take different forms in different institutional settings and historical periods, and no single model suffices to fully characterize all of the forms that privacy issues can take.

> Section 2 motivates this study by discussing a set of emerging technologies for tracking people and materials. Consideration of these technologies within existing concepts of privacy reveals certain previously unfocalized elements, most particularly the reorganization of activity to accommodate the tracking process.
>
> Section 3 takes up this observation more formally by introducing and defining the surveillance model and the capture model of privacy issues.
>
> Section 4 discusses the capture model in more depth, relating it to deeply ingrained aspects of applied computing as a professional practice. It introduces the concept of a "grammar of action" and provides several examples. It then describes an idealized five-stage cycle for the development of capture systems and reflects on certain computer-supported cooperative work systems in this light.
>
> Section 5 describes some trade-offs inherent in the concept of capture, and consequently in the very design of computer systems as they are currently understood.
>
> Section 6 introduces the general question of capture as a social phenomenon, insisting that capture be studied against the background of the larger institutional dynamics in which it is embedded.
>
> Section 7 offers a provisional analysis of the political economy of capture, starting with a discussion of the role of information technology in reducing economic transaction costs.
>
> Section 8 concludes by returning to the comparison between the surveillance and capture models and assessing some of the possible futures to which they point.

2 Tracking

This reexamination of privacy was originally motivated by the emergence of new technologies for the tracking of people, automobiles, packages, materials, and so forth. In the "active badge" project at Olivetti (Want *et al.* 1992) and Xerox (Weiser 1993), for example, employees wear on their clothing a black plastic rectangle called a "badge" that uses infrared light to indicate its location to devices mounted on walls and ceilings, which in turn are connected to a database. Several experiments have explored various uses of the badges, for example to determine a colleague's location in the building or to automatically direct a given individual's calls to the physically closest telephone. This research has been viewed as a step toward "ubiquitous computing," in which computational machinery is distributed throughout the physical environment (e.g., Gold 1993). For example, several groups (Elrod *et al.* 1993, Mill *et al.* 1992) are creating "smart buildings" in which climate controls are integrated with networked digital systems.

Active badges may be the best-known tracking technology, but they are hardly unique. Other tracking schemes involve radio-frequency beacons installed on materials in manufacturing and distribution (Fales 1992, Sabetti 1993). And the trade press has reported on numerous implementations of tracking systems:

• UPS uses bar-codes and a customized electronic clipboard to track the movements of packages; when a package is delivered, the clipboard digitally records the recipient's signature and sends information about the package's status to a central computer through a nationwide cellular telephone network (Duffy 1993, Eckerson 1991).

• The Canadian Ministry of Transportation uses a wireless packet radio network and a national database to keep track of commercial vehicles in Toronto. Police and inspectors use information provided by the system to check drivers' speed and watch for unlicensed vehicles, and they can call up a complete history of any vehicle in a few seconds (Loudermilk 1993).

• A trucking firm called Americana Inc. uses wireless communications and the US military's Global Positioning System (GPS) to allow dispatchers to automatically track its trucks. Each truck carries an Apple Macintosh that periodically takes a reading from a GPS device and sends it to headquarters by electronic mail (Lawton 1992).

• Computer networks are increasingly making possible automatic real-time data collection and analysis for large-scale accounting and control systems, and this development is revolutionizing (if belatedly) the field of management accounting (Johnson and Kaplan 1987: 5–6 ff.).

• A system called VoiceFrame is used to monitor people who have been convicted of crimes. Each offender wears a bracelet that notifies the authorities if it passes outside a certain boundary (Leibowitz 1992).

• In a wide range of "virtual reality" and "telepresence" systems, some mechanism continually informs a computer about the locations of certain parts of a person's body. The locations might be computed and transmitted by devices that are physically attached to the relevant body parts, or they might be computed by a stationary device that observes the body's motion, perhaps through a video camera (Meyer, Applewhite, and Biocca 1992).

• One division of NCR has integrated its just-in-time manufacturing systems with a plant-wide system of bar-code readers. The status of each job is available from computer terminals throughout the organization (Anonymous 1990).

• Fast food chains are rapidly integrating their operations through point-of-sale (POS) terminals and bookkeeping systems for tracking individual stores' activities by interconnecting their local computers with mainframes at headquarters, which performs intensive analysis of the resulting data (McPartlin 1992, Simpson 1989). Items captured and stored in the database include "product mix, sales statistics, labor information, food costs," "bank deposits, cash register information, sales totals, average order amounts at different points in the day," and customer traffic (Baum 1992). Most such systems have replaced branch managers' functions with centralized control (Walton 1989: 42 ff.), a pattern found throughout mass retailing (Smith 1988).

• Numerous projects are currently building systems for "design rationale capture" (DRC) (Carroll and Moran 1991). The idea is that design changes in large engineering projects are often made difficult by inadequate institutional memory about the reasoning behind previous design decisions. A DRC system fills this gap by allowing designers to maintain a running account of their reasoning during the design process, using a taxonomy of types of reasoning and a complex system of datastructures for representing them all. This material is then stored for later reference. For Carroll (1992), design rationale capture is the culmination of an underlying logic of computer design activities. Design practice, he argues, can be viewed as reifying a particular work practice, and design rationale capture similarly involves the reification of the design process itself, with all of its elements of hermeneutic inquiry.

• Several vendors have built software systems for tracking job applicants through the whole application and interview process. The systems can keep track of each individual's paperwork, generate routine letters, and maintain a database of applicants that can be searched in a wide variety of ways, including generating documents for affirmative action reporting and the like. Employees participating in the hiring process update the database upon each step of the process (Romei 1991).

• In Thailand, the Ministry of the Interior is developing a centralized database to maintain information on each of the country's citizens. Each individual will have a unique identification number recorded on a card with a magnetic strip (Hoffman 1990).

The cases vary among themselves in several ways. Although each system keeps track of significant changes in a tracked entity's state, the nature of these changes varies. In some cases the changes are simply changes in physical location, reckoned against some kind of stationary coordinate grid; the system may well place some kind of interpretation on these locations, perhaps relative to a street map. In other cases the changes are defined in institutional terms, for example whether a package has been formally received or whether someone has been formally offered or turned down for a job. In the former case, the term "tracking" takes on a more literal sense of tracking through space. In the latter case, the term "tracking" is a metaphor; the entity in question traces a trajectory through a more abstract space which might have numerous "dimensions."

One might further distinguish between systems that track human beings and systems that track physical objects. Such a distinction would be misleading, though. Systems are indeed found at each extreme—for example radio transmitters attached to shipping crates or fastened to prisoners' limbs. But many of the systems track both people and objects, and others track objects as stand-ins for people. A system that tracks people by means of identification cards, for example, is really tracking the cards; any connection between the card and person will have to be made in some other way, such as an official or supervisor checking each individual's appearance against a photograph upon each significant event. Similarly, a system that tracks trucks can generally depend on a stable correspondence, at least over short periods, between trucks and their drivers.

Systems that track physical objects, for their part, vary considerably in the means by which they detect significant state changes. Some depend on complex schemes for reckoning absolute or relative location; these systems may only require an approximate location, and thus may only receive a periodic update from a location measuring device. Other systems depend on a distributed system of passive sensors. Yet others might involve sensors that actively seek out the entities being tracked. But a large number of systems involve human intervention: a human being executes some physical action that closes a causal chain between the tracked entity and the centralized system, thereby signifying that such-and-such a state-change has taken place.

In general, the various tracking systems vary widely in the way they divide their computational labor between the moving entity, some stationary computer system, and various human or mechanical intermediaries. A GPS device, for example, performs all of the necessary computation at the location of the object being tracked. At another extreme, a tracking system might employ an algorithm to locate the tracked entity within each successive video image it receives from a stationary camera. And in the middle ground between these extremes lie numerous schemes for splitting the burden of tracking, for example by placing bar codes or LED's on the entity being tracked, or by restricting the entity's movements so that it necessarily comes into contact with relatively simple sensors (Udoka 1991). (For a general treatment of this trade-off in the design of robots, see Donald (forthcoming).)

Despite all of these variations, the various tracking systems have a great deal in common. In each case, some entity changes state, a computer internally represents those states, and certain technical and social means are provided for (intendedly at least) maintaining the correspondence between the representation and the reality. The computer may maintain a centralized database (this is the usual case) or it may be more widely distributed. Each entity has a definite identity that remains stable over time, and if several entities are being tracked then the tracking system has some means of consistently "attaching" a given entity to its corresponding representation. This representation will be expressed within some mathematically definable representation scheme, which is capable of expressing a certain formal space of states of affairs. The computer maintains a representation only of certain aspects of the entity. In particular, the representation scheme recognizes certain specific kinds of changes of state, namely those which correspond to changes in the stored representation. A system for tracking an object's location, for example, should be unaffected by changes in its color; the recognized state-changes will all take the form of transitions from, say, one sequence of coordinates to another. As the entity's corresponding representation changes, records may well be kept of its state transitions, yielding a "history" of its trajectory through time. And this trajectory, of course, can be either literal or metaphorical, depending on what aspects of the entity are represented.

In addition to the continual updating of a representation, each tracking system is capable of closing a causal loop between the entity and the computer. That is, information does not simply flow from the entity to the computer; in addition, certain human or mechanical agents, faced with a given entity in a prescribed type of situation, are capable of determining its identity and "calling up" the information in its "file." (These agents' activities may, of course, be tracked as well.) Again, the causal means that provide for this loop-closing vary widely, from bar codes to identification cards to license plates to keys to paperwork of all sorts, and the computational division of labor among the entity, agent, central computer, and so forth varies widely as well.

Tracking systems like these can obviously be used for good or ill. Other things being equal, it is probably a good idea to track hazardous materials, government money, and so forth. At the same time, research on computers and privacy has emphasized the fear, often perfectly justified, that the accumulated information about a tracked person might be used for abusive purposes, for example stalking by a would-be assailant, irresponsible publication of embarrassing facts, or oppressively detailed control of work activities. In particular, this research has focused on the element of data-collection; its question is what becomes of the data once it is collected. Yet tracking schemes have another side: the practical arrangements through which the data is collected in the first place, including the arrangements that make human activities and physical processes trackable. As human activities become intertwined with the mechanisms of computerized tracking, the notion of human interactions with a "computer"—understood as a discrete, physically localized entity—begins to lose its force; in its place we encounter activity-systems that are thoroughly integrated with distributed computational processes. It is this deeper implication of tracking that forms the central motivation for this paper.

3 Surveillance and capture

Let us, then, formally introduce the surveillance model and the capture model of privacy issues. A "model," for present purposes, is a way of looking at things; specifically, it is a set of metaphors. Distinct models do not divide the world's sociotechnical phenomena into nonoverlapping classes; instead, they simply point out some potentially significant features of the phenomena—features that may call for more concrete analysis.

The surveillance model has five components:

(1) visual metaphors, as in Orwell's "Big Brother is watching you" or Bentham's Panopticon;

(2) the assumption that this "watching" is nondisruptive and surreptitious (except perhaps when going astray or issuing a threat);

(3) territorial metaphors, as in the "invasion" of a "private" personal space, prototypically the family home, marked out by "rights" and the opposition between "coercion" and "consent";

(4) centralized orchestration by means of a bureaucracy with a unified set of "files"; and

(5) identification with the state, and in particular with consciously planned-out malevolent aims of a specifically political nature.

When stated in this way, it becomes evident that the surveillance model is a cultural phenomenon. Although its earliest genealogy deserves further research, its modern history is clearly rooted in the historical experience of secret police organizations and their networks of listening devices and informers, most prominently in the totalitarian states of Nazi Germany and the Soviet Union, and to a lesser but still significant extent in the United States. George Orwell's *1984* gave these symbols their most vivid literary form, but the cultural legacy of this history is also evident in, for example, the unpleasant connotations associated with certain uses of a word like "files." Moreover, philosophers and cultural critics have generally held vision and visual metaphors in low esteem through much of this century, as Jay (1993) has documented in the case of France. In any case, it is important to keep in mind that the surveillance model is a system of metaphors; in applying the surveillance model to a private company, for example, one is simply *likening* it to a malevolent state organization, and it will be important to explore the limits of this comparison.

The surveillance model is by far the most prevalent in the literature on privacy. It is found, for example, in definitions of privacy in terms of the right to be left alone, or in concerns over information being used for unintended purposes. Indeed, the vast majority of the existing literature on computers and privacy employs the surveillance model without critically analyzing it or considering alternatives, indexing it through the term "surveillance" or references to "Big Brother" and other themes from Orwell (Burnham 1983, Clarke 1989, *The Economist* 1993, Flaherty 1989, Flynn 1993, Gandy 1993, Larson 1992, Piller 1993, Rabel 1993, Robins and Webster 1988, Rule 1974, Smith 1979, Ware 1993). My point is not that this work is wrong, but rather that alternative models might draw different, but equally important, elements into the foreground.

One such alternative metaphor-system is the capture model. In naming this model, I have employed a common term of art among computing people, the verb "to capture." Computationalists' discourse rarely brings to the surface the connotations of violence in the metaphor of "capture"; captured information is not spoken of as fleeing, escaping, or resenting its imprisonment. The term has two uses. The first and most frequent refers to a computer system's (figurative) act of acquiring certain data as input, whether from a human operator or from an electronic or electromechanical device. Thus one might refer to a cash register in a fast-food restaurant as "capturing" a patron's order, the implication being that the information is not simply used on the spot, but is also passed along to a database. The second use of "capture," which is more common in artificial intelligence research, refers to a representation scheme's ability to fully, accurately, or "cleanly" express particular semantic notions or distinctions, without reference to the actual taking-in of data. Thus one might refer to the object classes of an object-oriented computer program as "capturing" the distinction between standing orders and particular occasions on which goods are delivered. This ambiguity between an epistemological idea (acquiring the data) and an ontological idea (modeling the reality it reflects) is remarkably common in the vocabulary of computing. (AI researchers, for example, apply the word "epistemological" in the *second* sense of "capture," not the first.)

The capture model can be contrasted point-by-point with the surveillance model. It comprises:

(1) linguistic metaphors for human activities, assimilating them to the constructs of a computer system's representation languages;

(2) the assumption that the linguistic "parsing" of human activities involves active intervention in and reorganization of those activities;

(3) structural metaphors; the captured activity is figuratively assembled from a "catalog" of parts provided as part of its institutional setting;

(4) decentralized and heterogeneous organization; the process is normally conducted within particular, local practices which involve people in the workings of larger social formations; and

(5) the driving aims are not political but philosophical, as activity is reconstructed through assimilation to a transcendent ("virtual") order of mathematical formalism.

Since the capture model is less familiar than the surveillance model, the next four sections will be devoted to explaining it. The capture model, like the surveillance model, is a metaphor-system and not a literal description. It can, for example, be applied equally well to public or private organizations (or to the many activity-systems that cross the increasingly permeable boundaries between these two domains), although my analysis will focus on workplace settings. It is important to make clear, with regard to point (5), that the capture model is a philosophical metaphor in the same sense as the surveillance model is a political metaphor. The actual institutional sites to which the capture model might be applied presumably have their political aspects; the point is simply that the capture model suggests using certain philosophical projects as models for understanding the activities in these sites.

The two sets of metaphors have significantly different origins. Whereas the surveillance model originates in the classically political sphere of state action, the capture model has deep roots in the practical application of computer systems. As such, technical developments such as the tracking schemes described in Section 2 do not bring the capture model into existence; rather, they express in a clear way something that has long been implicit in applied computer work, whether or not its relevance to privacy issues has been recognized.

4 Grammars of action

Computers are frequently said to store and transmit "information." The term, though, conceals a significant ambiguity. On one hand, information can be defined (as per Shannon and Weaver) as a purely mathematical measure of information and information-carrying capacity, without regard for the content. On the other hand, information is information also *about* something. (A similar point applies to customary uses of the term "data.") Although it makes sense to speak of false information (for example, in a faulty credit database), the tacit assumption is most commonly that information is true—that it corresponds in some transparent way to certain people, places, and things in the world. This assumption does not, strictly speaking, derive from any inherent property of computers. It is, rather, a theory of representation that is embedded in the way that computers have customarily been used.

To see this, consider a textbook of information management such as Martin (1989). Martin's goal is to instruct MIS managers on the principled construction of information systems, and specifically on the principled selection of what ought to be represented. In doing this, he describes an ontology of entities and relations and functions and activities, along with a set of procedures for systematically representing the existing organization in these terms. Having prepared this self-representation, the next step is to implement it on a computer. The purpose of this computer will be to *model* the organization—that is, to maintain a set of datastructures that mirror the day-to-day activities of the organization's members. In philosophical terms, the resulting computer will embody a correspondence theory of representation: the machine's internal states will be "true" (so far as this theory is concerned) because they maintain a certain fixed set of relation-preserving mappings to the external states of affairs in the world.

The practice of constructing systematic representations of organizational activities is not at all new, of course, nor is it inherently tied to computer systems development. Indeed, Martin emphasizes that it can be valuable in itself, even without any computers being installed, simply for the redundancies and other inefficient patterns of activity it can bring to management's notice. As such, it clearly stands in a line of descent that includes the elaborate representational schemes of industrial time and motion studies (Gilbreth 1912, Holmes 1938) and other forms of systematic rationalization of work activities (Lichtner 1924). When applied to the tracking of organizational processes, of course, these schemes relied heavily on paperwork (Yates 1989) or on the intrinsic controls built into the movements of machinery (Edwards 1979).

Besides the creation of tracking systems, systematic activity-mapping schemes have also been applied to the automation of activities. Couger (1973), for example, surveys a variety of such schemes from the early days of computing, each based on tracing the flows of information within a business. A map of these information-flows, and of the information-processing operations that take place along the way, could be treated as a blueprint for a computer program that automated those same operations.

Yet another analogous representation practice is found in research on "knowledge representation" in the field of artificial intelligence. Several of the entity-relationship diagrams in Martin (1989: 168 ff.) resemble nothing so much as the "semantic networks" employed in AI knowledge representation research (Brachman and Levesque 1985). AI researchers, more than their counterparts in other kinds of applied computer science, set about explicitly searching for ontological systems that would allow a computer to represent cleanly and accurately a wide range of human knowledge—including knowledge about human activities and social organizations.

Despite their varied surface forms, these lines of research together constitute a coherent genealogy—a tradition of applied representational work that has informed organizational practice the world over. Its underlying approach is organized and reproduced largely through its practical conduct: its methods, its language, its paradigms of good practice, its training regimens, and so forth. Although it has become deeply identified with organizational applications of information technology, it is (at least in principle) neither a necessary nor a sufficient condition for the use of computers. At the same time, it has grown such deep roots in computational practice that it is hard to imagine what any alternative computational practice would be like.

Among the many attributes shared by these representation schemes, perhaps the most significant for present purposes is their use of linguistic metaphors: they each employ formal "languages" for representing human activities. Human activity is thus effectively treated as a kind of language itself, for which a good representation scheme provides an accurate grammar. This grammar specifies a set of unitary actions—the "words" or "lexical items" of action, which AI people call "primitives" and which Quinn (1993: 103–109 ff.) calls "minimum replicable units." It also specifies certain means by which actions might be compounded—most commonly by arranging them into a sequence, although various languages provide more sophisticated means of combination (for example, conditional and iterated sequences).

These *grammars of action* are central to the capture model. Grammars of action have many and varied manifestations.

- Accounting systems, for example, are based on grammars of action; in order to keep a set of books, it is necessary to organize one's financial activities with a view to categorizing every move as one of the action-types that one's particular accounting scheme recognizes.

- Telemarketers and many types of telephone-based customer service personnel employ scripts that are based on a set of standard moves, many of whose names are drawn from the structured patter of sales people (e.g., "assumptive close"). Some grammars of sales interaction are extraordinarily complex (Miller and Heiman 1987).

- A limited-access highway (such as the roads in the American interstate highway system) enforces, through both physical and legal means, a simple grammar of action whose elements are entrances, discrete continuous segments of traveled roadway, and exits. Toll-collection systems for such roads often employ a keypunch card which contains a table for mapping "grammatical" trips to collectible tolls.

- The user interfaces of many (if not all) computers are readily understood as supplying their users with grammars of action. The permissible unitary actions are ASCII keystrokes, menu selections, shell commands, and so forth. Some projects have attempted to formalize the interaction-patterns discovered in empirical study of human conversations, and then to build computer programs that can engage in these patterns (Luff, Gilbert, and Frohlich 1990).

- Waiters in large restaurants frequently employ an automated system for passing orders to the kitchen and keeping track of tabs (Rule and Attewell 1989, Quinn 1992: 142–145). The waiter might interact with the system by swiping a card through a reader on the cash register and entering commands on a touch-sensitive display.

- "Enterprise integration" (EI) systems draw an organization's computer systems together on a global network with a standardized set of communications protocols and data models. One proposal for an EI architecture (Pan and Tenenbaum 1991) breaks an organization's work activities down into "tasks," each represented within a common language, and automatically evaluates which tasks should be assigned to computational "agents" and which should be assigned to human workers.

What matters in each case is not the sequences of "inputs" to or "outputs" from a given machine, but rather the ways in which human activities have been structured. The capture model describes the situation that results when grammars of action are imposed upon human activities, and when the newly reorganized activities are represented by computers in real time. It is convenient to subdivide this process into a five-stage cycle. This division is, of course, a great oversimplification: the phases frequently operate concurrently, advances in one phase may force revision of the work done in an earlier phase, and work in each stage draws on a wide range of sociotechnical advances not necessarily related to the other stages.

Analysis. Somebody studies an existing form of activity and identifies its fundamental units in terms of some ontology (e.g., entities, relations, functions, primitive actions, and so forth). This ontology might draw on the participants' terms for things, or it might not. Programming languages and systems analysis methodologies frequently supply basic ontologies (objects, variables, relations) upon which domain-specific ontologies can be built. The resulting ontologies are sometimes standardized across whole institutions, industries, or markets.

Articulation. Somebody articulates a grammar of the ways in which those units can be strung together to form actual sensible stretches of activity. This process can be complicated, and it often requires revision of the preceding ontological analysis. It is typically guided by an almost aesthetic criterion of obtaining a complete, closed, formally specified picture of the activity.

Imposition. The resulting grammar is then given a normative force. The people who engage in the articulated activity are somehow induced to organize their actions so that they are readily "parseable" in terms of the grammar. The "somehow" is typically both social (explicit procedures backed up by certain relations of authority) and technical (whether through machinery or simply through physical barriers); participants in the activity may or may not participate in the process and may or may not resist it. Institutions frequently impose grammars on activities for reasons other than real-time capture—for example, for security, efficiency, protection from liability, and simple control.

Instrumentation. Social and technical means are provided, whether through paperwork or machinery, and potentially with a complex division of labor, for maintaining a running parse of the ongoing activity. This phase may coincide with the imposition phase, or it may follow by years or decades. Afterward, the participants begin, of necessity, to orient their activities toward the capture machinery and its institutional consequences.

Elaboration. The captured activity records, which are in economic terms among the products of the reorganized activity, can now be stored, inspected, audited, merged with other records, subjected to statistical analysis, employed as the basis of Pareto optimization, and so forth. Likewise, concurrent computational processes can use captured records to "watch" the ongoing activities for purposes of error detection, advice giving, performance measurement, quality control, and so forth. These additional processes might arise simultaneously with the instrumentation phase, or they may accumulate long afterward.

This cycle is normally attended by a kind of mythology, according to which the newly constructed grammar of action has not been "invented" but "discovered." The activity in question, in other words, is said to have *already* been organized according to the grammar. Of course this is not wholly false; imposing a grammar that radically and arbitrarily misrepresents the activity will probably lead to calamity. But even when a grammar of action is relatively "good" in this sense, its imposition will generally require hard work, both for the people who are imposing the grammar and the people upon whom the grammar is imposed. The work of these latter participants consists in part of finding ways to organize one's activities, even in the tricky and exceptional cases, so that they can be parsed within such-and-such a vocabulary of discrete units.

Indeed, it is crucial to appreciate the senses in which the imposition and instrumentation phases constitute a reorganization of the existing activity, as opposed to simply a representation of it. Let us distinguish eight such senses, in increasing order of significance for the current argument:

(1) The introduction of new technologies, whether they involve the capture of activities or not, is frequently the occasion for a wide variety of other kinds of changes to the activity, for example due to extrinsic economic changes (e.g., Iacono and Kling 1987). Indeed technological change is generally inseparable from broader social changes.

(2) The representations constructed in the articulation phase (based to some extent on empirical study of the activity, but mostly on informal speculation and scenario-making) and then in the elaboration phase (based on the newly accumulated database of parsed activity) frequently suggest rearrangements of the activity (Quinn 1992, Taylor 1923). Some of these rearrangements may be designed in part to facilitate the capture process, as in Hammer's (1990: 112) dictum, "Capture information once and at the source."

(3) Grammars of action frequently oversimplify the activities they are intended to represent, if only because the people who articulate the grammars are only superficially acquainted with its actual complexities and the actual social forces that determine its form (Suchman and Jordan 1989). The ontology may fail to make enough distinctions, or else whole subcategories of "invisible" activity might go unrepresented. The grammar might impose overly restrictive ordering constraints on the unitary actions, it might neglect the interleaving of distinct forms of activity, or it might mistake prescribed procedures for an accurate descriptive account (or at least a practicable form) of the activity (Suchman 1983). As a result, the participants in the newly instrumented activity will find it necessary to evolve a system of "work-arounds" to keep things going (Gasser 1986).

(4) Grammars of action can be "mistaken" in other ways. Most especially, they can encode a systematically distorted conception of the activity. For example, Kling (1991) argues that extant computer-supported cooperative work (CSCW) systems are based on ontologies that recognize cooperation but

not conflict, and collaboration but not competition (cf. Orlikowski 1993). The imposition of a distorted grammar on an activity can have a wide range of consequences.

(5) When the practical circumstances of an activity are instrumented, the resulting machinery rarely takes its measurements without human cooperation, interpretation, categorization, data entry, report writing, displaying of identification, swiping of cards through readers, aiming of sensors at bar codes, and so forth. The real-time accumulation of data on the activity, in other words, introduces new elements into the activity itself. When these elements are not anticipated in the design, the potential for disruption is great. Medical settings, for example, often report backlogs of unentered data (Hawker 1991, Walton 1989: 20).

(6) The people whose activities are being captured will probably adjust their conduct based on their understanding of what will become of the data and what this entails for their own lives. For example, they might work faster, choose easier (or otherwise advantageous) tasks, conduct certain aspects of the activity out of the reach of the instrumentation, change course depending on patterns that might emerge from already-captured data, and so on. In general, as Suchman (1992) suggests, they will maintain an orientation to the "image" they project to whoever is making use of the captured information, be it a boss, a colleague, an auditor, a regulatory agency, an insurance company, or whatever. On Suchman's analysis, the compliance between system records and ongoing events is an interpreted or negotiated correspondence rather than a literal one. The relation of records to events involves organization members' judgement calls about what is a close enough fit "for all practical purposes." Thus, inasmuch as the captured actions are addressed to an "audience" via computer-mediated representation, they take on a "performative" quality (cf. Dourish 1993) that belies the intendedly objective character of the representational process (cf. Garfinkel 1984 [1967]).

(7) Given this human intervention in the capture process, the process often becomes the site of more overtly political conflicts. The participants may adjust the timing and contents of the various data-capture events to their advantage. They might interpret and categorize events in sympathetic ways, bias judgement calls in one direction or another, or choose action-sequences that include or exclude certain elements. They might attempt to minimize use of the computer or use tracking data to coerce or influence others in the organization. They might falsify certain information, they might delay entering it, or they might neglect entering it altogether.

(8) The newly introduced system might bring new institutional dynamics, not least because the designers' ontologies and grammars will normally be oblivious to the political dimensions of activity (Kling 1980). These new dynamics might range from manipulation of the institutional procedures around the system's use to lobbying for technical changes to overtly political campaigns to regulate uses of the technology.

The picture that emerges is at odds with the mythology of transparent representation. The phenomena listed in (1) and (2), to be sure, only conflict with the mythology to the extent that the imposition of a grammar cannot be distinguished from the other ways in which activities change. One might argue, moreover, that the phenomena listed in (3) and (4) can be mitigated through more sophisticated analysis and articulation. And the phenomena listed in (5) through (7) can often be mitigated to some degree through increasingly rigid sociotechnical means of instrumentation (an instance of (8)). But no matter how thoroughly the capture process is controlled, it is impossible, short perhaps of total mechanization of a given form of activity, to remove the elements of interpretation, strategy, and institutional dynamics. This is not to say that capture is impossible; to the contrary, numerous impressive examples already exist. The point, rather, is that capture is never purely technical but always *sociotechnical* in nature. If a capture system "works" then what is working is a larger sociopolitical structure, not just a technical system (Bowers 1992). And if the capture process is guided by some notion of the "discovery" of a preexisting grammar, then this notion and its functioning should be understood in political terms as an ideology.

A good example of the five-stage capture cycle is found in the research of Winograd and Flores *et al.*. on CSCW systems. In their original research on The Coordinator (Flores *et al.* 1988), they made explicit the methodological principle that system design should begin with an ontology that clarifies the underlying structure of existing practices. Although this assertion is far from novel in itself, their contribution was to radicalize it through the application of philosophical concepts (Winograd and Flores 1986). The idea is that a deeper-than-normal ontology can provide a firmer and more accurate basis for system-building. Winograd and Flores take their inspiration for this project from the existential hermeneutics of Martin Heidegger's *Being and Time* (1961 [1927]). Heidegger's project was to employ successive cycles of phenomenological description to uncover successively deeper layers of ontological structure in human experience, eventually yielding some kind of authentic engagement with the ultimate ontological category of Being itself.

For Winograd and Flores, this method promises a kind of ultimate authority to their project of *a priori* clarification (Suchman 1993). Human activities, they argue, go astray when they depart from the essential structures that rigorous phenomenological analysis reveals, and computer-mediated tools can prevent such mistakes by imposing particular grammars of action upon their users. Although this idea is altogether natural within the traditions of computer science, and while Winograd and Flores' philosophy is alert to some of the oversimplifications implicit in conventional computational practices, Heidegger would have been aghast at the idea of formalizing ontological categories in computational (or otherwise mathematical) terms, much less employing machinery to enforce compliance with them.

Winograd and Flores' ontology, moreover, has little to do with Heidegger's, being drawn principally from the quite un-Heideggerian theory of speech acts (Searle 1969). In their design for The Coordinator, they provide a grammar of linguistic action in conventional state-graph notation. Users exchange electronic messages in conducting their work, and they are supposed to label each message with a particular speech act. The system, meanwhile, can capture the speech-act structure of each sequence of interactions. Although some research groups have presented equivocal evaluations of The Coordinator's success in practice (e.g., Bullen and Bennett 1990), it is not my purpose to argue that such systems cannot work. Quite the contrary, I wish to portray The Coordinator and its more sophisticated successors (Marshak 1993, Medina-Mora *et al.* 1992) as deeply rooted in a social and technical tradition. Although computer-supported cooperative work systems such as The Coordinator require their designers to perform particularly rigorous ontological work in the analysis and articulation phases (cf. Clawson and Bostrom 1993), this work is no different in kind from the generations of systems analysis that have gone before it.

To summarize, the phenomenon of capture is deeply ingrained in the practice of computer system design through a metaphor of human activity as a kind of language. Within this practice, a computer system is made to capture an ongoing activity through the imposition of a grammar of action that has been articulated through a project of empirical and ontological inquiry. Advances in computer science have thus gone hand-in-hand with ontological advances. Furthermore, the phenomenon of capture also underlies the tracking systems discussed in Section 2. Tracking is impossible without a grammar of states and state-changes and the technical means to detect the states (or the state-changes) when they occur. Except in the simplest cases, this will require that the grammar be imposed through one means or another: location tracking devices, paperwork, identity cards, and so forth. The resulting "technology" of tracking is not a simple matter of machinery: it also includes the empirical project of analysis, the ontological project of articulation, and the social project of imposition.

5 Capture and functionality

A variety of projects, particularly in the participatory design movement (Schuler and Namioka 1993), have sought alternatives to the engineering strategy of thoroughgoing capture, through schemes that allow people to record information in the form of computerized text (and in other computerized media as well) without imposing any detailed grammar on it. The stored materials can later be retrieved and interpreted by others. Simple electronic mail and hypertext systems work this way, as do certain more sophisticated systems (MacLean, Young, and Moran 1989).

But these systems all participate in a trade-off that goes to the core of computing: a computer—at least as computers are currently understood—can only compute with what it captures; so the less a system captures, the less functionality it can provide to its users. To understand this trade-off, consider the contrast between voice mail and electronic mail. Both media are routinely employed to convey stretches of language from one person to another, as well as a variety of other functions: storing the messages, reviewing them later, replying to them, attaching timestamps and labels to them, and so on. Nonetheless, they capture different aspects of the language: whereas voice mail captures spoken language at the level of sampled frequency spectra, electronic mail captures written language at the level of ASCII keystrokes. Each medium thus has capacities that the other does not: voice mail, unlike e-mail, can transmit singing and languages without Latin orthographies, and e-mail archives, unlike voice mail, can be searched by keyword. Finally, neither medium captures the grammatical structure of the messages it transmits, much less anything about the content of those messages. Thus neither medium can offer features based on automatic recognition of agrammaticality, urgency, or relevance to a given topic. (It may be possible to heuristically *infer* such matters from e-mail messages, but systems for doing so are far from practical at this moment.) Some analogous examples include the contrast between painting and drawing programs, and between ASCII-based text editors and WYSIWYG word processors.

This trade-off is also found in systems for tracking human activities through automatic capture. Simply put, a system can only track what it can capture, and it can only capture information that can be expressed within a grammar of action that has been imposed upon the activity. Numerous systems, including many of the examples in Section 2, reside toward the minimal end of this trade-off since they only track simple position information. Systems like these are not particularly convincing cases of the capture model since they do not usually require much imposition beyond the installation of the tracking instruments themselves. But position tracking is frequently a precursor to more qualitatively complex kinds of capture, for example when positional information is stored along with other events or transactions that might be captured: arrival at a certain destination, crossing a certain boundary, changes in the status of materials or participants, encounters with other participants, and so forth.

The inherent trade-off of computer systems for capturing human activities underlies the most significant technical trend in their ongoing historical development: the tendency toward ever "deeper" articulation and capture of activities. As Quinn (1992: 104 ff.) has put it in the case of businesses in service industries, the "minimum replicable unit" has gotten steadily smaller:

> Early in the life cycle of many service industries, the smallest truly replicable unit seemed to be an individual office, store, or franchise location. Later, as volume increased, it often became possible for the headquarters to develop and replicate greater efficiencies within locations by managing and measuring critical performance variables at individual departmental, sales counter, activity, or stock-keeping unit (SKU) levels. Then the successful reduction of key activities to their most refined elements allowed McDonald's, Federal Express, Wal-Mart, Citicorp, Mrs. Fields, Pizza Hut, and even the New York Stock Exchange (NYSE) to push the repeatability unit to even smaller "micro management" levels. Replicating precisely measured activity cycles, delivery times, customer query sequences, personal selling approaches, customer data, inventory control patterns, ingredients, freshness and cooking cycles, counter display techniques, cleanliness and maintenance procedures, and so on, in detail became keys to service and financial success. Lapses led to difficulties.

Each step in this process of ontological refinement requires designers to revisit each of the five stages of the capture cycle, formulating ever more refined ontologies and grammars of activity and then imposing, instrumenting, and elaborating these through work reorganization and new technology. The remainder of the paper considers certain aspects of the social organization of this process.

6 Capture in society

The previous section has described the capture model largely as something internal to the engineering and scientific traditions of computer work. And indeed, considered simply as a set of ideas, the capture model is very much a creature of computing research and its intellectual genealogy. The systems that result from the application of these ideas, though, are sociotechnical phenomena of considerable magnitude whose analysis requires us to consider numerous factors beyond the ideas themselves. It is far too early to make any final assessment of capture as a social phenomenon. Instead, I would like simply to sketch some general analytical considerations that might be helpful in guiding future research and activism.

Ideas about computers and privacy, Section 2 has argued, are, among other things, cultural phenomena. As such, they routinely structure writing and thinking on the subject without anyone necessarily being aware of them. They do so in many ways: through metaphors and other literary figures, through more or less conventionalized genres of writing, and through habits of selective perception and inquiry. As Kling and Dunlop (1993) have pointed out, analysis of the place of computer technology in society has often been impoverished through a bifurcation into two structurally opposed genres, which they call utopian and anti-utopian. The utopian genre, as its name suggests, emphasizes good things: efficiency, the amplification of various professions' powers, and other beneficial consequences of computing. The anti-utopian genre, for its part, draws on a stock of cultural images of class conflict and totalitarian domination. Both genres are prevalent in journalistic and academic writing alike.

In the particular area of workplace computing, one strand of anti-utopian writing is found in union-oriented criticisms of managerial control imperatives (Garson 1989, Howard 1985, Shaiken 1985; cf. Rule and Attewell 1989). The argument, first formalized by Braverman (1974) but possessing deeper historical roots in the American union movement, was originally motivated by real historical conflicts over production knowledge, which consisted of the appropriation of craft knowledge through scientific management and the replacement of craft work-ways with fragmented and rationalized forms of work enforced through direct surveillance and control. An extensive school of thought has generalized this experience into a theory of the historical development of work.

Just as the utopians are often accurate in reporting the benefits of computing, these critics are surely not hallucinating the instances of computer-mediated domination they describe, particularly in certain manufacturing and distribution industries with long histories of organized workplace conflict. But a considerable body of empirical research has demonstrated that the picture, at least in the present day, is more complex than this single-factor theory can explain (Thompson 1989). In particular, Kling and Iacono (1984) argue against reducing the managerial strategies and organizational dynamics around computing to simple hierarchical control. Their goal is not simply to find a compromise or halfway position between the utopian and anti-utopian genres, but rather to develop a multi-dimensional model that elucidates a variety of interactions. In particular, they argue for an institutional model based on complex patterns of negotiation and control that operate in all directions, not just from the top down. Allen (1994), in particular, describes some emerging patterns of lateral control relations in increasingly integrated firms. Attewell (1991) broadens the scope of analysis even further, arguing that an adequate model of organizational computing must integrate several disparate factors: an organization's environment, culture, business strategy, work organization, and labor market conditions.

When applied as the sole framework of computing and privacy, the surveillance model contributes to the near-inevitability of oversimplified analysis. For example, it has directed several authors' attention to the rise of computer-mediated schemes for detailed monitoring of work activities (e.g., Clement 1988), the idea being that distributed computer systems have the potential to establish a regime of total visibility through real-time digital representation of work activities. But while numerous workers have justly resented their experiences with such systems, the systems themselves are evolving, and the evidence is equivocal on their ubiquity, their effectiveness, and the degree of resentment they have provoked (Grant, Higgins, and Irving 1988; Kling 1989; Kling and Dunlop 1993). Again, the point is not to identify a halfway position between extreme views, but to come to a more complicated appreciation of the actual dynamics of such developments. Unfortunately, all the surveillance model offers is a metaphor of bureaucratically organized state terror that often seems disproportionate to the actual experience of corporate life. The rhetoric of "Big Brother technologies" is easily—and frequently—ridiculed through paraphrase in terms of "sinister conspiracies" and the like. The paradoxical result is that genuinely worrisome developments can seem "not so bad" simply for lacking the overt horrors of Orwell's dystopia.

To be sure, the capture model is compatible with some perfectly conventional utopian and anti-utopian scenarios. And it is worth asking, what would a total reorganization of all spheres of life in accord with the capture model be like? Some guidance on the question is available simply from the capture model's definition: grammars of action would have to be articulated for every domain of human activity (work, consumption, travel, politics medicine, and so forth), and these grammars would have to be imposed on their respective domains, with the result that sociotechnical machinery of numerous types would register every state-change of any significance in real time.

What would become of the data in this imaginary world? Whereas the surveillance model suggests that the resulting masses of data would be gathered and stored in some central location, the capture model is agnostic on this matter. Indeed, the capture model emphasizes that capture, as a specifically social process, is not a unitary phenomenon. To the contrary, every domain of activity has its own historical logic, its own vocabulary of actions, and its own distinctive social relations of representation. As a result, information gathered through capture in one domain of activity may or may not be commensurable with information captured in another domain. Even without this element of unification and centralization, though, this picture of a totally captured society offers plenty of opportunity for utopian and anti-utopian speculation. In particular, it has a millenarian flavor of perfect transparency of correspondence between digital representations and the now fully ordered affairs of embodied activity.

Nonetheless, this picture is wholly unsatisfactory, since it provides no notion of the larger social dynamics that capture processes will participate in or interact with. Indeed, without a worked-out conception of how real activities might actually be reorganized during the various phases of the capture cycle, this sketch of a hypothetical world of total capture is hard to distinguish in any convincing way from the utopias and dystopias associated with the surveillance model.

Any serious analysis of capture, then, will require an understanding of the social relations within which the sociotechnical phenomenon of computing is embedded. In particular, it does not suffice to postulate a historical trend toward ever-more-thorough capture of human activities without providing some way to analyze the social forces that structure the social relationships around capture in any given setting. Far from portraying "capture" as a social actor in its own right, a nuanced understanding of the capture model sketches out the landscape of possibilities and alternatives upon which particular concrete instances of capture will be contested.

In considering the institutional context of the capture model, it will help to distinguish the general concept of capture from two specific applications of grammars of action, automation and Taylorism. While "automation" has a broad meaning, referring to any introduction of new technology, it also refers more specifically to the systematic replacement of human activities with the operation of machinery. This process often involves the representation of existing forms of activity by means of grammars of action, for example by systems analysts who map out the information flows in an organization with the aim of reproducing them all in software. In such a project, the intention is not to instrument the activity but simply to replace it. In work rationalization according to Taylor and his followers, engineers represent existing forms of activity with the goal of reorganizing them according to principles of efficiency. Again, the resulting activity is probably not instrumented, for the simple reason that its precise structure and speed are already known.

Automation and Taylorism are both extremely restrictive approaches to work reorganization. In particular, they both address the twin imperatives of efficiency and control in the same fashion: by legislating the precise sequence of actions in advance. As a result, they are both highly inflexible. This inflexibility is reflected, in turn, in the wide range of sociological theories of organization that are based on a simple opposition between "routines" and "non-routine" (i.e., "skilled") activities (Cyert and March 1963, Nelson and Winter 1982, Sabel 1982, Stinchcombe 1990). Capture, by contrast, permits efficiency and control to be treated separately, so that people who engage in heavily captured activity have a certain kind of freedom not enjoyed by people in Taylorized work. Inasmuch as capture is based on a linguistic metaphor, this freedom is precisely the type ascribed to language users by linguistic theories of grammar—for example in Chomsky's (1971: 50) notion of "free creation within a system of rule." That is, just as the speakers of English can produce a potentially infinite variety of grammatical sentences from the finite means of English vocabulary and grammar, people engaged in captured activity can engage in an infinite variety of sequences of action, provided these sequences are composed of the unitary elements and means of combination prescribed by the grammar of action.

It is thus that captured work activities are often connected with the corporate discourse of "empowerment" (Agre forthcoming). In particular, capture is compatible with modes of work reorganization that increase the skill level of jobs, as well as with "de-skilling," since capture does not require that control be exercised through the fragmentation of jobs and the *a priori* specification of their forms. Instead, capture permits work activities to be disciplined through aggregate measures derived from captured information. Taylorite time-and-motion studies might be performed as well, but their purpose is now to ensure that highly efficient sequences of action exist in the first place. The general picture of empowerment and measurement is consistent with a wide range of power relations, from the intensive production pressures placed on fast food workers by centralized monitoring of captured information to the relatively gentle bureaucratic negotiations experienced by doctors dealing with the medical-activity capture schemes of hospitals, health maintenance organizations, and insurance companies. In particular, the measurements that are derived from representations of captured work can be put to a variety of uses, including piece-rate pay and periodic adjustments of work methods. The ultimate use of such measurements is the establishment of bidding for services in real-time markets, whereby the control function previously provided by bureaucracy is transferred to the inherent discipline of the market. A useful theory of the capture model's place in society would provide a way of understanding when the capture model is employed, how it is employed, and how its employment affects relationships among people. A great deal of work is required before such a theory can be formulated, but at least some plausible starting points are available.

7 The political economy of capture

These general considerations provide the background for an analysis of capture as an institutional phenomenon. While institutions deserve analysis on numerous levels, I propose to focus on Ciborra's (1983, 1987) economic model of the institutional effects of information technology. The analysis in this section will be considerably more speculative than in previous sections, and should be understood as the outline of a research agenda.

Ciborra's model is based on Coase's (1937) notion of "transaction costs." Coase begins by looking at all productive human interactions as economic exchanges, and then he asks why some such relations are organized through market mechanisms and others are organized within the authority relationships of hierarchical firms. His answer, roughly speaking, is that the boundaries of firms are drawn around transactions which are less costly to perform within a hierarchy than they are to perform in a market. Transaction costs, which are the costs associated with the use of market exchange, include the costs of locating and evaluating the various goods and services for sale in the market, defining the precise nature of the goods and services to be exchanged, and negotiating and enforcing the contracts that govern the exchange. (For the subsequent history of the theory of transaction costs, see Williamson and Winter (1991).)

Markets work over time to reduce transaction costs, for the simple reason that competition tends to reduce all costs of production. For example, improved computing and communications technologies make it easier to collect and analyze information on offerings available in the market. As technological changes permit decreases in transaction costs, the theory predicts that the boundaries of firms and the contractual basis of various economic arrangements will change as well in particular ways. For example, firms may begin to purchase certain goods and services on the open market instead of organizing their production in-house, and patterns of vertical integration may change as it becomes more efficient to coordinate certain institutional interfaces through market mechanisms rather than bureaucratic organization.

Ciborra (1987: 258–260) applies this theory to the role of information technology in organizational change. Following Ouchi (1979), he extends Coase's framework slightly by distinguishing three organizational types—markets, bureaucracies, and clans—depending on the degree of ambiguity or uncertainty present in a given way of producing and selling a given product or service, and on the degree of congruence among the interests of the various parties to the interaction. According to this analysis, an economic relationship will be organized as a market (with completely separate transactions on every occasion of exchange) when ambiguity and uncertainty are low and the interests of the parties are in conflict; it will be organized as a rule-bound bureaucratic organization when ambiguity and congruity of interests are moderate; and it will be a closely knit, informal "clan" when ambiguity and congruity of interests are high. (Numerous intermediate and hybrid forms are found as well.) Formulated in this way, the theory specifically predicts that, as transaction costs are reduced, industries will demonstrate a historical trajectory in the direction from clans to hierarchies to markets.

If true, this theory ought to be invaluable to managers faced with planning the organizational concomitants of technological change. With the transition from clan to hierarchy, or hierarchy to market, or with other significant transitions in work-organization within each of these categories, the theory of transaction costs prescribes in some detail the economically most efficient and stable contractual form that can be given to the social relationships in the new form of work. In particular, Ciborra (1987) argues, strategies for designing and managing information technology ought to depend on which category of economic relationships is present (that is, the relationships that *will be* present once the system is working).

When applied in accordance with the capture model, information technology reduces transaction costs by imposing more clearly defined—less ambiguous and less uncertain—relationships upon the parties to economic interactions, thereby decreasing the overhead associated with coordination of various individuals' activities. More specifically, once a grammar of action has been imposed upon an activity, the discrete units and individual episodes of the activity are more readily identified, verified, counted, measured, compared, represented, rearranged, contracted for, and evaluated in terms of economic efficiency. This is a particularly simple matter when the interactions in question are already organized by market relationships, and Ciborra conjectures (1987: 263) that "market transactions rather than bureaucratic firms are at present the main field of application of DP technology, since the structured and standardized nature of those transactions make them more suitable to automation." Indeed some of the most spectacular applications of information technology are found in the operation of global markets in stocks, commodities, currencies, and derivatives built upon these things (Kurtzman 1993), and this increasingly includes generalized markets in debt streams of all sorts (Lenzner and Heuslein 1993).

But information technology can also reduce information costs when applied to work activities in bureaucracies and clans, perhaps leading these activities to change their economic organization. When designed and introduced in accord with the capture model, through the use of an ontology and grammar of social interaction, computer-supported cooperative work (CSCW) tools are particularly well suited to this purpose. The grammars which such tools impose upon an organization's activities necessarily structure, to some substantial extent, the relationships among the organization's members (Ciborra and Olson 1988). In particular, Ciborra (1987: 263) recommends for this purpose the framework of speech acts and commitments (Flores and Ludlow 1981) later employed by the Coordinator (see above, Section 4). (As a general matter, of course, such systems are more readily implemented when supporting activities that are already organized through a grammar of action. The point is simply that they may prove suitable for less structured activities as well.) Once these qualitative structures of work interactions have been formalized and successfully submitted to automatic tracking and enforcement, it costs less to coordinate them all.

The analysis of transaction costs has political consequences for the design of computer systems that support cooperative work. For example, Ciborra and Olson (1988) assert that, in reducing transaction costs, new technologies can be designed to reinforce clan-like structures as opposed to creating economic pressures for a transition to hierarchical or market structures. But this is contrary to Coase's (1937) original argument, which is that the use of markets or hierarchies (or, by extension, clans) is determined by their relative costs, with non-market organizations' savings in transaction costs being balanced against their comparative economic inefficiencies. (Incidentally, clans should not be confused with the contemporary phenomenon of frequently reorganized multifunctional "teams," which are, economically speaking, really a kind of internal labor market.) By this logic, technologies that reduce transaction costs will, other things being equal, necessarily shift the balance in the direction of market relations. But, as Coase points out, new technologies can also reduce the costs of organizing (he cites the telegraph and telephone, though the point clearly applies to computer networks as well), thus potentially preserving or even extending the economic scope of firms even in the face of reduced transaction costs. The broader point has considerable significance for designers who wish to encourage clan-like forms of social relations as opposed to market or hierarchical relations: a focus on the reduction of transaction costs will not serve this goal.

These propositions on transaction cost economics, together with the foregoing analysis of capture, suggest a rudimentary theory of the political economy of captured information. To place this theory in perspective, it will help to consider Schiller's (1988) analysis of information as a commodity. Schiller argues against deriving the economic properties of information simply from its inherent qualities (its lack of inherent physical form, ease of duplication, and so forth). Instead, he asserts that the specific historical form of information depends on its embedding in a particular set of social relationships. Information, in particular, has increasingly become a commodity, that is, something produced, exchanged, and used within the framework of a market economy. Indeed, as a rapidly expanding sector of the market, information has become "a fundamental source of growth for the market economy as a whole (1988: 27)." Information, though, has not always been a commodity in this strict sense, and Schiller points to the historical process by which the production of information has become a market-based industry largely comparable to any other, a process that has involved the progressive reorganization of the human activities through which information is produced and used.

The economic theory of capture presented here makes it possible to extend Schiller's analysis in the case of one considerable category of information commodities, namely captured information. Regardless of its particular content, captured information is distinguished by its dual relationship—both product and representation—to the human activities upon which particular grammars of action have been imposed. In particular, the capture process makes "visible" a great deal of information-creating activity which had formerly been left implicit in the production of other, historically prior commodities. Moreover, the phenomenon of capture extends market relations not simply through the commodification of the captured information itself (if in fact that information is marketed), but also through the movement toward market relations, through a reduction in transaction costs, of the human activities that the information represents. In other words, by imposing a mathematically precise form upon previously unformalized activities, capture standardizes those activities and their component elements and thereby prepares them (again, other things being equal) for an eventual transition to market-based relationships. This transition is not a mechanical process, to be sure; attempts to impose grammars of action upon existing forms of activity are themselves forms of activity pursued by fully blown human agents, and they regularly fall prey to technical or economic miscalculations, or to the resistance of the participants. The tendency of information technology to contribute to the spread of market relations into previously hierarchical or informal territories of activity should thus be understood as the historically contingent confluence of a disciplinary practice and an economic "law," on the same basis as the mutual accommodation of supply and demand in perfect markets.

That said, the role of information technology in the generalization and extension of market relations is formidable and not to be underestimated. The process is extraordinarily systematic. At the level of the professional practice of computer people it takes the form of a kind of representational crusade—the conscious formulation of a thoroughgoing system of ontological categories for the full range of productive activities, at every level from the global economy as a whole to the most refined unitary action. No matter how forbidding their discursive forms may be and no matter how esoteric much of their specific content routinely is, these ontological schemes must nonetheless be understood fundamentally not as "technical" but as "social." In other words, the practice of formulating these ontologies is, all disciplinary insularity aside, and regardless of anyone's conscious understandings of the process, a form of social theorization. And this theorizing is not simply a scholastic exercise but is part of a much larger material process through which these new social ontologies, in a certain specific sense, become real.

The relevant sense of "reality" must be defined with care, since, as Section 4 has argued at length, the articulation and imposition of grammars of action routinely involves a kind of mythology: the idea that the activity in question has already been organized in accord with the grammar, and that the subsequent capture scheme simply reads off, in real time, a representation of this preexisting formal structure. This kind of mythology is frequently associated with the constitution of novel commodities, and may even help define the commodity-form as a social phenomenon. Indeed, the theory of transaction costs exhibits the same form of mythology, inasmuch as it presupposes that the entire world of productive activities can be conceptualized, *a priori,* in terms of extremely numerous episodes of exchanges among economic actors.

The truth, of course, is more complicated. The introduction of capture systems into existing activities requires a great deal of effort, including not simply the technical work of building and installing the system but the social work of imposing the system and then living with it. In particular, the work of imposing a capture system frequently involves conflict, as the affected parties organize resistance to it and its beneficiaries organize to overcome, dissolve, or circumvent this resistance (Agre in press). Normally these conflicts take place within the context of existing organizational structures, but if the transaction cost analysis is any guide then many of these conflicts will become largely moot as the contested social relationships move increasingly toward the market. The growth in temporary employment (Negrey 1993, Sacco 1993) and the trend toward outsourcing of non-core functions (Quinn 1992) may be, at least in part, one reflection of this movement. Be this as it may, a rapidly growing literature is exploring the potentially considerable structural changes to firms and markets in which information technology may participate (Davis 1987, Quinn 1992, Scott Morton 1991).

The analysis in this section, once again, should not be understood as a finished theory but as a conjectural outline of a program of research. Lest the theory be overgeneralized, several qualifying points, already implicit in the argument above, should be emphasized. Information technology is not synonymous with the capture model (at least not in principle), the application of information technology can have other consequences besides the reduction of transaction costs, and reductions in transaction costs do not necessarily induce transitions to market relations if other, countervailing factors are present. Changes that reduce the costs of some transactions may be accompanied by, even linked to, other changes that simultaneously increase the costs of other transactions. (Indeed, Allen (1994) suggests that increased integration of production processes requires new, less routinized kinds of relationships among the people involved.) Applications of information technology are invariably accompanied by other developments and other agendas that can influence the shape and consequences of narrowly technological changes. Finally, all of these phenomena are subject to contestation on a wide variety of fronts.

These qualifications having been stated, the hypothesis seeking validation can be formulated in the largest possible terms: the computer practitioner's practice of capture is instrumental to a process by which economic actors reduce their transaction costs and thereby help transform productive activities along a trajectory towards an increasingly detailed reliance upon (or subjection to) market relations. The result is a generalized acceleration of economic activity whose social benefits in terms of productive efficiency are clear enough but whose social costs ought to be a matter of concern.

8 Conclusion

The previous sections have outlined a political economy of workplace privacy, building on an analysis of the professional practice of computer people. This discussion provides some resources for a more careful consideration of the relationship between the two models of privacy, the surveillance model and the capture model, that I introduced at the outset. Let us review these models' respective definitions, recalling once again that they are intended as metaphor-systems and not as mutually exclusive categories:

> (1) The surveillance model employs visual metaphors, most famously Orwell's "Big Brother is watching you"; the capture model employs linguistic metaphors by means of various grammars of action.
>
> (2) The surveillance model emphasizes nondisruptive, surreptitious data collection; the capture model describes the readily apparent instrumentation that entails the reorganization of existing activities.
>
> (3) The surveillance model is concerned to mark off a "private" region by means of territorial metaphors of "invasion" and the like; the capture model portrays captured activities as being constructed in real-time from a set of institutionally standardized parts specified by the captured ontology.
>
> (4) The surveillance model depicts the monitoring of activity as centrally organized and presumes that the resulting information is centrally stored; the capture model emphasizes the locally organized nature of contests over the capture process and their structuring within particular institutional contexts.
>
> (5) The surveillance model takes as its prototype the malevolent political activities of state organizations; the capture model takes as its prototype the quasi-philosophical project of ontological reconstruction undertaken by computer professionals in private organizations.

The body of the paper has introduced a reasonably substantive theory of capture as part of the historical dynamics of a market economy. This theory does not pretend to cover all uses of commodified information, and it would be worth exploring the possibilities of a parallel theory of information formed into commodities through processes better understood through the surveillance model. Such a theory is available in the work of Gandy (1993), who emphasizes the now vast market machinery around the personal information that people leave behind in a wide range of public records and economic transactions. Much of this information, no doubt, arises in the first place through the capture of activities of various kinds. One possibility is that market pressures of various sorts tend to induce a transition in the manner in which information is collected, away from the surveillance model and toward the capture model. Such a trend, if it exists, will presumably be most marked in workplaces, where the relations of power necessary to impose grammars of action are the most fully developed. But the accumulation of personal information through medical care, the contractual conditions of insurance coverage, and driving on increasingly instrumented public roads (Bender 1991, Jurgen 1991) also provides promising sites of investigation along these lines.

Some additional topics invite further research. It would be valuable to catalog the kinds of organizational transformations that can accompany the imposition of grammars of action. Capture, and particularly the sharing and standardization of ontologies, may provide a vocabulary for exploring some of the interlocking, overlapping, and cross-fertilization among various forms of computer-mediated work that are evolving within the global economy (Rosenberg 1982). The processes of articulation and imposition should be studied empirically in a variety of settings, particularly with regard to the forms of "participation" that they exhibit. The genealogy of the capture model should be sought in the history of ideas and in the historical development of the computer profession and its practices. The transaction cost model of capture economics should be evaluated and extended with reference to detailed case studies.

The analysis of the capture model has significant implications for designers. It provides some tools for placing technical design-styles in larger political and economic contexts, and thereby for more consciously setting research priorities in accordance with democratic goals. This analysis might also provide some impetus for investigations of the underlying structures of design practices, and it might provide a prototype for research into the political and economic dimensions of various specific formations of design. Finally, it would seem important to articulate various counter-traditions of design and their associated counter-visions of human activity, keeping in mind the trade-offs that are stubbornly inherent in computers and computational design as these things are currently constituted.

Acknowledgements

This paper originated in comments that I prepared as a discussant at the Symposium on Basic Research Topics at the Conference on Computer-Human Interaction in May 1992 in Monterey, California. Thanks to John Carroll and Jim Hollan for their roles in organizing this meeting. I presented a subsequent version at the Third Conference on Computers, Freedom, and Privacy in March 1993 in San Francisco. Thanks to numerous participants in this conference for their useful comments. The paper has also benefitted from comments by Jonathan Allen, Rick Crawford, Bruce Donald, Mike Robinson, Dan Schiller, Lucy Suchman, and Randy Trigg.

Bibliography

Philip E. Agre, From high tech to human tech: Empowerment, measurement, and social studies of computing, in Geof Bowker, Leigh Star, Les Gasser, and Bill Turner, eds *Social Science Research, Technical Systems and Cooperative Work,* forthcoming.

Philip E. Agre, Conceptions of the user in computer system design, in Peter Thomas, ed., *Social and Interactional Dimensions of Human-Computer Interfaces,* Cambridge: Cambridge University Press, in press.

Jonathan Allen, Mutual control in the newly integrated work environments, *The Information Society* 10(3), 1994, this issue.

Anonymous, Bar code data collection is the key in the success of NCR's JIT processes, *Industrial Engineering* 22(9), 1990, pages 30–32.

Paul Attewell, Big brother and the sweatshop: Computer surveillance in the automated office, Sociological Theory 5(1), 1987, 87–89. Reprinted in Charles Dunlop and Rob Kling, eds., *Computerization and Controversy: Value Conflicts and Social Choices,* Boston: Academic Press, 1991.

David Baum, Au Bon Pain gains quick access to sales data: Unix-based cooperative processing system gives restaurants a competitive advantage, *InfoWorld* 14(32), 10 August 1992, page 46.

Jacob G. Bender, An overview of systems studies of automated highway systems, *IEEE Transactions on Vehicular Technology* 40(1), 1991, pages 82–99.

John Bowers, The politics of formalism, in Martin Lea, ed., *Contexts of Computer-Mediated Communication,* New York: Harvester Wheatsheaf, 1992.

Ronald J. Brachman and Hector J. Levesque, Readings in Knowledge Representation, Los Altos, CA: Morgan Kaufmann, 1985.

Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century,* New York: Monthly Review Press, 1974.

Christine Bullen and John Bennett, Learning from user experiences with groupware, in *Proceedings of the ACM Conference on Computer-Supported Cooperative Work,* Portland, Oregon, 1988, pages 125–139.

David Burnham, The Rise of the Computer State, New York: Random House, 1983.

John M. Carroll and Thomas P. Moran, Introduction to this special issue on design rationale, *Human-Computer Interaction* 6(3–4), 1991, pages 197–200.

John M. Carroll, Creating a design science of human-computer interaction, in Alain Bensoussan and Jean-Pierre Verjus, eds., *Future Tendencies in Computer Science, Control, and Applied Mathematics: 25th Anniversary of INRIA,* New York: Springer Verlag, 1992.

Noam Chomsky, *Problems of Knowledge and Freedom: The Russell Lectures,* New York: Pantheon, 1971.

Claudio U. Ciborra, Information systems and transactions architecture, *International Journal of Policy Analysis and Information Systems* 21(3), 1983, pages 145–160.

Claudio U. Ciborra, Research agenda for a transaction cost approach to information systems, in Richard J. Boland, Jr. and Rudy A. Hirschheim, eds., *Critical Issues in Information Systems Research,* Chichester, UK: Wiley, 1987.

Claudio U. Ciborra and Margrethe H. Olson, Encountering electronic work groups: A transaction costs perspective, *Proceedings of the Conference on Computer-Supported Cooperative Work,* September 26–29, 1988, Portland, Oregon, pages 94–101.

Roger A. Clarke, Information technology and dataveillance, *Communications of the ACM* 31(5), 1989, pages 498–512.

Victoria K. Clawson and Robert P. Bostrom, *Facilitation: The human side of groupware,* Paper presented at the Groupware '93 Conference, San Jose, California, 1993.

Andrew Clement, Office automation and the technical control of information workers, in Vincent Mosco and Janet Wasko, eds., *The Political Economy of Information,* Madison: University of Wisconsin Press, 1988.

Ronald H. Coase, The nature of the firm, *Economica* NS 4, 1937, pages 385–405.

J. Daniel Couger, Evolution of business system development techniques, *Computing Surveys* 5(3), 1973, pages 167–198.

Richard M. Cyert and James G. March, *A Behavioral Theory of the Firm,* Englewood Cliffs, NJ: Prentice-Hall, 1963.

Stanley M. Davis, *Future Perfect,* Reading, MA: Addison-Wesley, 1987.

Bruce Donald, On information invariants in robots, unpublished manuscript.

Paul Dourish, Culture and control in a media space, in Georgio de Michelis, Carla Simone and Kjeld Schmidt, eds., *Proceedings of the Third European Conference on Computer-Supported Cooperative Work: ECSCW'93,* Dordrecht, The Netherlands: Kluwer, 1993.

Caroline A. Duffy, UPS toes the line with its package-tracking technologies, *PC Week* 10(25), 28 June 1993, page 211.

Wayne Eckerson, Hand-held computers will help UPS track packages; tablets will let drivers capture electronic signatures, *Network World* 8(18), 6 May 1991, pages 15–16.

The Economist, Big Brother is clocking you: The technology that promised fewer traffic jams may damage your civil liberties, *The Economist*, 7 August 1993, pages 71–72.

Richard Edwards, *Contested Terrain: The Transformation of the Workplace in the Twentieth Century,* New York: Basic Books, 1979.

Scott Elrod, Gene Hall, Rick Costanza, Michael Dixon, and Jim des Rivieres, Responsive office environments, *Communications of the ACM* 36(7), 1993, pages 84–85.

James F. Fales, Exciting times for new developments in tracking systems, *Industrial Engineering* 24(5), 1992, page 14.

David H. Flaherty, *Protecting Privacy in Surveillance Societies: The Federal Republic of Germany, Sweden, France, Canada, and the United States,* Chapel Hill: University of North Carolina Press, 1989.

Fernando Flores and J. J. Ludlow, Doing and speaking in the office, in Goran Fick, Ralph H. Sprague, eds., Decision support systems: Issues and challenges, Oxford: Pergamon Press, 1980.

Fernando Flores, Michael Graves, Brad Hartfield, and Terry Winograd, Computer systems and the design of organizational interaction, ACM Transactions on Office Information Systems 6(2), 1988, pages 153–172.

Laurie Flynn, They're watching you: Electronic surveillance of workers raises privacy concerns, *San Jose Mercury News,* 13 June 1993, page 1F.

Oscar H. Gandy, Jr., *The Panoptic Sort: A Political Economy of Personal Information,* Boulder: Westview Press, 1993.

Harold Garfinkel, "Good" organizational reasons for "bad" clinic records, in *Studies in Ethnomethodology,* Polity Press, 1984. Originally published in 1967.

Barbara Garson, *The Electronic Sweatshop: How Computers are Transforming the Office of the Future into the Factory of the Past,* New York: Penguin, 1989.

Les Gasser, The integration of computing and routine work, *ACM Transactions on Office Information Systems* 4(3), 1986, pages 205–225.

Frank B. Gilbreth, *Primer of Scientific Management,* New York: Van Nostrand, 1912.

Rich Gold, This is not a pipe, *Communications of the ACM* 36(7), 1993, page 72.

Rebecca A. Grant, Christopher A. Higgins, and Richard H. Irving, Computerized performance monitors: Are they costing you customers?, *Sloan Management Review* 29(3), 1988, pages 39–45.

Michael Hammer, Reengineering work: Don't automate, obliterate, *Harvard Business Review* 68(4), July-August 1990, pages 104–112.

A. Hawker, Not standard practice, *Health Service Journal* 101, 28 March 1991, pages 31, 33.

Martin Heidegger, *Being and Time,* translated by John Macquarrie and Edward Robinson, Harper and Row, 1961. Originally published in German in 1927.

Thomas Hoffman, Database control, *Information Week* 277, 9 July 1990, page 26.

Walter G. Holmes, *Applied Time and Motion Study,* New York: Ronald Press, 1938.

Robert Howard, *Brave New Workplace,* New York: Penguin, 1985.

Martin Jay, *Downcast Eyes: The Denigration of Vision in Twentieth-Century French Thought,* Berkeley: University of California Press, 1993.

H. Thomas Johnson and Robert S. Kaplan, *Relevance Lost: The Rise and Fall of Management Accounting,* Boston: Harvard Business School Press, 1987.

Ronald K. Jurgen, Smart cars and highways go global, *IEEE Spectrum* 28(5), 1991, pages 26–36.

Rob Kling, Social analyses of computing: Theoretical perspectives in recent empirical research, *Computing Surveys* 12(1), 1980, pages 61–110.

Rob Kling and Suzanne Iacono, Computing as an occasion for social control, *Journal of Social Issues* 40(3), 1984, pages 77–96.

Rob Kling, Theoretical perspectives in social analysis of computerization, in Zenon W. Pylyshyn and Liam J. Bannon, *Perspectives on the Computer Revolution,* second edition, Norwood, NJ: Ablex, 1989.

Rob Kling, Cooperation, coordination and control in computer-supported work, *Communications of the ACM* 34(12), 1991, pages 83–88.

Rob Kling and Charles Dunlop, Controversies about computerization and the character of white collar worklife, *The Information Society* 9(1), 1993, pages 1–30.

Joel Kurtzman, *The Death of Money,* New York: Simon and Schuster, 1993.

Erik Larson, *The Naked Consumer: How Our Private Lives Become Public Commodities,* New York: Henry Holt, 1992.

George Lawton, Macs hit the road to keep trucks on track, help cut costs, *MacWEEK* 6(41), 16 November 1992, pages 32–33.

Ed Leibowitz, Halt: Open architecture detains prisoners under house arrest and keeps tabs on parolees, *Teleconnect* 10(11), 1992, pages 36–38.

Robert Lenzner and William Heuslein, How derivatives are transforming Wall Street, *Forbes* 151(7), 29 March 1993, pages 62–72.

William O. Lichtner, *Planned Control in Manufacturing,* New York: Ronald Press, 1924.

Stephen Loudermilk, Toronto tracks vehicles over wireless net, *PC Week* 10(6), 15 February 1993, pages 47–48.

Paul Luff, Nigel Gilbert, and David Frohlich, eds., *Computers and Conversation,* London: Academic Press, 1990.

Ronni T. Marshak, Action Technologies' workflow products, *Workflow Computing Report* 16(5), 1993, pages 1–20.

James Martin, *Strategic Information Planning Methodologies,* second edition, Englewood Cliffs, NJ: Prentice Hall, 1989.

John P. McPartlin, Press 1 for cheeseburger: IS chiefs scramble for advantage in the fast food fracas, *Information Week* 374, 18 May 1992, page 78.

Raul Medina-Mora, Terry Winograd, Rodrigo Flores, and Fernando Flores, The action workflow approach to workflow management technology, *Proceedings of CSCW–92,* Toronto, Ontario, 1992, pages 281–288.

Kenneth Meyer, Hugh L. Applewhite, and Frank A. Biocca, A survey of position trackers, *Presence* 1(2), 1992, pages 173–200.

Peter A. D. Mill, Volker Hartkopf, Vivan Loftness, and Pleasantine Drake, The challenge to smart buildings: User-controlled ecological environments for productivity, in David V. Gibson, George Kozmetsky, and Raymond W. Smilor, eds., *The Technopolis Phenomenon: Smart Cities, Fast Systems, Global Networks,* Lanham, MD: Rowman and Littlefield, 1992.

Robert B. Miller and Stephen E. Heiman, Conceptual Selling, New York: Warner, 1987.

Cynthia Negrey, *Gender, Time, and Reduced Work,* Albany: State University of New York Press, 1993.

Richard R. Nelson and Sidney G. Winter, An Evolutionary Theory of Economic Change, Cambridge: Harvard University Press, 1982.

Wanda J. Orlikowski, Learning from Notes: Organizational issues in groupware implementation, *The Information Society* 9(3), 1993, pages 237–250.

William G. Ouchi, A conceptual framework for the design of organizational control mechanisms, *Management Science* 25(9), 1979, pages 838–848.

Jeff Y.-C. Pan and J. Marty Tenenbaum, An intelligent agent framework for enterprise integration, *IEEE Transactions on Systems, Man and Cybernetics* 21(6), 1991, pages 1391–408.

Charles Piller, Privacy in peril: how computers are making private life a thing of the past, *Macworld* 10(7), 1993, pages 124–130.

James Brian Quinn, *Intelligent Enterprise: A Knowledge and Service Based Paradigm for Industry,* New York: Free Press, 1992.

Timothy R. Rabel, Software and privacy: revising Orwell, IEEE Software 10(3), 1993, pages 92–93.

Kevin Robins and Frank Webster, Cybernetic capitalism: Information, technology, everyday life, in Vincent Mosco and Janet Wasko, eds., *The Political Economy of Information,* Madison: University of Wisconsin Press, 1988.

Lura K. Romei, Software helps find the applicants you need, *Modern Office Technology* 36(8), 1991, pages 52–53.

Nathan Rosenberg, *Technological interdependence in the American economy, Inside the Black Box: Technology and Economics,* Cambridge: Cambridge University Press, 1982.

James B. Rule, Private Lives and Public Surveillance: Social Control in the Computer Age, New York: Schocken Books, 1974.

James Rule and Paul Attewell, What do computers do?, *Social Problems* 36(3), 1989, pages 225–241.

Charles F. Sabel, *Work and Politics: The Division of Labor in Industry,* Cambridge: Cambridge University Press, 1982.

Tony Sabetti, RF/ID creates dynamic links between people, objects, and processes, *I&CS (Instrumentation & Control Systems) 66(10),* 1993, pages 41–44.

Samuel R. Sacco, All employment relationships are changing, *Modern Office Technology* 38(5), 1993, pages 47–48.

Dan Schiller, How to think about information, in Vincent Mosco and Janet Wasko, eds., T*he Political Economy of Information,* Madison: University of Wisconsin Press, 1988.

Douglas Schuler and Aki Namioka, eds., *Participatory Design: Principles and Practices,* Hillsdale, NJ: Erlbaum, 1993.

Michael S. Scott Morton, ed., *The Corporation of the 1990s: Information Technology and Organizational Transformation,* New York: Oxford University Press, 1991.

John R. Searle, *Speech Acts: An Essay in the Philosophy of Language,* Cambridge: Cambridge University Press, 1969.

Harley Shaiken, *Work Transformed: Automation and Labor in the Computer Age,* New York: Holt, Rinehart, and Winston, 1985.

Robert Ellis Smith, *Privacy: How to Protect What's Left of It,* New York: Anchor Press, 1979.

Steve Smith, How much change at the store?: The impact of new technologies and labour process on managers and staffs in retail distribution, in David Knights and Hugh Willmott, eds., *New Technology and the Labour Process,* London: Macmillan, 1988.

Arthur L. Stinchcombe, *Information and Organizations,* Berkeley: University of California Press, 1990.

Lucy A. Suchman, Office procedure as practical action: Models of work and system design, *ACM Transactions on Office Information Systems* 1(4), 1983, pages 320–328.

Lucy Suchman and Brigitte Jordan, Computerization and women's knowledge, in Kea Tijdens, Mary Jennings, Ina Wagner, and Margaret Weggelaar, eds., *Women, Work and Computerization: Forming New Alliances,* Amsterdam: North-Holland, 1989.

Lucy Suchman, Technologies of accountability: Of lizards and aeroplanes, in Graham Button, ed., *Technology in Working Order: Studies of Work, Interaction, and Technology,* London: Routledge, 1992.

Lucy Suchman, Do categories have politics?: The language/action perspective reconsidered, in Georgio de Michelis, Carla Simone and Kjeld Schmidt, eds., *Proceedings of the Third European Conference on Computer-Supported Cooperative Work: ECSCW'93,* Dordrecht, The Netherlands: Kluwer, 1993.

Frederick Winslow Taylor, *The Principles of Scientific Management,* New York: Harper, 1923.

Paul Thompson, *The Nature of Work: An Introduction to Debates on the Labour Process,* second edition, London: Macmillan, 1989.

S. J. Udoka, Automated data capture techniques: A prerequisite for effective integrated manufacturing systems, *Computers and Industrial Engineering* 21, 1991, pages 217–222.

Charles Von Simpson, Food fight: Business strategies, Computerworld 23(40), 2 October 1989, pages S22–26.

Richard E. Walton, *Up and Running: Integrating Information Technology and the Organization,* Boston: Harvard Business School Press, 1989.

Roy Want, Andy Hopper, Veronica Falcao, and Jonathan Gibbons, The active badge location system, *ACM Transactions on Information Systems* 10(1), 1992, pages 91–102.

Willis H. Ware, The new faces of privacy, *The Information Society* 9(3), 1993, pages 195–212.

Mark Weiser, Ubiquitous computing, *Computer* 26(10), 1993, pages 71–72.

Oliver E. Williamson and Sidney G. Winter, *The Nature of the Firm: Origins, Evolution, and Development,* Oxford: Oxford University Press, 1991.

Terry Winograd and Fernando Flores, *Understanding Computers and Cognition: A New Foundation for Design,* Norwood, NJ: Ablex, 1986.

JoAnne Yates, *Control through Communication: The Rise of System in American Management,* Baltimore: Johns Hopkins University Press, 1989.