Surveillance and Capture: Two Models of Privacy

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Two models of privacy issues are contrasted. The surveillance model employs visual metaphors (e.g., "Big Brother is watching") and derives from historical experiences of secret police surveillance. The less familiar capture model employs linguistic metaphors and has deep roots in the practices of applied computing through which human activities are systematically reorganized to allow computers to track them in real time. The capture model is discussed with reference to systems in numerous domains.

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:

(1) 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.

(2) 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.

The next section 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. The third section takes up this observation more formally by introducing and defining the surveillance model and the capture model of privacy issues. The fourth section 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. The fifth section describes some trade-offs inherent in the concept of capture, and consequently in the very design of computer systems as they are currently understood. The sixth section 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. The seventh section 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. The final section concludes by returning to the comparison between the surveillance and capture models and assessing some of the possible futures to which they point.

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 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 U.S. 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; pp. 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 et al., 1992).

- One division of NCR has integrated its just-in-time manufacturing systems with a plantwide 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 perform 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 certain branch managers' functions with centralized control (Walton, 1989, p. 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 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 require only an approximate location, and thus may receive only 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 LEDs 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 enti-

ties 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 that 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, or both, 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 are 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.

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, proto-
typically 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"

(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 phe-
nomenon. Although its earliest genealogy deserves further research, its modern history is
clearly rooted in the historical experience of secret police organizations and their net-
works 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 con-
notations 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 ap-
plying 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 with-
out critically analyzing it or considering alternatives, indexing it through the term surveil-
lance 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 & 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 re-
senting 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 re-
search, refers to a representation scheme's ability to fully, accurately, or "cleanly" ex-
press 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 pro-
gram 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 "epistemo-
logical" in the *second* sense of capture, not the first.)

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

(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 that involve people in the workings of larger social formations

(5) Driving aims that 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 earlier 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.

Grammars of Action

Computers are frequently said to store and transmit information. The term information, 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, pp. 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 (1992, pp. 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. 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 et al., 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, pp. 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. The five main stages are as follows:

- *Analysis.* Somebody studies an existing form of activity and identifies its fundamental units in terms of some ontology (entities, relations, functions, primi-

tive 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 "parsable" 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 "listen to" 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 been not "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 roughly 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, p. 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 their actual complexities and the actual social forces that determine their 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, p. 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' judgment 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 judgment 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, conflict with the mythology only 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, 1991), 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 & 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 earlier. 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.

Capture and Functionality

A variety of projects, particularly in the participatory design movement (Schuler & 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 et al., 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 compute only 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 track only what it can capture, and it can capture only information that can be expressed within a grammar of action that has been imposed upon the activity. Numerous systems, including many of the examples cited earlier, reside toward the minimal end of this trade-off, since they track only 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) 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 (pp. 104 ff).

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.

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 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 & 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 workways 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 multidimensional 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 can lead to 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 employees 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 et al., 1988; Kling, 1989; Kling & 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. 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 engaged 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; p. 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 "deskilling," 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.

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 that 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, pp. 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, p. 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 & 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 that such tools impose upon an organization's activities necessarily structures, to some substantial extent, the relationships among the organization's members (Ciborra & Olson, 1988). In particular, Ciborra (1987, p. 263) recommends for this purpose the framework of speech acts and commitments (Flores & Ludlow, 1980) later employed by The Coordinator (see above). (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 clanlike 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 clanlike 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" (Schiller, 1988, p. 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 that 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 has been argued at length earlier in this paper, the articulation and imposition of grammars of action routinely involve 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 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 noncore 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 toward an increasingly detailed reliance upon (or subjection to) market relations. The result is a generalized accel-

eration 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.

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 the definitions of these models, 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-fertiliza-

tion 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 countertraditions of design and their associated countervisions of human activity, keeping in mind the trade-offs that are stubbornly inherent in computers and computational design as these things are currently constituted.

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