Computerization and Social Transformations

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This article examines the relationship between the use of computer-based systems and transformations in parts of the social order. Answers to this question rest heavily on the way computer-based systems are consumed *—not just produced or disseminated. The discourse about computerization advanced in many professional magazines and the mass media is saturated with talk about "revolution," and yet substantial social changes are often difficult to identify in carefully designed empirical studies. The article examines qualitative case studies of computerization in welfare agencies, urban planning, accounting, marketing, and manufacturing to examine the ways that computerization alters social life in varied ways: sometimes restructuring relationships and in other cases reinforcing existing social relationships. The article also examines some of the theoretical issues in studies of computerization, such as drawing boundaries. It concludes with some observations about the sociology of computer science as an academic discipline.*

The Question of Social Transformation

One of the fascinating and important sociological questions surrounding computerization is the extent to which the use of computer-based systems really transforms any part of the social order—and if so, how? Answers to this question rest heavily on the way computer-based systems are *consumed* —not just produced or disseminated. This question differs from the central focus of the sociology of technology on the conditions that produce differing technologies and the character of technological alternatives (e.g., Bijker,

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Hughes, and Pinch 1987).[1] In my view, it is a fundamental question, since social studies of technology gain their public value by shedding light on the consequences of social groups using various technologies. Moreover, if we want technologists to take the social consequences of their designs into account, some group should be producing reliable studies to help inform their actions. Whether and how the widespread use of computer-based systems transforms parts of the social order are just two of the fascinating questions about the social consequences of computerization. But they have attracted attention and stimulated significant discussion.

Studies of computerization and the quality of working life are one domain in which scholars and professionals have raised questions about social transformations attributable to computerization. In addition to a large body of specialized research studies (cf. Attewell 1987a, 1987b; Dunlop and Kling forthcoming; Danziger and Kraemer 1986), several authors have addressed this question in books with a broad historical sweep and bold theorizing. In *Information Payoff: The Transformation of Work in The Electronic Age,* Strassman (1985) argues that computerization will make work more varied, interesting, and flexible. In contrast, in *Work Transformed,* Shaiken (1986) argues that (under capitalism), managers routinely computerize so as to increase their control by fragmenting and deskilling jobs. Zuboff's (1988) *In the Age of the Smart Machine: The Future of Work and Power* describes case studies of clerks and blue-collar workers—all of whom found their work made more abstract, confusing, and socially isolating after computerization projects. Each of these authors argues that computerization transforms work, but each identifies different typical changes. Each of these authors attempts to characterize computerization within a single overarching logic. The boldness of the accounts is daunting, and yet each author's evidence seems carefully selected to fit his or her logic of social change.[2]

There are now a large number of social studies of topics such as computerization and work, the practices of software developers using artificial intelligence, the use of computer-based models in policy making, the relationship between computerization and the structure of organizations, and computerization and shifts of power. I find the best-quality studies are often relatively micro in scale. There are tens of thousands of settings in which people and organizations computerize; these vary in social scale, ecology of social interests and their balance of power, relevant ideologies, technical and economic options, and so on. We therefore have trouble assembling a credible composite historical portrait of the links between computerization and the larger social order.

Although their social roles are the subject of immense hype, computer-based technologies are potentially socially transformative (Kling and Iacono 1990). By transformative, I mean that they can play key roles in restructuring major social relationships—interpersonal, intergroup, and institutional. Computer systems can restructure social relationships by altering the kinds of information readily available, reorganizing patterns of access to information, altering the cost and work of organizing information, and shifting patterns of social dependencies for key resources, such as computing and skilled computing staff. Whether computer-based systems have been integrated into social settings so as to transform them, reinforce patterns of preexisting social relationships, or have negligible influence is still the subject of research. Moreover, the systemic character of the transformations that do occur is still unclear. Computerization also raises questions about value conflicts and social choices that participants often do not seem to understand very well. Articulating these social choices is a potential contribution of scholars who do social studies of science and technology.

I will examine some of the attempts my colleagues and I have made to work on questions like these through a 20-year program of research at the University of California, Irvine (UCI), on the social aspects of computerization. We did not conduct these in scholarly isolation, although the active research community was tiny when we began. I have published integrated reviews of social studies of computerization elsewhere that identify key lines of work and theoretical perspectives of the larger research community (Kling 1980, 1989; Dunlop and Kling forthcoming).

In the early 1970s, I teamed up with Kenneth Kraemer, a scholar of public administration, and Jim Danziger, a political scientist, to study the social impacts of computing through a series of empirical studies of computerization in organizations. The researchers at UCI, including Kenneth Kraemer, Jim Danziger, John King, Suzanne Iacono, Nick Vitalari, and me, have examined how computer-based information systems are adopted, what interests they serve, and what consequences they have for organizational practices, decision making, and work life. We have studied computerization in a variety of institutional sectors—including government agencies, factories, banking, schools, offices, and homes. We have tried to amplify the level of social realism in studies of computerization, while avoiding the tendencies to create captivating, but oversimplified and ungrounded, narratives (Kling forthcoming). These studies have focused on computerization within organizations—the primary setting of computer use in the 1970s and 1980s. Much of our work is therefore anchored in theories of organizations.[3] I draw upon some of that research in this article.

Discourse about Computer Revolutions — Popular and Academic

Social change is sometimes treated as a specialty topic within sociology. Yet ideas about social change so permeate the discourse and images of computerization that they should be at the center of attention for sociological inquiry. I do not mean that sociologists should uncritically accept glossy images of "information societies" or "computer revolution" or "revolutionary this and that," which are part of the official story of computerization — pushed by the marketing arms of computer vendors as well as futurists like Alvin Toffler and John Naisbitt and sympathetically amplified by journalists in the mass media.

Toffler (1980) helped stimulate enthusiasm for computerization in these popular terms in his best seller *The Third Wave*. He characterized major social transformations in terms of large shifts in the organization of society driven by technological change.[4] Toffler is masterful in describing major social changes in energetic prose, for example:

> Today, as we construct a new info-sphere for a Third Wave civilization, we are imparting to the "dead" environment around us, not life, but intelligence. A key to this revolutionary advance is, of course, the computer. (P. 168)
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> As miniaturization advanced with lightening rapidity, . . . [e]very branch factory, laboratory, sales office, or engineering department claimed its own. . . . The brain-power of the computer . . . was "distributed." This dispersion of computer intelligence is now moving ahead at high speed. (P. 169)
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> The dispersal of computers in the home, not to mention their interconnection in ramified networks, represents another advance in the construction of an intelligent environment. Yet even this is not all. The spread of machine intelligence reaches another level altogether with the arrival of microprocessors and microcomputers, those tiny chips of congealed intelligence that are about to become a part, it seems, of nearly all the things we make and use. (P. 170)
>
> What is inescapably clear . . . is that we are altering our info-sphere fundamentally. . . . we are adding a whole new strata of communication to the social system. The emerging Third Wave info-sphere makes that of the Second Wave era — dominated by its mass media, the post office, and the telephone — seem hopelessly primitive by contrast. (P. 172)
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> In all previous societies, the infosphere[5] provided the means for communication between human beings. The Third Wave multiplies these means. But it also provides powerful facilities, for the first time in history, for machine-to-machine communication, and, even more astonishing, for conversation between humans and the intelligent environment around them. When we stand back . . . it becomes clear that the revolution in the info-sphere is at least as dramatic as that of the technosphere — in the energy system and the technolog-

> ical base of society. The work of constructing a new civilization is racing forward on many levels at once. (Pp. 177-78)

Toffler's breathless enthusiasm can be contagious—but it also stymies critical thought. Toffler opens up important questions about the way information technologies alter how people perceive information, the kinds of information they can get easily, and how they handle the information they get. But his account—like many popular accounts—caricatures the answers by using only illustrations that support his generally buoyant theses. And he skillfully sidesteps tough questions while titillating readers with sentences like "The work of constructing a new civilization is racing forward on many levels at once."

Toffler's vision is not dated, however. This is an excerpt from a recent article by two respected information systems scholars:

> The office of the late 1990s can now be envisioned. Its staff of professionals and managers are surrounded by intelligent devices that speak, listen, or interact with them to determine what is to be accomplished and how it is to be done. Contacts with other departments, other divisions, customers, vendors, and other organizations are made with little effort and without human intervention. Behind the scenes, systems are being developed by system developers equipped with versatile and highly integrated software. (Straub and Wetherbe 1989, 1338)

This vision has a character similar to a spaceship in which the crew is highly automated and staffed with robots. But the problematic that these people and organizations suggest—that computerization plays an important role in transforming our social worlds—is too important to ignore. Moreover, this is a pivotal time in which key social choices might still be influenced by sharp and sensitive social analysis.

Sometimes good social analysts get caught up in the rhetorical fervor. For example, in his book on scientific revolutions, the historian Cohen wrote:

> As I was writing this chapter, a glance at a single shelf in my study showed almost a dozen books on computers had 'revolution' in the title. Who would deny that there has been a computer revolution? (1985, 21-22)

I have examined numerous books with terms like *computer revolution* or *information revolution* in their titles. Remarkably, none of these books carefully characterizes computer revolutions analytically or behaviorally. They do not explain how we would know one when we saw it. They usually refer to the pervasiveness of computer systems in social life and suggest that when powerful technologies become commonplace, social life must be altered. I do not mean that a case could not be made. But to my knowledge,

no one has tried to make a careful case—indicating what kinds of social relations have been transformed, at what level of social activity, under what conditions, and what has *not* changed.

I believe that a careful assessment would show that the restructuring of social relations because of computerization has been much more important in some institutional areas than in others. For example, computer-based systems have been part of larger and more far-reaching structural transformations in travel reservations and banking than in the instructional aspects of schooling (unless one considers mass testing). As we know from studies of other social revolutions, such as the industrial revolution and the transition from feudalism to capitalism, major social transformations differ in their timing and depth in different places and social sectors.

I have become skeptical of stories of computerization and social transformations that absorb all changes into one dominant logic—whether it is the blooming of a knowledge-based society (Strassman 1985), a progressive expansion of monopoly capitalism and the domination of the working class (Noble 1984), or a "control revolution" (Beniger 1986).

These single logics have compelling simplicity. They are useful starting points for more subtle inquiries. But as total frameworks, they often mislead. In our studies at UCI, we have taken a position that is *open to the possibility* of social transformations facilitated by computerization. Simultaneously, we have been skeptical of many of the technologically utopian and dystopian claims.

The Varied Character and Conditions of Social Transformations

Transformed Images

Between 1973 and 1979, my colleagues at UCI and I conducted a series of studies about the social impacts of computer-based information systems on the character of work, the nature of decision making, and shifts in the character of services in American local governments. This is a complex set of studies, which I can only begin to sketch. We undertook several qualitative case studies and two large-scale surveys supported by intensive fieldwork.[6]

At the time, a large fraction of the information systems in municipal governments supported finance/taxation/payments and police work. Early on in our study, I learned about the development and use of an information system in a southern city that was used to better provide welfare services to needy people in the city and county. The city, which I have called Riverville, had

several dozen public and private welfare agencies in its jurisdiction (Kling 1978).

The interactive computerized "urban management information system," called UMIS, was described in about 10 articles that were published in professional conferences about information systems or human services management, and in several national news magazines. According to the stories, people would have trouble figuring out which social programs they were eligible for and sometimes "got lost" in shuttling between agencies. The staff that managed UMIS described a series of additional benefits that it was to provide – including reducing paperwork, improving managerial control, and providing key data for needs assessments and program evaluation. I was keenly interested, because the majority of computerized information systems we were studying did not do much to support direct services to people. Here was an interesting exception.

I spent a week in Riverville in 1974 and again in 1975 trying to understand the use and impacts of the system on welfare operations. In the first year's fieldwork I found UMIS heavily used in certain city welfare agencies – in neighborhood referral centers. But it did not seem to have many of the reported consequences for reshaping administrative operations. For example, there were no reductions in paperwork or data for "needs assessments." There was no way to assess a reduction in people getting lost between agencies, since there was no "lost-and-found" client office or tally. Other changes were equally elusive.

In 1975 the city committed an additional $200,000 to operating UMIS after some key federal grants ran out. I was surprised that the city maintained UMIS, despite what seemed to be minor enhancements to their welfare operations. In my second year's fieldwork, I learned that UMIS's primary value was in *enhancing the welfare agencies' image* when they dealt with federal funders and auditors. Welfare administrators claimed that the federal staff from the Department of Health, Education, and Welfare (HEW) saw them as more competent when they used computerized records rather than paper records. Welfare seemed to hum in Riverville when auditors saw UMIS. They were more willing to allocate federal welfare funds to the city. And that was UMIS's primary value to city officials.

All the published accounts of UMIS value led readers to focus inward on the administrative practices of the welfare agencies – and relationships between them. They carefully deleted UMIS's role in these agencies' negotiations with a major source of resources: HEW. It's not clear that local administrators anticipated the negotiating leverage that UMIS would provide. But it was clear that they gained substantial advantage by keeping the

story of its administrative value alive even when they could not realize those dreams.

Managerial Actions Facilitating Social Transformations

In a recent study, Tom Jewett and I contrasted the way that two clerical work groups computerized (Jewett and Kling 1990): the central accounting group in a mortgage bank ("Western Mortgage") and an order-taking group (customer service) in a sales department of a large pharmaceutical firm ("Coast Pharmaceutical").[7] The two work groups are similar in many respects, despite the obvious differences in their major business activity. Both firms provide comfortable office facilities, with attractive modular furnishings. At first glance, the duties of most members in both groups appeared to be primarily clerical. However, on closer study we found that the job content in both groups has been expanding. We have found that employees are no longer confined to simple data entry or bookkeeping tasks. Instead, they are expected to assume increasing responsibilities—for example, tracking down customers' late orders and integrating computer systems into their work routines. The typical members of both groups completed at least some college education and characterized their jobs as "professional," rather than "clerical."

Both work groups were extensively computerized by 1987, in the sense that they had terminals or PCs for at least half of their work group members. However, both groups adopted major new computer-based systems in 1989, and these were catalysts for some changes in the organization and content of work. These changes have increased the number of tasks and responsibilities of their jobs. Western Mortgage acquired a minicomputer system for basic accounting, such as general ledger and accounts payable. It replaced computer services that previously had been contracted to an outside vendor. In previous years, the accounting group used microcomputers for spreadsheets, word processing, and scheduling. But they simply prepared the accounting transactions in a manual form in their office for processing by an outside service bureau. At Coast Pharmaceutical, a new order-tracking system was developed to replace an existing system. Both implementations were "top down," since the initiative for new systems came from outside these work groups.

At Coast Pharmaceutical, managers have consciously changed the tasks being performed in the customer service group. Every job description was rewritten—a very lengthy and complex procedure. The former order entry clerks were reclassified as customer service representatives—a change not

only in name but in increased responsibility and more extensive contact with customers. Each representative, for example, was expected to set up a specific service program for one or more major customer accounts. The representative's pay was also increased by one or two levels.

Many of the order entry/customer service procedures have been computerized for a number of years. As jobs were being changed, the older computer system was gradually upgraded. The customer service personnel designed key parts of the final system to better support their responsibility for tracking all orders placed by a customer. Several managers and employees participated in seven week-long off-site meetings to do the actual work; they reviewed their progress and solicited inputs from other clerks in the group. Clerical participation at Customer Service has not been limited to the computer project; clerks were also involved in redesigning their jobs. This participation may have increased the workers' perceptions of their own influence within the organization.

Western Mortgage installed a minicomputer to replace computer services previously contracted to an outside vendor. For the clerks and supervisors in accounting, the new system has brought changed work procedures. Before, they manually coded ledgers for entry by an outside data-processing service. Now, Western's clerks enter their own figures directly into the computer system. Before, clerks moved between their desks and the file cabinets, frequently consulting others to obtain information for financial reports. Now, they remain at their desks, consulting instead the computer data bases.

Managers do not appear to have intentionally designed these changes but appear to be aware that changes have occurred. On one hand, the clerks have learned new computer skills that some of them believe would help in seeking future employment. On the other hand, opportunities for social interaction within the workplace have decreased, because of less walking around. An eventual outcome could be increased boredom and less social cohesiveness in the work group. Some clerks also see the new requirement for data entry as loss of status.

A vendor developed the software and Western's own Information Systems Department provided hardware support. Accounting clerks and supervisors were involved only when they attended a vendor training session shortly before the new system was installed. But the training was incomplete because the system design was still in flux. Clerks had to develop their own outline of the "basics" for using the computer. They do not see much contribution of computing to their productivity and do not have frequent informal discussions about computerization. The same "laissez-faire" management appears to characterize other aspects of work in accounting. There is no formal

training program, since newly hired employees are expected to be experienced in accounting procedures.

In these two work groups, different management approaches have resulted in very different changes from the computerization projects. The customer service project is transformative in nature—the computerization was an adjunct to job redesign and other organizational practices that were taking place simultaneously. Clerks shifted from passive order entry clerks to much more active roles to help track orders and improve sales and service. Managers believed that high levels of personal involvement and employee participation were needed to restructure jobs and practices as integrated activities. They provided training programs and continuing support for both the new work procedures and the new computer system.

The accounting project, on the other hand, was relatively nontransformative—the new computer system was seen as a simple substitute for the manual procedures and outside computer system. Managers appear to have believed initially that jobs would not be significantly changed as the computer system was implemented. Since there was little need for computer training prior to bringing this computer system inside the accounting department, they did not realize the extent to which training would now be important. Clerks and supervisors were left to rely on themselves and their co-workers for continuing support. While the jobs were upskilled and clerks had fewer opportunities for casual social contact, they remained relatively routinized clerical jobs.[8]

Social Reinforcement

Much of the discourse about computerization is decorated with the promise of the new: futurists like Toffler have coined terms like *electronic cottage* and *info-sphere*. Many computer specialists champion the special role of "expert systems." A recent article about competition in the computer industry in *Fortune*, a popular business magazine, included this sentence: "The industry that has transformed the way that most people work is about to transform the way that most people *want* to work" (Gannes 1988, 43; Gannes's italics).

In our studies of urban information systems (URBIS), we examined the ways in which computer-based systems were instruments in power games played within local governments. In *Computers and Politics* (Danziger et al. 1982), we explain that part of the study in detail. We examined the possibility that computerization alters the politics within local governments in four ways: managerial rationalism (criteria of rationality for the organization as a

whole characterize choices), technocratic elitism (technical assessments made by skilled specialists guide organizational choices), pluralism (different coalitions are advantaged by different decisions, depending on the time and issues), and reinforcement politics (those with most resources gain more influence, while those with fewer resources lose subsequent influence). While we found some support for each of these four models, we found that the reinforcement-politics model had the most systematic support.

In small cities, the top officials (mayors or mangers) were usually able to use computer-based information systems to tighten their control over departments and to gain power at the expense of the part-time city councils. In contrast, the large cities had huge departments with substantial expertise. In these larger cities, we found that departments computerized in ways that brought them more influence relative to central administrators and to the city councils. On the whole, city councils lost influence regardless.

I discuss the findings of reinforcement politics to suggest why computer-based systems need not be instruments of social transformation—for a different reason than the Riverville example. In the case of Riverville, UMIS did not seem to alter social relations within the welfare agencies, between them, or even with their clients. An explanation based on reinforcement politics suggests that the changes need not create new kinds of social relationships—but can strengthen existing ones.

Ideologies and Discourse about Computerization

Much of what we know about the role of computerized technologies in social life comes from a variety of tainted sources—like the professional conferences and news weeklies that published stories about UMIS. During the last 15 years I was first disappointed in, then took for granted, the typical discrepancies between how organizations actually computerize and stories of major social changes or transformations.

In the early 1980s Suzanne Iacono and I conducted several studies of the role of complex information systems in organizational life. One of our key cases focused on a complicated computerized inventory control system, called a material requirements planning (MRP) system, in a medium-sized high-technology manufacturing firm that we called PRINTCO.

We found that PRINTCO's staff frequently recited the same list of organizational impacts in similar terms, such as cost reductions and more efficient uses of inventory. We found some of these claims impossible to document. For example, no one—not the material control managers, the vice

president of finance, or the data-processing manager – could give us a decent estimate of the costs of their inventory control system. Consequently, claims about cost effectiveness were based on something other than tight evidence. We found that many key staff in PRINTCO – including the board of directors and top material managers – had gone to special workshops run by national consulting organizations about this kind of inventory control system. Many of the lower level material control staff attended workshops held by a relevant professional association with local chapters – the American Production and Inventory Control Society. The society's booklets and workshops were important carriers of their litany of changes that the staff then saw.

The staff of PRINTCO had more basis for the belief in their computer system's role in their organization's practices than did the welfare staff of Riverville. For example, the material control manager monitored "inventory turns" as a way of keeping track of how efficiently they were stocking key parts. I am not calling their beliefs delusional. But they voiced them with a confidence that came more from accepting a received ideology than from immediate observation.

We also learned the role that ideologies played in developing support for computer-based systems in studying the PRINTCO case. MRP was an instrument for the material managers. We found that they used their MRP system to gain control over the purchasing staff and to help production line managers battle with projections made by marketing staff. But customizing an MRP system for a manufacturing firm takes tremendous work. It is a major effort to train many staff in the necessary workplace disciplines such as recording data accurately and to insist that all material transfers be reflected in written records. The ideology of MRP impacts helped the material managers *mobilize support* for the organizational changes needed to make the system work locally.

In fact, some of the social changes we observed were ignored in the official MRP literature (Kling and Iacono 1984). For example, we found a general tightening of workplace discipline around record-keeping practices and a restructuring of reporting relations to give material control managers greater influence in the firm. There were some social changes – some arguably transformative – but not where the ideologies of MRP guided us to look. On the other hand, we found the managers at PRINTCO failed in trying to change their MRP system to a newer version, despite major investments in new equipment and several related organizational changes (Kling and Iacono 1989b). Ironically, we invoked theories of institutionalization to explain the relative stability of PRINTCO's information systems and the social organization that supported their computing arrangements.

Based on our observations in this case study and in other settings, Suzanne Iacono and I concluded that ideologies play an incredibly important role in helping key players mobilize support for specific forms of computerization in their own organizations. These key players often participate in a larger social world, outside the organizations that employ them, where they learn, and also refine and promulgate, these ideologies. We become specially skeptical when advocates of computerization (futurists like Toffler or Naisbitt) or critics like Shaiken uncritically accept stories of technological effectiveness as reliable knowledge. At best these ideologies provide clues about what might happen when organizations computerize, but they merit careful empirical investigation to verify their accuracy.

Mobilizing Ideologies and Technological Utopianism

During the past 30 years, social groups in Western societies—especially in the United States—have embarked on major campaigns to computerize. Many of the dominant visions have been articulated by technologists and futurists rather than social analysts. Much of this writing has been framed with a particular brand of utopian thought—technological utopianism. This line of analysis places the use of some specific technology, such as computers, nuclear energy, or low-energy low-impact technologies, as key *enabling elements* of a utopian vision (Kling forthcoming; Dunlop and Kling forthcoming).

Suzanne Iacono and I recently characterized important forms of computerization as the by-product of loosely organized social movements rather than simply an industry selling products to an eager market (Kling and Iacono 1988). Groups that form around a computer technology form a social movement to the extent they (a) have mobilizing ideologies that promote an improved social order or oppose an intolerable social order, (b) form organizations that include a diverse membership, and (c) promote the movement through communication channels and publications.

We examined five arenas of computerization as the activities of social movements: urban information systems, artificial intelligence, office automation, instructional computing, and personal computing. In some of these arenas—such as instructional computing—there are looser social criteria for what constitutes success than in other areas—such as inventory control. Ideologies are more likely to be potent in the face of ambiguous evidence to help make simple sense of complex and conflicting events.

These computer-based social movements share ideological beliefs:

1. Computer-based technologies are central for a reformed world.
2. The improvement of computer-based technologies will help reform society.
3. No one loses from computerization.
4. More computing is better than less, and there are no conceptual limits to the scope of appropriate computerization.
5. Perverse or undisciplined people are the main barriers to social reform through computing.

We did not argue that computerization has not had demonstrable value in some cases, or that it has not changed social systems in some cases. We argued that the ideologies permeated many accounts and shaped the discourse about computerization, and that they are often monochromatic (see also Kling and Iacono 1990).

Activists and computer revolutionaries have not been timid in articulating a social vision that places computer-based systems at the center of a social universe. While I have referred to more popular and academic writers, most computer-based systems are installed with little public view of the social visions held by their designers, developers, and implementors. Here I am thinking of a wide variety of systems, including some that are extremely large in social scale – nets of automated teller machines, interbank clearinghouses for electronic funds transfer, air traffic control systems, and airline reservation systems.[9]

The rhetorics justifying these developments are often anchored in images of an "information society." All such single labels to characterize an era are misleading. But the labels are important when they catch on and shape popular discourse and influence policy debates and organizational action.

Some Conceptual Issues in Studying Technological Systems

To help advance social studies of computerization, the following conceptual issues need serious work: how to characterize the social-technological systems that are the objects of our inquiry and subjects of our theories, how to characterize the social organization that supports these social-technological systems, and how to draw boundaries around studies so that they are manageable by the tiny groups of researchers who investigate them.

Characterizing Technological Systems

One aspect of computerization that makes it difficult as a topic of inquiry is the problem of characterizing appropriate units of analysis. A good deal of

discourse about computerization focuses on a convenient fiction called "the computer system." The computer-based systems that people and groups actually develop and use differ in important technical and social ways. These differences often seem to matter. The computer system is a convenient fiction that deletes nuances of technical differences and social organization when these do not matter. But since different technical features of the computer system and the social organization sometimes do matter, the convenience becomes a liability if our conceptual language is imprisoned in talk about "the computer."

From a technological standpoint, the computer systems that people use are embodiments of procedures running on a particular kind of computer hardware. The hardware may be faster or slower, physically larger or smaller, connected to other machines or not, and provide monochrome or color displays. Technologically, the software is not cut from "common cloth." Information systems differ in key capabilities and their modus operandi. For example, some data base management systems require that each new capability be programmed by a skilled programmer (e.g., Revelation). Others, which have powerful commands on menu systems (such as Paradox), allow moderately skilled users to navigate through data bases in complex ways without requiring all searchers and reports to have been previously programmed by a highly skilled specialist.

Why would such a difference in the architecture of data base management systems matter to a social analyst of technology? If one asks whether computerization leads to changes in the skill level of jobs, then the extent to which the systems people use enable them to develop new or expanded skills is an important part of the answer. Some organizations adopt systems that require programming (and provide no end user flexibility aside from a narrow range of menu choices). In those organizations, we would expect much less upskilling to be likely for people who stay in the computerized tasks — ceteris paribus.

Computer-based systems have important social characteristics as well. The specifications of a Turing Machine have not changed in 50 years. But people ascribe status to real computer systems that are anchored in their social worlds. Many professionals would feel embarrassed to assert that they were working with 20-year-old computer systems, even if they are functionally superb. Artificial intelligence researchers have eschewed IBM mainframes for years and have often generalized their dislike to PCs. Computer scientists have generally galvanized around Macs rather than PCs, even though there are technical ways to configure them similarly and economic incentives for buying PCs. Consequently, people's behavior with computer-

based technologies can hinge on their ascribed social characteristics as much as on their technical features, such as information flows and transformations.

The Social Organization of Access to Information Systems and Information

In addition, access to computer-based systems is organized. A simple example will suffice. When an university instructor adds a computer component to a course, there are specific choices about access to equipment. In order to make efficient use of teaching assistants and equipment, he or she might have computers in tightly scheduled labs. (In the "chemistry lab model," students are assigned fixed times, such as 9:00 A.M.-10:00 A.M., to complete their assignments.) Alternatively, he or she might allow students to use the labs at their discretion, between 8:00 A.M. and 10:00 P.M. (open labs are a library model). Students who take the scheduled lab course might complain that computerizing the course has regimented their lives. It is the social organization of access, rather than "a computer," which is the appropriate object of their complaint.[10]

Let us take a different example. In the United States, consumers have substantial control over payments with credit cards. They can contest billings and withhold funds until disputes with their creditors are resolved. Also they have very limited liabilities for lost cards and few liabilities for errors. In the late 1970s, some managers of the largest banks (Citicorp in New York), began to seek legislation that would remove these protections in the case of debit cards. And they were largely successful (Kling 1983). A debit card has the same physical appearance as a credit card, but the social system of regulation is much more cashlike than a credit card. Compared with credit cards, debit cards facilitate more rapid payments to merchants, do not allow stop payment, and have much higher liability for loss of the card if it is not reported promptly. Electronic funds systems based on credit cards and debit cards have superficial similarities, but consumers have fewer rights and more responsibilities with debit cards.

Computerization as a Social and Technical Process

Because the process of introducing computers changes many elements of social life in organizations concurrently, computerization is not simply installing computer-based systems. In fact, most substantial computerization projects require some changes in key social relationships, even though some important authority relationships are usually untouched (Kling and Iacono

1989a; Jewett and Kling 1990). Our previous example of adding a computer lab to an existing course illustrates some of the ways in which key social choices are coextensive with a computerization project. The social dimensions of the process render computerization socially complex and also technologically indeterminate. There is often more than one way to computerize some segment of social life. The "same equipment" can have different social consequences when the associated social arrangements are substantially different.

Web Models

Since people use computer-based systems in a social setting, the boundaries around the computer must include a good slice of their social worlds. But how to draw boundaries is not always clear. One criterion is clear—that in studies of computer use—and impacts—the infrastructure for support must be included as part of "the computer system" (Kling 1987). In the early 1980s, Walt Scacchi and I developed a crude framework to help set boundaries for social studies of computerization that focused inside organizations—web models (Kling 1987; Kling and Scacchi 1982).

Web models conceive of a computer system as an ensemble of equipment, applications, and techniques with identifiable information-processing capabilities. Each computing resource has costs and skill requirements that are only partially identifiable. Most computer-based information systems do not operate automatically and without human intervention. People and groups who use a computerized information system sometimes see a social support system—however ill organized—along with the physical machinery as something that will help to control their use of the focal technology: to help them learn what it is good for and how to use it, fix problems, and so on. We call this social organization the infrastructure of computing support.

Computer systems and their support organizations are also social objects that may be highly charged with meaning. This approach focuses substantial attention on three key concepts: the *social contexts* in which a computer-based system is develop and used, the *infrastructure* of support for the system (including the social organization of access), and the *history of social arrangements* within which the computer-based system is developed. Web models view information systems as complex social objects constrained by their context, infrastructure and history (Kling and Scacchi 1982).[11]

We articulated this approach as an alternative to "engineering models," which focused on the equipment and its information-processing capabilities as the focus of analysis and formal organizational arrangements as the basis

of social action. We called this asocial alternative "discrete entity" analyses. For example, returning to Riverville, discrete entity analyses focused our attention inward on administrative operation, rather than on a social context that included federal funding and a history of dependencies in which the city staff relied upon external funds for many welfare programs. Web analyses would focus attention outward as well as inward—historically, as well as toward the future. In web analyses, "contexts" refer to social groups and relationships—not to an undifferentiated bath that warms the subjects of our studies.

But where and how should one draw useful boundaries? Why not define the web of dependencies for Riverville's UMIS throughout the public sector? It is possible to set up *criteria* for boundaries a priori. Organizational participants select computing arrangements to leverage their negotiations in a larger social order. They also find that participants are constrained by resources and organizational routines that are defined outside the formal boundaries of their organizations. Organizations that have critical ongoing negotiations with outsiders—clients, auditors, regulators, vendors, competitors—will sometimes develop computing arrangements to enhance their bargaining positions. To understand these choices, a larger situational boundary that includes this expanded organizational set must be drawn. These boundaries themselves cannot be completely defined a priori. Nor can they be defined before the participants of these larger negotiating contexts are identified.

We proposed three criteria for drawing the boundaries of larger-scale situations that serve as useful contexts for a given focal situation (Kling 1987)—include people, equipment, and organizations: (a) who are part of a chain of *resource dependencies,* (b) *who are taken account of* by participants or (c) who *constrain the actions* of the focal actors. A web analyst also includes key social relationships among these people, equipment, and organizations in the analysis.

These criteria help draw *temporal boundaries* as well. Studies of social change and transformations require some kind of historical perspective. But we have not had decent analytical criteria for where to start. Not all studies of computerization should be anchored in the dawn of the control revolution in the late nineteenth century. For example, we feel confident in starting our study of Riverville's welfare administration in the 1960s, PRINTCO's MRP system in the 1970s, and the system changes at Coast Pharmaceutical and Western Mortgage in the 1980s by reference to these criteria. We have found that computerization is often an ongoing process. People and organizations change systems and associated work practices slowly over time, with occasionally more abrupt discontinuities when major systems are changed

or social arrangements purposely restructured (Kling and Iacono 1989a; Zmuidzinas, Kling, and George 1990). This view differs substantially from that of analysts like Zuboff (1988) who view computerization as a one-shot alteration of technology and work practices, but whose sense of history includes several distinctive ways of radically restructuring work with new technologies over the centuries.

These issues of drawing boundaries and characterizing key social processes confront anyone undertaking well-grounded empirical social studies of computerization. There are still open questions about the time scale over which to expect social transformations to take place. When they come as a by-product of elite control over small social units, social relations may be transformed in one or two years. But some organizations may transform over periods that are closer to a decade, and social sectors may take even longer.

The Information and Computer Sciences

I have discussed computerization—the deployment of computer-based systems in social settings. But the social organization of the computing world, including the information and computer sciences as a professional community and as an academic discipline, is also an important focus of study. In Europe, the term *informatics,* as defined by International Federation of Information Processing Societies, covers a broad set of studies that are segmented into different disciplinary niches in the United States. Informatics is segmented across schools of management, engineering, library science, and "computer science" departments. *Computer science* is now a commonly accepted label, but what it denotes is sometimes unclear, even to academics and researchers who self-identify with the term. The topics of investigation are sufficiently heterogeneous—and the lack of an underlying paradigm so problematic—that *computer studies* might be a more apt term. But most people who self-identify with computer science want to play the science game—with large amounts of grant money and possible memberships in the National Academy of Sciences.

In so doing, computer scientists have been deleting "the social" from their conceptions of the discipline. One commonplace view of computer science and engineering is reflected in a recent report by the Association for Computing Machinery's Task Force on the Core of Computer Science.

> Computer Science and Engineering is the systematic study of algorithmic processes—their theory, analysis, design, efficiency, implementation and

> application – that describe and transform information. The fundamental question underlying all of computing is, What can be (efficiently) automated? . . . The roots of computing extend deeply into mathematics and engineering. Mathematics imparts analysis to the field; engineering imparts design. (Denning et al. 1989).

The expansion of computing (and computer science) has depended on the improved usability of computer-based systems, not simply on their efficiency. The "micro revolution," for example, has placed tens of millions of computers and terminals on the desks of many managers, professionals, and clerks in industrial countries. Networking has made electronic mail accessible to millions of managers and professionals. The theories that help explain the expansion of computing applications, which ones work well or badly (and in what terms), are *not* fundamentally mathematical studies of algorithms.

While the computability perspective contributes important insights to "computing in the laboratory," it cannot readily help computer specialists understand computerization in the larger world. Computer science has strong social roots on which rest many studies of the usability of computer-based systems. But most computer scientists are reluctant to acknowledge the social basis of the usability perspective. I believe that part of this reluctance can be found in the academic debates over the role of computer science as a science, and the way in which mathematics, rather than the social sciences, better advances the status of computer science among the sciences. In the United States, computer studies have two major academic homes. Departments of computer science are usually located as a science within the liberal arts or in schools of engineering, and departments of (management) information systems are usually located within business schools. While the research done in these two kinds of departments overlaps, they serve different constituencies and have substantially different battles with other disciplines over their scientific status. The computer science departments are often contrasted with laboratory sciences, like chemistry or physics (and sometimes mathematics); the information systems departments are often under attack from economically oriented finance and marketing faculty who dominate many of the major business schools. In either case, the ways that professors interested in computing strive for academic legitimacy often leads them to focus on the "hard" sides of their discipline.

The education of hundreds of thousands of computer science students has been shaped by the computability perspective. They leave academic computer science programs with some skills in designing software systems and programming them. They usually take courses in data structures and algorithms in which they learn to appreciate and carry out mathematical analyses

of computer performance. But they leave systematically ignorant of the ways in which social analyses of computer systems provide comparably important insights into the effectiveness of computing in the world. Many segments of the computing community would much better understand computerization and be able to play more responsible professional roles by adopting a more fundamentally social view of the process.

Computerization itself is a social and technical process in which key actors are reconfiguring social and technical resources. Callon (1987) characterizes engineer sociologists as designers of new technologies, such as electric cars. The key agents of computerization in use are widely varied—managers and professionals of all kinds. But they also take an active role as sociologists in practice when reorganizing for computer-based systems. I am less impressed than Callon about the quality of the sociology-in-practice that many managers and professionals develop.[12] There is an important element of anthropological humility in Callon's approach—of taking native views seriously and not simply dismissing them as "primitive" a priori. However, there is also a risk in developing a romance with the natives.

There was a meeting of about 150 transportation specialists in the hotel where this article was first presented in the previous week. Some of the specialists were technologists with visions of "smart cars" that would use radars and sensors to navigate the freeways efficiently and drive just a few feet away from each other—safely and at high speed. There was no special enthusiasm for developing "smart drivers." Nor did there seem to be substantial discussion of alternative scenarios with different technological foundations—as in the difference between emphasizing telecommuting for many people versus smart cars.

In the past decade, some sociologists of technology have noticed that the conventional theories of innovation were rather mute about the dissemination of technological devices and systems; there were few studies of rates of adoption and the social location of early adopters. They felt that the nature of the technologies sometimes mattered—different technologies could have different social consequences. The approach of "radical symmetry" involved understanding technologies as social objects, as well as the social systems that are coextensive with them.

Many of the technologists' visions delete people and social order in important ways. This deletion can be naive. But it is often self-serving—as when artificial intelligence researchers, with substantial military funding in the United States, argue against the value of social inquiry about the social roles of computer technologies.

Conclusions

Questions of the big social transformations attributable to forms of computerization are of central importance. They have motivated a substantial program of research at UCI during the last 20 years. I have highlighted the research at UCI, but there is synergy between our work and research conducted by numerous other scholars whom my colleagues and I cite in specific papers and books.[13]

We are in the peculiar position of living in a society in which the discourse about computerization advanced in many professional magazines and the mass media is saturated with talk about revolution. Yet substantial social changes are often difficult to identify in carefully designed empirical studies. Unfortunately, many of the claims about what computerization means are *not* worked out with the scholarly care of Beniger's arguments about the control revolution. In "The Mobilization of Support for Computerization" and "Making the Computer Revolution," Suzanne Iacono and I examined the ways in which interest in computerization is often stimulated by social movements. Some movement spokespersons (usually male) articulate strong, technologically utopian visions.[14]

I have discussed some ways in which the studies my colleagues and I have conducted undermine simple stories of social transformation. Computers did not make welfare hum in Riverville. We found that computerization fostered a reinforcement politics, not a new form of politics, in local governments. But in the MRP studies, we found important changes in the tightness of workplace disciplines and in the power of a semiprofessional group. And managerial actions helped reshape work through computerization at Coast Pharmaceutical. In this case, managers interested in transforming work found computerized systems to be a helpful instrument (but managerial intention is not a good predictor of subsequent social changes). We are still working out a comprehensive characterization of the role of technologies in changing (and transforming) parts of the social order.

In my view, "a computer revolution" has not happened systematically in most social sectors. For example, there have been some major structural transformations in banking linked to numerous kinds of computer systems for transferring funds and managing accounts but negligible changes in schooling. The work arrangements of some occupations, such as copy typists, has been radically restructured. Bureaucratic record keeping, which affects social control and privacy,[15] has seen some major structural rearrangements, such as the expansion of third-party data brokers like TRW Creditdata. But

the majority of white-collar work has been altered in interesting procedural ways without radically restructuring the organization of work for the majority of people in computerized workplaces. We still have much to learn about the special conditions when social relations, such as those in workplaces, are significantly transformed through computerization. (Authority relationships, for example, are often highly institutionalized, and many computerization projects reinforce them rather than transform them.)

The movement activists, the computer revolutionaries, are working hard to *make* a revolution—with varying success. Their visions suggest a socially conservative revolution that will primarily advantage already-powerful social interests. It is much harder to develop a progressive social vision to help shape appropriate computerization. It is far easier for us to criticize their visions than to develop a sounder sociology of alternative futures.[16]

But I wonder how far critique alone will take us in a world in which relatively conservative activists are playing key roles in shaping our remaining choices. The main alternative normative analyses of appropriate computerization are articulated by countermovements whose interests intersect with some special form of computerization: in workplaces, intrusions on personal privacy, and consumer rights, for example. These countermovements articulate how computing should be balanced with competing values, such as good jobs, cooperative work relationships, fair information practices, and consumer control. However, these specialized views do not add up to a coherent alternative humanistic vision for appropriate computerization (Kling and Iacono 1988).

This is a great historical moment for social analysts to examine what kinds of social transformations have and have not happened and why. And it is important for us to articulate the real social choices that remain. If we do not, who will?

Notes

1. This question is much closer to that asked by Cowan (1983) in her pioneering study of household technologies.

2. Harvey (1989) is unusually forthright in observing that we are in a period of significant historical transition that the conventional logics of social change have trouble explaining adequately. See especially chapter 10.

3. Our work took a critical view of the rationalist traditions projecting the consequences of computer-based systems—often espoused by managerial analysts such as Leavitt and Whisler, Vincent Giuliano, or Harvey Poppel.

4. The "Second Wave" was the shift from agricultural societies to industrial societies. He contrasts industrial ways of organizing societies with new social trends that he links to computer and microelectronic technologies.

5. Toffler defines an info-sphere as "communication channels through which individuals and mass messages could be distributed as goods or raw materials" (p. 35).

6. Much of our data collection focused on computerization in six domains of activity, including the processing of traffic tickets, the monitoring of budgets, the conduct of police investigations by detectives, managerial reporting, and the development and use of urban plans. We chose domains that frequently had some kind of computer support – so we could compare computerization and social changes across 40 governments in our main survey (Danziger et al. 1982; Kraemer et al. 1987; Danziger and Kraemer 1986).

7. Western Mortgage and Coast Pharmaceutical are pseudonyms.

8. Our accounting case at Western Mortgage parallel's Zuboff's (1988) clerical computerization case study. Jewett and Kling (1990) report how changes in the computer system during the first stages of its implementation led to significant confusion in the short run. But as the system stabilized and clerks became more skillful, their disorientation decreased. Zuboff observed the changes in procedures that accompany computerization projects and argued that the resulting disorientation is a by-product of more abstract work. We disagree; the work of the accounting clerks in Western Mortgage was comparably abstract before and after computerization. They were always working with data about money and never physically counting piles of cash and coins.

9. Recently, for example, the White House announced a $1.9 billion project to develop very high speed networks to connect 100 major research universities and research laboratories, dubbed "data super-highways." These networks are supposed to provide a "1000-fold" improvement in performance compared with today's computer networks.

10. Note, however, that more expensive systems are more likely to be tightly scheduled. Thus a push for state-of-the-art systems in financially constrained schools might lead to more regimentation, on average.

11. Walsham, Symons, and Waema (1988, 193-94).

12. But I appreciate his methodological point of not treating such actors as sociologically naive by definition.

13. See also Dunlop and Kling (forthcoming) for a collection of articles about the social dimensions of computerization written by a variety of scholars.

14. See Dunlop and Kling (forthcoming, section 1) and Kling (forthcoming).

15. Cf. Rule et al. (1980), Laudon (1986).

16. See, for example, Pfaffenberger (1988) and Kling and Iacono (1990).

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