Annu. Rev. Anthropol. 1993. 22:107–32

COMPUTING AND SOCIAL CHANGE: New Technology and Workplace Transformation, 1980–1990

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KEY WORDS: information technology, cultural perspectives on computing, cultural construction of technology, technology actor networks, computer revolution

INTRODUCTION

This essay reviews anthropological and related cultural studies of the relationship between new technology and change in the workplace and society over the last ten years. Computers are machines that manipulate data rapidly and flexibly to extract information. Since most of the workplace technology that has recently been made broadly available depends on computers, the term "computing" is used here to mean "using new technology."[1]

There are several reasons why anthropologists should be concerned about the computing/work/social change relationship. Theoretical argument in interdisciplinary technology studies (e.g. between interpretivists and materialists) strongly parallels and influences contentious debates within our discipline. The computing/change relationship is of general concern in the complex social

[1] This is true with only a few notable exceptions (e.g. microfiche). Since computers in the workplace were rare until recently, "computing" and "using new technology" are reasonable approximations of the longer phrase, "using new technology based on computing." The stress on computing rather than computers follows from the efforts of scholars like Suchman (122), who argue against talk that isolates artifacts from the way in which they are used.

0084-6570/93/1015-0107$05.00

formations in which we increasingly work. To win support, policy proposals must be perceived as likely to work, and therefore must fit popular conceptions. Thus, a broad range of deliberate social and economic policy interventions take the centrality of computing to economic revitalization as a given.

In popular discourse, this relationship is framed by "the computer revolution," the idea that we are living through a period of major social change caused primarily by the computerization of workplace technology. This notion is easily contested, but it can be framed more usefully as the proposition that computing constitutes a significant new technology actor network.

Several recent ethnographic studies describe new technology workplaces, associated information practices, and relevant social mediators, including class, gender, and race/ethnicity. This review focuses mostly on studies in the United States, which are considered in terms of their general contribution to the social study of work and technology and their specific relation to the actor network proposition. The review concludes with an assessment of the weaknesses in anthropology's contribution to the study of the relationship.

THE POPULAR CONCEPTUALIZATION: THE COMPUTER REVOLUTION

Because it is so widespread, any research on the social correlates[2] of computing will be read as framed by the idea that we are living through a computer-based social revolution. This idea is plausible because there is evidence of substantial, multi-dimensional change in contemporary social formations, and such changes are temporally correlated with the rapid spread of computing. Prevailing common sense interprets this correlation causally: (*a*) The spread of computer-based new technology is transforming the nature of work[3] and (*b*) This transformation of work produces a broadly transformed society. The strong belief that computers more or less directly transform society is held in both overdeveloping and underdeveloping nations. The thesis takes curricular form in "Computers and Society" courses, which address "the impact of computers on society." The popularity of this belief can be established by looking

[2] In everyday discussion, one is more likely to hear reference to the impacts of computing than to the correlates. The former usage is avoided here because it implies that technology causes social change—the technicist assumption. Computing anthropologists desire to establish empirically the nature of the relationship between computing and its social correlates.

[3] As used in the computer revolution discourse, "work" means activity in workplaces, i.e. jobs. Given the centrality of the workplace to the computer revolution, it is natural that the bulk of cultural work on computing has focused on such labor sites. Nonetheless, some studies take a broader view; sociologist J. Rule (114) has addressed issues of privacy and citizenship, for example. As I have outlined the case (54), there is a considerable critique of the equation of work with "job" in the anthropology of work literature, but the issue is less relevant to this review's terms of reference.

at most contemporary educational or labor force political or planning documents. For example, the new "career pathways" program, cooperatively developed by New York State government, the teachers union, and the Business Council, would refocus public education on the new job skills perceived to be required by technology.

The computer revolution view is firmly ensconced in public intellectual discourse. In his influential but flawed comments on the increasingly unequal experience of African Americans, Wilson (131) treats workplace technological change as a substantial cause. The notion is equally central to the stories told by preeminent postmodernist Lyotard (87).

One popular evaluation of the change induced by computerization, "computopian," presents the impacts of computing as fundamentally positive. This is the dominant view in both the United States and in states of the former Soviet Union. Borrowing from Williams' examinations (130) of the degenerative or putrefying tendencies of contemporary social formations, I choose to call the other, opposing view "compputropian." In this view, computerization has dire consequences, especially for already vulnerable social groups like the working class. Such views were expressed strongly in the Nordic countries, for example. The essential point, however, is that both views accept the basic premise of a computer-induced social revolution.

CRITIQUE OF THE COMPUTER REVOLUTION

This strong view is technicist: It assumes that social change is a consequence, not a cause, of technological change. While also a widely-held presumption, technicism's limitations as an explanatory position are demonstrated by Noble (97), who shows how social processes impact computing before computing impacts society. Awareness of the American predilection for technological determinist explanations, as well as the similarity between the rhetorics of the computer revolution and computer salesmanship, should also make us suspicious. In its presumption that correlation equals causation, the strong view displays the ecological fallacy.

I have summarized (58) substantial empirical evidence that either work has actually not changed all that much, that the extent of social change is exaggerated, or that the connection between these forms of change is weak, substantially mediated by other social forces. Indeed, how society changes has more to do with how people interpret computerization than with any separable technological impact.

AN ALTERNATIVE CONCEPTION: COMPUTING AS ACTOR NETWORK

Instead, one can ask if a computing-based technology constitutes a significantly new type of actor network,[4] the framework used in social studies of technology by Latour (82) and Grint (51). They invoke the idea that, rather than being artifacts alone, technologies constitute and are constituted by networks of interacting human, organizational, and artifactual entities or actors. New actor networks are created through interaction and negotiation among elements with differing and often conflicting forms of agency; consequently, they are more or less unstable. Periodically, however, particular actor networks attain enough stability to become taken for granted.

Phrased in terms of actor network theory, the computer revolution becomes the idea that computing in practice constitutes a significant new technology actor network. This weaker idea is less vulnerable to the critiques described above. Describing a technological change in terms of actor network theory allows us to deconstruct our enquiry into several interconnected dimensions:

1. Is the new actor network or system stable?
2. Do the artifacts—e.g. computers—actually have the capacity to do what they are alleged to be capable of in the shared conceptualizations of the network?
3. Are the potentials for new forms of activity implicit in the new network actually realized?
4. Is the new network associated with new forms of social agency?
5. Is it characterized by social alliances substantially different from its immediate predecessors?
6. Do groups and organizations with significant social power, whether new or preexisting, actually frame their activities in terms of the concepts embodied in the technology?

The more often one can answer "yes" to these questions, the greater the likelihood that one is dealing with a significant new technology actor network. Effective computing machines—and technological systems based on them—have been developed only recently. Actor networks based on these machines are necessarily new, but novel capacities are not in themselves evidence of significance. Moreover, the highly contingent nature of technology actor networks may severely limit their explanatory value. They tend to fall before

4 Pfaffenberger (107) uses Hughes' concept of "technological system" to make similar points regarding the necessity of thinking of computing technology within a social context. Actor network as a concept has the advantage of not implying that the set of relations under examination are necessarily systematic.

Schneider's graduate school quip about functionalisms—that they amount merely to the meager claim that things are the way they are because, if they were not, they would be different. That the exact relevance of technology actor networks is difficult to specify theoretically is especially problematic for theory that attributes agency to nonhuman entities.

If one wishes to derive implications—in social policy or designing work processes, for example—from the social study of computing as a technology actor network, one must be able to say something more about the intrinsic characteristics of a new network, such as specifying the sources of its stability. There is little literature on how one determines which technology actor networks are related to basic social change, even evolutionary social change, and which are not. To say that the new technology actor network based on computing is significant, one needs standards of significance. In short, the issue in the relationship of new technology to work and society is whether computer-based technology actor networks are significantly new.

Close analogues of the idea that computing constitutes a significantly new technology actor network can be found in contemporary social thought, as in "post-Fordism." Fordism was Gramsci's (47) name for the kind of society emerging in the mid-twentieth century, characterized by mass consumption of goods mass produced increasingly via fixed or so-called "Detroit" automation. For Harvey (63), postmodern, post-Fordist society "...was in part accomplished through the rapid deployment of new organizational forms and new technologies in production. Though the latter may have originated in the pursuit of military superiority, their application had everything to do with bypassing the rigidities of Fordism..." (p. 284) Similarly, Castells (20) presents new technology and change in political economy as the dual sources of the "informational city," which he sees as the characteristic new spacial form. His view of technology is echoed in the influential ideas of Piore & Sabel (108).

Such arguments place new technology based on computing within a developmental sequence that can be specified empirically. This allows one to separate substantially new networks from "just another technology (55)." Acknowledging the importance of work, these arguments also recognize that any fundamentally new network engenders new world views (postmodernism) and/or a new spacial arrangement (informational city). In these more nuanced arguments, the new technology/social change relationship emerges as the central issue of contemporary social thought.

COMPUTING STUDIES

What do cultural perspectives in general and anthropology in particular contribute to the analysis of whether computing constitutes a significant new

technology actor network? Most of the vast literature regarding computing and social impacts merely repeats the accepted strong computer revolution hypothesis, so it is of limited empirical value. "Computing studies" is a useful term with which to label the discourse that rejects technicist presumptions and attempts to encourage empirical research on computing and its social correlates. This discourse has roots in various academic disciplines and national scholarships. One important root is Noble's study (97) of the history of technology, which plays a central role in the attempt by Bijker et al (10) to encourage a sociology of technology. The workplace implications of computing are a key illustration in Braverman's work (17), as they are in the important work of Braverman successors like Kraft (75), Zimbalist (140), and Glenn & Feldberg (45). Equally important is work in computer science, particularly the research of Kling (71) and others active in Computer Professionals for Social Responsibility. Nordic computer science is noteworthy for its attempts to develop a socio-technical perspective on information system development; perhaps the applied work of Ehn (33) is known best.

In the mid-1980s, computing studies reached a level of methodological sophistication. For example, both Attewell & Rule's research (1) on workplace computerization near New York and my research with Barbara Andrews in Sheffield, England (60) attempted to bridge the gap between case studies of particular firms and national aggregate data by developing regionally-integrated studies. Given the tendency of compputropians to focus primarily on case studies, while computopians tend to use data in aggregate, such studies were theoretically necessary. While discourse is still too frequently truncated at discipline boundaries, computing studies have a palpable research tradition.

COMPUTING STUDIES IN ANTHROPOLOGY

A substantial proportion of computing studies manifest a cultural perspective. Wynn (136), Chick & Roberts (21), Pfaffenberger (105), and Suchman (121) have contributed a distinctively anthropological tone. To hear the tone, one must read widely. One must also distinguish anthropologists who study computing as a cultural process (computing anthropology) from those who are mostly interested in computers as a tool or computing as a methodology in anthropology.[5]

Most of the computing in anthropology discourse is tangential to the work and social change foci of this review, but there are two points of substantial interface. One is in the work of scholars like Read (109), for whom the

[5] The "computing in anthropology" discourse has considerable presence within the discipline, as in Boone & Wood (16) or Fischer & Finkelstein (38). Regular features appear in the *Anthropology Newsletter* on computing (e.g. in a column entitled "Soft.where").

computer can be used as a tool to discover underlying cultural structures hidden to the unaided anthropologist, or like Lundsgaard (86), for whom the entities included in expert systems constitute distinct cultural realms in their own right [but cf Forsythe (39)]. Batteau (7) argues that anthropologists have much to learn from the results of the computer-based structured methodologies used by engineers to increase functionality. A second point of articulation is in the work of anthropologists like Sapir (117) and Gatewood (44), whose reflexive contemplation on their own use of computers provides interesting cultural insight into what computing involves.

Despite an unsuccessful attempt to organize a Computer Unit within the American Anthropological Association (AAA), based on the computing in anthropology perspective, the AAA's General Anthropology Division Committee on Computing as a Cultural Process has thrived. The Committee recently changed its name to the Committee on the Anthropology of Science, Technology, and Computing. Among anthropologists who study computing culturally, some such as Pfaffenberger (105) and I (55, 58) reject the computer revolution hypothesis. Others like Wynn & Jules-Rosette (69) take the computer revolution as a central presumption of their argument. Evans & Bernard (36) assert the notion in spite of the fact that their data appear to erode it.

Most computing anthropologists, however, merely make a pro forma nod to the social influence of computers in an introduction or conclusion and marginalize the notion in the rest of their analysis. Their position is equivocal, appearing to accept the computer revolution by adopting its rhetoric but implicitly rejecting its importance analytically by placing stress on other, nontechnological mediators.

Occupational Cultures

Gregory's exploration (49) of organizational conflict in Silicon Valley is an early example of the stressing of difference in occupational cultures rather than machine perspectives to explain the dynamics subsequent to the introduction of new technology. From an earlier study of the consequences of differences between managers and scientists in genetic engineering firms (28) to his latter work on the effects on production of differences in occupational culture between engineers trained in the United States and Japan (31, 32), Dubinskas, one of the major anthropological contributors to studies on new technology and work, also attends to the way cultures specific to particular occupations affect computing's correlates. Zahrly & Baba have argued (138) that workers and managers not only develop discrepant views of technology, but finding the means to overcome these differences becomes a major preoccupation of new technology work process development. Baba (4) traces these views to previous occupational socialization.

Downey (27) has given attention to the ways that computing approaches (e.g. computer-aided design/computer-aided manufacturing) have become integrated into the occupational culture of engineers. His current work focuses on the role of engineering education in the creation of an occupational culture coming to terms with new technology. Pfaffenberger (106) identifies several points at which the fate of on-line information systems intersects with the occupational culture of librarians.

Organizational Dynamics

These authors also place considerable emphasis on how general organizational dynamics mediate relationships among new technology and work. Baba (2) links the changed relationship between universities and industries as much to the decline in federal spending for universities as to recent technological change in these industries. The authors in Dubinskas' collection *Making Time: Ethnographies of High-Technology Corporations* (30), examining how time is culturally constructed in various high technology organizations, include several comments about the role of computers but primarily stress organizational factors.

Traweek's *Beamtimes and Lifetimes* (126), a comparative ethnography of particle accelerators in the United States and Japan, is also about time. She focuses on the role of organizations and the machines they build in creating an occupational culture of elite physicists, especially experimentalists. Computing and its artifacts are a regular *leit motif* in her discussion of the Stanford Linear Accelerator: the presence of computing and its artifacts in the offices of the experimentalists, as opposed to the theoreticians; computers as a symbol of being at the forefront of high energy physics labs; and the nature of the concrete fortress computer building, which has its own special IBM developmental staff. The switching of electronic beams, the core activity at the Stanford Linear Accelerator, is controlled by computers, and switching is one of the few occupations held by both women and men in roughly equal numbers, for some women have been promoted from clerical positions to become accelerator operators.

Freeman has studied female clericals working in Barbados on data telecommunicated from abroad. Her review of new forms of "home" work (41) stresses new technology as a facilitator rather than as a cause.

Management Strategies

In a fascinating study of a large high tech firm (76), Kunda gives organizational culture a new twist by pointing out how the culture is used in this firm to constitute a quasi-structure or matrix, which builds upon the new computing technologies that are also the firm's primary product. Kunda appropriately places this approach within the context of previous strategies for control of

workers while also acknowledging some impediments to its success. Nash's ethnography (95) of Pittsfield, Massachusetts, while recognizing that technological innovation may lead to enterprises that employ different segments of the population, argues that such shifts must be seen against the backdrop of old management control strategies. What is new is that such strategies are being worked out on a world rather than national scale.

Gendering

As indicators of what could be accomplished through participant observation, Lamphere's studies of the clothing industry (e.g. 78) were important contributors to the early stage of the anthropology of work. These contained little reference to computerization, except that it was the male cloth cutters who operated new computer-guided machines. Her more recent studies (79, 80) of new technology in the southwest develop the gender and technology theme further. For example, in discussing women's employment in the electronics industry, she draws attention to both the relatively higher wages and the lower levels of industrial security, health, and worker power through trade unions that women in new technology industries experience.

Robotics and other forms of computer-based automation in production have potential for eliminating the salience of physical capacity at work and therefore for lessening gender differences. However, Hochwald's studies (64, 65) of New York City newspaper computerization found little evidence that computerization had changed the results of workplace gendering. Similarly, Ong concludes (102) that, while the particular form of oppression has changed, Third World women in high-tech industries remain oppressed. She interprets the research on these women and new forms of work as justifying a focus on how the link between gender and technology is socially constructed. Traweek's work (125) is perhaps the best treatment of how gendering constitutes new technology while also being constituted by it.

Race/Ethnicity

Barnes (6) refers to the disemploying impacts of new technology on black men, but she gives little attention to technology in her discussion of black women and discrimination in the workplace. Robotham (110) discusses the conflict that characterizes the career of a black Jamaican worker. His computer experience gives him tremendous substantive authority, but he lacks the credentials held by his white supervisors in a bauxite production facility. Sacks (116) addresses how the dynamics of race came to the fore when an attempt was made to introduce a new computer system into a hospital.

This work presents new technology as terrain on which racial relationships are worked (and often reworked) rather than as a cause of new racial dynamics. The authors in Lamphere's recent collection on immigration (81) stress the

importance of differences both within and between ethnic groups who enter the United States economy. Grenier et al (50) argue that analyses of economic fate must include attention to experience in the informal (unwaged) as well as formal economies.

Political Economy

In their study of homelessness in New York City (66), Hopper et al identify technological innovations, along with intensified international competition, and capital flight, as implicated in the decline of local manufacturing jobs. Job decline in this sector, loss of public sector jobs, and increase in service jobs are all given equal weight as important labor market changes. Technological change is thus one of many elements in the economic structure shift responsible for the contemporary social changes resulting in homelessness.

Hopper et al are among those whom Lamphere (79) describes as the new urban anthropologists, scholars who combine ethnography with an emphasis on political economic context. Perhaps the strongest such voice is Nash whose review (94) of anthropological perspectives on the world system hypothesis of Wallerstein describes technological innovations as reducing the cost of production and therefore reinforcing central control. While critiquing technological determinism, she lists technological innovation as one of several bases for dependency.

The authors in Rothstein & Blim's *Anthropology and the Global Factory* (113) similarly present the correlates of technology as highly mediated by political economy. Rothstein (112) endorses a relatively strong statement about the impact of new technology (as well as its potential for fostering new forms of resistance), but Blim's view (13) is less forceful. Although Blim recognizes that, as described by Piore & Sabel (108), new technology is part of the decentralization characteristic of the early economic resurgence in the "Third Italy," computer-based systems are more characteristic of the larger, more traditional economic units that survive later economic contraction than they are of the smaller units that predominate in the earlier, highly publicized expansion.

The State

Both Caulkins (101), while at the Office of Technology Assessment, and Johnsrud (68) have studied the role of federal policy in shaping the spread of new technology. Jules-Rosette (69) also places great stress on the national level in her comparative study of the narrative of computing policy in Kenya and Ivory Coast. Andrews & I (60) draw attention to the role of national state policy, in addition to the changes in the regional job market, the international political economy, and the social construction of gender, in determining the social correlates of computing. We conclude, however, that class is the ulti-

mate mediator of the social correlates of computing. Similarly, Casey (19) describes a case where the incorporation of health and specifically safety demands relevant to computing, along with other "new social movement" perspectives, was an important ingredient of relative trade union success in Puerto Rico.

COMPUTING WITH A CULTURAL PERSPECTIVE

Descriptive anthropological studies of computing document how the relationship between computing and change at work and in society is highly mediated. Because the specific mediators stressed are those already stressed by previous cultural studies of work, computing anthropology can be interpreted as an extension of the new anthropology of work.

Applied research in computing anthropology also demonstrates how the organizational and social correlates of computing are highly mediated. Here anthropologists use a cultural perspective as a basis for organizational intervention at the same time as the computers are introduced. As consultants, Koons & Novak (74) introduce a computer system that improves quality of production and work life in a Cameroon telecommunications facility. The applied computing anthropology of Novick & Wynn (99), Suchman & Trigg (123), Sachs (115), and Wynn (137) addresses development of computing artifacts and systems under the rubric of participatory design (e.g. 48). This initiative, first developed in the Nordic countries to stimulate more effective workplace democracy, has gradually developed into a full-fledged alternative approach to the development of information systems. Blomberg is an anthropologist who does similar computer-supported cooperative work (14), developing systems that enhance the ability of groups to work collectively.

Anthropologists vary in their views of how well cultural perspectives are accepted by computer specialists. Lundsgaard (86) sees himself as a full participant in system development. In contrast, despite several years of work implementing systems for educational computing, Bader & Nyce (5) argue that differences in epistemologies severely limit integration of cultural and technical perspectives. Forsythe (40) combines a critique of the epistemological presumptions of artificial intelligence (AI) with the use of ethnography to build effective AI systems. Blomberg & Suchman (15) are notable for developing a particularly focused picture of work politics, while simultaneously exploring technology options for existing labor processes.

Applied cultural studies of computing allow projection of some programmatic notions of how to develop information practice critically and self-consciously:

1. Development should be preceded by broad analysis, involving the frank participation of workers and managers of preexisting organizational dynamics. Particular attention should be given to separating out truly needed information from needs that are, for example, simply institutionalizations of the reproduction patterns encouraged by occupational cultures.

2. Because of the dangers of the "dazzle" effect—presuming that the best solutions are the most technological—models of information needs should at first be formulated independent of computer options.

3. Consideration of computing options should only begin after all groups involved have requisite knowledge, and decision making should be culture-centered and collaborative. This means taking into account both the broader social dynamics within which individuals and organizations set goals and the strategies for achieving these goals.

4. Develop and test prototypes under real conditions, and redevelop through several iterations.

ANTHROPOLOGY AND SOCIAL STUDIES OF WORK AND TECHNOLOGY

The factors giving computing anthropology its distinctiveness in relation to other scholarship include:

Methodology

Work anthropologists like Lamphere and Nash & Sacks, and computing anthropologists like Wynn, Sachs, and others see the methodology of ethnography as the most significant contribution of computing anthropology. Ethnography may be thought of in many ways, as is evident from recent comments by Clifford & Marcus (22) and Marcus & Fischer (88). Defined as participant observation, ethnography can easily be split from anthropology and added to the methodological armamentarium of other disciplines such as sociology. Strongly influenced by linguistic and ethnomethodological orientations during graduate study at the University of California at Berkeley,[6] Suchman, Traweek, and Wynn, as well as anthropologists of technology like MacLennan, develop an ethnography of computing in a manner that privileges interpretivist approaches. This cast to computing anthropology's methodology is

6 I understand Garfinkel originally to have raised an argument against both of the then dominant schools of sociological theory, structural functionalism and conflict theory. In his view, the theorizing of both schools was premature, in that sociology was unable to provide a convincing account of how structure could arise out of the minutiae of human interaction. Language becomes paradigmatic for the scholar preoccupied by such problems. Priority is given to study of the social construction of micro worlds and, for example, the inadequacy of cognitive science models in accounting for their characteristics.

evident in the semiotic orientation of Jules-Rosette (69) and the interpretivism of Dubinskas (29) and Pfaffenberger (107).

Critique of Standard System Development

Information practices based on technicist cognitive science models often fail, in major part because their models do not capture essential elements of human communicative practice. Lucas was among the first within computer science to make this argument in *Why Information Systems Fail* (85). Within the Association for Computing Machinery in the United States and the European International Federation for Information Processing, it is common if not dominant practice to draw attention to the importance of the human element. Mumford's socio-technical approach to development was an advance over previous machine-centered approaches (92), although it is marred by a tendency to take organizational structure as a given rather than as a dynamic element itself subject to change.[7]

Perhaps the most suggestive models of information practice from a "pure" communication perspective are those of Winograd & Flores (134) and Suchman (121). In *Plans and Situated Actions,* for example, Suchman demonstrates the poverty of cognitive science models of human action, arguing instead that action is situated in particular social constructions of the moment. Suchman argues that cognitive science models that presume decisions based on premeditated understandings systematically misapprehend communication and action. Orr's work (103) also makes similarly useful cultural contributions to work practice in technology.

Skill

The notion that new technology tends to undermine worker skill in the labor process was central to Braverman's "degradation of work" thesis (17). "Deskilling" was a consequence of the way in which capitalists selecting technologies that reduced worker control in order to reduce workers' collective social power. Whether new technology deskills has been a primary focus of post-Braverman studies of work, especially of computing. Research with rural machinists in Pennsylvania convinced Chick & Roberts (21) that computer-

7 Such attempts to graft a social view onto a technical one, or even to integrate social and technical views, are not likely to produce better information practices; only an alternative conceptualization, which locates technical moments appropriately within a broader social frame, is likely to produce effective systems. Although his editorial in the *Communications of the Association for Computing Machinery* rightly rejects the program of trying to design human error–proof systems, Norman (98) still maintains a dual view of information practice, which treats technology and the user as ontologically distinct. Shakel's ergonomics for system design (119) carry this to an extreme, complementing a discourse on "deciding which aspect of the work process is best carried out by a human element" with one that calls for thoroughly participatory design, including support to groups as well as individuals in the design process.

based technologies require new layers of skill added to previous ones. In her work on an inventory control expert system in a manufacturing plant, Sachs (115) identifies new forms of tacit knowledge essential when it is necessary to move between the real world of production and the image of the production process projected by the expert system. Baba (3) reconceptualizes skill as a collective rather than individual issue.

Skill data indicate that computer-mediated jobs often involve as much substantive skill as the jobs they replace. However, the new jobs entail less formal recognition of skill and therefore fewer benefits, less self-esteem, etc. Even more likely, the new jobs undermine the effective power of older, collective working class social forms such as trade unions, necessitating new forms of social power for class cultural reproduction. Long term results have as much to do with class as with technology.

Working Knowledge

Interest in working knowledge is a response to deskilling because a decline in the knowledge that workers apply is a strong indication of skill decline. Kusterer's *Know-How on the Job* (77), an early ethnographic study of worker knowledge, was notable for its stress on the relatively dense cognitive accomplishments of so-called unskilled or semi-skilled workers, the related distinction between formal and substantive skill, and the stress on tacit knowledge. Interest in activity theory and the structure of cultural domains, the methodological interest in narratives and ethnomethodology, and the practical interest in participatory design have reinforced an interest in worker knowledge in the studies of Orr, Sachs, and Suchman.

What Technology Is

The theoretical moment has become polemical within social studies of technology. On one side are Latour & Woolgar (82) and Grint (51), who refer to themselves as social constructionists. The strongest advocates of the actor network approach, they see studies of technology as the production of texts. Since there are no grounds for preferring one interpretation over any other, social study of technology is a purely interpretive, critical activity.

A relegation of ethnology to the background is implicit in much of their work, and is explicit in Grint's attempt to write a sociology of work text. Because each work experience is constructed through the interpretations of actors involved in the relevant networks, no generalizations about work beyond its diversity can be made. Because technology networks are not just human constructions, all attempts to identify some basic similarities among forms of work—Bravermanite, structural/functional, Marxist, organizational cultural—fall before a radical relativism.

Many of the difficulties that follow from such positions are identified by Kling (72, 73) in his polemic with Grint & Woolgar (52) in *Science, Technology, and Human Values,* the journal of the Society for Social Studies of Science.[8] Such views limit the ability of the analyst to intervene at the level of policy, for example. The critique that Kling shares with Winner (133) and others who refer to themselves as political constructivists is that radical interpretivism marginalizes questions of power and exploitation—e.g. whether new computing technology will support or undercut community resistance to those organizations that use it to marginalize workers and peasants. Grint's book is a long and often disingenuous polemic against Marxism and related materialist perspectives on technology. Both Kling on the one side and Woolgar on the other do their empirical work on computing, and at least Woolgar identifies himself as an ethnographer.[9]

Because this debate is both inadequately reflective about methodology and too abstract about data, there is much space for a positive contribution from computing anthropology. Pfaffenberger (107) provides a positive example of cultural analysis that embeds technological systems in artifacts that are themselves the residue of previous political struggles framed in symbolic discourse. New technology is perceived to have material, determinant qualities precisely because it embodies the momentum of previous human activity, momentum that is particularly difficult to change in the short run, because any significant new technology actor network materially integrates widely dispersed practices. Such momentum limits human action, therefore justifying the attribution of agency, as argued by Haraway (61), to the nonhuman components of technology actor networks.

Among philosophers, Elster (34) has developed an extremely broad critique of dominant models for *Explaining Technical Change.* Elster's perspective can be usefully bridged to that of Callinicos (18), Bhaskar (9), and other Marxist realist philosophers.

Rosenberg has done much to take economic thinking about technology *Beyond the Black Box* (111). Likewise, Dosi et al in the United Kingdom and

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8 The Society is the main interdisciplinary body in which American computing anthropologists are involved. Unfortunately, it usually holds its meetings at the same time as the AAA, and even though this problem has been pointed out to the Society on several occasions, it happened again in 1993.

9 A third theoretical pole, feminism, is also evident in the Society for Social Studies of Science. Interestingly, there are fewer direct points of contact between the feminists and either side of the polemic than one might expect, although it is an admittedly male discourse. Croissant (23) suggests that standpoint epistemologists may provide ways to mediate the apparent contradiction between interpretivism and political constructivism, especially through a deconstructive and then reconstructive discourse over objectivity. Harding presented the same point recently at a conference on Rethinking Marxism. Feminist technology scholars like Wajcman (128) and Haraway (61) present standpoint epistemologies as a way to recognize both the agency implicit in interpretivistism and the structure of technological systems.

the Netherlands (26) develop a social view of technology, with which they challenge the dominant neo-classical economics:

> The socio-institutional framework always influences and may sometimes facilitate and sometimes retard processes of technical and structural change, coordination, and dynamic adjustment. Such acceleration and retardation effects relate not simply to market "imperfections" but to the nature of the markets themselves and to the behavior of agents (that is, institutions are an inseparable part of the way that markets work) (p. 2).

The history of technology viewpoint, including the Society for the History of Technology and the journal, *Technology and Culture,* have been summarized recently by Cutcliffe & Post (24) in one phrase: *In Context.* This scholarship is committed to purging historical discourse of teleology and placing technological development in society. In Winner's pithy phrase, "technologies have politics" (132). Toulmin's *Cosmopolis: The Hidden Agenda of Modernity* (124) critiques the scientific/technological revolution mindset of the twentieth century, of which the computer revolution is the most current manifestation. Toulmin critiques the philosophical presumptions of modernist science based upon his experience as a practicing theoretical physicist.

CULTURAL PERSPECTIVES AND THE COMPUTING ACTOR NETWORK

Cultural studies are contradictory regarding the specific question of whether computing constitutes a significant new technology actor network. Much of the data justifies skepticism. Blim's (13) is only one of several studies that lead one to question the stability of new computer-based workplace regimes. Some of the strongest early compputropian writers in Zimbalist's Bravermanite *Case Studies on the Labor Process* (139) (e.g. 25, 45) describe computing as having strongly proletarianizing, centralizing, and deskilling implications. However, these forms of office automation were based on mainframe or timeshare minicomputing, whereas microcomputing applications have different correlates (37). Friedman's model of system development (42) identifies three distinct phases, during which hardware, software, and end-user concerns replace each other as the primary locus of concern.

The new networks do not automatically create much potential for new activities. The dynamics of many information practices, like those in the mid-1980s worksites that I studied in New York State (53), have less to do with designed characteristics of systems than with preexisting social mediations. Equivocal data regarding workplace computing confound computopians and compputropians equally. An early study (129) by Wilkinson, for example, illustrates a variety of outcomes from the same technology, undercutting Shaiken's negative conclusions (118). Noble's demonstration (97) of the role

of ideology in decisions about technology development effectively counters Blauner's "euskilling" position (12), whereas Wood's authors (135) counter Braverman's view (17) that computers deskill office work. In terms of employment rates, sectoral studies like Pemberton's on United Kingdom building societies (104) and Murray's on United Kingdom banking (93) show decidedly mixed consequences. Friedman (42), pointing out that Kraft's (75) predicted deskilling of computer workers themselves has not materialized, relates this to new information systems' failure to deliver the more effective communication promised, and that the discontinuous pace of development in workplace computing is itself evidence of the social dependence of technology.

An imaginative early piece on computerization by Turkle (127) describes the "computer as Rorschach" phenomenon, that "computered" people project onto the computer all sorts of dreams, desires, and visions. She implies that such projections are a vehicle to bring about new, fundamentally transformed, "informated" [to use Zuboff's term (141)] social agencies. Today, we read Turkle's image rather differently: that computers reflect visions whose sources lay elsewhere, outside the technology itself. Instead, analysts like Pfaffenberger (105) focus on why there has not been a personal computer revolution or a substantial extension of democracy through on-line information systems (106). In her work on a Norwegian home shopping/information service, for example, Berg (8) stresses the importance of the interpretive moment, especially how gender structures the radically different ways men and women use the system. Cultural studies suggest that apparently new forms of agency are actually contingent upon preexisting social arrangements.

Nonetheless, other data are more compatible with the conclusion that computing does constitute a significant new technology actor network. Anthropologists like Lincoln (84) and Joans (67), who study the "virtual communities" supported by new technology, emphasize and endorse informants' willingness to frame their activities in computerization's terms. It is common today to stress the ideological as opposed to the material role of computing in discussions of contemporary social change. For example, Andrews & I (60) find several instances in Sheffield where computing, as a symbol of the new, was contrasted with symbols of the old—e.g. trade unions. The flexibility of computing makes one trade union strategy—maintenance of rigid demarcations in work roles—less viable. This does not mean trade unions lose all merit, but Fordist organizational forms associated with the working class are losing power, and this loss has to do with computing, albeit more socially than technically.

The willingness of people to identify trade unions as old and computers as new has much to do with the creation and reproduction of ideologies. Newman (96) examines the perceptions of American workers involved in the shutdown of a long-established sewing machine plant. Workers' contradictory views are

variations on a moral drama about forsaking craft and community. Interestingly, failure to invest in new technology, rather than new technology itself, is perceived to be the ultimate cause of the shutdown.

The necessarily equivocal judgment about computing as a new network is well illustrated by the switch from national to international currency markets (60). Computer-based information technology for accounting made an international market possible, and that market's current form—trading is more or less "real time" throughout the world—would be impossible without computing. Nonetheless, the dynamics of this market have a great deal to do with the creation of the Euro-dollar market after World War II, the rise of transnational corporations, and the spread of the global factory.

Mobile picket lines were an important element of the successful British miners' strikes in the 1970s. The existence of a remotely accessible national automobile registry enabled the British police to interfere more effectively with "flying" pickets in 1985–1986. Miners did not lose the strike simply because of computers, but the new technology provided both symbolically and actually powerful means for a more aggressive national state (60).

In sum, it is conceivable that a stable, substantial, and new technology actor network is emerging around computing. This network may, for example, change the labor process as much as the introduction of "machinofacture" in the nineteenth century changed the manufacture labor process introduced in the eighteenth century (55). There can be no doubt that new information technology has the capacity to be transformative. To date, this potential may have been realized in some situations, but we cannot conclude that this is the general case.

LIMITS TO COMPUTING ANTHROPOLOGY: THE PROBLEMS WE CHOOSE

We cannot be conclusive because of limits on computing studies in general and in computing anthropology in particular. The first stage of anthropological interest in computing could be labeled "computing and anthropology," during which we acknowledged that these two activities were interrelated. The current "computing anthropology" stage arrived when, on the one hand, anthropologists like those included in Boone & Wood's *Computer Applications in Anthropology* (16) became fascinated by the new information technology. On the other hand, some anthropologists applied cultural perspectives in computing, as in participatory design. The anthropologists in the two groups have had little to do with each other.

A satisfactorily cultural understanding of computing as a particular kind of human activity would allow the unification of computing in anthropology and

anthropology in computing into a third, mature anthropology of computing. "Culture-centered computing," (57) for example, means developing information systems that are thoroughly contextualized, informed by both an understanding of organizational culture (in our sense) and how information technology is itself cultural.[10] Yet in an extended phone conversation with me, one applied computing anthropologist supported the current state of affairs, saying something like,

> Who cares whether computers are really changing society? The fact that employers think this is true means that they are more open to thinking about the way that information systems can affect organizational culture, which means more opportunities, like participatory design, for us anthropologists to have an impact.

Leaving the computerization debate in the background muddies the analytic point we want to make: that what happens when the computers are introduced has much more to do with organizational culture, occupational culture, gender, class, power, or a host of other mediating social forces and cultural constructions than it has to do with the technology per se. The notion that computing has certain natural social impacts marginalizes our role in developing computing systems. We become like the Human Relations psychologist, compelled to see work problems as arising elsewhere, so the job is to help the worker adapt to, not change, her situation. If we accept the computerization hypothesis, our applied job is reduced to helping individuals and organizations cope with the inevitable.

METHODOLOGICAL LIMITS

The interpretivist/ethnomethodological orientation legitimates one cultural voice in computing, but it also has a downside. It is difficult to base a study of the computing as new technology network proposition on ethnomethodological presumptions. To reject any methodology other than ethnomethodology is to allow our problems to be dictated by our methods, the "misplaced concreteness" excoriated by Mills (91).

10 A number of such projects already exist, such as the Utopia Project described by Ehn (33), where Swedish graphic artists in the newspaper industry developed a computer-based prototype that built on, rather than replaced, their craft skills. The SPRITE (Sheffield Peoples' Resource in Information Technology) project (57) is an instructive example of community computing, which, by placing computing resources in the hands of mostly unwaged people, contributed to the development of an alternative politics of computing. The Library Project (57), directed by Sheffield Common Council and the Human-Centered Office Systems Group at Sheffield Polytechnic, demonstrates the value of feminist consciousness raising techniques to the empowerment of clerical workers in the development of more effective information and communication practice.

The strong presence in computing anthropology of people employed in the private sector means greater access to worksites, but surely one of the negatives is reinforcement of the preoccupation with micro methods and issues as opposed to macro ones, such as the relationship of computing to the question of human liberation from exploitation. Also, the fact that Koons & Novak (74) were employed by the company installing the system they studied should not disqualify them from doing research, but perhaps it was not wise of them to make system success the main focus of their research.

Computing anthropology has emerged during the near-hegemony in anthropology of postmodernism. Its doctrinaire commitment to the equality of texts marginalizes those on the outside trying to legitimate their concerns, as argued so convincingly by Mascia-Lees et al (89). In the hands of humanities-based cultural studies people, postmodernism also inevitably reinforces narrow attention to the single case. Any attempt to separate out an empirical moment—and therefore, any discourse on the methodology to be employed in empirical activity—is suspect. Postmodern semiotic presumptions limit the value of Jules-Rosette's potentially important comparative study (69) of national computing policy in Africa. When epistemology cannot be practiced, the result is endless critique.

Just as a discourse on ethnography is needed in social studies of science and technology, a discourse on methodology is needed in computing anthropology. There are viable epistemological alternatives to an encompassing ethnomethodology, including standpoint epistemologies developed by feminists like Haraway (61) and Harding (62) who study science and technology, and the realism of those like Bhaskar (9) whose work grows out of analytic Marxism. The latter was the methodological discourse on which Andrews & I based our field study of computing and change in Sheffield working class culture (60). These alternatives provide a better basis for our most important decision: Which of all of the potential research problems competing for our attention do we pursue?

THEORETICAL LIMITS

The theoretical moment in computing anthropology is underdeveloped in part because an obvious reason to theorize, discussion of the computerization hypothesis, is buried in the background. Theories of preference [e.g. Sachs' use of activity theory (35, 115)] reenforce ethnomethodology. However, just as feminism may provide a rapprochement between political and social constructivism within computing studies, it may help bridge the similar divide between political economy and interpretivism in the anthropology of computing. My current project, an ethnographic study of the networks through which comput-

ing is socially constructed at the national level in Scandinavia, tries to use standpoint epistemologies to connect social structure and social construction.

Fenno-Scandian scholars like Bjorn-Andersen (11) and Nygaard (100) have made contributions to our understanding of the role of social factors in the construction of computing and the desirability of participatory design (48). Contributions on numerous other issues have been made by Nordic computing anthropologists: Julkenen & Sarmela (70) on the ethno-national dialogue that has emerged following the breakup of the Soviet Union, Lie (83) on the reproduction of gender, Garsten (43) on national styles within the same computing corporation, and Melstroem (90) on jokes and stories among engineers and programmers as texts.

Nordic scholars like Ehn (33) and Goeranzon (46) draw attention to the role of the state in computing, acceptance of which follows from the comparatively noncontroversial role of the region's states in the reproduction of social life. Attention to such issues grows out of long traditions of national/cultural self-consciousness, fostered by an ongoing dialogue regarding both the differences between Nordic and other regional cultures and states as well as differences within the region. Study of the state in computing has increased awareness of the range of policy interventions possible for both public and nonpublic organizations--—e.g. trade unions.

Experience in Finland and Scandinavia using computing policy as a means to extend substantive democracy reinforces awareness of how the correlates of computing are mediated by social process. Indeed, a truly new computer-based technology actor network is unlikely to develop before a broad range of social policy issues are dealt with. Before computing can replace large numbers of workers, a general alternative to the job as a device to distribute the means of consumption must be found. Clearly, on-line data bases and electronic bulletin boards have the capacity to extend democracy. Their failure to do so is likely connected to the absence of the kinds of social policies that would be pushed by organizations providing alternatives to the weakened trade unions and mass political organizations.

Concern for the authoritarian possibilities of the computing actor network is not new. In Siegel's account (120), Steve Jobs and his Silicon Valley "comrades" created the microcomputer as a counterbalance to the disempowering of the individual inherent in centralized computing. Pfaffenberger's work on this history will doubtless give it valuable context.

CONCLUSION

Cultural study of the problem of new technology, work, and social change means framing the issue holistically, recognizing that the interrelationships must be placed in, not technically abstracted from, an appropriate context.

Because the holistic tradition within the discipline justifies integrative approaches to large scale processes of change, anthropology is well placed to participate in cultural study of new technology.

Yet we do either computing in anthropology, or anthropology in computing, not both. Existing studies of computing reflect broader disciplinary ambivalences. We tend to either ground our work in technology, as in cultural ecology, or oppose culture to it, as in semiotics. A new anthropological approach to the study of work started to emerge in the mid-1970s, but I feel (56) that it has yet to leave a cumulative, distinctive contribution to the broader field of work/organizational studies. Such comments may sound narrowly professionalist, but the concepts of culture, ethnography, and description have been substantially impoverished in their appropriation, bereft of their anthropological context, by the larger field.

Phrasing the popular notion of a computer revolution in terms of technology actor networks would allow computing studies to move its interdisciplinary project forward. A thorough examination of how substantially new the computing network is will help computing studies clarify background assumptions and construct a more holistic narrative, one with room for empirical, interpretive, political, structural, and postmodern moments.

In spite of its shortcomings, analysis (59) in computing studies does indicate that, in the long run, system development approaches that attend to the broad cultural dynamics of the computing context lead to systems that work better than those that do not give such attention. A more proactive awareness of the potential implications of computerization and a commitment to influencing these implications in line with articulated policy objectives encourage the spread into popular consciousness of less mythologized, more accurate images of computing.

In the future, more attention should be directed to the most general contexts of computing, those extending beyond organizational boundaries. The class, gender, and racial/ethnic and international cultures in which individuals participate, and the way in which such cultures both encourage and limit the range of strategies available for human intervention, greatly influence the dynamics of information practice. More mature study of computing as a cultural process will lead to more successful techniques for system development as well as identification of social policies more conducive to humane information practices.

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