The introduction of new technologies into the advanced capitalist work process continues to provoke sharp theoretical debate. While mainstream theories predict an upgrading of work content, recent Marxist analyses argue that workplace automation tends to deepen the subordination of the worker beneath the means of production. This study aims to adjudicate between these rival perspectives. The analysis centers upon the communications industry in the United States, a highly automated "knowledge" industry rapidly undergoing the transition to competitive market conditions. Official statistics on the changing occupational structure of this industry, combined with survey data on job content, indicate the existence of an upgrading effect between 1950 and 1980. In more recent years, however, the onset of a deskilling trend is found: The more automated the workplace, the less autonomous and conceptually demanding the job tends to be. Further analysis suggests that workplace automation differentially affects the various occupational categories.

New Technology, Job Content, and Worker Alienation

A TEST OF TWO RIVAL PERSPECTIVES

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One of the more salient controversies within the sociology of work and occupations concerns the impact of new technology on work and alienation. According to mainstream schools of thought, the modernization of work processes tends to upgrade the worker's position by

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increasing the level of freedom and responsibility inherent in the job (Blauner, 1964; Faunce, 1965; Shepard, 1971, 1977; Hull et al., 1982; Hirschhorn, 1984). According to a second, more critical, perspective, automation serves instead to deepen the worker's subordination beneath the means of production (Braverman, 1974; Noble, 1978, 1984; Cooley, 1980; Zimbalist, 1979). To address this controversy, two research designs have typically been employed. First, aggregate data on the U.S. labor force have been used to measure changes in work content over time (see Spenner, 1979; Rumberger, 1981; Wright and Singelmann, 1982; and Spenner's comprehensive review, 1983). While the aggregate approach has proved useful, conclusions have been limited by the quality of available data.[1] In addition, aggregate studies are typically unable to explore differences in job content within particular occupations (e.g., across firms or economic tiers). Such differences are usually averaged into overall occupational means, with a consequent loss of precision.

A second research design—the case study approach—overcomes many of these limitations while introducing others of its own (see Wallace and Kalleberg, 1982; Kraft, 1977; Nichols and Benyon, 1977; Hull et al., 1982). While case studies offer a closer, more sensitive appraisal of shifts in job content than would otherwise be possible, and can often measure workers' responses to these shifts as well, such detail is usually bought at a price. Most important, the link between the particulars of a given case and trends at the societal level usually remains obscure. One means of solving the latter problem, however, has been to select a "critical case"—that is, to choose a research context the nature of which is believed to be especially revealing (e.g., Goldthorpe et al., 1969; Kraft, 1977). In fact, many of the studies conducted in the upgrading genre have been of this type. Thus the chemical industry, owing to its use of highly automated, continuous process technology, has frequently been invoked as an exemplar of the automated workplace more generally (Blauner, 1964; Shepard, 1971; Wedderburn and Crompton, 1972; Cotgrove and Vamplew, 1972; and many others). This decision would seem unfortunate, for the peculiar characteristics of chemical processing may simply be too great to permit sound generalization. Arguably, study of other, more information-based industries would provide a stronger foundation for research on the relation between work and automation more generally (Low-Beer, 1978; Hirschhorn, 1984).

This article uses the case study design in order to contribute to the ongoing debate over technology, work, and alienation. Attention is focused upon the communications industry, a heavily automated knowledge industry undergoing rapid increases in competition. The question is whether, in the context of these conditions, new technology gives rise to a deskilling trend, as degradation theorists predict, or whether a different, more benign outcome follows the introduction of new technologies. The article begins by explicating the two major perspectives that have informed discussion of workplace automation. Then, to provide a backdrop for the analysis, the article briefly discusses structural changes under way within the communications industry. The methods used in this study are then described, and the analysis presented. Although limitations in the research design do restrict the scope of the study's conclusions, theoretically relevant suggestions can nevertheless be drawn.

CONFLICTING PERSPECTIVES ON TECHNOLOGY, WORK, AND ALIENATION

In the decades after World War II, a theory of work and technology began to emerge that essentially predicted the withering away of alienated labor (Bell, 1960; Blauner, 1964; Faunce, 1965; Shepard, 1971, 1977). This perspective, which was to become the dominant paradigm within the field, held that mechanization had indeed given rise to highly specialized, simplified, and alienating work (much as classical Marxism deplored). However, this theoretical framework held that the process of automation would lead labor beyond its purely alienated form. Automation would free the worker from direct machine pacing and reintegrate highly specialized tasks into more meaningful wholes (Faunce, 1965). In Blauner's (1964) version of this thesis, the job of the control room operator within chemical plants was adduced as an example of the expected trend toward more autonomous, challenging jobs. A more recent form of this theory is articulated by Hirschhorn (1984), who contends that automation moves the worker "from being the *controlled* element in the production process, to operating the controls, to *controlling* the controls" (p. 73). Reduced to its essentials, then, the upgrading perspective predicts that workplace automation increases both work

autonomy and complexity, thereby reducing alienation from work as well.

Diametrically opposed to this theory of upgrading is a second, far more critical perspective toward workplace automation. Most forcefully developed in Braverman (1974), this second perspective holds that whatever emancipatory potential new technologies might harbor is systematically thwarted by capitalist production relations. Given the ongoing struggle for control between workers and employers, the introduction of new technologies cannot be seen as innocent. Inevitably, automation is used by management to expropriate the workers' skills, thereby reducing worker control over the production process. In this way management can more easily intensify workers' jobs. Rather than "upgrading" the workers' position, then, technologies like numerical control of machine tools, electronic typesetting equipment, or word processing equipment have been viewed by deskilling theorists as providing the occasion for an "incessant *lowering* of the working class as a whole below its previous conditions of skill" (pp. 129-130; emphasis added). Apace with the development of science and technology, "the 'progress' of capitalism seems only to . . . *subordinate* the worker ever more decisively" beneath increasingly powerful machines (p. 231).

Both the upgrading and the deskilling perspectives have been criticized on several grounds. For example, research informed by the upgrading paradigm tends to rely upon a crude technological determinism, which unwisely locates production technologies beyond societal influence. Moreover, studies in this genre sometimes begin by engaging the Marxist theory of alienation, but end up invoking job satisfaction measures as their major empirical indicators (see discussion in Vallas and Yarrow, forthcoming; Erikson, 1986). And as was mentioned above, process technologies need not represent automated factory work more generally. Indeed, the highly toxic nature of the object of production, rather than the degree of automation, may be the most salient determinant of the chemical work process. If so, then much of the research in the Blauner tradition cannot easily be generalized to other contexts.[2]

The degradation thesis too has been criticized, at the hands of Marxist and non-Marxist theorists alike. To begin with, studies in this genre often ignore the existence of factors such as economic dualism (Edwards, 1979; Friedman, 1977), the advent of the welfare state (Burawoy, 1983), and the existence of gender inequality (Crompton and Jones, 1984; Feldberg and Glenn, 1983; Hacker, 1979), all of which may

either modify or counteract the deskilling trend. By taking craft labor as their point of departure, degradation theorists tend to idealize precapitalist work processes (Form, 1980). In so doing, they misspecify the role of craft labor within U.S. labor history (Stark, 1980). Moreover, deskilling theory has focused one-sidedly on objective occupational conditions, divorced from the subjective experience of work. As a result, the consequences of work redesign for either alienation or class consciousness have often remained obscure (see Vallas, forthcoming). Finally, both the upgrading and the deskilling perspectives can be faulted for relying upon overly simplified models of technological trends, which in all probability do violence to a more complex or contradictory reality (see Lee, 1981; and below).

The goal of the present study is primarily to strengthen the empirical basis undergirding the deskilling debate. In the process, theoretical suggestions will be extracted from the study's findings, and promising lines of inquiry are suggested in the conclusion of the article. While technology figures prominently in the analysis, technological determinism is explicitly disavowed. My point is merely to understand the significance of new technology within the existing set of (capitalist) work relations. If the degradation thesis is the more valid perspective, then workplace automation should render work less autonomous and conceptually demanding, thereby fostering greater alienation from work as well. If the upgrading thesis is the more adequate perspective, then the opposite relations should obtain: Automation should increase the autonomy and conceptual content of work, thereby *reducing* worker alienation. Before describing the data used to test these competing perspectives, I will briefly describe the industrial context within which the study was performed.

THE TRANSFORMATION OF THE COMMUNICATIONS INDUSTRY

Changes in the communications industry can be understood as the product of two interrelated trends: the growth of competition, coupled with the introduction of highly automated equipment. To grasp the first of these trends, it is vital to note that competition within the industry predates the breakup of the Bell system. Beginning in the 1960s, small business equipment and communications firms began to press for access to Bell transmission lines. The Federal Communications Commission

gradually began to grant such demands, and in a series of decisions increasingly allowed encroachments upon the Bell monopoly (Kohl, 1982). This weakening of the Bell system culminated in the Justice Department's antitrust suit, which eventually divested AT&T of its regional holding companies. In short, while the breakup of the Bell system has dramatically increased the level of competition within the communications industry, the breakup was itself the product of competitive pressures that had been accumulating for some time.

Moreover, industrial boundaries have evolved in new directions. Most notably, the communications and computer product markets have rapidly converged, thereby increasing the level of competition all the more. Owing to this convergence of the computer and communications industries,

> companies that once dominated their respective sectors (for example, AT&T and IBM) now compete with one another, as their once-distinct products collapse into one new market [Kohl, 1982: 59].

A single, highly competitive telecommunications industry has been the result.

The industry is divided into distinct tiers. At the national level is the information services market, in which long-distance voice- and data-transmission services and equipment are sold. This tier includes AT&T Information Services (ATTIS), AT&T Communications (ATTCOM), Rolm (controlled by IBM), and independents such as GTE, MCI, and others. Although AT&T still predominates, the consensus among economists is that its share of the market is under siege, as competition becomes fierce within this tier especially.

The local tier of the industry includes the regional holding companies spun off in the AT&T breakup, which still enjoy a relatively monopolistic economic position. However, even the holding companies have felt unprecedented competition. Inasmuch as the provision of local telephone service is no longer subsidized by long-distance revenues, holding company managements are experiencing cost pressures as never before. Here too the restructuring of the industry has resulted in increased competition.

The second major trend under way within the communications industry is the transition from manual or mechanical equipment to more fully electronic, automated machine systems. Although the process of technological change has spread unevenly across the different occupational

categories (see below), no major occupation has been untouched by the automation process. Especially during the 1970s, computerization began to transform the jobs of customer service representatives and clerical workers, as well as operators (Brooks, 1977). Computerized systems for the entry and retrieval of information on customer accounts, equipment orders, billing, and directory assistance are now commonplace. A majority of white-collar workers in the industry now make use of video display terminals in the course of their work.

Craft jobs have also faced important technological changes. For example, craft workers in central offices have witnessed the shift to Electronic Switching Systems (ESS), digital equipment that stores switching information within computer memory, and that uses microelectronic circuitry to route calls down appropriate paths. Initially introduced in the mid-1960s, ESS equipment is now used to handle the majority of subscriber calls (Almquist and Fessler, 1979; Amin et al., 1981); its use will be universal by the mid-1990s.[3] Parallel changes have begun to affect workers in the outside crafts who install or maintain trunks, cables, and loops. Perhaps most important, the use of copper wire as a means of transmitting calls is now widely seen as obsolete and is increasingly giving way to fiber optic technology (Dymmel, 1979). The effects of this shift and other new technologies on the jobs of cable splicers, line workers, and systems technicians are potentially far-reaching.

Thus, taken as a whole, the communications industry has experienced the rapid transition to competitive market conditions, combined with the widespread introduction of digital and other advanced technologies. This particular set of circumstances would seem to represent an especially favorable terrain for adjudicating between the upgrading and the deskilling perspectives toward workplace automation. For one thing, the technologically advanced conditions within this branch of the economy arguably prefigure tendencies under way within the growing knowledge sectors of the economy more generally. Equally important, the rapid transition from monopoly to competitive conditions presents us with precisely those pressures that degradation theorists see as the basis for deskilling: the need to squeeze a larger and larger amount of surplus value out of each unit of variable capital (wages).[4] In the context of such changed economic conditions, do advanced technologies in fact lead to the degradation of work context? Or does a different outcome follow from the automation of the work process? Does workplace

automation engender increased worker alienation, as deskilling theorists predict? Or does the restructuring of communications workers' jobs have a more benign effect? These questions are addressed below.

METHODS AND DATA

This article has made a number of methodological assumptions that must be kept clearly in mind. First, the major source of data for the analysis is a cross-sectional survey administered to a sample of communications workers in two northeastern states. This design carries with it several important limitations, the most important of which is the difficulty implied in using cross-sectional analysis to measure workplace change. Efforts have been made to overcome this limitation, however. First, official statistics on the changing occupational composition in the industry, informed by survey data on job content, can provide some tentative suggestions of historical shifts.

Second, a synthetic cohort design is used to draw inferences concerning apparent changes in work content. That is, the analysis compares similar occupational categories at different stages in the automation process, thereby affording a view of the probable impact of technology upon the work process. The assumption here is that within a given occupation, differences between technologically primitive and advanced work locations do indeed reflect temporal shifts or trends, rather than differences independent of technology as such. While this strategy cannot support the same degree of certainty that longitudinal research would permit, the assumptions involved do not seem unwarranted. Indeed, a parallel strategy was used in Blauner's *Alienation and Freedom*; there, industries studied at a single point in time were taken to represent different stages of the industrialization process (see also Hull et al., 1982).

SAMPLE

In the summer of 1984, officials and staff of District 1 of the Communications Workers of America (CWA) were approached and asked to sanction a survey of telephone workers.[5] The survey was designed to address "basic" sociological issues (as concern us here) as well as more "applied" issues (involving worker health and the efficacy of Quality of

Work Life programs). Union officials agreed to support the study, and they were instrumental in providing access to local union leaders.

Efforts were made to include as representative a set of local unions as possible. Ultimately, eight locals representing workers in the major occupational categories agreed to participate in the survey. These locals represent operators, switching and maintenance craft workers, clerical workers, and customer service representatives, among other job categories. They range in size from a few hundred to more than 10,000 workers, and are spread throughout New Jersey, western New York State, New York City, and Long Island. It should be noted that two locals declined to participate: in one case, because Labor Department litigation drained the resources of the executive board; and in the other, because a rank-and-file reform campaign placed the local officers in a difficult situation. Hence, to the extent that any bias occurred in the selection of local unions, it would have resulted in an overrepresentation of stronger, better functioning locals. Thus, if anything, our data should be more favorable to the upgrading hypothesis. In the estimation of national union staff, however, such influences represent a minor concern at most.

Upon request, local union officials provided lists of discrete work locations—physically or organizationally distinct work sites within their jurisdictions—that were then used as the basis for the sampling frame. A random sample of work sites was drawn, stratified by organizational division (plant, traffic, and commercial units), local union, and workplace size. Note that the primary sampling unit was the workplace, not the individual worker, a procedure that allows for the aggregation of data to measure contextual effects (see below). The final sample included 29 work sites employing 1,585 workers. During the summer of 1985, questionnaires were distributed to all workers employed at the sampled sites. By September, 802 valid responses were collected, a response rate of 50.6%. This response rate is somewhat low, in large part because resource limitations prevented greater contact with rank-and-file leaders. (Where personal contact was established, response rates were significantly higher.) Despite this concern, the sample distribution conforms (with some minor deviations) to the population parameters (see Table 1). Note that operators are somewhat overrepresented, and professional/technical workers somewhat underrepresented. Inasmuch as the bulk of the analysis concerns within-occupation trends (see below), case weighting techniques have been deemed unnecessary.

TABLE 1
Occupational Distribution of the Sample and the Population

Occupation	N	Sample (%)	Population (%)
Switching, Installation and Repair Crafts	276	34.4%	35.3%
Clerical workers	209	26.1	22.7
Operators	163	20.3	13.8
Customer Representatives	84	10.5	13.6
Other (incl. engineers and drafters)	70	8.7[a]	17.0
Total	802	100.0%	100.0%

a. The underrepresentation of this occupational category stems largely from the exclusion of professional engineers from union bargaining units.

MEASURES

Degree of Automation

Here, *degree of automation* simply means the extent to which digital or other advanced equipment has replaced older, mechanical tools and machines.[6] Workers were asked to respond to a series of occupation-specific measures regarding the types of equipment they typically use in their work. These items were designed on the basis of taped interviews with key informants in the major occupations. These items allow us to discriminate among workers using relatively primitive equipment (coded as 1), those using equipment at intermediate levels (coded as 2), and those who use the most advanced instruments of production (coded as 3). Table 2 outlines the method used in assigning scores to workers in each occupation. As an example, inside craft workers who use ESS or other digital systems are assigned the highest automation scores. Their counterparts still using electromechanical, crossbar-1 or -5 equipment are assigned scores of 2. The technology of clerical work, by contrast, is measured on the basis of the intensity of VDT use during the course of the working day.

TABLE 2
Measuring Automation at the Individual Level, by Occupation

Occupation	Equipment considered	Automation score
Traffic service position operator	Constant use of VDT monitor:	2
Directory Assistance operator	Constant use of VDT monitor:	2
	" " " , plus ARS:	3
Clerical workers, customer representatives and drafters	VDT use 25% of working day or less:	1
	VDT use between 25 and 75% of working day:	2
	VDT use more than 75% of working day:	3
Switching equipment technicians and frame administrators	Crossbar-1 or Crossbar-5	2
	Electronic switching system (ESS-1), ESS-2 or digital:	3
Installers and repair technicians, cable/line workers, service and systems technicians.	Subscriber loop control (SLC-96), Dimension and fiber optics each rated equally, as follows.	
	Uses 0 types:	1
	Uses 1 type:	2
	Uses 2 or 3 types:	3

NOTE: Workers in other occupations have been assigned missing values on automation.

In order to derive a contextual (i.e., group-level) measure of the degree of automation, individual-level automation scores were aggregated by workplace (Lazarsfeld, 1955; Coleman, 1969). Hence this indicator of technological development is composed of the mean level of automation that obtains within each work location. In order to separate within-group variation (individual effects) from between-group variation (the purely contextual effects), a term has been constructed that represents each worker's deviation from the workplace mean (see Tannenbaum and Bachman, 1964; Alwin, 1976; Lincoln and Zeitz, 1980). By including both measures of technology in regression equations, it becomes possible to measure both the individual effects of technology (i.e., working with more or less automated equipment) and the contextual effects (working in a more or less automated work location). These will serve as our independent variables.

Job Design

In the course of defining the concept of skill, Spenner (1983: 828-829) distinguishes two salient dimensions: autonomy-control and substantive complexity. In constructing measures of job content, the present approach parallels Spenner's conceptualization, with one revision. *Work autonomy* is defined as the extent to which workers are free to direct the manner and the pace of their work. Rather than focusing on work complexity, however, the present analysis prefers to speak of the *conceptual content* (or the level of conceptual demands) characteristic of workers' jobs. In keeping with Braverman's theory, *conceptual content* is defined as the extent to which the job requires independent thought or judgment, rather than the labor of execution alone (see also Spenner, 1983: 829).[7] Note that a third dimension of job content sometimes used in the upgrading literature—functional specialization—has not been included in the analysis (see Faunce, 1965). Thus work autonomy and conceptual content make up the measures of job design analyzed below.

Six items designed to measure work autonomy were included in a factor analysis and found to be unidimensional. These items asked workers to indicate "how often the following statements apply to your job." (Note that all items face in direction of low autonomy; hence coding has been reversed.) The items used were as follows:

My job requires that I do things just the way I am told.
If I leave my work area for a moment, my supervisor starts wondering where I am.
The amount of work I do is carefully measured by the people above me.
My job requires that I complete a certain amount of work per minute or hour.
My job requires that I keep working every minute of the day.
My job requires that I work very fast.

Workers who "rarely or never" encounter these conditions are considered to have high work autonomy. Those who "almost always" experience them are taken to have little or no autonomy. The reliability of the resulting scale (using Cronbach's alpha) is .85. The index ranges from 6 to 24; as suggested, high scores indicate greater autonomy-control.

The second dimension of job design has been measured using items adapted from the *Dictionary of Occupational Titles* index of occupational complexity (see U.S. Department of Labor, 1978; Spenner, 1979,

1983; Kohn, 1969; Kohn and Schooler, 1983). These items asked workers to indicate which of a pair of statements involving data, people, and things better described their job demands. Five spaces were left between the items in each statement pair. Each pair was coded from 1 to 5. The statement pairs were as follows:

> My job requires me to analyze and interpret the information I use./My job requires me to enter, check, or convey information.
> When I'm working, people look to me for guidance./When I'm working, people tell me what they want me to do.
> My job requires that I know how to use a wide variety of tools or machines./My job requires that I know how to use only a few tools or machines.

One last pair was included to measure the overall level of conceptual demand:

> On my job I do the same things, over and over./On my job I get to do a number of different things.

Inasmuch as these items measure different facets of conceptual content (the people-data-things triptych), they were not expected to correlate highly. As expected, however, the measure is closely bound up with pay ($r = .48$) and gender ($r = .47$, indicating greater conceptual demands within male jobs). Moreover, the Spearman's rho between this index and the 1977 *Dictionary of Occupational Titles* scores on occupational complexity—now nearly a decade old—is .60, further supporting the measure's validity. The index of conceptual content ranges from 4 to 20, with high scores representing more complex work.

Alienation from Work

Conceptualization and measurement of worker alienation, of course, are themselves much debated issues (Seeman, 1975; Geyer and Schweitzer, 1981; Erikson, 1986). The approach used here departs from the Seeman (1959) tradition in order to conform more closely to the original Marxist approach.[8] Admittedly, alienation is defined somewhat narrowly, referring only to subjective work orientations, rather than to objective-historical trends. However, this focus will provide a useful cor-

rective against the objectivistic biases inherent within structuralist Marxism, which leave little room for worker subjectivity.

Here, *alienation from work* means an attitudinal configuration marked by four characteristics: (1) an instrumental (means/end) orientation toward the job; (2) a lack of subjective involvement in the work itself; (3) an inversion of the worker/tool relationship, in which the tools are perceived as controlling the worker, rather than the reverse; and, finally, (4) an aversion toward the work as well (see Marx, 1961: 61-80; 1967: 310). While, ideally, multiple dimensions would be used to measure to this operational definition, the following five items were deemed adequate to the task at hand. Workers were asked how often they feel each of the following ways about their jobs:

The only thing I look forward to on my job is getting paid.
The time really drags for me when I'm at work.
On my job I feel as if the machines and equipment control me.
When I'm working I feel like I become just another part of the machinery.
I really have to force myself to go in to work.

The resulting scale has an alpha of .84. Logarithmic transformation was used to remove a negative skew; high scores indicate greater alienation from work.

ANALYSIS AND RESULTS

The analysis begins by exploring apparent shifts in skill levels over time. For this purpose, Federal Communications Commission data on changes in the occupational distribution of the industry work force represent a necessary point of departure (see Figure 1). In 1950 the single largest occupation within the industry was the operators, who far outnumbered their closest (craft) counterparts. Since then, the automation of operator services has cut the number of operators in half, even as the volume of calls has grown. In proportional terms, operators have declined from more than 42% of the work force in 1950 to less than 16% by 1980.

At the same time, employment in other occupations has shown secular growth. For example, professional and semiprofessional employees (largely engineers and drafters) have expanded from a minor

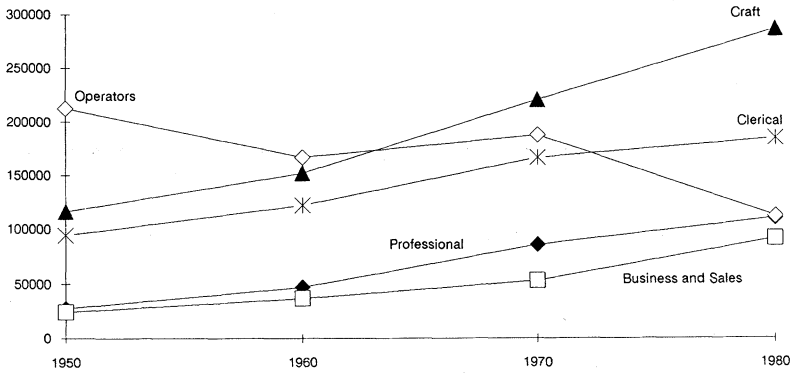

Figure 1: Employment in the Communications Industry (in thousands), by Occupational Group, 1950-1980

SOURCE: Federal Communications Commission (1950; 1960-1980).

to an appreciable presence within the industry work force. The increasing emphasis in the industry upon market competition is reflected in the growth of both sales and clerical workers. Most striking, however, is the expansion of the craft occupation, the absolute numbers of which have more than doubled. In relative terms, the size of the craft category has expanded from 23% of the industry work force in 1950 to 35% in 1980. Moreover, craft work has now displaced the operators as the largest occupational category within the industry. This latter trend suggests that a growing proportion of the work force is needed to install and maintain the increasingly automated equipment.

Caution is needed in interpreting these data. They do provide information about the relative size of occupational categories. But taken by themselves, they tell us nothing as to job content. Conceivably, even as craft occupations have numerically expanded, the autonomy and complexity of these jobs may have declined. Indeed, precisely *because* craft jobs have expanded, management may have more reason to deskill or dilute craft work.[9] The question here is whether the expansion of craft jobs signifies a shift toward genuinely skilled work. Using the survey data described above, this question can be addressed. Table 3 presents mean levels of autonomy and conceptual demands by occupational category, adjusted for gender. The results clearly suggest that the two craft occupations (particularly the inside crafts) involve tasks that *are*

TABLE 3
Mean Work Autonomy and Conceptual Content by Occupational Category, Adjusted for Gender

Occupational Category	Autonomy-Control	Conceptual Content
Inside Crafts	16.95	14.78
Outside Crafts	14.03	14.52
Customer Service Reps.	13.36	12.22
Clerical Workers	14.32	11.32
Operators	7.85	7.61
Mean	13.55	11.97
Standard Deviation	4.81	4.07
F	65.464	42.885
p	<.0005	<.0005

significantly more autonomous and conceptually demanding than the industry mean. In other words, the term *craft* is rather more than an obsolete occupational designation. It therefore seems safe to conclude that the contraction of the operators' jobs, coupled with the expansion of skilled craft positions, does indeed suggest the existence of an upgrading tendency during the years 1950 to 1980. The question then concerns the nature of any trends under way within the more recent period. In keeping with the strategy outlined above, the survey data on technology, job design, and alienation will be used to address this question.

The model used in the analysis of the survey data is congruent with the thinking of Blauner, Faunce, Shepard, and other upgrading theorists; it can, however, be used to test predictions made by the deskilling perspective as well (see Figure 2). The model holds that advanced technologies impinge upon job design, in turn affecting levels of worker alienation. To apply the model, a series of relatively simple equations

TABLE 4
Work Autonomy Regressed on Technology and Controls, for the Total Sample and Occupational Subgroups (Standardized Coefficients)

Predictor	(a) Entire Sample	(b) Operators	(c) Clerical Workers	(d) Inside Crafts	(e) Outside Crafts	(f) Customer Rep's.
Seniority	.01	-.11	-.03	-.07	.00	.04
Gender (female=1, male=2)	.33****	---[a]	.05	.12	-.01	.11
Size[b]	.04	-.03	-.04	.37***	-.18	-.18
Automation (Ind. level)	-.16****	-.02	-.28****	-.23*	-.05	-.26*
Automation (Aggregate)	.13***	-.07	-.44****	-.06	.34**	-.13
R^2	.151	.021	.243	.228	.103	.125
N	(654)	(118)	(218)	(103)	(87)	(72)

a. Insufficient variance for inclusion in equation.
b. Workplace size is coded as on questionnaire as follows: < 10 workers = 1; 10-25 = 2; 26-50 = 3; 51-100 = 4; 101-200 = 5; 201-500 = 6; > 500 = 7.
*p < .05; **p < .01; ***p < .001; ****p < .0001.

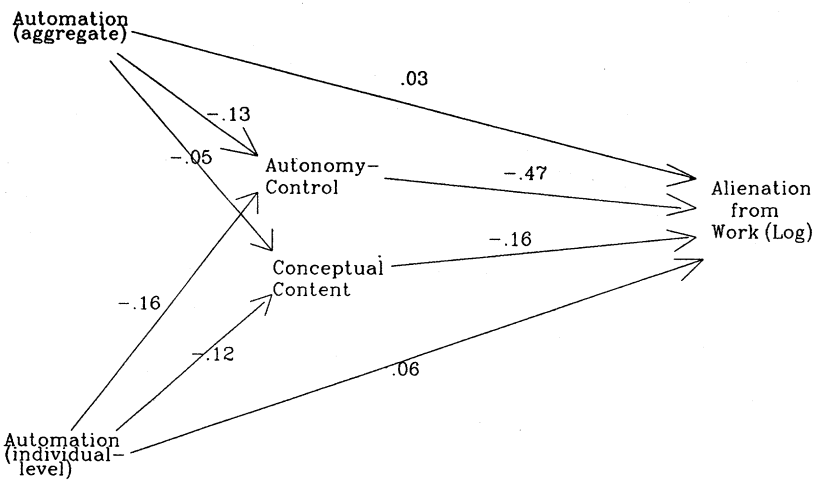

Figure 2: A Model of the Relations Among Technology, Work Design, and Alienation from Work (Entire Sample)

TABLE 5
Conceptual Content Regressed on Technology and Controls, for Entire Sample and Occupational Subgroups (Standardized Coefficients)

Predictor	(a) Entire Sample	(b) Operators	(c) Clerical Workers	(d) Inside Crafts	(e) Outside Crafts	(f) Customer Rep's.
Seniority	.16****	.07	.17*	.11	-.07	.19
Gender (female=1, male=2)	.44****	---[a]	.15*	.11	.06	-.07
Size[b]	.03	.09	-.01	.06	-.04	.21
Automation (Ind. level)	-.12***	-.01	-.18**	-.17	-.08	-.06
Automation (Aggregate)	-.05	.00	-.14*	.02	.42**	.13
R^2	.260	.013	.081	.076	.170	.098
N	(619)	(103)	(212)	(101)	(82)	(74)

a. Insufficient variance for inclusion in equation.
b. Workplace size is coded as on questionnaire as follows: < 10 workers = 1; 10-25 = 2; 26-50 = 3; 51-100 = 4; 101-200 = 5; 201-500 = 6; > 500 = 7.
*p < .05; **p < .01; ***p < .001; ****p < .0001.

was used: thus the job design measures were regressed on technology and controls, and worker alienation was regressed on technology, work design, and controls. As noted above, the analysis is complicated by the need to examine the implications of new technologies within each occupation (to derive the synthetic cohort). For this reason the model is applied not only to the overall sample, but also to the occupational subgroups.

The overall effects of new technologies on job design and worker alienation can be seen in column a of Tables 4 through 7; the relevant coefficients have been entered into the paths given in Figure 2. Most notably, while the longitudinal data adduced above suggested the existence of an upgrading trend, the survey data indicate the onset of a degradation effect within the present period. For example, Table 4a reveals that after adjusting for controls, the effects of automation at both individual and aggregate levels are significant, and in the direction predicted by degradation theorists: The higher the level of automation, the less autonomous the work. The consequences of automation for the conceptual content of workers' jobs, however (Table 5a), are somewhat

TABLE 6
Alienation from Work Regressed on Technology, Job Design Measures, and Controls, for Entire Sample and Occupational Subgroups (Standardized Coefficients)

Predictor	(a) Entire Sample	(b) Operators	(c) Clerical Workers	(d) Inside Crafts	(e) Outside Crafts	(f) Customer Rep's.
Seniority	.03	.05	.02	.01	.08	-.05
Gender (female=1, male=2)	.03	---[a]	.01	.11	.08	-.10
Size[b]	.03	.08	-.03	.00	.16	.31**
Automation (Ind. level)	.06	-.08	.20**	-.24*	.10	.21*
Automation (Aggregate)	.03	-.02	.07	-.03	.10	-.17
Autonomy	-.47****	-.39***	-.29****	-.45****	-.53****	-.25*
Conceptual Content	-.16***	-.02	-.24***	-.16	-.10	-.07
R^2	.326	.171	.275	.240	.354	.291
N	(619)	(103)	(212)	(101)	(82)	(73)

a. Insufficient variance for inclusion in equation.
b. Workplace size is coded as on questionnaire as follows: < 10 workers = 1; 10-25 = 2; 26-50 = 3; 51-100 = 4; 101-200 = 5; 201-500 = 6; > 500 = 7.
*p < .05; **p < .01; ***p < .001; ****p < .0001.

less pronounced; here, only the individual-level coefficient is significant. The effect of automation is again negative, however, reflecting a trend toward lower conceptual content. Moreover, for the sample as a whole, automation engenders increased levels of alienation from work (see Figure 2 and Table 7a). This latter effect is primarily indirect; that is, technologically induced increases in worker alienation are for the most part explained by changes in job design (especially through decreased autonomy).

As noted above, however, the overall relation between automation and job design need not indicate the existence of a dynamic pattern or trend. Nor can we assume that the effects of technology are homogeneous across all occupational groups. It will therefore be crucial to examine the effects of automation *within* each occupation. Toward this end, the total effects have been estimated for each occupational category. The relevant coefficients are provided in columns b through f

TABLE 7
Direct, Indirect, and Total Effects of Advanced Technology[a] on Alienation from Work, by Occupation[b]

	(a) Entire Sample	(b) Operators	(c) Clerical Workers	(d) Inside Crafts	(e) Outside Crafts	(f) Customer Rep's.
Indirect Effects of Technology	.17	.04	.29	.15	-.20	.09
Direct Effects of Technology (net of job design)	.09	-.10	.27	-.24	.20	.04
Total Effects of Technology Alienation.	.26	-.06	.56	-.09	.00	.13

a. Standardized regression coefficients for job and workplace automation have been summed to represent the net effect of technological development.
b. All equations contained controls for age, race, gender, and workplace size.

of Tables 4 through 7. These data reveal that the effects of technology on job design do indeed vary significantly across the occupational groups: that is, technology *differentially affects* the various occupations.[10]

Upgrading theorists would expect that at the highest levels of automation, the least skilled jobs (here, the operators) should begin to manifest greater autonomy or conceptual demands. As is shown in column b of Tables 4 and 5, however, the survey data provide no indication of a beneficial effect. Automation has no significant effects upon job content at all within this occupational group. Presumably, any effects of automation have already been felt; no further trends can be detected.

In three of the remaining four categories, however—the clerical, inside crafts, and customer service jobs—a significant trend toward deskilling is apparent (see Tables 4 and 5, columns c, d, and f). In the case of customer representatives and inside craft workers, working with highly automated equipment (i.e., individual-level automation) does

reduce worker autonomy. However, automation at the aggregate or workplace level has no significant impact upon these workers' jobs. Note further that the conceptual content of these two occupational categories does not change in the wake of automation, at either the individual or the workplace level of analysis. In the case of clerical workers, however, the change in work content is especially pronounced. For example, we find that automation at both levels of analysis significantly reduces clerical workers' autonomy (Table 4c). Similarly, Table 5c reveals that the conceptual content of clerical work again declines significantly, apace with automation at both levels of analysis. These findings suggest that clerical work is especially vulnerable to technological deskilling, while inside craft workers and customer representatives experience a weaker trend in the same direction.

The implications of technology for the last occupational category, however—the outside crafts—clearly stand at odds with degradation theory. As column e of Tables 4 and 5 reveals, automation does significantly affect the design of these workers' jobs, but in the opposite direction from that predicted by the degradation thesis. That is, for the outside crafts, advanced technology seems to *increase* both the autonomy and the conceptual content of the job. In this case, then, employment within technologically advanced contexts seems to *strengthen* craft control, rather than to destroy it.[11] Thus, although inside craft jobs experience a moderate trend toward deskilling, the outside crafts encounter an even stronger tendency in the opposite direction. What this pattern suggests is that skilled craft labor is not so much abolished as transformed: The position of the inside craft force seems to weaken, while that of the outside crafts is enhanced.[12]

The findings discussed thus far suggest that advanced technology has *differential* effects on work content. While automation seems clearly to modify the content of certain occupations, it has the opposite effect upon others. Although the dominant trend (affecting three of the five occupational categories) is in the direction of deskilling, such differential effects are not easily squared with notions of a "homogenization" effect, which deskilling theorists often expect.

To this point the subgroup analysis has been concerned solely with work content, without regard for alienation from work. When the full relationships among advanced technology, work, and alienation are examined, certain instructive patterns result (see Tables 6 and 7). First, as Table 7 suggests, the total effects of technology on worker alienation

are appreciable within only one of the five occupational categories—that of clerical work. The findings thus provide further evidence that computerization adversely affects this group. Note, however, that the effect of computerization on worker alienation among the clerks occurs not only through changes in job content (the indirect effects) but also due to factors unrelated to either autonomy or conceptual demands (the direct effects, even while controlling for job content). The latter, direct effect of technology on alienation very likely flows from increased constraints upon social interaction, which computerization implies.

Technological change does increase worker alienation among the customer service representatives, but the effect here is much less pronounced than the one that prevails among the clerical group. Thus, although the adverse effect of advanced technology does indeed exist, it is primarily found among clerical workers. Equally important, we find that among workers employed in each of the craft occupations, new technologies exert *opposing* or *counteracting* influences upon worker alienation that balance one another out. These influences are revealing in their own right, inasmuch as they begin to suggest the complexities involved in the process of technological change.

We have seen that among the inside craft group, automation—in this case, the use of electronic switching systems—seems to reduce work autonomy, and thereby to engender greater alienation from work. However, as the data given in column d of Table 6 suggest, the *direct* effect of automation among members of this group (after adjusting for changes in work content) is to *reduce* their level of alienation. Thus even as these workers' level of autonomy is reduced, other aspects of their job are apparently enhanced, thereby counteracting the modifying effect. Presumably, the beneficial effect of automation stems from the greater ease with which faulty electronic components can be identified (and perhaps from their quieter operation as well).

When the model is applied to the outside craft group, new technology again exerts contradictory effects upon worker alienation. As we have seen, among the outside crafts new technologies tend to increase the autonomy and conceptual demands of workers' jobs. Hence the *indirect* effect of automation is to reduce these workers' levels of alienation (see the top row of Table 6, column e). However, the *direct* effect of technology again operates in precisely the opposite direction. After adjusting for the changes in job content, the use of automated equipment tends to increase worker alienation among the outside crafts.[13]

Again, these findings suggest that technological change affects different facets of the same occupation in conflicting ways. For the craft jobs at least, while some occupational rewards are diminished, others are enhanced. In these cases, new technologies appear to have *contradictory consequences* for worker alienation, rather than the uniform effects existing theories expect.[14]

The overall impact of new technologies upon worker alienation can be understood in the following terms. Given the existence of countervailing influences within the two craft groups, the effects of new technology are off-setting and reflect no appreciable shift in craft workers' level of alienation.[15] Among the clerical workers, however, the direct and indirect effects of technology operate in the same direction, resulting in a substantial trend toward greater alienation from work. The latter finding can be interpreted as offering partial support for theories of the proletarianization of clerical jobs (e.g., Glenn and Feldberg, 1979; Carchedi, 1977; Braverman, 1974; Crompton and Jones, 1984; Vallas, 1987).

In sum, the survey data suggest the emergence of an overall degradation trend. But more elaborate analysis reveals this trend to be much more uneven or contradictory than deskilling theorists expect. Where job design is concerned, technology seems to have differential effects across the various occupational categories. While some occupations (especially clerical jobs) are apparently being deskilled, others (craft jobs) may actually be upgraded. Thus the technological restructuring of work would seem far less uniform than deskilling theorists allow. Moreover, when we examine apparent trends in the experience of work, we find that automation seems to have complex or contradictory effects even *within* particular occupations. Again, new technologies seem to operate in ways that are more differentiated than either theory acknowledges (Hodson, 1985). Apparently, although technological change may effect job content in one direction, it may at the same time have an opposing effect upon other facets of the work situation.

DISCUSSION

By focusing on the communications industry as a strategic terrain for research, this study has sought to contribute to the debate over advanced technologies, the labor process, and worker alienation. As suggested,

the research design employed here has been limited in certain important respects. Thus the study has only indirectly adduced evidence of trends in job design. The population from which the sample was drawn is geographically limited (involving only two northeastern states) and bears upon but one highly unionized industry. Issues of response rate and measurement error also require further qualification of the results. Despite these caveats, however, certain provisional conclusions can be drawn.

Official statistics on the changing occupational distribution within the industry, informed by survey data on job content, suggest the existence of an upgrading tendency during the 1950-1980 period. It was toward the end of this period—especially during the 1970s—that economic and technological changes within the industry began to make themselves felt. And indeed, the survey data provide indications that a degradation of work has emerged within more recent years. While these data are limited, they suggest that the upgrading effect within the industry has for the most part been reversed.

But if a degradation effect has taken hold, by no means does it uniformly affect the workers in this industry. To the extent that the restructuring of the labor process here can accurately be depicted, it is not the *homogenization* of labor that seems to be occurring, but rather continued inequality. Indeed, two worlds of work seem to persist within the communications industry. On the one hand, we see a historically growing proportion of craft occupations the position of which seems relatively insulated against the degradation process Braverman described. On the other hand, we find clerical labor—now the second largest occupation in the industry—bearing the brunt of the degradation effect. In this connection it can be surmised that clerical workers are slowly becoming the functional equivalent of the operators, whose ranks have nearly disappeared. If so, then the industry would be characterized by a *polarization* of skill levels, rather than the emergence of "simple, undifferentiated labor."[16]

Thus this study suggests that automation has differential effects—contradictory consequences—both within and between occupational categories. Where the contradictory effects *within* specific job categories are concerned, the following points emerge. As was suggested, the present analysis underscores the need to conceive of automation as a process that may bring simultaneously opposing influences to bear upon particular occupations. While further research is needed as to the

prevalence of such contradictory effects, the implication is that the relation between new technologies and the experience of work may be more internally variegated than has thus far been acknowledged. Conceivably, studies that find that new technology has little or no effect upon attitudes toward work might well overlook the operation of conflicting processes underlying the null outcome.

Equally important are the uneven effects of new technology *between* the different occupations. While the data used in this analysis cannot explain such differential effects, some hypotheses in this vein can be advanced. For example, the existence of an occupational community such as craft workers often sustain (Salaman, 1975, 1986) may provide sufficient social and cultural resources as to modify the outcome of technological change. In theory, new machines might permit close electronic measurement of worker performance; but in practice, the solidarity of the craft group may prevent the realization of such possibilities. Similarly, variations in the strength of union representation available to particular occupational groups may condition or modify the outcome of new technologies. Where little union protection is available, the modifying effects of automation may be especially pronounced. Finally, the overwhelmingly female composition of the clerical work force may affect the technology/work relation, inasmuch as sex-based ideologies concerning women's work may render the "autonomization" of clerical jobs all the more difficult to achieve (Feldberg and Glenn, 1983; Hacker, 1979; Form and McMillen, 1983). While these possibilities can be articulated, they cannot be tested within the present study. The key for future research may be to focus upon the conditions under which the automation process occurs, rather than simply upon the outcome as such.

Perhaps most important, the pattern found above suggests that economic competition, rather than automation in itself, may play the decisive role in conditioning the relation between new technology and job design. While more certain conclusions must await further research, the present study begins to suggest that under monopolistic conditions, greater "play" may exist within the division of labor. Hence, greater space can be accorded skilled occupations. Under more competitive conditions, however, a certain "hardening" effect may emerge in which management begins to seek out opportunities for deskilling that otherwise would have gone unexplored. Of course, this study suggests that such a hardening effect may be unevenly imposed upon the different

occupations. Still, the point is that the implications of new technologies cannot be understood in abstraction from their economic context. In short, the characteristics of the economic environment may condition the relation between technology and work. While Blauner was quite conscious of such socioeconomic influences (e.g., 1964: 171), other upgrading theorists have focused purely upon technical imperatives. This focus may be misplaced.

A final point concerns the implications of rising competition throughout the American economy. Virtually all of the research on shifts in work content has been conducted with reference to the period immediately prior to the economic retrenchment of the middle and late 1970s, and the movement toward deregulation as well. If, as this study suggests, rising competition may have implications for shifts in job design, then the addition of more recent data points may ultimately prove crucial if the deskilling debate is to be addressed properly.

NOTES

1. The *Dictionary of Occupational Titles* data have been much used, even though important problems of validity remain unresolved. For critical discussions of the DOT data, see Miller et al. (1980), Spenner (1983), and Hunt and Hunt (1984).

2. Recent research has challenged the validity of Blauner's conclusions, even with respect to the chemical industry. See Nichols and Benyon (1977) and Halle (1984).

3. For discussion of the consequences of ESS from a deskilling point of view, see Newman (1982) and Howard (1980). The case of the Test Desk Technician (an elite central-office craft that was largely destroyed by automation) is sometimes discussed as an example of the wider deskilling trend. The question here is whether this case does in fact represent the modal trend in the industry more broadly.

4. Thus Kohl (1982: 64) refers to a growing "push for labor cost savings" throughout the industry, largely due to competitive pressures.

5. The CWA is a large, national union representing more than half a million workers. It is the major union in the industry, with many more members than either the International Brotherhood of Electrical Workers or the Telecommunications International Union. District 1 of the CWA encompasses workers employed in New York, New Jersey, and New England.

6. Conceptual approaches toward technology that differ from that used here can be found in Amber and Amber (1962), Bright (1958), and Faunce (1965). Note that the present approach is more narrowly focused upon the equipment itself than is the case within the organization literature. For a discussion and an example, see Baron and Bielby (1982).

7. Conceptual content is here understood to be a subset of the more general dimension of occupational complexity.

8. For recent theoretical and empirical analysis grounded in the Marxist theory of alienation, see Archibald (1978), Torrance (1981), Archibald et al. (1981), and Vallas and Yarrow (forthcoming). See also Kanungo (1982: 36).

9. Arguments to this effect can be found in Newman (1982) and Kohl (1982), both of whom are concerned with changes in skill levels within communications.

10. When tests for interaction using dummy variable regressions are performed, interaction terms for the outside craft and clerical groups are highly significant, adding appreciably to the R^2 for the additive equation.

11. This finding is bolstered when we examine workers' responses to a series of items measuring perceived change in the workplace. These items asked whether "the more complex, skilled parts of your job have been computerized," whether changes in technology have "reduced the discretion or judgment your job requires," whether the work has become more "routinized," and so forth. The percentage of outside craft workers who reported such adverse changes was in all cases lower than in any of the other four occupations. In addition, interviews of several local union officers reinforced the thrust of this conclusion. These interviews suggest that where advanced technologies are used by the outside craft force, foremen—whose production experience was based on the older systems—have little or no personal experience in its use. As a result, first-level supervisors are forced to depend on the workers' knowledge even more so than before.

12. Interestingly, outside craft workers seem to make up the basis for local union leadership. Similar dynamics are reported by Herding (1972).

13. Unstructured interviews of craft workers and local officers suggest that where the system is highly automated, problems of communication between inside and outside workers are often exacerbated. Thus outside craft workers are forced to spend very long periods of time waiting for information needed to complete their tasks, a fact that very likely reduces their involvement in the job itself.

14. One reviewer quite rightly advises caution in the use of the term *contradictory*. My use of the term is meant to refer to phenomena subject to opposing influences at the same point in time. Erik Olin Wright's (1979: chap. 2) notion of contradictory class influences is roughly parallel.

15. Note that the effect of worker autonomy on alienation is strongest among the two craft groups (see Table 6). This point underscores the persistence of a craft tradition among these skilled groups.

16. Traditional notions of the class structure locate lower-level office employees "above" skilled manual workers. However, the present study suggests that such notions are increasingly obsolete. It is not so much that clerical work undergoes a reduction to the position of manual work, as is often claimed. Instead, the situation of clerical workers drops farther *below* that of skilled manual labor as computerization is pressed forward. For comparison of the position of clerical and manual workers, see Baron and Bielby (1982: 185) and Wright and Singelmann (1982).

REFERENCES

ALMQUIST, M. L. and G. E. FESSLER (1979) "Switching control centers: switching system maintenance—and more." Bell Laboratories Report (June).

ALWIN, D. F. (1976) "Assessing school effects: some identities." Sociology of Education 49 (October): 249-303.
AMBER, G. S. and P. S. AMBER (1962) Anatomy of Automation. Englewood Cliffs, NJ: Prentice-Hall.
AMIN, A. T., W. HAUN, and D. MULDER (1981) "Sleuthing for troubles in ESS networks." Bell Laboratories Report (October).
ARCHIBALD, W. P. (1978) "Using Marx's Theory of Alienation empirically." Theory and Society 6.
ARCHIBALD, W. P., O. ADAMS, and J. GARTRELL (1981) "Propertylessness and alienation: re-opening a 'shut' case," pp. 149-175 in R. F. Geyer and D. Schweitzer (eds.) Alienation: Problems of Meaning, Theory and Method. London: Routledge & Kegan Paul.
BARON, J. N. and W. T. BIELBY (1982) "Workers and machines: dimensions and determinants of technical relations in the workplace." Amer. Soc. Rev. 47 (April): 175-188.
BELL, D. (1960) "Work and its discontents," pp. 222-265 in The End of Ideology. Glencoe, IL: Free Press.
BLAUNDER, R. (1964) Alienation and Freedom: The Factory Worker and His Industry. Chicago: Univ. of Chicago Press.
BRAVERMAN, H. (1974) Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century. New York: Monthly Review Press.
BRIGHT, J. (1958) Automation and Management. Boston: Harvard Business School.
BROOKS, T. R. (1977) The Communications Workers of America: Story of a Union. New York: Mason-Charter.
BURAWOY, M. (1983) "Between the labor process and the state: the changing face of factory regimes under advanced capitalism." Amer. Soc. Rev. 48 (October): 587-605.
CARCHEDI, G. (1977) The Economic Identification of Social Classes. London: Routledge & Kegan Paul.
CHARLES, T. (1986) "New technology and the future of work: the state of current research." Presented at the 11th World Congress of Sociology, New Delhi.
COLEMAN, J. R. (1969) "Relational analysis: the study of social organizations with survey methods," pp. 517-527 in A. Etzioni (ed.) A Sociological Reader on Complex Organizations. New York: Holt, Rinehart & Winston.
COOLEY, M. (1980) Architect or Bee? The Human/Technology Relationship. London: Langely Technical Services.
COTGROVE, S. and C. VAMPLEW (1972) "Technology, class and politics: the case of the process workers." Sociology 6: 169-185.
CROMPTON, R. and G. S. JONES (1984) White Collar Proletariat: Deskilling and Gender in Clerical Work. Philadelphia: Temple Univ. Press.
DYMMEL, M. D. (1979) "Technology in telecommunications: its effect on labor and skills." Monthly Labor Rev. (January).
EDWARDS, R. C. (1979) Contested Terrain: The Transformation of the Workplace in the Twentieth Century. New York: Basic Books.
ERIKSON, K. (1986) "On work and alienation" (1985 presidential address to the American Sociological Association). Amer. Soc. Rev. 51 (1): 1-9.
FAUNCE, W. (1965) "Automation and the division of labor." Social Problems 13 (Fall).
Federal Communications Commission (1950) Statistics of the Communications Industry. Washington, DC: Government Printing Office.
Federal Communications Commission (1960-1980) Statistics of Communications Common Carriers. Washington, DC: Government Printing Office.

FELDBERG, R. and E. GLENN (1983) "Technology and work degradation: effects of office automation on clerical workers," pp. 59-78 in J. Rothschild (ed.) Machina Ex Dea. New York: Pergamon.

FORM, W. (1980) "Resolving ideological issues on the division of labor," pp. 140-155 in H. Blalock (ed.) Sociological Theory and Research: A Critical Appraisal. Glencoe, IL: Free Press.

FORM, W. and D. B. McMILLEN (1983) "Men, women and machines." Work and Occupations 10 (May): 147-178.

FRIEDMAN, A. (1977) Industry and Labor: Class Struggle at Work and Monopoly Capital. London: Macmillan.

GEYER, R. F. and D. SCHWEITZER [eds.] (1981) Alienation: Problems of Meaning, Theory and Method. London: Routledge & Kegan Paul.

GLENN, E. and R. FELDBERG (1979) "Proletarianizing clerical work: technology and organizational control in the office," pp. 51-72 in A. Zimbalist (ed.) Case Studies on the Labor Process. New York: Monthly Review Press.

GOLDTHORPE, J. et al. (1969) The Affluent Worker in the Class Structure. London: Cambridge Univ. Press.

HACKER, S. (1979) "Sex segregation, technology and organizational change: a longitudinal study of A.T.&T." Social Problems 26 (5).

HALLE, D. (1984) America's Working Man. Chicago: Univ. of Chicago Press.

HERDING, R. (1972) Job Control and Union Structure. Rotterdam.

HILL, S. (1983) Competition and Control at Work: The New Industrial Sociology. Cambridge: MIT Press.

HIRSCHHORN, L. (1984) Beyond Mechanization. Cambridge: MIT Press.

HODSON, R. (1985) "Working in 'high-tech': issues and opportunities for the industrial sociologist." Soc. Q. 26 (3): 351-364.

HOWARD, R. (1980) "Brave new workplace." Working Papers for a New Society (November-December).

HULL, F., N. S. FRIEDMAN, and T. ROGERS (1982) "The effect of technology on alienation from work: testing Blauner's inverted U-curve hypothesis." Work and Occupations 9 (February).

HUNT, T. L. and H. A. HUNT (1984) An Assessment of Data Sources to Study the Employment Effects of Technological Change. Washington, DC: National Academy of Sciences, Committee on Women's Employment and Related Social Issues.

KANUNGO, R. N. (1982) Work Alienation: An Integrative Approach. New York: Praeger.

KENDALL, P. and P. LAZARSFELD (1955) "The relation between individual and group characteristics in the American soldier," pp. 290-296 in P. Lazarsfeld and M. Rosenberg (eds.) The Language of Social Research. Glencoe, IL: Free Press.

KOHL, G. (1982) "Changing competitive and technology environments in telecommunications," pp. 53-76 in D. Kennedy et al. (eds.) Labor and Technology: Union Response to a Changing Environment. University Park: Pennsylvania State University, Department of Labor Studies.

KOHL, G. (n.d.) "Divestiture: the framework." Internal memorandum, Communications Workers of America, Development and Research Department, Washington, DC.

KOHN, M. (1969) Class and Conformity: A Study in Values. Homewood, IL: Dorsey.

KOHN, M., C. SCHOOLER, et al. (1983) Work and Personality: An Inquiry into the Impact of Social Stratification. Norwood, NJ: Ablex.

KRAFT, P. (1977) Programmers and Managers: The Routinization of Computer Programming in the United States. New York: Springer-Verlag.
KRAFT, P. (1979) "The industrialization of computer programming: from programming to 'software production,'" pp. 1-18 in A. Zimbalist (ed.) Case Studies on the Labor Process. New York: Monthly Review.
LEE, D. J. (1981) "Skill, craft and class: a theoretical critique and a critical case." Sociology 15 (1).
LINCOLN, J. and G. ZEITZ (1980) "Organizational properties from aggregate data: separating individual from structural effects." Amer. Soc. Rev. 45 (June): 391-408.
LOCKWOOD, D. (1958) The Blackcoated Worker: A Study in Class Consciousness. -London: Allen & Unwin.
LOW-BEER, J. R. (1978) Protest and Participation: The New Working Class in Italy. Cambridge: Cambridge Univ. Press.
MacKENZIE, G. (1973) The Aristocracy of Labor: Skilled Craftsmen in the Class Structure. Cambridge: Cambridge Univ. Press.
MARX, K. (1961) Economic and Philosophic Manuscripts of 1844. Moscow: Foreign Languages Press.
MARX, K. (1967) Capital, Vol. I: A Critical Analysis of Capitalist Production. New York: International.
MILLER, A. R., D. J. TREIMAN, P. S. CAIN, and A. A. ROOS (1980) Work, Jobs and Occupations: A Critical Review of the "Dictionary of Occupational Titles." Washington, DC: National Academy Press.
MONTGOMERY, D. (1979) Workers' Control in America: Studies in the History of Work, Technology and Labor Struggles. New York: Cambridge Univ. Press.
NEWMAN, D. (1982) "New technology and the changing labor process in the telephone industry: the union's response." (unpublished)
NICHOLS, T. and H. BENYON (1977) Living with Capitalism: Class Relations and the Modern Factory. London: Routledge & Kegan Paul.
NOBLE, D. (1977) America by Design: Science, Technology and the Rise of Corporate Capitalism. Cambridge: MIT Press.
NOBLE, D. (1978) "Social choice in machine design: the case of automatically controlled machine tools, and a challenge for labor." Politics and Society 8 (3-4).
NOBLE, D. (1984) Forces of Production: A Social History of Industrial Automation. New York: Knopf.
RUMBERGER, R. W. (1981) "The changing skill requirements of jobs in the U.S. economy." Industrial and Labor Relations Rev. 34: 578-591.
SALAMAN, G. (1975) "Occupations, community and consciousness," in M. Bulmer (ed.) Working Class Images of Society. London: Routledge & Kegan Paul.
SALAMAN, G. (1986) Working. London: Tavistock.
SEEMAN, M. (1959) "On the meaning of alienation." Amer. Soc. Rev. 24.
SEEMAN, M. (1975) "Alienation studies." Annual Rev. of Sociology 1: 91-123.
SHEPARD, J. (1971) Automation and Alienation: A Study of Office and Factory Workers. Cambridge: MIT Press.
SHEPARD, J. (1977) "Technology, alienation and job satisfaction." Annual Rev. of Sociology 3.
SPENNER, K. I. (1979) "Temporal changes in work content." Amer. Soc. Rev. 44: 968-975.
SPENNER, K. I. (1983) "Deciphering Prometheus: temporal changes in the skill level of work." Amer. Soc. Rev. 48: 824-837.

STARK, D. (1980) "Class struggle and the transformation of the labor process: a relational view." Theory and Society 9 (1).
STEWART, A., K. PRANDY, and R. BLACKBURN (1984) Social Stratification and Occupations. New York: Holmes & Meier.
TANNENBAUM, A. and G. BACHMAN (1964) "Structural versus individual effects." Amer. J. of Sociology 69 (May): 585-595.
TORRANCE, J. (1981) "Alienation and estrangement as elements of social structure," pp. 68-96 in R. F. Geyer and D. Schweitzer (eds.) Alienation: Problems of Meaning, Theory and Method. London: Routledge & Kegan Paul.
U.S. Department of Labor (1978) Dictionary of Occupational Titles (4th ed.). Washington, DC: Government Printing Office.
VALLAS, S. P. (1987) "White collar proletarians? Computerization, clerks and working class consciousness." (unpublished).
VALLAS, S. P. (forthcoming) "The labor process as a source of class consciousness." Sociological Forum.
VALLAS, S. P. and M. P. YARROW (forthcoming) "Advanced technology and worker alienation: comments on the Blauner/Marxism debate." Work and Occupations.
WALLACE, M. and A. L. KALLEBERG (1982) "Industrial transformation and the decline of craft: the decomposition of skill in the printing industry, 1931-1978." Amer. Soc. Rev. 47: 307-324.
WEDDERBURN, D. and R. CROMPTON (1972) Workers' Attitudes Toward Technological Change. Cambridge: Cambridge Univ. Press.
WOOD, S. J. (1982) The De-Skilling of Labour? Skill, De-Skilling and the Labour Process. London: Hutchinson.
WRIGHT, E. O. (1979) Class, Crisis and the State. London: Verso.
WRIGHT, E. O. and J. SINGELMANN (1982) "Proletarianization and the changing American class structure," pp. 176-209 in M. Burawoy and T. Skocpol (eds.) Marxist Inquiries: Studies of Labor, Class and States. Chicago: Univ. of Chicago Press.
ZIMBALIST, A. (1979) "Introduction," in A. Zimbalist (ed.) Case Studies on the Labor Process. New York: Monthly Review Press.