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Automation, Skill and the Future of Capitalism

By Paul S. Adler

1. Introduction

The area of "labor process studies" has undergone important mutations since Braverman's (1974) landmark study *Labor and Monopoly Capital*. Braverman's basic thesis was that capitalist domination of the labor process has been progressively consolidated by a deskilling and degradation of work and that this same transformation of work would ultimately lead to revolt by alienated workers. Against Braverman's diagnosis of "a secular trend toward the incessant lowering of the working class as a whole below its previous conditions of skill and labor" (1974, p.129), the more recent inclusion of a variety of other factors--market pressures, ideologies, institutions, worker resistance--as counterweights to deskilling pressures helps explain the greater diversity of outcomes than Braverman's approach would imply.

The resultant state of research--as exemplified in collections like *The Degradation of Work?* (Wood, 1982), *Job Redesign: Critical Perspectives on the Labour Process* (Knights, Willmot, and Collinson, 1985), or in the research of Noble (1984) and Shaiken (1985)--has gained enormously in resolution and precision.

But, in the process, a key challenging insight of Braverman's work has been abandoned. The idea that close study of the labor process could yield insight into the destiny of capitalism is increasingly construed as futile. Whereas Braverman saw trends in work content and organization as shaping the long-run evolution of capitalism--defined very broadly as a form of society based on the competition of independent firms employing wage-labor--the more recent research aims at finer-grained analysis of specific firms or industries. It is therefore deliberately modest in its historical scope.

These new questions are indeed very interesting; but I do not believe that they exhaust the issue. Moreover, I shall attempt to show that their analysis can benefit from the restoration of more viable generalizations at the broader, historical level.

This article goes therefore somewhat against the current. Many commentators have argued that it is time to leave Braverman behind. By contrast, my critique of the shortcomings of Braverman's analysis of long-run, aggregate tendencies will

retain his ambition of historical scope, and will attempt to build a conceptual basis for useful empirical research that bears directly on the "big questions" he addresses.

To summarize the key points of my argument: the difficulty with the automation-skill debate as it pertains to long-term trends lies in the concepts of skill being used. Braverman's skill yardstick--the craftsman--is increasingly obsolete (Section 2). An alternative framework for analyzing skill is developed from close examination of the case of bank computerization (Sections 3 and 4). This framework encompasses a quantitative dimension--substantive complexity as measured by training-time requirements--and three qualitative dimensions--responsibility, abstractness and interdependence (Section 5). Compared to Braverman's focus on craft autonomy and expertise, this four-dimensional framework provides a richer framework for empirical investigation of skill trends. These dimensions also prove to be homologous with the basic building block of the capitalist form of society--that is, the commodity, the product produced for sale on the market (Section 6). This framework thus allows us to address directly the question of how skill trends might impinge on capitalism's viability.

The banking case (and many other case studies re-read in this light) suggests that competitive pressures force managers to seek out more productive ways of implementing automation, and these ways typically (although not always) involve more training, higher levels of responsibility, more abstract tasks and goals, and greater functional interdependence. My argument will be that these trends in automation's impact on skill requirements undermine the effectiveness of traditional personnel management practices. In doing so, these trends simultaneously undermine the viability of the commodity form of labor-power and create the premise of alternative post-capitalist forms of organization.

2. The Need for a New Concept of Skill

The central problem is that of the impact of automation on skill requirements under capitalist conditions. My focus is exclusively on long-run and aggregate trends.¹ This section explains why we need a new concept of skill.

1. There are, of course, many crucial issues to be explored in the short run: in particular, under capitalist conditions, structural shifts are generally not planned at the societal level, with the effect that even if these shifts are positive for most workers, and *a fortiori* if the shifts are only favorable in the long run, they impose real costs on individual workers and waste social resources.

Spenner's (1983) review of the major empirical studies on skill trends is most useful. The result of this survey is a resounding rejection of Braverman's diagnosis of "a secular trend toward the incessant lowering of the working class as a whole below its previous conditions of skill and labor." Not one of the systematic, aggregate studies of trends in individual occupations or in average labor-force requirements shows a deskilling trend; most show a clear up-grading both for most (although not all) occupations taken individually and for the labor force as a whole.

But the slippery core of all these studies--and the core that Braverman pre-emptively attacked in the concluding chapter of his book--is in our measurement of skill. The basic reason for this slipperiness lies not so much in the tools of observation (although those problems are substantial), as in our concepts of skill. The literature is populated by almost as many skill concepts as there are authors (see references in Spenner, 1983 for a brief overview).

Braverman's concept of skill has indubitable attraction. It is based on a craft model, encompassing task variety and scope, responsibility and autonomy, and the integration of mental, manual and social components of work. It can be summarized as a concept with two key dimensions: substantive task complexity and autonomy/control; but in Braverman's view these are closely correlated. Indeed such a close correlation is critical to his whole argument.

That such a correlation is not self-evident is, however, easily seen. One can, for example, easily imagine jobs with almost no autonomy but very high training requirements--and that one would have to qualify as highly skilled: take the airline pilot who must follow a pre-set procedure for every situation. On the other hand, one might wonder what one should make of an infantryman in the military, who is a jack-of-all-trades, but who is considered--for having full mastery of a complex, multi-faceted task and a low degree of specialization--to be the lowest-ranking element in the skill hierarchy of the military.

It is therefore important to distinguish more carefully the different "dimensions" of skill. If our focus is on the very long run, then it might be appropriate to begin our search for a viable skill concept with the economic determinants of skill. In this perspective, skill is basically the relative economic value of different types of labor; on this basis, skills can be measured by the relative training-times associated with their "production." This dimension could be thought of as closely related to Braverman's substantive task complexity dimension. By relating it to an economic mechanism, we can assure ourselves that our construct is not only a thought-construct, but also one that reflects a real process--that of the basic, long-run "value" determination of

relative wages.²

It remains to be seen, of course, how relevant this determination is, relative to the weight of social and ideological forces acting on relative wages. There are excellent reasons for thinking that *in anything but the long run* supply-and-demand, institutional, political and ideological realities can swamp this economic determination of skill. Moreover, which characteristics individual firms recognize as skill varies greatly--with some constraints like the relative undervaluing of women's jobs. But in a theory of long-run historical tendencies, it might be useful to at least begin by abstracting from these qualifications.

Now, insofar as skill is basically a question of training time, the data reviewed by Spenner suggests that skill levels (as best they have been measured) have increased over time. It is, of course, impossible to tell from the data whether employers have merely profited from exogenous trends in the workforce as regards, in particular, rising educational levels, or whether it is primarily the requirements of production that have driven changes in the training and educational systems. But in either case, over the long run, skill--understood as training time--and automation bear some positive correlation to each other. (Note that this proposition in no way excludes the possibility that workers' skills are rising even faster than job skill requirements.)

Whatever the weaknesses of this training-time definition of skill, it has one key strength, namely, that it poses with great clarity the next step in the analysis. If skill is defined in this way, it has a purely quantitative measure, being ideally reducible to hours of training time. The question that immediately makes itself manifest is then: what sort of qualities is the training designed to inculcate or to elicit? The challenge, therefore, is to establish a framework for analyzing this "qualitative" question.

This has been one of the attractions of Braverman's framework: his yardstick for skill--the craftsman--exemplifies not only the quantitative dimension I have identified as substantive task complexity, but also an intuitively appealing qualitative dimension--autonomy/control.

2. This premise reflects a certain convergence of human capital theory and classical Marxist theory. For Marx, the relative value of different classes of the commodity "labor power" depends on the socially necessary labor time required to "produce" it, i.e., training and education. Its "price" will fluctuate around this value as a function of short-term supply and demand factors, perhaps systematically biased by political and ideological factors. The human capital approach is thus a model of the surface relations characterizing the market for labor power -- a price model, as opposed to the underlying value model.

Braverman's craft concept of control is, however, inadequate. The key weakness of Braverman's craft yardstick is that the dissolution of craft autonomy is no longer central to the comprehension of contemporary trends. Ignoring the fact that a craft status never characterized more than a small minority of workers (Form, 1980), we might accept that the fragmentation of craft was a central feature of the passage from handicraft to manufacturing. Although different industries, regions and plants evolve at uneven rates, the dominant process of twentieth century capitalism is, however, a new one--the passage from manufacturing to large-scale machine-based industry and the growing importance of technical change as a source of productivity improvement. In other words, the dissolution of craft and the associated forms of worker autonomy characterizes an "early" phase of capitalist development--one that is certainly still underway in some industries, but no longer representative of contemporary capitalism's basic thrust. In Marx's terminology, the dissolution of craft has more to do with the transition from the "formal" subordination of labor to the "real" subordination of labor than with the subsequent development of the real subordination of labor.

In anticipation of some of these difficulties, Braverman argued:

I hope no one draws from this conclusion that my views are shaped by a nostalgia for an age that cannot be recaptured. Rather, my views about work are governed by nostalgia for an age that has not yet come into being, in which, for the worker, the craft satisfaction that arises from conscious and purposeful mastery of the labor process will be combined with the marvels of science and the ingenuity of engineering, an age in which everyone will be able to benefit, in some degree, from this combination (1974, p.7).

"Craft satisfaction" may not, however, "combine" so easily with the marvels of science. Think of the modern doctor: the advances of medical science--and not merely the capitalist organization of medicine--have led to a fantastic degree of specialization and an almost total loss of autonomy. This specialization has not, however, meant a deskilling--on the contrary. It is true that no one doctor enjoys "conscious and purposeful mastery of the labor process." (Unless, that it, "labor process" is tautologically redefined to be whatever cluster of tasks the individual doctor does have control over.) But this reflects an increasingly complex interdependence of different elements of what might be called the "collective medical worker." The idea of craftsman-like "autonomy" and "control" cannot capture the quality of highly-skilled but highly-specialized jobs, whether they be neurosurgeons or manufacturing technicians.

However, Braverman's approach has another attraction that we cannot ignore. With his conception of skill, he manages to pose a question that I have put at the heart of this essay, namely the question of capitalism's viability as a system. If, through a process that was inevitable given capitalist relations of production, workers were to become progressively deskilled and their jobs were to become progressively degraded, then the implication would be clear: revolt would become progressively more likely. This increasing probability of revolt would also be fueled by the fact that deskilling would break down hierarchical levels within the working class, and thus form the homogenous proletariat that Marx envisaged.

Now, phrased this way, we see a very interesting feature of Braverman's framework, namely, that it is formally analogous to the now out-moded theory of "absolute immiseration:" just like the supposed tendency towards the lowering of real wages, deskilling progressively degrades the workers' condition to the point where they have no choice but revolt. This implicit message has, I believe, been at the heart of the attraction of Braverman's work. It is a powerful polemical stance.³ This explains why it has been sustained for so long by so many in the face of so much data that apparently contradict it.

But the principle that a fruitful theory of skill might derive from a conceptual structure that linked work qualities to the question of the viability of capitalism is most intriguing.

At this stage of our search for a framework for the qualitative analysis of work useful for long-run analysis--a framework that might have a bearing on the viability issue itself--we can proceed either inductively or deductively. The following analysis proceeds inductively. It outlines the major loci of the qualitative changes in work that I have found in French banks. After briefly outlining the major technological changes in banking, I will discuss the evolution of skill requirements, using a "pre-theoretical" categorization of job characteristics. On this basis, a new framework emerges quite naturally. I shall return to sketch the deductive route and the implications of this framework in later sections.

3. The polemical power of the idea of absolute immiseration is bolstered by the fact that there are so many "local" instances of absolute immiseration both in the economic sense (cyclical downturns) and in the labor process sense (real cases of deskilling.) This is, no doubt, why Marx maintains the polemic even in the passages of *Capital* where he distances himself from the theory (Marx, 1981, p.768ff.).

3. Automation in Banking

Let us first review the nature of bank automation. I shall take my examples from French banking, with which I am more familiar (Adler, 1981).⁴ Over the 1950-1980 period, the number of bank accounts was multiplied by a factor of more than five, encouraging French banks--which are, on average, monsters by U.S. standards⁵--to undertake very ambitious computerization programs. The resulting systems in French banks are quite similar to those found in larger and more technically progressive U.S. institutions.

Banks began introducing computers during the 1950s, even while mechanization was still being completed. Data processing was initially in the "batch" mode, with overnight processing; the liaison between the computer center and the user-departments involved card-punching (or, later, magnetic tape recording) for data-entry and the physical transportation of computer printouts.

The second phase of computerization was characterized by the diffusion within the bank of computer terminals. First, they were installed in the processing and accounting departments. Then, towards 1970, they appeared in purely interrogative mode (data could be accessed but not entered) in the branches, where they offered up-to-date balance information. Beginning in the late 1970s, interactive terminals allowing data-entry as well as data-access began to appear in all the bank departments--a development that was almost complete in the major French banks by 1985.

With the new interactive technology came changes in work organization. Management was quick to seize upon the potential offered by the technology to attack the sources of growing labor tension in the "paper processing" departments. These tensions were manifested in France by a major, crippling strike in 1974; in the U.S. the corresponding tensions took the form of exacerbated turnover rates.⁶ The specialization of data-entry tasks also

4. My field work was conducted principally in one of France's big four banks over the 1980-1981 period. This research involved 4 months full-time field work, several hundred interviews of bank personnel and management at all levels, and participant observation for one month working as a teller at two branches, representative of Stage 3 and Stage 4 configurations, discussed below. Sections 3 and 4 draw on my discussion in Adler (1985).

5. Four French banks long figured in Dunn and Bradstreet's top ten world banks (by balance sheet).

6. O'Brien (1968) cites annual turnover among bookkeepers in U.S. banks in the 40% to 80% range.

generated intolerably high error rates in both countries.

French banks therefore abandoned the doctrine of centralizing processing activities and separating them from commercial functions. The new principle was to de-specialize data-entry as far as possible, making everyone responsible for the accuracy of their own data. Processing was progressively decentralized to the back-office of the local branch and even right out to the front desk. In entering data, the teller, like the other users, is now automatically informed of any inconsistencies or implausible data that the system has detected, and is asked to rectify the entry. Processing time and errors are thereby minimized.

As banking moved from mechanization to computerization, work has been totally transformed. The worker is now entirely dependent on the computer system--whose malfunctioning is frequent enough to constitute in itself a permanent feature of computerized work. Work is mediated by a new language of computer codes. A series of tasks formerly considered the very essence of bank work has been eliminated, including accounting imputation and adjustment, classification of documents, multiple entries of data, manual data search, and supervision by signature. A new range of tasks has been introduced. Accountants now diagnose and rectify anomalies listed by the computer system. New types of errors--and fraud--appear. Their greater cost and more difficult diagnosis are congruent with the level of automation. Surveillance of work no longer takes the form of a document-by-document verification and the signature by officers of large-sum transaction records. It has become a combination of the computer control of data consistency/plausibility and personal identification code status, and the supervisor's *en masse, ex post* surveillance of a computer record of exceptional operations.⁷

The parallels between the computerized on-line banking system and the automation of petrochemical refineries are striking. If in refineries production is of the "continuous flow" process kind, in banks there is a literally instantaneous production process. Once the raw material--data--enters the bank's records in any form at any place, it is automatically and instantaneously fed into all the pertinent accounts including the client's account, the bank's general ledger, its auxiliary accounts, official accounts, and control

7. Access to the data system is obtained by keying-in a personal identification code, which also indicates to the computer the nature of the operations the operator is authorized to conduct. It is the use of such codes that makes individual job monitoring technically possible. Note that in France the threat of labor strife encouraged bank managements to abandon any such monitoring.

accounts.⁸

With this automation, banking finds itself confronting a general characteristic of higher levels of automation. Reducing repeated entry of the same data and controlling automatically for data plausibility together permit a major reduction in the frequency of errors. But both those errors that subsist and the new sorts of error proper to such systems have a greater average unit cost, due to their instantaneous propagation, their inherent complexity, their unpredictable form, and their correspondingly increased discovery and rectification costs. The total cost of errors will normally be reduced, but the nature of the quality control problem is transformed.⁹

4. Skill Impact of Banking Automation

How can we characterize the corresponding shift in skill requirements? At this preliminary stage, it is useful to cast our net as wide as possible, and therefore to begin with as pragmatic an approach as possible.

I have adopted a framework derived from job evaluation practices, a relatively standard twelve-category breakdown of distinct "worker contributions," that was used in a land-mark study of automation by James Bright (1958a). This section analyzes each of these contributions as they have evolved in the course of the computerization of low-level clerical operations in banking, and compares the latest phase of banking computerization with Bright's generalizations concerning the higher levels of automation. The interest of this comparison is enhanced by the fact that Braverman (in Ch. 9) relies on Bright's analysis as one of the major exhibits for his deskilling case.

The use of banking as an example of a highly-automated process is perhaps surprising, but entirely appropriate. The distinguishing features of the highest levels of automation as defined by Bright--and the definition has dated surprisingly little--are these: that long sequences of operations are conducted without any human intervention (in banking: automatic updating of multiple interrelated accounts), except for the input of raw materials (data) and a constant surveillance; the system controls for the quality of inputs (by computer checks for data plausibility

8. In reality, some accounts are changed so often that continuous updating of the permanent file is too expensive. These data are fed automatically to locally processed, provisional files, which are then automatically fed into central permanent files at the end of the day.

9. For an identical generalization derived in an altogether different context, see Weiner, 1985.

and consistency) and for the compatibility of its own sub-operations (by account balancing tests); the system anticipates action required and adjusts to provide it (with advanced computer systems equipped with dynamic processing, multiprogramming, and virtual memory.)

Table 1: James Bright's assessment of the skill requirements of the highest automation level.

<u>Worker Contribution* or Sacrifice Traditionally Receiving Compensation</u>	<u>Requirement at Highest Level of Automation</u>
Physical Effort	Nil
Mental Effort	Decreasing-Nil
Manipulative Skill (dexterity)	Nil
General Skill	Decreasing-Nil
Education	Increasing or Decreasing
Experience	Decreasing-Nil
Exposure to Hazards	Nil
Acceptance of Undesirable Job Conditions	Decreasing-Nil
Responsibility**	Increasing, Decreasing or Nil
Decision Making	Decreasing-Nil
Influence on Productivity***	Nil
Seniority	Not Affected

*Refers to operators and not to setup or maintenance workers, engineers, or supervisors.

**Safety of equipment, of the product, of other people.

***Refers to opportunity for the worker to increase output through extra effort, skill, or judgment.

Source: Bright, 1958b.

The conclusion Bright drew concerning the evolution of skill requirements in automated contexts is summarized in Table 1.

Bright's is a largely pessimistic diagnosis from the workers' point of view.¹⁰ Only "Education" and "Responsibility"

10. The one positive element in Bright's analysis from the workers' point of view is that he saw little probability of large numbers of workers finding themselves so undertrained as to be unemployable. For

requirements are not forecast in regression--and then only provisionally, since Bright (1958b) writes: "When a pattern of predetermined actions can be mechanically achieved, there is no particular need for the understanding, the training, and the education on the part of the operator" and "the ultimate effect of the higher levels of automation is to remove responsibility for performance from the hands of the worker."

Let us examine the banking case factor by factor and compare it with Bright's assessment.

(1) Physical effort

Bright's assessment of declining physical effort requirements seems difficult to dispute. He underestimates the various ergonomic problems--which, it is true, have only recently come into prominence. It is unclear under which rubric these problems should be classed; I shall leave them to the "Hazards" section.

(2) Mental effort

Bright's diagnosis of reduced mental effort reveals an important shortcoming in the application of his framework. In relation to the highest levels of automation, he writes (1958b): "By definition, the more automatic machines employ control devices that regulate their performance to achieve the desired end without human attention. Therefore, mental strain as a result of mental effort is ultimately reduced."

The automatic control capacity of the advanced machine system may well reduce quantitatively the human's role; such is the basis for Bright's argument. But Bright seems to be so impressed with automation's potential for self-regulation that he ignores the original question: given that employment levels will adjust to reduce any redundancies in the work force, what is the qualitative nature of the remaining jobs?¹¹

In banking, the increasing degree of automation means the replacement of a sequence of specialized departments each

management on the other hand, Bright's prognosis was overwhelmingly optimistic, since the predominant fear at the time of his research - the 1950s - was that automation would require massive and expensive retraining programs.

11. In fairness to Bright, it should be recalled that he was intervening in a context dominated by the fear of massive short-term increases in skilled-labor requirements. He was overstating his case on this subject when he ventured into the broader, longer-run issues we are exploring.

performing a small number of elementary data-entry tasks by a system in which a single operator enters into the system all the variables needed for each transaction. A simple operation like cashing a check involves 19 distinct tasks of several different kinds (data-entry, data verification, terminal procedural commands, physical manipulation) that the teller, working with an on-line terminal, must execute in precise order, respecting the software's sequence of decision branches. Each separate task is simple, but their correct combination and ordering, especially while scrutinized by a line of impatient customers, demands the internalization of a new sort of intellectual discipline: the ability to master procedural, algorithmic modes of thought (Shiel, 1981). We shall return to the impact of this aspect of automation on other factors, but we should note here that the mental effort involved in constantly maintaining a "clear head" is not to be underestimated. It is a new form of effort for many workers.

Another feature of particular importance is the fact the interaction with the automatic system (as with advanced manufacturing equipment) is mediated by a multiplicity of codes. Even when software becomes more user-friendly, the operator-machine interface is not one characterized by truly "natural" language. A common illusion here is that habit can render banal the new code-mediated tasks. Detailed research has shown that even after a long apprenticeship, coded data-entry involves perceptual processes that are ergonomically more demanding than those involved in the entry of regular text; whence a second source of mental effort Bright ignores (Durraffourg et al., 1979).

To step outside the sphere of low-level bank operators for a moment, we should note in passing that there is another, less obvious, form of mental effort that Bright underestimates. In discussing the highest automation levels, Bright writes: "The progressive effect of automation is first to relieve the operator of manual effort and then to relieve him of the need to apply continuous mental effort" (1958a, p.188). He describes the role of the operator of more advanced machinery as "patrolling" or "machine-tending," evoking the image of the night watchman. Studies of refinery workers indicate, however, that the mental effort of surveillance imposes a considerable burden of a new kind, when *continuous* concentration of the kind associated with manual fabrication activities is replaced by the strain of *continual* watchfulness and readiness (see Galle and Vatin, 1980 and Edwards and Lees, 1974).

Highly automated systems generate a new and complex operating mode which demands of workers that they be ready to react rapidly even after hours of apparent inactivity. Associated with this new operating mode is a new sort of strain due to the conjunction of (a) high levels of responsibility (to which subject

we shall return), and (b) modes of system failure increasingly difficult to predict (on this last factor, see Hirschhorn, 1981).

Bright ignores such problems in his faith that machines will eventually control themselves. But as control functions become more sophisticated, the problem is only removed to higher levels of responsibility.

(3) Manipulative skill (dexterity)

Here, as with physical effort, it is clearly difficult to dispute Bright's claim that dexterity requirements will decline as automation levels rise. Typing skills have become a more common requirement, but in their specifically manual component these are of a lower level of complexity than many of the manual skills automation displaces.

(4) General Skill

It is of particular interest to find that the case of banking runs counter to Bright's diagnosis of falling general skill requirements as measured by training time.

Training programs are expensive, and can be cited as justification for higher pay scales. But the managers I interviewed expressed their concern that underestimating the new training needs would prove to be myopic, by limiting the capability of operators not only to fully master their current tasks, but also, and perhaps more importantly, by hampering their ability to adapt to constantly evolving computer procedures.

Bright (1958a) argues: "In many instances, the need for education and understanding of principles may continue well into the higher levels [of automation]. However, these eventually become unnecessary contributions as reliability increases." So imagine the bank managers I interviewed--*before* the computerization process moved into the highest levels of automation.

The managers responsible for computerization were haunted by the following scenario: the client comes in, angry, wanting to know why the transfer s/he effected a month ago has not been credited to his/her account. The teller has no one to turn to. It was indeed the teller who had effected the operation on the terminal at the front desk. There is no longer a chain of processing offices handling these operations. By the same token, there is no longer a series of office chiefs to whom the teller can turn in order to determine where along the processing chain the operation has broken down.

Hence the "bankers' paradox": they had indeed hoped to simplify operations and therefore reduce training requirements when they computerized. Despite the public presentations about enriching teller jobs, such was in fact their main concern. And now, committed to a vast program of branch computerization, they discovered--with not little anxiety--the magnitude of the training task before them. If a modicum of what they have come to call "local mastery" were not sustained at the employee level, the bank was liable to find itself swamped by angry customers. The lesson of the banking case is straightforward: the need for "local mastery" grows as the level of automation increases.

The only possible response to this pressing need is training. Three areas of training development have emerged as particularly important:

- (a) basic computer literacy;
- (b) information regarding the structure of the bank's processing system;
- (c) and, for (b) to have any meaning for the employees, a much broader understanding of the logic of bank accounting.

The bank I studied most closely, like others in France, was therefore busy developing educational courses, software, and video cassettes. It was still unclear how many hours of training would be necessary. But banks, because of their line of business, were not, unlike many other industries, able to bury their heads in the sand and ignore the training imperative associated with all but the technically most elementary jobs: training has had to go beyond the immediately functional if it is to be really operational.

(5) General education

Clearly, sooner or later some of the basic computer literacy described in the previous paragraph will come to be accomplished in the framework of general education. This shift and upgrading in skill requirements explains the shift in recruitment criteria for entry-level positions to a minimum of a high school diploma and a preference for two years of college (Cossalter and Hezard, 1983).

It is, furthermore, not just the quantity of education demanded that is changing. It is also its content and form that evolve. The "clear thinking" requirements of the associated procedural operating modes seem to pose a challenge to the educational system.¹²

12. We are witnessing a cultural mutation of considerable proportions, perhaps to be compared to the "Americanization" process lived by the wave of immigrants that populated the Ford assembly line at

(6) Experience

Bright's diagnosis--declining experience requirements--is here also dictated by his assumption that the machine will eventually be totally reliable in doing what the worker once did. Hopefully my point on this score has already been made.

But we still need to characterize the *absolute* level of experience required as well as the changing *relative* weights of education, training and experience requirements as the level of automation rises.

To take the relative question first: to the extent that literacy, numeracy and technological culture requirements rise, one could hypothesize that experience-based "tricks of the trade" will play a correspondingly reduced relative role. The banking case supports this hypothesis. I noted above the need for basic accounting training for low-level bank personnel. Pushed as they are to the periphery of the account fabrication process, their mastery of their own tasks demands some understanding not just of the computer system in its technical dimension, but also of the accounting logic which governs the inter-relation of the various types of bank accounts. In the previous stages of bank technique, no such breadth of training was required. All the functional training for low-level positions was acquired on-the-job. This no longer suffices.

The problem is posed even more acutely for positions requiring greater technical expertise and/or responsibility. Previously, it was by the successive apprenticeship of several departments that upwardly-mobile personnel learned their banking. Now, experience cannot suffice, as critical operating procedures have been internalized in the computer system.

In both instances, for operating personnel and for higher-level personnel, education and training requirements are increased, and on-the-job experience requirements become relatively less important.

On the other hand, computer systems, despite being situated

the beginning of the century. Whereas Ford's problem was developing body disciplines and life-styles that would permit immigrants from largely rural backgrounds to operate assembly-line facilities, today's problem is expressed in a *New York Times* article this way: "Educators are starting to ask whether the way Americans think, the way they go about defining and solving problems, will be altered, for better or for worse, by increasing experience with the systematic and quantitative thinking that goes into programming a computer" (Fiske, 1982).

at very high levels of automation, are not entirely standardized--far from it. If small-scale users usually buy packaged software, larger users are constantly adapting their applications. The result is that many operators have to learn quite idiosyncratic company-specific systems in constant evolution.

The overall effect is that the *absolute* level of the experience requirement often increases with automation, even though its *relative* importance decreases.

(7) Exposure to hazards

It seems reasonable to hypothesize that with the "peripherization" of workers vis-a-vis direct product manipulation, workplace hazards are probably as a general rule on the decline. It seems reasonable, too, to note that the harsh conditions of yesteryear are easily forgotten, magnifying the relatively minor inconveniences of today. But there are some ergonomic problems associated with current computerized equipment, problems that cannot easily be relegated to the status of "undesirable job conditions."

Current computer display systems can aggravate eye- and back-strain. The problem is partly in the equipment design and installation. Too often no provision is made for adjustment of lighting, height, tilt, physical configuration of screen and keyboard, etc., violating elementary industrial engineering norms. For another part, the problem resides in the current technology of cathode-ray tubes: limited definition, high scintillation, poor contrast control, etc.¹³

Clearly, improvements in this area are needed. Unrectified, such strain can lead to serious injury. Equally clearly, such problems are not inherent in the automation level; they are surmountable, if only under the impetus of organized intervention. Some French banks are already using liquid crystal displays which dramatically reduce most of the visual problems. The adoption was motivated by management's desire to still union and public criticism.

The key ergonomic problems, however, seem to be due not to the level of technology, but to the organization of work. High-concentration tasks with highly constrained operating modes, exemplified in such jobs as data-entry clerks, should, for ergonomic reasons, not be maintained for more than a couple of hours at a time (cf. Grandjean and Vigliani, 1980). Such has been

13. See the various publications of the *National Institute of Occupational Safety and Health*.

the recommendation of various European bodies, and more and more employers are responding to the challenge of this norm by de-specialization, incorporating data-entry tasks into other jobs, like the bank teller's.

Thus, while not minimizing equipment-related problems, I would hypothesize that not a few of the ergonomic problems ascribed to new technologies reflect a displacement onto technology of frustration with other factors, like work organization or job content. Indeed, the next paragraph shows that the very nature of automated work may be aggravating these other factors.

(8) Undesirable job conditions

To observe the banking industry is to witness a strange scene. Effort requirements may be on the decline; skill requirements seem to be on the increase; yet jobs are not experienced as any more satisfying. On the contrary, the lack of interest that characterizes many banking jobs is eventually classified as an "undesirable job condition" in itself. An example: French banks have been forced to give a high priority to automating securities department processing jobs for the simple reason that these jobs were experienced as so boring that stable staffing could not be assured.

For the mass of workers who will assure the interface and surveillance functions, like the bank employees in their vast majority, the scenario seems to be this: as the fabrication process is automated, as the worker is rendered increasingly peripheral to it, the operator's work is reduced from its concrete, tangible form to a more abstract activity--interface and surveillance. In this transformation, the concreteness of the task's goal is diminished. There is clearly a segment of the work force for whom the "concrete object" is the system itself: programmers, managers, etc. Their case is more complex. But most employees find that in place of the easily apprehended goal of correctly effecting a distinct operation, the new situation substitutes a much more amorphous objective--that of ensuring the smooth functioning of an almost totally automated set of interrelated operations. With the peripherization of the worker, it is not only the *means*--computer-mediated transactions via coded commands--but also the *ends* of work that appear as less concrete and more abstract.

If the abstraction of means increases training requirements and mental effort, the abstraction of ends leads to a very different result--work is often experienced as intensely boring.

(9) Responsibility

Despite Bright's agnosticism and (ultimately) pessimism on

this factor's evolution, the evidence from banking, as well as a closer reading of Bright's own refinery case, would suggest fairly unambiguously that responsibility generally increases with automation.

The key consideration in the banking case is the multiplicity of operations that the computer conducts on the basis of a single data-entry: the teller's operation, sometimes augmented by that of the remaining processing units, feeds a multiplicity of accounts at all levels of the bank's records. The banks have therefore invested considerable effort in developing data consistency/plausibility checks. These, however, are never perfect. As infrequent as errors may thus become, the complexity and therefore the unit cost of the remaining errors are correspondingly increased.

The concern expressed by bank managers for the maintenance of "local mastery" is rooted in such problems. Similarly, the reorganization of the remaining processing departments into zones of geographic responsibility¹⁴ bears witness to the operational, and not simply humanistic ideological, motivation for this concern with responsibility. The same motivation encourages banks to reorganize into more autonomous work teams to allow employees to assume this broader responsibility.

The import of such an increase in responsibility for even banal banking jobs is, I believe, considerable. The central issue is that the responsibility solicited from workers is no longer confined to the object of maintaining work-effort standards. The workers are asked to play a different role: they are asked to be responsible for the integrity of the process and for its results. Of course, managers have always wanted as much. What has changed is that now the technical characteristics of production make such responsibility an operational imperative.

(10) Decision making

This factor is closely linked to the preceding one. The difficulty of any diagnosis here is that this factor conflates changes in the scope of decisions with changes in the degree of authority in decisions of a given scope.

The banking case lends some support to the thesis that authority can be centralized in a set of operating procedures written into the software, thereby reducing the autonomy of decision of the local personnel. Such centralization, however, becomes costly--for example, in poor quality results--when it

14. Citibank has undertaken a similar reorganization: see Matteis, 1979.

undercuts the real mastery of local operations. Centralization of key (strategic) decisions is thus commonly combined with a change in the scope of decisions, to encourage a concomitant decentralization of minor (operating) decisions.

As others have also pointed out, a significant feature of the new configuration is that organizational coordination structures themselves become more "abstract" insofar as they are increasingly embodied in software routines rather than in the personal authority of the local management (Zuboff, 1982). This automation of coordination is not without dramatic repercussions on the supervisor's role. Technological trends seem to encourage the shift in the sources of supervisors' legitimacy from technical expertise to team facilitator.¹⁵

To conclude, however, as Bright does that decision-making contributions of operatives are decreasing or nil, is manifestly inadequate.

(11) Influence on productivity

I shall not restate my case for believing that worker performance in automated environments is decisive for operational efficiency. Bright's position does, however, reflect more profound features of the situation that indeed merit attention.

Under automated conditions, major productivity increases can no longer come from rationalizing the worker's gestures, as in the Taylorist mode. Freeing the production process from its dependence on the craftsman's dexterity and eliminating the technical inadequacies that created numerous "pores" in the working day have both facilitated intensification of work effort.

Meanwhile, behind the scenes as it were, the progressive mechanization and automation of production, and the economic rationality and operations rationale that have developed with it, have been working to attribute to human intervention a different type of efficacy. Science and technology progressively displace both dexterity and intensity of effort as the key to productivity increase. This tendency reinforces the significance of the worker's role in guaranteeing the smooth functioning of the highly automated system.

15. This shift generates new legitimacy problems. The criteria for promotion to supervisor level give less weight to experience and technical expertise, and more weight to personality qualities. More subjective criteria mean more fragile authority.

Table 2: Comparing the Banking Case and Bright's Assessment at the Highest Automation Level

Worker Contribution	Bright's Assessment	Banking Cases	
		Quantitative Changes	Qualitative Changes
1) Physical effort	Nil	Decreasing	But see Hazards on strain
2) Mental effort	Decreasing -Nil	Increasing	Algorithmic operating modes desplace manual gesture
3) Manipulative	Nil	Decreasing	But: see Experience re: "tricks of the trade"
4) General skill	Decreasing -Nil	Increasing	Technological literacy Local Mastery Cognitive Learning
5) General education	Increasing or Decreasing	Increasing or Decreasing	Technological culture Intellectual discipline("clear head")
6) Experience	Decreasing -Nil	Decreasing and/or Increasing	Decreasing relative to education, but increasing absolute level due to dynamic large-system idiosyncracies
7) Exposure to hazards	Nil	Decreasing	But: pervasive strain with highly constrained operating modes
8) Acceptance of undesirable job conditions	Decreasing -Nil	Decreasing objectively, but Increasing subjectivly	Intrinsic boredom displaces physical conditions as key issue subjectively
9) Responsibility	Increasing, Decreasing or Nil	Increasing	Responsibility for production, not just effort Team effort, not just individual effort
10) Decision making	Decreasing or Nil	Decreasing and/or Increasing	Centralization of parameters Decentralization of operating variables Note: more abstract decision processes
11) Influence on productivity	Nil	Increasing	Cost of errors and downtime (work efficacy, not intensity) Role interdependence
12) Seniority	Not affected	Decreasing and/or Increasing	See: Experience

One source of Bright's confusion may lie in the fact that as a general rule the worker's contribution to productivity is much less individual in more automated settings. The effectiveness of automated systems is governed by the quality of the interaction between members of the work team, between technicians and workers, between Engineering and Operations, between all these and the Training department, and between manager and employees.

(12) Seniority

This factor is often a surrogate for experience. As such, I have suggested that its importance is subject to conflicting pressures, and may, as a result, be declining relative to education and training but increasing in absolute terms. A further downward on this factor's importance, perhaps a transitory one, but one currently causing significant hardship, is the perception of greater flexibility of younger workers compared to older workers. Older workers are less likely to have the requisite new skills, and older workers are often presumed--often incorrectly--to be less able to adapt.

5. From "Worker Contributions" to Dimensions of Skill

In summary, we can compare Bright's evaluation of the impact of automation on worker contributions with the preceding analysis of banking. Table 2 recapitulates the salient features of both evaluations, comparing Bright's prognosis of the skill shifts associated with advanced automation and my analysis of advanced computerization in banking.

Examination of this table leads me to two principle conclusions. First, in contrast with Bright, the banking case shows at least as many quantitative increases as decreases. Notice, furthermore, how on some of the contributions which have assumed particular importance in my analysis, Bright is either undecided and tending to pessimism (general education, responsibility) or is in stark disagreement with the analysis of the banking case (mental effort, general skill, influence on productivity).

More important perhaps is that my rejection of Bright's pessimism is reinforced by consideration of the changes in the relative weights of the different worker contributions. From this point of view, most of the decreases we observe can only be judged welcome: the decrease in major hazards, the substitution of mental for physical effort, of general skill and education for manipulative skill, experience, and seniority.

The second principle conclusion I draw from Table 2 is even more critical for the argument of this paper. Reviewing the last

column of Table 2, we can identify the symptoms of a misfit between Bright's twelve-dimensional analysis and the observed evolution of work. This misfit leads me to suggest that beneath Bright's structure there is a deeper, four-dimensional structure at work: (1) degree of substantive complexity (low to high); (2) type of responsibility (responsibility for effort versus responsibility for results); (3) the type of expertise (manual versus cognitive), and (4) type of interdependence (individual or sequential versus collective). The three qualitative dimensions are summarized in Table 3.

Table 3: Three underlying qualitative dimensions of work

Qualitative Changes	Dimensions	
- Local mastery - Responsibility for production - Influence on productivity - Cost of errors	Social	responsibility for process integrity and results
	versus	
	Private	purely instrumental attitude to work, responsible primarily for work effort
-Algorithmic operating modes -Cognitive learning -Decision-making processes -New ergonomic problems -Computer literacy -Importance of general training -Intrinsic boredom -Intellectual discipline	Abstract	abstract, mental, machine-mediated tasks with cognitive learning but with low inherent interest
	versus	
	Concrete	tangible immediacy of tasks and goals, with manual or rote learning
-Team responsibility -Role interdependence	Collective	systematic interdependence critical role of coordination between tasks and between departments; job rotation and teamwork encouraged
	versus	
	Individual	stand-alone or purely mechanical, sequential linkage of individualized jobs

Two claims can be made for this four-dimensional framework.

First, a strong claim: the banking case suggests that these four dimensions are ones that management has to address in the medium-long run in designing jobs. Any theoretical analysis of skills should therefore encompass them.

Evidence from other industries supports the banking case in this. Job evaluation systems, for example, obviously deal with the first, quantitative dimension, but have also been shown to be sensitive to the other three, more qualitative factors:

-If the benchmark jobs are characterized by responsibility-for-effort, responsibility-for-results will be undervalued. The steel industry had to confront this issue when it became obvious that production operators' responsibility for assuring operations continuity was a greater productive contribution than the craftsmen's traditional responsibility for careful parts machining (Steiber, 1959).

-If the benchmark jobs are all "concrete," the system will undervalue more abstract forms of expertise, particularly in their effort and general skill contributions. Women's clerical jobs have often been undervalued in this way, the menial physical exertion of many "male" jobs often being privileged over routine mental effort (Treiman and Hartmann, 1981).

-And if the system interdependence is such that a sustained integration of learning and doing seems necessary, the job evaluation approach itself may have to be jettisoned or profoundly modified in favor of a system in which wages reflect skills acquired rather than the requirements of the particular job currently occupied (Lawler, 1981).

Cain and Treiman's (1981) statistical analysis can also be marshalled to provide surprisingly strong support for this framework.¹⁶ They performed a factor analysis on the 44 variables used by the Dictionary of Occupational Titles to characterize occupations. Factor analyzing a 10% sample of the DOT's 12,099 occupations, they found factors which correspond closely to the dimensions I have identified:

(a) a "substantive complexity" factor captures the general training requirements of the first quantitative dimension;

(b) "motor skills" and "physical demands" factors are summarized in my manual versus cognitive expertise;

(c) a "management" factor captures some of the elements of the responsibility dimension;

(d) an "interpersonal skills" factor captures--as best the DOT

16. Surprising, that is, to the author. The analysis of Cain and Treiman only came to my attention some time after this framework had been articulated.

characteristics allow--the interdependence dimension;

(Cain and Treiman also identified an undesirable working conditions factor that is irrelevant for our purposes.) Evidence of the broadly positive nature of this shift in the banking case is indirect but eloquent: between 1969 and 1977, the period of most intensive computerization, the proportion of lower-tier employees in French banks fell from 58% to 45%, with complementary gains in the category representing more-skilled employees and supervisors (32% to 42%), and to a lesser extent in the professional and management category (9% to 13%).¹⁷

In one of the largest banks (approximately 40,000 employees), the evolution of the personnel structure demonstrates this upgrading over an even longer period (Delegation Nationale CFDT, 1985). Their detailed statistics make it possible to distinguish within the middle-tier those without any supervisory responsibility (at least as of 1970, when the middle-tier was redefined to include a first level without supervisory responsibility. Such a promotion opportunity began to appear necessary to accommodate the upgrading of the employee skill base). Table 4 shows a dramatic upgrading trend.

Table 4: Structure of personnel in one major French bank.

Year	Lower-tier Employees	Middle-tier Employees		Management and Professionals	Total
		Without Supervisory Responsibilities	With Supervisory Responsibilities		
1950	74.4%	0	17.9%	7.7%	100%
1960	68.2%	0	22.1%	9.7%	100%
1970	59.8%	11.6%	19.2%	9.4%	100%
1980	35.2%	25.9%	26.4%	12.5%	100%
1983	31.0%	28.5%	27.6%	12.9%	100%

Source: Delegation Nationale CFDT, 1985.

Follow-up interviews with personnel directors in this bank (conducted in June 1985) revealed a broad consensus that such shifts did indeed represent skill upgrading, and that this upgrading trend has continued. Task complexity has increased, if only modestly, and there has been significant horizontal job "enlargement" and vertical job "enrichment": the level of

17. Data supplied by the Association Francaise des Banques.

responsibility required of operating personnel, the breadth of these responsibilities, and the need to understand broader segments of bank operations have been major preoccupations of training and personnel managers.

The generalizability of these results is naturally subject to debate. I have elsewhere (Adler, 1987) reviewed a series of recent case studies which suggest that upgrading may be more frequent than the research conducted in the wake of Braverman may have led us to believe. More importantly, Spenner's review (1983) of the major statistical studies conducted to date shows that of the seven studies of job content, five showed upgrading, two showed no effect, and none showed deskilling, and of the six studies of labor force composition, five showed upgrading, one showed no net effect, and none showed deskilling. The case for net upgrading--albeit modest--for both occupations and the labor force as a whole is much stronger than many have suggested.

The banking case cannot by itself prove, but it can certainly suggest that, as a general rule, and despite a great deal of diversity in the situations of firms and occupations, automation will encourage shifts in a distinct direction along each of these dimensions, towards:

- more substantive complexity,
- more responsibility for results,
- more abstract reasoning, and
- more complex interdependence.

Certainly, many other factors apart from technology bear on skill levels and job content; and indeed many other factors apart from operations efficiency bear on the choice of technology. But the banking example, like many others read through these theoretical lenses and like the admittedly weak statistical data available, suggests that deskilling and degradation of work--interpreted as Braverman's "secular trend toward the incessant lowering of the working class as a whole"--may be a myth.

6. The Dimensions of Skill and the Commodity Form

The key insight derived from the banking example is in the idea that any analysis of skill and automation will have to confront both the quantitative dimension of substantive complexity as well as the more qualitative dimensions of responsibility, abstractness and interdependence.

These terms reflect the intersection of the inductive moment of my research and a deductive experiment conducted in parallel. I should therefore explain the nature of this deductive experiment and readers will be able to infer for themselves how successful the

overall experiment has been.

The experiment consists in taking Marx's conception of the commodity form as a guide to the analysis of the dimensions of skill. Briefly put, the substantive complexity dimension represents the value of relative skill as measured by training time. The three qualitative dimensions represent the labor market's three principal *conditions of existence* as a means of governing the production and allocation of the commodity labor-power. These conditions of existence can be characterized by three polarities:

- *Social/private*: The needs of society are satisfied by the sale of products produced in independent, private enterprises. There is a basic split between the social nature of those needs and the private ownership of the firms that are the means of satisfying these needs. This split is the most fundamental condition of any market's existence, including the labor market: supply and demand meet on the market place, not in some preestablished economic plan.

- *Abstract/concrete*: The exchanges that take place between buyers and sellers are exchanges that are normed by the equivalence of the quantity of abstract labor embodied in the commodities being bought and sold. Abstract labor is labor made commensurable by a process whereby we abstract from its particular concrete qualities.

- *Collective/individual*: Even though the laborer, the bearer of labor-power, is a "free individual" and the exchange of labor-power for wages is an individualized transaction, the labor process is basically a collective activity, drawing many individual workers into an enterprise under common direction.

The deductive experiment consists in taking these theoretical and macro-social conditions of existence of the labor market and effecting a double shift by finding for them corollaries that are both concrete (as opposed to theoretical) and centered in the "micro" reality of the labor process (as opposed to referring only to macro-societal phenomena):

- *social/private*: we can interpret the shift in the nature of responsibility requirements as expressing a "socialization" of the worker's role, since with automation the worker is increasingly asked to contribute not only his/her effort but also his/her sense of responsibility for the integrity of the process and for the quality of the product; the worker no longer appears in the labor process as a mere *homo economicus*, but instead as a being with social as well as economic dimensions.

- *abstract/concrete*: we can relate the theoretical categories

pertaining to the commensurability conditions of existence of the market to the abstract or concrete nature of tasks, to the corresponding cognitive or manual-rote nature of expertise, and to the theoretical or experiential learning process.

- *collective/individual*: this polarity can be applied directly to the nature and degree of interdependence between workers.

The idea of such a theoretical-to-concrete shift comes from Marx.¹⁸ What I have done in identifying my three qualitative dimensions of work is to pursue this operation of concretion from the more macro level, at which Marx situates his comments on socialization and abstraction, into the more micro level of the labor process itself.

Let us therefore review the four dimensions of skill in this light. In each case, the interpretation of the concept in a concrete and micro form uncovers a basic contradiction between the productivity- and technologically-driven requirements of contemporary industry and traditional personnel management practices which reflect the commodity status of labor. In each dimension, we shall be able to highlight automation-induced trends in work which both undermine the commodity form of labor and suggest the emergence of new, post-capitalist forms of organization.

18. Marx (1973, pp.101-104). Marx argued that the reason his concept of abstract labor is pertinent is that labor had in reality become abstract. By this he refers to the breakdown of guild secrets and to the mobility of workers between different lines of work - which are the concrete conditions making possible the comparison of labor times. Prior to such labor mobility, real labor times were a closely guarded secret of the guilds, and abstract labor was therefore a purely theoretical construct. Similarly, Marx argues that the social character of production is evidenced not only in the somewhat theoretical fact of private production for social needs but also in something much more tangible, namely, the interdependence of activities in different producing units. Finally, Marx's concept of the collective worker is not only an abstract concept designed to reflect the fact that most production takes place in plants that employ more than one person, but is also a concept that permits concrete analysis of specific structures of cooperation that characterize different industrial forms. In this way, Marx establishes the foundations for a set of what he calls "concrete universals." This somewhat peculiar concept emerges in Marx's discussion of abstract labor in the first German edition of *Capital*, where he makes the apparently preposterous claim that the real world operates as if, alongside all of the animals in the animal kingdom, there existed as well an animal called "Animal" (Marx, 1867, para. 65). In other words, alongside the various forms of concrete labor there existed something called "abstract labor" that was just as real, just as tangible, and just as important in its effects.

In this way, we return to Braverman's challenge of linking labor process analysis to broader societal themes. But in my analysis, we will find a progressive strengthening of worker capabilities, not a process of degradation.

(1) Complexity

That automation tends, on average and over large aggregates, to generate increases in the "substantive complexity" of work is well enough accepted (Spencer, 1983). But whether such increases undermine in any direct way the commodity form of labor is less obvious: of the four dimensions I have identified, this one, being quantitative, is the one most directly linked to labor as a commodity. My principal argument will be that changes in the other dimensions of skill undermine the salience of this dimension: as work becomes more responsible, abstract and interdependent, either the training time required to engender these qualities becomes impossible to measure, or that measure becomes ineffective in assuring wage equity.

But a secondary argument is also in order: as the level of complexity rises, we should expect greater firm-specificity of skills. This correlation is not very tight, since high-level personnel in some specialties are notoriously foot-loose. But as a general rule, and one subject to empirical testing, we could expect that the greater the complexity of the individual's knowledge-base, the more numerous the potentially valuable tacit linkages between that base and the context of its deployment.

If the firm-specificity of skill increases, the normal labor market processes fail, and non-market allocation processes internal to the firm emerge (Doeringer and Piore, 1971). Many students of so-called "internal labor markets" have presented the basic rationale for such institutions in the somewhat conspiratorial terms of "divide and conquer" (Gordon, Edwards, and Reich, 1981). Others note these arrangements' economic efficiency under a set of assumptions somewhat more plausible than those of the traditional neoclassical theory of the firm (Yellen, 1984).

But a very different reading of the issue is possible, focused on the fundamental historical significance of the shift from a market to a non-market mode of labor allocation for a growing proportion of the labor force.

Edwards (1979) presents a fascinating sketch of the evolution of labor control systems from simple (supervisory) control to technical (technology-mediated) control to bureaucratic control. He analyzes this sequence as a series of independent changes brought about by class conflict. If the sequence has any historical "sense" for him it is that it has been a process which "turned conflict

within the firm decisively" in favor of capitalists (p.200). But the same evidence can be read--and I believe, read more plausibly--as a sequence expressing real socialization, as capitalists cede their authority in turn to norms of technical efficiency and then to negotiated political/ethical norms of fairness, rights, and duties.

The pervasiveness of such a shift is indicated by the frequency with which even non-unionized "progressive" firms impose on themselves strict ethical norms and administrative procedures in order to maintain their workers' confidence.

The development of internal labor nonmarkets thus tends to undermine the viability of the commodity form of labor at the same time as it tends to establish a new labor allocation process based on negotiated authority.

(2) Responsibility

As automation levels rise, I have suggested that responsibility-for-effort tends to become responsibility-for-results, and the "managerial" content of work thus increases. The worker is no longer merely the one-dimensional *homo economicus* of the wage-effort bargain, but is called upon to take an active role in assuring the success of a collaborative venture. This represents what can be construed as a socialization of the worker's role in the labor process--adding social depth to the one-dimensionality of the wage-laborer as *homo economicus*.

Responsibility appears to be moving in this more "socialized" direction partly because of the general evolution of our culture, but also because more automated systems seem to require it. As the level of automation increases, systems become more vulnerable to unforeseen contingencies, and the workers' role shifts from providing effort to monitoring the system and responding to these contingencies (Hirschhorn, 1984).

The challenge to the commodity form of labor posed by this socialization lies in the fact that this quality, the importance of which seems to be growing with automation, can have no economic value determination: the "conditions of production" of a "sense of responsibility" are radically indeterminate, and measurement of the quantity of skill via training time (human capital) becomes impossible.

Now, the underlying efficacy of the wage-form is based on a genuine--if somewhat elementary--concept of justice: wage levels should reward investments in human capital. But when critical skills cease being behavioral and become instead attitudinal, the wage-determination yardstick shifts from training time and the anonymous realm of economics to the more subjective realm of

politics and ethics. With this shift, an important element of the legitimacy of the wage system--its anonymity and resultant objectivity--is undermined.

Beyond this destructive movement, this socialization of work might also explain what could prove to be a sustained trend toward higher levels of concern for corporate culture and consensus-based decision-making. Moreover, an associated hypothesis would suggest that the only possible basis for consensus and for the sustained, as opposed to occasional, cooperation it requires, is broader worker participation in decision-making processes.

(3) Abstraction of Expertise

The abstraction of work is driven by the fundamental peripherizing nature of automation: workers' tasks shift from fabrication to control and interface functions. Their contribution shifts from manual/rote execution of pre-specified routines to problem-identification and problem-solving activity. Among Cain and Treiman's factors, we can thus expect the importance of motor skills and physical demands to diminish (1981).

On the one hand, this takes us beyond what Marx (1963) called "craft idiocy"--the model of the craftsman at the center of the productive act becomes obsolete, and is replaced by that of the operator who "controls the controls" (Hirschhorn, 1984). The associated increases in complexity and responsibility reinforce the trends we have already noted.

But on the other hand, and more intriguingly, abstraction risks undermining the "use-value" of work to the workers--its intrinsic, humanly satisfying value. When employees are no longer the principal agents of production--instead, standing along-side it, often as mere "button pushers"--it is more difficult for them to confirm any sense of self-worth by referring to their own role in making the product. As numerous case studies of control-room operators have shown, automation means that boredom can become a real problem even when other dimension of the job evolve towards greater responsibility and complexity. This boredom can reasonably be hypothesized to have a negative effect on employee motivation.

The problem is not so much in the non-tangible nature of the tasks. Managerial and professional tasks are not tangible, but they pose no intrinsic motivational problem. That is because managers and professionals work *on* the system, not merely *in and around* it; the goals of their activity--designing and directing the overall system--are therefore quite concrete to them. But for the lower-level employees, since their own dexterity or "art" is no longer at

the center of production, goals risk becoming very abstract, and their role risks appearing to them as "mere work." Interestingly, there appears to be a growing number of jobs like control room operators that are simultaneously boring (most of the time) and highly responsible and complex.

In rendering work intrinsically less interesting for (larger?) numbers of workers, automation might thus be hypothesized as undermining the work ethic itself, and thereby undermining another critical condition of viability of the commodity form of labor. Many low-end computerized jobs are simply so boring as to make them impossible to staff on a full-time basis. The ergonomic problems of such work, the difficulty of maintaining acceptable quality levels without tangible motivating elements, and the scarcity of people willing to work such jobs on a full-time basis, all suggest that automation (in conjunction with broader social trends in work expectations) might be undermining another key mechanism of the invisible hand: the supply of labor may not ever match demand within feasible wage rates.

Part of the remedy to this problem might be a higher degree of association of workers with the overall objectives of the organization to compensate for the loss of their identification with their own specific tasks. We have already noted this possible element of the post-capitalist firm in the form of worker participation.

But another part of the remedy might have to be shorter working hours at least for a significant--and perhaps growing--segment of the workforce. And this too, would subtract from the centrality of the market.

(4) Interdependence

Let us hypothesize that automation and productivity pressures tend to drive work organization from the stage of stand-alone independent work stations, first to sequential interdependence--where workers depend on other workers further up the assembly line--and beyond that, into a stage of systemic, reciprocal interdependence characteristic of many computer-integrated operations (Thompson, 1967). Beyond the increase in the importance of interpersonal skills, this greater interdependence seems to call for a new definition of individuality--and therefore for new types of incentives.

As systemic interdependence develops, the division between intellectual and manual work, between conception and execution, becomes progressively more blurred: the manual execution tasks are infused with a higher technical and managerial coordination content, and technical staff has to cooperate with workers to

develop and debug new products and processes. Managers are forced to emphasize the productive aspect of their roles and deemphasize the monitoring aspect. Workers can thus no longer be managed as passive, technical inputs, and management needs to acknowledge them as active stakeholders in the firm.

With this hypothesized trend, problems might be expected to arise for the individualized form of the wage--a foundation stone of the commodity form of labor (Polanyi, 1957). When workers' contributions are interdependent, group incentives appear more attractive; but group bonus systems challenge the individualized wage-form. Second, such recognition puts the autonomy of the worker collective in a very powerful position vis-a-vis management. Third, to the extent that team-work and other social skills become more important, interdependence poses the same difficulties of objective measurement as responsibility.

These trends suggest the emergence of a new, more socially dense sense of individuality, one that expresses a new definition and balance of the individual and the collective dimensions of worker identity and interests (Lodge, 1975; Unger, 1975).

7. Conclusion

The preceding discussion has argued that skill has several distinct dimensions, and long-run automation trends seem to encourage distinct shifts along each of these. These shifts may be supported or inhibited by other developments, especially developments at the broader societal level; but technological change in the capitalist labor process seems to generate changes in work that not only tendentially increase skill levels, but also undermine the viability of the human capital, market-driven regulation of the value of work. Automation seems to undermine the commodity form of labor in several mutually-reinforcing ways: complexity induces greater firm-specificity which undermines the effectiveness of the labor market as a mechanism for matching supply and demand; responsibility undermines the legitimacy of the human capital yardstick of wage determination; boredom undermines the efficacy of the wage as a critical force in the mobilization of labor; interdependence undermines the individuality of the wage-form.

Alongside these destructive effects, however, I have identified some trends and pressures which seem to prefigure a new "post-capitalist" form of organization: the subordination of market mechanisms to negotiated ethical, political, and technical norms as well as the emergence of demands for increased democracy in the workplace, for free time, for recognition of workers as collective stakeholders in the firm.

My argument has been primarily a technological determinist one. There is good reason to reject technological determinism in anything but the very long run; but my time-frame is precisely the secular process of change in fundamental social forms. Even in this time-frame, technological determinism is subject to the criticism advanced by Levine and Wright (1980) against Cohen's (1978) presentation of Marx's theory. Levine and Wright show that social change, and, in particular, changes of mode of production, are created by class activity, not by anonymous forces like "technology." They show further that the capacity of classes to act in a concerted manner is above all a political and ideological matter, not primarily an economic/technical one. This critique ignores, however, the role played by economic/technical developments in *fashioning* the capabilities that workers bring to the political task. Such a proposition entails no claim that the forces shaping class capabilities from outside the labor process are unimportant, or even that they are less important. Nor does this proposition suppose that previous mode-of-production transitions were similarly propelled. But it does suggest that some element of "technological determinism"--not to the exclusion of other determinations--may be a fruitful way of approaching the analysis of longer run trends.

The dimensions of skill I have identified permit us to understand the manner in which automation is shaping class capabilities in the labor process, by increasing technical culture (complexity), by expanding responsibility (socialization), by broadening intellectual horizons and by encouraging recognition of labor *per se* as a historical problem (abstraction), and by forging new forms of group identity that allow for higher forms of individuality (collectivization).

If these are indeed the general trends in the evolution of work, then the critique of Braverman to date has not been radical enough. Braverman's vision of the progressive degradation of work leading to revolt can be contrasted with the thesis that Schumpeter (1976, p.162), in what might be one of the most insightful exegeses of Marx, formulated thus:

The capitalist process not only destroys its own institutional framework but it also creates the conditions for another. Destruction may not be the right word after all. Perhaps I should have spoken of transformation. The outcome of the process is not simply a void that could be filled by whatever might happen to turn up; things and souls are transformed in such a way as to become increasingly amenable to the socialist form of life. With every peg from under the capitalist structure vanishes an impossibility of the socialist plan.

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