In the Name of Efficiency

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To Harriet Held Greenbaum

CHAPTER

1

Introduction

Back in the 1960s I was a computer programmer. Like most of the 200,000 or so other programmers, I enjoyed the work—particularly its opportunities for diversity and challenge. Comparatively high-paying, computer programming offered high status because its skills were little understood and in great demand. By the early 1970s some of the craftlike characteristics of this work had begun to change. The changes, like most day-to-day happenings, appeared quite slowly. But as they began to increase in tempo, it gradually became apparent that work activities once controlled by data-processing workers were no longer in their control. In 1972, A. P. Ershov, an outside observer of the data-processing situation, had this to say about the changes:

> The volume of work to be done is increasing, and wages less so. The romantic aura surrounding this inscrutable occupation is, if it ever really existed, beginning to fade. . . .
>
> Even the claim of programmers to be a special breed of professional employee has come to be disputed. Still more significant, authority over the freewheeling brotherhood of programmers is slipping into the paws of administrators and managers—who try to

> make the work of programmers planned, measurable, uniform and faceless.[1]

From the time of Adam Smith's lengthy discourse on the division of labor in *The Wealth of Nations*, management has almost religiously recited the principle that labor must be divided into discrete steps. Our society is the result of a two-hundred-year-old experiment in this principle. Everything we buy, from McDonald's hamburgers to automobiles, represents the activities of divided and fragmented labor. But management would not be able to coordinate these subdivided activities if each task had not been preplanned and carefully defined.

The events of the seventies are not discontinuous with the past. They are not created solely by the economic crisis, but are rather the logical outgrowth of prior management movements toward worker efficiency. Since the turn of the century, when Frederick Taylor began "Scientific Management," there has been movement toward increased routinization and repetition at the expense of worker decision-making and variety of tasks. Taylor's Scientific Management sought to develop methods to motivate blue-collar workers while removing the craft nature of their work and replacing it with repetitive functions, paving the way toward assembly-line operations, for once the workers' tasks were isolated and timed, it was possible to routinize them as activities along a conveyor belt. This change in industrial work was successful for industry managers. It created a consistent and predictable level of productivity and helped control the workers. Although white-collar spectators were reluctant to see this trend toward routine work encroach on their jobs, encroach it did, as the number of white-collar jobs expanded.

Although some management theorists have scorned the idea that this principle could be applied to the "elite" in the computer field, the majority of management practitioners marched along toward work division, standardization, and simplification. From a management perspective, the reasons are obvious; work that is not carefully planned, simplified, and divided *cannot* be brought under management control.

In the late 1960s academics were hailing increases in education and automation as two indicators of the coming humanization of work. Economic theorists, such as those from the "human capital" school, argued that increased educational levels indicated that Americans were preparing themselves for better and more challenging jobs.[2] Automation theorists foresaw the day when computers would be able to perform most routine functions, freeing workers to take on jobs that promised more variety and opportunity for thought. Yet by 1970 Ivar Berg and Sherry Gorelick reported that Americans were already overeducated for the jobs they held.[3] Similarly, a 1973 Health, Education, and Welfare Department study concluded that "many workers at all occupational levels feel locked-in, their mobility blocked, the opportunity to grow lacking in their jobs, challenge missing from their tasks."[4]

In what began as a personal study, I set out to explore what was taking place in data-processing workshops and why it was happening. Many have said that the changes in the work process were just the results of the "normal" changes that occupations go through as they mature. And in the growing body of literature about occupations I did indeed find that data-processing work was not unique. Many jobs, from auto mechanics to making x-rays, had undergone similar changes, or were in the process of undergoing them. In each occupation, as knowledge and skill were removed from the workers, pride, motivation, and job satisfaction eroded. What was most noticeable about the changes in each occupation was that they were anything but "natural"; workers fought against these forms of change, and managers had a hard time implementing them.

My purpose is not to bemoan the lost days of craftlike activity, but rather to highlight the history of the changes so that workers affected by them can better grasp the implications. The reasons for changes in the workplace are not always the reasons that appear on the surface. I want to peel away some of the masking reasons in order to identify the *purpose* of the changes. As long as developments in the workplace are made to appear natural, or inevitable, it is more difficult for people to influence them.

Although this is a case history of data-processing work, it can be relevant to other workers. To both blue-collar and white-collar workers who view their own jobs as boring and repetitive, the computer field has represented a bright spot on the horizon. Data-processing workers, with their status and technological tools, were thought to be free from the reach of occupational degradation. Most students at the community college where I teach and many data-processing workers still believe this to be the case. And if data-processing workers, with their status and technical skills, are not beyond the grasp of efficiency changes, how much more painful must be the plight of other groups of workers. While these occupational changes are quite pervasive the way that work is now organized is not the only way that it can be.

Most occupational change is made in the name of efficiency. Efficiency has come to be a catchword of the twentieth century. Although it usually means more output for each unit of input, it is so overused that it has almost lost its meaning. Together with phrases like "human resources," "labor-management problems," "labor productivity," and "technological developments," it envelops the issue of occupational change in a fog of mystification. If work is to be divided for the sake of increased efficiency, why is it divided in such a way that workers know *less* about what they are doing? When the divided work is reorganized, why is it put back together in the shape of a rigid hierarchy, so that those at the bottom have little say about the way work is done? And within the hierarchy, why are bureaucratic rules imposed over individual and collective decision-making?

Generally, managers claim that division of labor and specialization are made necessary by the size and complexity of the modern business organization. Management-induced change is often presented under the rubric "technical necessity." This sequence of events with technological

explanations is made to seem natural and inevitable. In addition, management has argued that particularly in data processing the shortage of available workers has necessitated increased routinization of work activities. And although they admit that some changes may result in the temporary removal of skill from some workers, they argue that the end result will be a general upgrading of the overall skill level. But these issues do not explain the drive for efficiency; rather they further bury its meaning in faulty assumptions and oversimplifications.

Management bases its concepts of efficiency on a set of rules and procedures that today are called "management science." Although its roots are in Frederick Taylor's Scientific Management, the newer "science" is more eclectic in nature—representing a sort of souped-up version of its predecessors. According to the literature of management science, labor is a resource much like any other business resource. As such, it is there to be used, recycled, made obsolete, measured, and controlled so that the results of this resource can be predicted and planned for. But the problem that management continually faces is that this resource does not respond as predictably as other units of input in a management model for efficiency. When management talks about boosting the efficiency of labor (people) it means more than simply increasing worker productivity—it also means controlling worker reactions. The second meaning often conflicts with the first and sometimes even dominates the actions of management.

In the data-processing field, for example, management has called for changes in the work process in order to increase labor productivity (output of labor). Over the last twenty years, and particularly during the last decade, these changes required increasing rules, standards, and management control, all of which were intended to increase the efficiency of data-processing labor. But today, even though most of the changes followed the theories prescribed by management science literature, data-processing management is still struggling to cope with what they call the "people problem." It has been estimated that the programming costs *per instruction* in constant dollars have climbed from $4.50 in 1959 to more than $8.00 in 1976.[5] If efficiency in the form of decreased costs was the objective, in management terms we can only ask "what went wrong."

Some management authors argue that increasing costs are the result of "poor" management. They claim that management is indeed a science that must be used precisely in order to gain desired effects. Others complain that the theories of management are not yet well developed and therefore the results are unpredictable. "Hard-line" managers blame the permissiveness of "soft-line" managers, whereas "soft-liners" argue that "hard-liners" dominate workers too severely. In the midst of the managers' controversy, one thing is quite clear: *regardless of the management style that brought about the change*, the results have all been in the direction of management exerting more control over the work process and the worker. If data-processing management has not yet achieved its primary objective of decreasing costs, it has nonetheless established itself successfully in the second objective—controlling workers.

Changes in the work process, then, are a fundamental form of management control. Harry Braverman describes these changes as the essence of Frederick Taylor's policies of Scientific Management: they are designed to remove workers' private knowledge about the labor process from the workers domain and place knowledge and control in management's repertoire.[6] Social scientists call this category of changes "work rationalization." They involve breaking down each task "into a large number of smaller and simpler steps."[7] In management jargon the term "rationalization" carries a positive value; it makes things appear to be more rational and therefore more sensible. But rationalization buries the fact that divided and specialized labor removes skills from worker control—a predicament few workers find sensible.

Changes that make work more "cut and dried" obviously have an effect on the worker. Our consciousness—the way we understand ourselves and our society, as well as the way we act within that society—is shaped by the power relations

we are pressed into during the working day. When thought process, creativity, social interaction, and physical mobility are taken away and replaced by rules and regulations that make us feel powerless, it is not surprising that our consciousness becomes limited and limiting. Work changes aimed at removing the very soul of the worker must indeed have a profound effect on the way we think and act. One hundred years ago Karl Marx commented that our social existence determines our consciousness.[8] Today it is clear that the social existence of the work culture still shapes our consciousness.

I found that the data-processing worker reacted on two quite different levels to the events shaping his or her job. One part of the individual seemed to accept management arguments for efficiency, grudgingly "admitting" that rules and standards are necessary for increased productivity and a more "rational" work environment. But another part reacted against most forms of change, causing management to shift tactics continually and adjust the work process to workers' preferences. Both "consciousness," so to speak, existed side by side in each person: the one that had been taught to follow rules and adapt to change and the one that felt that change was not in her or his own best interest and, in fact, wasn't rational. Richard Sennett and Jonathan Cobb describe similar conflicts faced by blue-collar workers:

> The arrangement of consciousness which puts competence "out there" gives a person boundaries within which he can feel freely and without a sense of responsibility for his social position. Dividing the self defends against the pain a person would otherwise feel, if he had to submit the whole of himself to a society which makes his position a vulnerable and anxiety-laden one.[9]

When workers talk of increased efficiency, the conversation is usually about producing better products and having more control over the way they make those products. Data-processing workers are no exception. Their suggestions for improving work procedures argue for less division of labor and more control over the quality of their labor. Maintaining a sense of dual consciousness is a painful process. Management science compels them to accept the way things are as the natural order, but their instincts and feelings rebel.

The changes that have been made in the name of efficiency are too widespread to be ignored and too entrenched to go away. They are not an accident of history; they are rather a reflection of both the economic and the social relations of the society. The division and organization of work represent a set of social relations that express the power relations in advanced capitalist society. Many management authors have argued that the particular form of these changes has not been successful because the very function of stripping knowledge and power from workers has caused workers to react "unproductively." Some have urged job enrichment and work humanization as counterbalancing forces. Yet their arguments are lost voices in the rising tide of job degradation and deskilling. The history of change within an occupation is also the history of a set of social relations.

In order to understand more clearly the purpose of management-induced change, I found it necessary to study both management literature and the consciousness of data-processing workers, tracing here the way management theory has shaped worker actions and, conversely, the way worker consciousness has affected the theories of management. I began by reading trade journals and the proceedings of data-processing society conferences; I found that, although they had the authoritative sound of written history, they did not capture the changes actually taking place on the shopfloor. Computer workers are quick to point out that the techniques presented in the management literature do not relate to what is happening to them on the job. I then focused on the differences between management theory and shopfloor practice by conducting numerous in-depth interviews with data-processing "old-timers" (in this field that means workers who have been around for ten years or

longer!) as well as interviews with newer workers.[10]

Because the nature of data-processing work is so broad I limited myself to an investigation of commercial data-processing jobs; that is, to jobs of those workers involved in writing and running programs that process data for business organizations. Essentially, these data-processing workers are record-keepers, for they are the workers who maintain the electronic records that keep track of commercial transactions. This study is primarily about computer programmers and computer operators who work in medium to large corporations, because it is the jobs of these workers that have undergone the most noticeable changes. Within this category I have focused more on programmers than on operators, both because the nature of programming work has changed more markedly and because the amount of data available on computer operators is comparatively small. Until now, little has been written about the men and women who operate the computer equipment.[11]

Throughout, I try to contrast management arguments for efficiency in the work process with worker perceptions of the changes that have taken place. Part One traces the historical and theoretical developments within the field, first outlining the changes in data-processing occupations and then summarizing the history of computer technology and use. The intent is to dispel quickly the myth that changes in data-processing jobs are primarily caused by technological change. Whereas most data-processing workers know that technology itself is a product of people, it is important to trace the history in order to lay the foundation on which a more complete and interactive history of occupational change can be built. Part I also presents the management theories that have had an influence on change in the workplace. The developing theme is one of management theory as a set of principles that define the social relations within a society. It shows management theory as an *ideology of both economic and social control.* The major management theories that define and describe management science are outlined, and the growing body of radical theory which looks at the same events quite differently, is highlighted. In the drive for efficiency management employs four types of strategies to mold worker activity. These strategies include the need for management control over the labor process, worker behavior, management organization, and technology.

Part II describes the practice of these four strategies in the data-processing field. What emerges here is a view of how worker actions influence management practice. We see that although management ideology is pervasive, data-processing workers attempt to mold a shopfloor culture of their own. We also see what happens when management tries to implement its theoretical principles. The social organization of data-processing work is examined, presenting in detail the actions of management and reactions of workers, describing the social customs and relations of the workplace that help data-processing workers cope with an attempt to change the existing power relations. The social relations of the workplace are more than a set of neutral bureaucratic principles. Efficiency and the management strategies used to implement it are potentially explosive. Data-processing workers may not perceive that they can do much about it, but their actions on the shopfloor indicate that they can go far toward redefining the way their work lives are organized.

CHAPTER 2

History

Changes in an Occupation

Discussion about business cycles is as commonplace in the computer field as it is in any other. Clearly, the computer industry has gone through a number of distinct periods, reflecting changes in the cost and type of computer applications. But in examining these periods we must not lose sight of the larger trends, or tendencies, that have occurred over the length of the computer age. They all point in one direction: they show the particular features of an occupation that has been transformed from worker-regulated processes to management-controlled tasks.

The generally acknowledged start of the computer age is in the early 1950s.[1] The first business computers were used for purely repetitive clerical functions that previously had been done by electronic accounting machines. These machines, often seen as the predecessor to the modern computer, were based on electromechanical devices for processing keypunched cards. They evolved from keypunch-card procedures developed by Herman Hollerith for the Bureau of the Census in 1890. Large banks, insurance firms, and similar companies that had already established the clerical procedures for card systems were able to change over to the faster, but similar, computer systems by the second half of the 1950s. Since IBM had 90 per cent of the keypunch-card tabulating business, they were able to take a lead in the computer manufacturing business.[2]

Computers were applied only to those situations where the work process was already divided and rationalized. Accounting and payroll systems, for example, were prime targets for early computer applications because they required little or no change in the established work practices.[3] There was only one technical distinction between the first computers and their tabulating ancestors: the tabulating machines had to be wired each time an operation was to be performed, whereas the computers could be programmed with a series of instructions that could be stored for later use. But this distinction, coupled with the fact that computers were used *in addition* to existing tabulating equipment, created the demand for a large number of new workers.

By 1955, the industry urgently needed skilled people to operate, repair, and program the burgeoning computer applications. The workers who had previously operated the tabulating machines could fill this demand only partially. Business was expanding rapidly; the dollar volume of banking transactions doubled during the decade.[4] Insurance transactions expanded similarly.[5] As Alan Westin and Michael Baker point out, transaction volumes increased heavily between 1940 and 1955, lending credence to managers' claims to "file automation as an absolute necessity to cope with the tremendous increase in transactions."[6] IBM saw this period as one in which large firms were so burdened with increasing data-handling problems that they ignored cost considerations. A chief executive of the company described the period this way:

> At the dawn of the electronic data processing era, pioneer users of EDPM (insurance companies, large banks, Federal Government, airframe and defense industries), in the main, were not motivated by displaceable cost considerations. Sheer transaction volume (or complexity of computational requirements) were such that the punched card technology was inadequate regardless of quantity utilized.[7]

Lacking a large enough pool of trained labor-power, computer manufacturers and companies using computers began to lure people away from the sciences, often offering unlimited flexibility in their work as well as comparatively high wages. Programmers, in particular, were like virtuosos in high demand, who could jump from job to job, being granted demands to match their expectations. Almost all were quite young, and they sought independence and creativity in a field that promised status as well as high pay.[8] Most computer workers were employed either by government contractors for aerospace and defense work or by computer manufacturing firms. Only the largest computer users (companies that use computers) like banks and insurance companies, for example, hired their own data-processing workers.

Pirating skilled labor from other fields paid off for the industry until the widespread use of computers began to cause other pressures. By 1962, 10,000 to 12,000 computers had been installed, with about 150,000 workers employed in their manufacture, programming, operation, and maintenance.[9] At the time that workers were enjoying the effects of a seller's market for their labor-power, management journals and marketing literature were beginning to call for standardization of job descriptions and routinization of data-processing tasks. High on the management list of reforms was an effort to stop the costly effects of personnel turnover, created by workers jumping to more highly paid data-processing jobs. Certainly, the 50 per cent growth in computer workers' salaries during the 1958–1962 period intensified the corporate drive to cut costs.[10] During the early 1960s corporate management began to expect more from computer applications. Early computer centers had generally been charged to "research and development," but by 1963 they were expected to show a "return on investment."[11] In addition, during the experimental decade of the fifties, computer manufacturers had carried most computer software (programming) costs in an effort to gain new customers. Now the burden of labor costs was shifting to computer users, who were expected to design and implement their own applications. The need for middle and lower management to control the undisciplined, job-hopping work force, combined with the pressures from upper management to account for their growing expenditures, greatly hastened the death of craftlike worker activity.

The 1960s was a period of tightening the reins on the data-processing work force. Management stepped up its drive for "efficiency" and what it saw to be its necessary corequisite—division of labor and rationalized rules. The independent computer labor force with its concentration and interchange of skills among workers was clearly a threat to management. Both corporate and data-processing management cried out for procedures to control more closely the actions and costs of data-processing workers. Dick Brandon, an influential industry consultant, for example, argued that the industry had reached "economic maturity" without developing proper working methods, procedures, and disciplines. He called for tighter management controls, formal standards, and performance measurements, while decrying the "loss of management control" over data-processing functions.[12]

By 1965, when IBM began to install the general-purpose System 360, management demands for controllable data-processing labor were intensified. The new systems, which promised greatly increased speeds and storage capacity over the existing computers, supported the demands of computer-user management for greater worker productivity.[13] Those of us in the field at the time of the introduction of the System 360 tend to remember it well, for almost overnight a firm division of labor occurred, not by chance as it seemed to us then, but by clear design. Although computer work had been divided by task in the 1950s, many activities had overlapped a good deal. In particular, computer programmers and operators would meet in the computer room, which, like a social hall, offered the

opportunity to exchange techniques and ideas. The installation of the System 360 provided management with reasons to change this. One of the first rulings to be enforced was a prohibition against programmers entering the computer room, thus isolating the two categories of labor and cutting off exchange of functions and rigidifying job classifications. From a financial point of view, corporate management saw the 360 as an increase in capital expenditure, requiring tighter controls and security. Thus, to them, the separation of operators and programmers was a necessary step in protecting their investment. Shopfloor managers were also quick to respond to the need to divide the work force in order to transfer some technical skill and control from the workers into their own domain.

In his excellent book, Philip Kraft describes the changes in the nature of programming tasks: "The transformation of programming is not the result of technological imperatives inherent in the logic of programming or computing. Programming has changed because managers, concerned about profits, have set about systematically and carefully to change it."[14] Computer programmers, who write the instructions (software) that make the equipment (hardware) actually work, were increasingly subject to rules, standards, procedures, and performance objectives that codified and routinized their tasks.[15] Computer operators were similarly molded. Operators tend the machines and see to it that the data are processed according to schedule. In addition to having standards and rules, their jobs were codified to the point where individual tasks became so routine that they were assumed by the computer system. Initially, for example, operators had to control the actions that started or stopped each step in the processing of an application. Improvements in computer software gradually incorporated these functions into automatic commands in the computer's operating or monitoring system.

It was during this period, when skills were removed from both operations and programming jobs, that the schools were beginning to turn out skilled computer workers. Universities were only too glad to respond to management pleas for more standardized programmers, and private institutes were quick to jump at the opportunity to make a profit training computer operators. Until the late 1960s computer manufacturers were the main source for training computer workers for few college or commercial programs existed. It was the joint demands for performance standards and an increased number of computer workers that pushed colleges to start computer science programs. Once begun, they churned out a large body of potentially disciplined future workers, giving management a larger pool of labor-power from which to choose.

During this process, as skill or craft work was abstracted from each task, programmers were encouraged to accept the myth of "professionalism," which kept them from organizing unions and seeing the changes for what they were. Indeed, strong evidence suggests that the impetus for professionalism has come from management and not from the workers themselves. Trade journals and computer associations, both overwhelmingly management organs, have strongly pushed the idea.[16] It seems likely that programmers, feeling the tide of job degradation, only too gladly clung to the belief that they were professional. Operators, lacking the "professional" designation, hung on to the status that came with working in an expensive "machine room."

But some of the glamor was removed in the early 1970s. In 1971, the Department of Labor decided that programmers were not professional employees and therefore were eligible for overtime pay. A federal judge upheld this in a 1976 decision, stating that programmers were not executive, administrative, or professional employees: "Of interest is the fact that a programmer does not need the expertise of the designer, need not know the inner workings of the computer, and can do adequate work with only a general familiarity of its function and a grasp of computer language."[17] The Department of Labor bulletin *Computer Manpower Outlook* noted "That some employers consider on-the-job training sufficient except for the top jobs (systems and management work) in a computer operation. They argue that the greater availability of college graduates in recent years enables them to hire persons with higher educational levels than is really required for the work."[18]

The 1960s saw the tightening of controls and the economic crisis of the early 1970s put the brakes on the data-processing field. Huge computer manufacturing firms, such as RCA, GE, and Honeywell, merged or went out of the computer business. Many small software and consulting firms also closed their doors, leaving computer workers for the first time in the midst of a declining job market. In 1972, an article in *Business Automation* commented: "Remember the people problem? It was a prime topic of conversation through the 1960's, but seemed to fade away in the past year or so. The job-hopping programmer or systems analyst will continue to be a rarity."[19] They characterized the data-processing labor market as one in which (1) personnel costs were stabilizing, (2) turnover was slackening, and (3) supply was approaching demand.[20]

Indeed, programmers' salaries began to reflect these trends. Breaking a long-standing upward curve, the average starting salary for programmers stayed at $8,500 between 1970 and 1972.[21] In 1975, a private survey found that programmers' salaries in large installations had risen only 2 per cent over the previous year, and yet large installations usually accounted for higher salaries and growth rates.[22] Computer operators met the same fate. The 1975 survey noted that their salaries did not increase between 1974 and 1975, a fact attributed to the "greater influx of entry-level people."[23] Yet the Department of Labor in 1974 cited labor costs as the prime ingredient in changing computer jobs:

> Because costs of computer manpower are a major part of computer user costs, manufacturers have a strong incentive to reduce the manpower needed to use their equipment by incorporating functions that currently are being performed by computer personnel into the hardware [equipment]. Also technological innovations that enable workers in other

> occupations to interact directly with computers and thus eliminate costly data processing specialists are expected to be stressed.[24]

The emphasis on decreasing computer "manpower" requirements has been a main theme in the second half of the 1970s. The economic crisis that produced the phenomenon of the unemployed programmer also produced some marked changes in the computer industry. Back in 1967, some observers had forecast the possible saturation of the computer market in the United States with the then existing hardware and software.[25] In fact this appears to have happened. By 1970, 51 per cent of IBM's revenues was coming from foreign operations. Both the characteristics of the declining computer market and the effects of the economic crisis had an influence on reducing computer manufacturing costs and prices. Computer manufacturers put a good deal of research and development into reducing the cost of the technology. They were aided by the federal government, which during the 1960s provided between 57 per cent and 63 per cent of *all* funds for research and development.[26] By the late 1970s computer hardware costs had declined significantly, opening up new computer markets.

In 1977, the *Wall Street Journal* had begun talking about the new "Burgeoning Computer Software Industry":

> The cost of computer power had come down so far that the butcher, the baker, and the candle stick maker can afford computers. Minicomputers, for instance, are available to virtually anyone. The creative uses of this new level of computers are endless—video games, and everything. And so this new technology has opened up varied thousands of jobs.[27]

The use of remote terminals means, in effect, that any desk within reach of a telephone can transmit data over phone lines to a distant computer. Retail stores have begun to use these services for up-to-the-minute inventory reports, as clerks key in information on each sale. Banks, insurance

companies, credit-reporting firms, and supermarkets are all tapping this new potential. The introduction of automated supermarket checkout counters has broken new ground in mass computer use. The late seventies have been called the age of the "mini" and "micro" computer revolution.

The expansion of computer applications to previously untouched areas has, once again, increased the demand for computer workers and brought about a slight increase in salary levels. Between 1975 and 1976 overall data-processing salaries increased at the rate of 5.7 per cent, although most of the larger increases were in managerial jobs. More current statistics show that the 1976–1977 increases have slowed to about 5 per cent with no increases for programmer or operator entry-level positions.[28] Although these percentages represent an increase over the early 1970s, cost-of-living increases have eaten up most gains for programmers and operators. Taking into account a 43.4 per cent cumulative cost-of-living increase since 1971,[29] 1977 entry-level salaries show no improvement over the early years of the decade. In 1977, commercial applications programmers at the entry level had a national average salary of about $11,000,[30] although the range ran from about $8,000 for coding, or lower level positions, to $15,000 for computer science graduates. Computer operators' salaries at the entry level range from $8,000 to about $10,000.[31]

But the economic expansion of the computer industry in the late 1970s is not the same as previous computer booms. The standards and procedures instituted in the previous decade and the chilling effects of the crisis in the early seventies have left their mark on the labor process for computer workers. *Quantitatively* the computer field is again expanding, but *qualitatively* a difference is involved for the workers. Data-processing jobs today are much more highly specialized and carefully defined than they were one or two decades ago. The performance objectives begun in the 1960s, although not as successful as most managers would like, now play a role in allowing management to control the schedules and actions of data-processing workers. Today, data-processing work is divided among systems analysts, programmers, and operators. Within each of these categories is an increasing number of subdivisions that separate workers. Programmers, for example, are specialized according to the type of industry for which they may write programs, such as insurance, banking, or manufacturing, and within these groupings they are usually classified by the type of computer language they use to code the programs. Even systems analysts who design the applications now produce their specifications within a framework of narrowly defined job steps.

The results for data-processing workers are quite evident. Increasing specialization limits their potential job mobility, putting a cap on management "turnover" problems. Rationalization of work procedures—in the form of rules, regulations, and prespecified work practices—cuts into their control over their actions on the job. And the "fear of unemployment" that materialized for the first time in the crisis of the early seventies has had a disciplining impact on workers' behavior. Many workers, particularly those that survived the layoffs, are more willing to adhere to management regulations. These trends are not likely to disappear. For data-processing management, the central focus still remains development of mechanisms to control data-processing workers. The computer industry has grown from fifty computers in 1955 to more than 155,000 general-purpose installations in 1976.[32] The number of data-processing workers has grown to somewhere in the neighborhood of 500,000 operators, programmers, and systems analysts in the mid-seventies.[33] It is estimated that of the total cost of a computer system today, roughly 75 per cent is attributable to software (program development, maintenance, and operation).[34] In other words, the major portion of data-processing costs is directly related to labor.

Controlling related labor costs of data processing is a major management concern, particularly as the market for computer systems continues to expand. The amount spent on workers particularly upsets managers as computer equipment (hardware) costs continue to decline. It has been estimated, for example, that the cost/performance ratio for

hardware has improved 200 times since 1955, whereas programmer productivity, the main factor behind software costs, has risen only 3 per cent each year.[35] Experts in the field see labor's share of total costs continuing to rise. In 1977 Dr. Richard Tanaka, then President of the International Federation of Information Processing Societies (IFIPS), warned that, by 1985, 90 per cent of data-processing costs would be workers' salaries.[36]

Since labor costs as a *percentage of total costs* are increasing, managers look for ways to decrease their dependence on workers. From management's perspective, the figures indicate that machines, namely computers, look more productive than human labor. Philip Kraft describes what managers set out to do about this: "Indeed, the principle was simple: if managers could not yet have machines which wrote programs, at least they could have programmers who worked like machines. Until human programmers were eliminated altogether, their work would be made as machine-like—that is, as simple and limited and routine—as possible."[37] Over the last twenty years worker tasks have increasingly been divided and decision-making functions been absorbed by management. Yet for both workers and managers in the data-processing field it is still not clear if these changes have indeed increased labor productivity and therefore enhanced efficiency.

Changes in Computers and Data Processing

Most workers and managers at the bottom of an organizational hierarchy see technology as something that controls their actions. The frightening fact is that technology does control actions, but only to the extent that it was *designed to do so*. "Technology" seems to be one of the most overworked words in the English language. Since it is blamed or praised for almost everything we do, it is hard to get a firm grasp on what it is and how it developed.

According to the dictionary technology represents "the sciences of the industrial arts"—that is, it involves the application of knowledge to industry. Clearly, it doesn't fall from the sky, or, as pretwentieth-century tales would have it, technology is not developed by independent craftsmen tinkering away in their basements. The image of isolated individuals stumbling on important innovative breakthroughs may be pleasant to retain, but this image just isn't true any longer. As Richard Hall explains: "Technological change does not occur in a vacuum. The organization, while critically affected by technology itself, is also the 'gatekeeper' in terms of implementing technological change or redesign of occupations."[38] Indeed, the main focus of IBM's defense in the government's antitrust case is the argument that its size is a necessary precondition for the accumulation of capital on a large enough scale to support technological development.

Technology is developed by certain groups of people for use by other groups. Its creation and use is a social process in much the same way that the organization of labor is a social process. It reflects the social relations of industry. In doing so, technology is of course limited by the power relations of the society. Whether the technology takes the form of a machine (hardware) or a set of programs developed to make the machine work (software), its development and use are determined by the activities of people. David Noble, studying the factors that led to engineering technology at the turn of the century, has this to say about technology:

> While it may aptly be described as a composite of the accumulated scientific knowledge, technological skills, implements, logical habits, and material products of people, technology is always more than this, more than information, logic, things. *It is people themselves*, undertaking their various activities in particular social and historical contexts, with particular interests and aims.[39]

Computer technology is not the sole determining force behind job change, even though this oversimplification is a frequent argument in management literature. It excuses job degradation without stopping to explain the complexities of

the issue. The capsule history provided here is intended to squelch the technological determinist arguments by showing the interrelations between the *use* of computers and the development of computer technology. Although readers in the data-processing field may already be familiar with this history, it is important to keep in mind the interactions among changes in computer technology, computer use, and data-processing job structures.

In a computer system the hardware is composed of a Central Processing Unit (CPU) and any combination of input/output (peripheral) devices attached to it. The Central Processing Unit has three parts that together allow information to be stored and processed (changed) temporarily according to sets of instructions.

Basically, it works like this: data transmitted from a separate input device are temporarily stored in a section of the CPU called the memory or primary storage unit; another section, called the control unit, acts as a traffic director in controlling and coordinating the flow of data; the third section, known as the arithmetic/logic unit, actually does the work of calculation and logical comparisons. Popular literature often portrays the memory unit as a kind of "super brain," but it really acts only as a sort of temporary scratch pad: a place to hold data for processing by the real workhorse—the arithmetic/logic unit. When it is necessary to save information for future processing, or whenever results are needed, instructions must be included to tell the processing unit to transmit information from the memory unit to an output device. Secondary storage devices like magnetic tapes or disks are used to record information that may be used over again. When a company processes its payroll, for example, the information about each employee is maintained on a secondary storage device and then "read in" when processing is necessary. When the data are input for processing, one record (an employee) is processed at a time in the Central Processing Unit, although the processing is so fast it may seem as though more is being done.[40]

The pre-commercial origins of modern computer history are usually traced back to the years during World War II when government funding was applied to military problems. The ENIAC, Electronic Numerical Intergrator and Computer, was completed at the Moore School in Philadelphia in 1945. Designed and built under the direction of John Mauchly and John Eckert, the processor was developed to calculate ballistic trajectories. By today's standards it was rather primitive; it stood 10 feet high and more than 100 feet long, and it had in excess of 17,000 vacuum tubes. Programming consisted of tediously rewiring the circuitry each time a new formula was required.[41] In addition to the ENIAC, a group at Harvard had been working on development of a processor that could store programs or instructions. The result of this effort was an electromechanical device known as the MARK I.

In the late 1940s Eckert and Mauchly left the Moore School and established their own company, which developed the first stored program computer—the UNIVAC I. Lacking sufficient capital to get the project off the ground, they merged with Remington Rand in 1950 and the following year they delivered the first UNIVAC I to the Census Bureau. The use of a computer by the Census Bureau marked its potential for record-keeping and widespread business use. Although the hardware was based on vacuum tubes that were fairly unreliable, the fact that programs could be changed without rewiring (the stored program concept) made the UNIVAC I a versatile machine. Five additional UNIVACS were built for government agencies before General Electric became the first private company to install a computer in 1954.[42]

It is clear that during the early 1950s Remington Rand, the manufacturer of the UNIVAC, had a "jump on the market." IBM rejected an offer to acquire the rights to this machine "because it felt that the greatest market potential for computers was in scientific rather than business applications."[43] The clamor for commercial computers—coupled with the developments of mass production techniques in computer manufacturing during 1954–1956—seems to have convinced IBM of the error of its ways. "By

making the most of Sperry Rand's mistakes,"[44] IBM avoided becoming a brief footnote in history. In 1955, it overtook Rand for the computer manufacturing lead. By 1957, it had 78.5 per cent of the computer market.[45]

IBM entered the computer age with 90 per cent of the punched card tabulating business.[46] In 1956, IBM introduced the Model 650 computer, which became an instant success because it offered their tabulating-card customers an easy transition to computer use: since the 650 had a card-reading input device, it allowed IBM's large customer base to continue using their existing punched card-oriented systems. In the same year IBM brought out its first "family" of vacuum tube computers—the 702, 704, and 705.[47] This gave the company a wider product line than UNIVAC and solidly entrenched IBM in the computer business.

The vacuum tube machines were known as the "first generation" of computers. Like the first ENIAC, they were quite large and required constant maintenance because tubes continually had to be replaced. In 1958, UNIVAC started what came to be known as the "second generation" of computers when it brought out the UNIVAC Solid State 80, which relied on transistors. RCA followed the transistor revolution, to be joined belatedly by IBM in 1959, when it began its 7090 series. Transistors had first been developed in 1948 at Bell Telephone laboratories and were used in the early 1950s for military equipment, but they were considered too expensive at the time for commercial application. Both government and business research and development efforts were applied to the problem of mass-producing transistors. By the late 1950s the cost of producing transistors was drastically reduced. Most observers agree that the second generation represented a technological break with the first, because the advantages of transistors in size, speed, and reliability were important in gaining general business recognition for computer potential.

It was during this period that IBM introduced the 1401 model, which caught on even faster than the 650. Like its predecessor, the 1401 offered tabulating-card users the opportunity to process their existing card-oriented applications faster. The 1401 became the workhorse of business; by 1964, more than 7,000 models were in use.[48] It was a big success in those industries like banking and insurance where rapid growth had made it difficult to handle the increase in record-keeping. In 1964, Honeywell delivered its H-200, modeled after the 1401 and considered by some a "technically very superior machine." Its introduction forced IBM to upgrade the 1401 models and develop competitive new products.[49]

Business expansion and the success of early computers in addressing the problems of business forced the computer manufacturing industry to find cheaper and more reliable components for computer construction. The second computer generation, lasting roughly from 1959 to 1965, was brought to an end by the introduction of integrated circuit components in the IBM 360 "family" of machines. The integrated circuit added speed and reliability to computer potential, but its development did not cause as sharp a break with the past as did the transistor revolution. Integrated circuits, like transistors, had been around for a decade before they were applied to general use. They had originally been developed by Texas Instruments and Fairchild Semiconductor for military products. From the standpoint of computer users, the IBM 360 was important because it was designed to offer compatibility between scientific uses and business applications as well as the interchangeability of input/output devices with CPU models. Even more important was the promise of interchangeability of operating system and program language software. Computer users had been clamoring for such developments since the late fifties. Despite delays in delivering IBM 360 models and major problems with software development, the IBM 360 was accepted as a "general-purpose" computer for a wide range of business applications.

Computer manufacturing competitors tried to cut into IBM's lead, but the 360 cemented IBM's dominance. In 1964–1965, RCA presented its Spectra 70 series, which was of identical design but faster, cheaper, and made entirely of

monolithic circuits. Its appearance forced IBM to "upgrade" its product line, but it failed to capture a foothold in the computer market. General Electric developed the 600 series, which offered new technology for time-sharing (many computer users sharing the same CPU at the same time). Like RCA's attempts, that of GE was unable to penetrate the market despite time-sharing, which was declared the "thing of the future" and widely demanded by business. General Electric's emphasis on time-sharing, however, forced IBM to alter its 360 hardware and software designs radically so that time-sharing could be added to IBM equipment.[50]

With expanding markets, computer manufacturers were able to concentrate on lowering manufacturing costs. Integrated circuits gave way to large-scale integration (LSI), and refinements in the manufacturing process resulted in increased speed and reliability along with rapidly decreasing prices. In 1965, a medium-sized IBM 360 cost between $700,000 and $800,000; by 1976, a comparable machine (although much faster) cost about $380,000. The same type of machine in 1953 would have cost about three million dollars. Expressed in terms of "memory capacity per dollar of rental," 1977 computers delivered about eighty times the capacity of the first-generation devices.[51]

Mass-production techniques now pack thousands of circuits onto silicon chips that are smaller than postage stamps. The miniaturization process, coupled with decreasing manufacturing costs, has enabled companies to develop minicomputers and microcomputers. These units have opened up new markets for computer manufacturers as smaller businesses now find computers within their price range.

Today, as the silicon chips become cheaper and more interchangeable, they offer management a strong inducement to replace software with hardware components. In other words, it is now possible to replace more of the human labor of programming and operations with inexpensive and reliable pieces of equipment.

The history of systems software development is perhaps best characterized by its constant lag behind hardware developments. By the late 1950s corporate users' groups such as SHARE and GUIDE had organized to try to begin measuring throughput and looking for ways to improve it. The biggest complaint from corporate management was that having invested so much in capital equipment they wanted some way to see it put to constant, efficient use. Operating systems were the answer, but their development rested on the use of programmers to write the necessary programs. And program development, of course, relied on labor-intensive activities, which in the early days had not been taken from their craft roots.

First-generation equipment was characterized by its lack of systems software support. Each time a program had to be run the operator would have to load the program and essentially start up the hardware. Programs were written in binary machine language, a tedious and time-consuming undertaking. By the end of the 1950s program language translators such as FORTRAN were gaining acceptance as were rudimentary operating systems. These early batch-processing operating systems made it possible to "compile, assemble and load [translate and store] a program with test data in one trip to the machine room."[52] Today this procedure is of course assumed, but at the time it represented a tremendous improvement in both machine efficiency (increasing the throughput of the hardware) and programmer and operator efficiency (taking less labor time).

Second-generation hardware "came with" its own operating system and program language translators. These support programs were leased as a package with the hardware. They offered greater machine and labor efficiency but posed two major problems. The first was a technical dilemma—the support programs that helped the equipment perform better were themselves inefficient because they required too much memory space. The bigger and more useful the operating system, the less room there was for user programs! The second problem was one of compatibility. Each computer manufacturer, and in fact each computer model, had its own systems software. The IBM 1401 commercial

model, for example, used operating systems and languages radically different from the scientific-based IBM 7090 series. This had advantages for the computer manufacturer because it virtually insured that customers would not switch products; their programs would not work on a competitor's machine or a different model. From the corporate user's perspective, differences between software packages created tremendous training costs, for corporations had to train their data-processing workers in the specifics of each machine and its associated software. Corporate users complained so bitterly that compatibility (standardization) became one of the chief design considerations behind IBM's third generation of hardware and software.

By 1965–1966, IBM was investing as much in software design as in hardware.[53] The operating systems allowed much greater throughput by making it possible to process more than one program at a time. Since third-generation hardware made memory space comparatively cheaper, it was possible to build machines with more capacity, diminishing the second-generation storage problem. But third-generation software lagged severely behind the introduction of the hardware. By 1967, two years after the installation of the first 360, corporate management was still complaining that the promised features of the software support had not been delivered. And programmers' and operators' complaints were even louder. "Bugs" in IBM's mammoth operating system were more common than smooth performance.[54] At the time, IBM kept promising users that the "next release" of the operating system would solve their problems. A decade later Frederick P. Brooks, Jr., the manager of the Operating System project, freely admitted its problems: "The product was late, it took more memory than planned, the costs were several times the estimate, and it did not perform very well until several releases after the first."[55] Brooks argues that the problems in software development stemmed from inadequate division of labor and control over the programmers. Now, after two decades of experimenting with the organization of programming labor, large-scale operating systems are able to assume more of the functions previously done by data-processing workers. Like advanced computer hardware, they have been designed to meet both the constraints of the computer-user market and the data-processing labor market. Whenever possible, the design considerations have attempted to augment and replace data-processing labor with hardware and software.

CHAPTER 3

Theory

Management Theory: From Scientific Management to Management Science

Despite the great changes in management methods and styles since the turn of the century, the objectives of management remain the same. They specify that the function of a firm is to grow, and that the growth process is dependent on the accumulation of capital. In order to provide the environment to foster such a growth process, management must effectively allocate the firm's resources.[1]

Management literature reflects and defines the courses of action that can be chosen by policy-makers in a firm. The literature plays an important role in telling us how top corporate managers *perceive* their environment and how these perceptions delimit their choice of solutions. The solutions management presents are clearly not the only possible ones, but they are the most likely choices based on management's definitions. Within the pages of management literature, for example, efficiency of all resources—both people and things—is determined by the ability of management to control, measure, and predict the outcome of the labor process.

The literature outlines the policies available to top management for guiding its planning process; but it does not necessarily specify the way decisions are carried out, nor does it describe what actually takes place in a firm. Management writings range from theoretical to specific "how-to" categories. Theoretical principles are often quoted and argued as the basis for defining problems and highlighting the range of solutions open to management planners. Despite repeated attempts to define management as a science, its theoretical writings do not represent a unified body of knowledge or a firm set of principles. Management "theory" is probably best described as a developing set of definitions and strategies. The wide range of theoretical styles reveals differences in perceptions of workplace reality and in the type of solutions espoused. On the most general level, the opposing views have been characterized as theory X and theory Y; theory X represents the school that places formal authority and coercion in the primary position, and theory Y emphasizes worker collaboration, motivation, and human relations.[2] Obviously, these characterizations represent a polarization of management attitudes, but they are helpful in pointing out the differences in management's perception of labor. All management theory views labor as a resource, like raw materials or energy, but the theories differ in their methods for increasing this resource's output and decreasing its cost. For management, the problem is simply this: most resources respond to definable and quantifiable management techniques for increasing output; labor does not.

Theory X proponents basically see labor as a resource constantly fighting for its goals at the expense of the firm's growth; therefore, coercion and authority are necessary to force this recalcitrant resource into line. Theory Y advocates also perceive a "problem" with labor's behavior within the firm, but they argue that workers are basically agreeable people who can be motivated to produce more for the firm. Both start from the same base in that they perceive that workers resist the conditions of labor, and both agree that this situation must be better controlled. Douglas McGregor, the originator of the "humanistic" theory Y, had this to say about management: "One of the major tasks of management is to organize human effort in the service of the economic objective of the enterprise. . . . Successful management depends—not alone, but significantly—upon the *ability to predict and control human behavior.*"[3]

Both theories are threads that have been woven into the fabric of current management styles. Starting with the Scientific Management school in the early part of the century, through the "human relations" movement beginning in the 1930s, and on into the synthesis of these ideas in the framework of management science after World War II, management theory can be traced. Management practice differs from theory, because it is closer to the scene of worker reaction and is therefore forced into making on-the-spot decisions, but even these decisions are defined within the framework provided by management theory.

The introduction of Scientific Management by Frederick Winslow Taylor in the early part of the century has been considered so significant that some have called it the "Second Industrial Revolution."[4] Most management textbooks date modern management theory from Taylor's writings. Taylor's Scientific Management addressed the problems of management control of the labor process as they related to the increased size of corporations in the beginning of the era of monopoly capital. His efforts were aimed at increasing the productivity of each department within an enterprise by compelling workers to intensify their labor. Intensification of labor was brought about by time-motion studies, in which outside experts observed the labor process and then set standards for increased productivity. Workers were offered financial incentives for increasing their output. Control over the *pace of work* and *definition of tasks* was taken from the worker and placed in the hands of management. Once the stopwatch was brought into the workplace it dominated workers' actions. Down to the level of body motion they were defined and standardized so that managers could enforce the intensified procedures.

In management literature Taylor is probably best known for this emphasis on separation between thought and action. The application of time-motion study to work activities was designed to abstract each of the "simplest elements" of each job in order to squeeze from these elements the parts that required knowledge and those that did not. By doing this, Taylor tried to show that management did not have to sit idly by while workers controlled the *pace* of their labor. His message was that management could regain control of the labor process by removing skill and knowledge from the workers' arena and incorporating it into management functions. The message was particularly attractive to management because industrial production was dominated in many areas by craft workers who did, in fact, have a degree of control over production based on their knowledge of the work process. Taylor's Scientific Management sought to break that control.[5]

Scientific Management not only represented a new approach to administration of workers, it also caused a change in the social system of work.[6] Within the social system of the workplace, power shifted from workers to managers. In the past, when workers had controlled their shopfloor activities, their knowledge of the work process gave them considerable leverage in dealing with management. Scientific Management pried that power loose. According to Peter F. Drucker, the basis of Scientific Management is "the organized study of work, the analysis of work into its simplest elements and the systematic improvement of worker's performance of each of these elements."[7]

Scientific Management did seem to result in increased output in most instances where it was at least partially applied, but the problems it created between labor and management were far-reaching. In a study of Taylorism at the Watertown Arsenal (1905–1915), Hugh Aitken found that the system succeeded in more than doubling the old rate of production, *but* its impact as a social system seriously affected continuation of that increased output. Worker unrest and reaction were so severe that the federal government outlawed Taylor's system from further application in government installations.[8] Douglas McGregor has argued

that because Scientific Management alienated the worker, it was costly in terms of sabotage and the rise of union militancy.[9]

By the late 1930s labor had built a sufficiently strong base through the union movement to be felt in many industries. The Depression increased the tempo of labor unrest. Rather than continue the openly antagonistic policies of Taylorism, management theory began to embrace the concepts of the "human relations" school: "it was no accident that the Human Relations movement followed in the wake of scientific management, mopping up the human residue left behind by the mechanistic organization of the work process."[10] Although increased output remained the order of the day, human relations theorists attempted to control workers by getting them to adjust better to their environment. If necessary, even the reverse—adjusting the work environment to worker needs—was called for if it did not conflict with overall corporate objectives. Perhaps the best-known example of this approach was the work of George Elton Mayo in the study of the Hawthorne Works at Western Electric Company. In contrast to Scientific Management and its unrelenting emphasis on quantifiable efficiency, human relations theorists interjected the concept of worker morale. The Hawthorne studies remind managers that improved human relations will improve morale, which in turn will increase production.[11]

This school of thought brought the social sciences into the management camp, introducing many new approaches to the problem of increasing worker morale.[12] Today, the writings that grow out of this school are heavily loaded with phrases like "human factor engineering," "human asset accounting," and "controlling human resources";[13] expressions that reduce human beings to abstract concepts conforming to the vocabulary of efficiency. The language of human relations attempts to create quantifiable terms by lumping people and things together. Scientific Management failed to consider individuals and nonmonetary matters, and human relations theories represented a management-defined step to correct the imbalance, but this approach would not survive, intact, the business transformations following World War II.

In his study of management change Maarten de Kadt states that "the control of labor has been a process that management has had to learn and to enforce anew in each period of newly expanded production."[14] Just as reactions to Scientific Management and the problems of continued accumulation induced changes in management theory during the 1930s, the problems of expanded accumulation after World War II created a new set of management dilemmas.

The approach developed over the last thirty years has come to be known as "management science." It incorporates Taylor's principles of efficiency and Mayo's theories of motivation into a body of knowledge that seeks to maximize the efficiency of the organization as a whole while minimizing the problems of worker resistance. Included in this synthesis are the tools and techniques of measurement developed during the Second World War for allocating resources to the battlefronts. These techniques, such as PERT (Progress Evaluation in Real Time) and Operations Research (OR), together with methods of analysis called the "systems approach," have given management its "scientific" base. Merging the behavioral and mathematical approaches, and at the same time borrowing freely from earlier management theories, management science stands prepared to juggle the complex problems of expanded growth.[15]

The most fundamental departure from Scientific Management is the view of efficiency as *more than simple cost reduction*. Imbedded in management science is the recognition that trade-offs are necessary between controlling workers and increasing their output. The systems approach emphasizes that the efficiency of the whole (the firm) may be different from the efficiency of its individual parts (units or departments).[16] Whereas Taylor tried to optimize the productivity of each worker in each department, management science indicates that efficiency of some departments may need to be sacrificed for the benefit of the whole organization—simply stated: the whole is not necessarily the sum of its parts. This idea provided a breakthrough in management thinking, for it allowed planners to support staff departments that were not efficient in and of themselves but provided services that helped bolster efficiency in other units. Data-processing departments, as well as legal, financial, and engineering functions, fit within this framework. Drucker stresses that the "system" is a social one and must be considered in this light:

> In some cases the best way to strengthen the system may be to weaken a part—to make it less precise or less efficient. For what matters in a system is the performance of the whole. . . .
>
> That the enterprise is a social rather than a mechanical system makes the danger [of emphasizing individual efficiency] all the greater.[17]

This concept of a system allows management to trade efficiencies throughout the firm and also to bring the principles into play at the level of individual workers. Its base rests on Taylor's principles for dividing labor, but it gives management the option of dividing certain tasks and at the same time integrating others. Scientific Management attempted to *fragment the tasks of each worker*. Management science makes it possible to apply the "right" motivating and/or fragmenting techniques in individual situations. Hales, in a study of the two schools of thought, summarizes the comparison this way:

> Scientific Management attempted to split up work into fragments, externally regulated. Operations Research, by virtue of its systems methodology and statistical techniques, can attempt the *integration* of systems activities which have their own internal structure of regulation.[18]

Isolating decision-making activities also makes it possible to apply Taylor's division-of-labor schemes to mental tasks. Herbert Simon, one of the best-known theorists for management science, emphasizes that new concepts of decision-making are necessary to divide white-collar actions into discrete tasks. He outlines three basic types of decisions that take place within the firm and explains how each can be made more *routine* and therefore subject to management planning. Essentially, Simon applies the tools of observation and measurement used by Taylor to the nonroutine functions of the firm.[19] In addition, his techniques are fully supported by the mathematical and statistical tools of management science, which allow management to build "control systems" based on *prespecified decision-making rules*. Rationalizing decision-making power goes one step beyond Taylor's techniques for removing worker skill and knowledge, for it allows a total separation between thinking and doing.

The emphasis on quantitative measurement of everything from worker actions to decision-making practice is a central focus of the literature of management science. Because management theory advocates quantitative measurement so persistently, many management practitioners are caught in the bind of measuring so many aspects of their operations that they find themselves drowned in a sea of quantitative reports.[20] Despite the sins of excess committed in the name of measurement, it is emphasized because it enables managers to plan and predict the functioning of each part of the enterprise and its relationship to the whole. The label "science" justifies the measurement of all variables in the production process, certainly including the quantification of what management calls its "human resources."

Management science literature places great importance on management's ability to predict and control each corporate resource. C. West Churchman, for example, outlines the way the systems approach can be used to *define each step in the work process* in order to bring it within range of management control procedures.[21] Alfred Chandler focuses on organizational policy that is aimed at gaining consistency, control, and predictability for the firm within its market. His emphasis on consistency *extends* the simple function of cost reduction by utilizing procedures to make

the firm respond flexibly to its environment.[22] And Douglas McGregor reminds us that "progress in any profession is associated with the ability to predict and control."[23]

At the most fundamental level, management theory addresses itself to the actions and behavior of workers. Central to the management of labor is the ability to carry out policies that increase the productivity of this resource. But increasing labor productivity is a complex issue, often plagued by problems that the literature calls the "unintended consequences" of management policy.[24] Terms such as "conflict," "resistance," "negative reactions," and "labor response" appear throughout management writings—but always with the warning that "good" management can control workers without such consequences.[25] Management science accepts the idea that workers may not always see policy in the "proper" light; worker resistance, therefore, can be expected, but ways to counter it also must be planned.

The ability both to increase labor productivity and to retard labor "unrest" demands the control and coordination of four essential variables: the work process, the behavior and discipline of workers, the shape of management organization, and the technology used in production.[26] Although this is no small feat for management, the parameters are made more complex by constant changes in market conditions and by the actions of workers. Every period of accumulation brings a reshuffling of the priorities and tactics involved in controlling these variables.

Labor process. Modern techniques for controlling steps in the work process date back to Taylor's efforts to make work procedures standardized and therefore more predictable. Changes in the process involve *observing*, *defining*, and *standardizing each action or task*. Clearly defined tasks make it easier for management to establish expectations about worker productivity. Scientific Management used time-motion studies to codify the work process. Within the framework of management science, those studies have been expanded to include operations research techniques for modeling and simulating change and the tools of systems analysis for defining the trade-offs between morale and efficiency.[27] Operations research provides the mathematical base for management to manipulate variables and create mathematical models for observing the consequences of change. Systems analysis provides the methodology for systematically isolating and analyzing current activities and planning for future action. Together, they set the parameters for the minimum and maximum limits of change that are realistic to anticipate.[28]

Worker behavior. Despite the mathematical tools available, the issue still remains whether or not management can create models of actions that accurately reflect worker rebellion. Failure to include variables that describe methods of worker reaction or failure to weigh such variables properly can severely affect the "solutions" provided by the model and ultimately the success of these solutions. Predicting worker behavior is quite different from planning the sequence of tasks in the work process.

The term "labor discipline" is central to management discussions of worker behavior. The more disciplined the worker is, the more likely he or she will be to adopt clearly defined work habits. Management texts outline strategies for selecting, educating, and motivating workers who demonstrate good work habits. McGregor's definitions of theories X and Y apply to the question of worker motivation. Authors that lean toward theory X remind managers that workers do not like work and should be coerced into accepting more productive behavior.[29] McGregor, and others of his persuasion, argue quite the opposite, maintaining that people want to enjoy work and actively seek ways to gain self-satisfaction from work activities. This more positive emphasis favors motivational strategies that involve the worker more.[30] Both theories, however, call for motivational schemes that include promotion ladders, behavioral "trait" rating (performance evaluation), and management control systems. These mechanisms, like the mathematical models of the work process, allow management to quantify factors concerning worker behavior.

Management organization. Management's ability to shape the organizational structure of the firm is critical for control of effective decision-making.[31] The degree to which top management can issue policy that will be effectively enforced by middle management and put into operation by the supervisory level is the essence of organizational structure: the shape of the organization can determine whether or not policy will be carried out.

Control over information is a key objective of organizational strategy. In the early part of the century Henri Fayol established a set of administrative principles that, like Taylor's work, remain at the root of most policy today. Fayol's principles called for "unity of command," in order for information to flow down a chain of command in which each person could receive orders from only one supervisor.[32]

Since the Second World War, organizational structure has shifted from centralized to decentralized.[33] Reshaped, it now includes forms of matrix structure which combine characteristics of the earlier structures.[34] The literature of management science contains a wide range of arguments about the "best" form for organizations. Drucker, for example, argues that differences between industries are important in determining the necessary degree of centralization or decentralization. The differences may be based on the extent to which the industry is "knowledge-based" (dependent on technical processes) and on the amount of competition present.[35] Other factors, such as the similarities and differences between occupations, may influence the choice of organizational structure.[36] Regardless of the specific shape of the organization, management texts agree that hierarchical structure and "information control systems" are required to carry out administrative policy.

Technology. Last, and certainly not least, is the necessity for management to allow for changes in the technical base of production and in the design of the product itself. According to management theory, technological innovation is a *process*, which, like the labor process, must be controlled and predicted.[37] The extensive funding of research and development efforts, through both private and government sponsorship, attests to the importance of the need for careful planning of the technical process.[38]

Some authors see technology as a determining force—one that defines the types of jobs and characteristics of the organization. But management theory, in general, is quite explicit about the need to *plan for technological developments* that meet the objectives of the firm. Management policy sets the parameters of technological design. It calls for concentration on developments that will *decrease costs* (both labor and materials) *and at the same time create a predictable level of performance*. Workers and lower level managers feel trapped by technology, whereas management science formulates policies that shape its characteristics. Contrary to the popular view that technology shapes jobs, Drucker argues that the organization of work (which must be controlled by management) influences technology: "The aspect of work that has probably had the greatest impact on technology is the one we know the least about: the organization of work."[39]

By focusing on the coordination of these four variables, management science recognizes that labor management is far more complicated than the old "kick-in-the-pants" school. It offers no single unified body of theory that best describes the tactics to follow, but it does provide a framework, through mathematical models and behavioral science, to isolate, define, and predict labor productivity. In doing so, it represents an ideology for social control.

Indeed, Drucker's view of management is one in which "management . . . [is] the central social function in our society."[40] Viewing management as a "discipline" rather than a "science," he sees well-organized management as that function which not only coordinates the enterprise, but also controls the economy and allocates the social resources. For Drucker, efficient management is a critical *social* function, for its effectiveness can determine how well the goods and resources of a society are distributed. His notion of the mission of management certainly takes it a long way from the "invisible hand" of Adam Smith. His vision indicates that society can be coordinated and controlled through the

theories and ideology of modern management. Smith's "invisible hand" becomes embodied in the highly visible actions of corporate management.[41]

Radical Theory: Labor Is More Than a Resource

The division of labor found in the workplace, with its fragmented jobs, overpowering technology, and rigid bureaucracy, is but one form of work organization. It is the form dictated by the goals of management science as it attempts to mold the social relations of the workplace. Behind the facade of managerial efficiency lies the power of managerial control over worker actions. Although most changes in the labor process are made to seem impersonal, they represent the exercise of managerial power over workplace control.

Radical theory examines the roots of the struggle to control the workplace and points to ways that work can be reorganized.[42] It looks at the way people try to enhance and upgrade their jobs rather than deskill them. It explores cooperative, collective work groups that arise in the midst of authoritarian, bureaucratic structures, and it emphasizes that fragmented jobs divide the self and weigh upon the consciousness of the individual. David M. Gordon distinguishes two forms of management efficiency: a "quantitative" one that management refers to when it looks for increased output; and a "qualitative" one that attempts to minimize workers' resistance by disciplining them to accept the current social relations.[43] An understanding of the second goal is necessary to demystify the things done in the name of efficiency.

The history of twentieth-century management theory is the history of increased quantifying, measuring, and predicting of "input" and "output" factors in the corporate productive equation. Managerial efficiency measures the ability to decrease the input of certain resources and/or increase the output, or results. The term "efficiency" for example, usually involves a whole string of variables: "Essentially, economizing means efficiency, least cost, greatest return, maximization, optimization and similar measures of judgment about the employment and mix of resources."[44] Management science, with its bag of quantitative tools, has had the greatest success with computing efficiency ratios for resources like raw materials, equipment, inventory, and other nonlabor "inputs." But labor continues to cause the biggest variance in calculating predictable statistics. The difference between labor's input and the output, or product, is marked and often erratic; sometimes it is not even quantifiable.

For radical theorists the distinction lies in Marx's differentiation between labor-power and labor. Labor-power is what the worker sells in the marketplace—it is the worker's *ability* to work. Labor, on the other hand, is the actual expenditure of physical and mental tasks *on the job*. In other words, management purchases labor-power, but what it gets, in the workplace is the amount of labor the worker wants to, or is forced to, deliver. The conversion of the purchased labor-power into actual labor is affected by the struggle between management and worker interests. Management theory seeks ways to extract more labor from the labor-power it has hired.[45] Labor, then, is not an "automatic" input. Within limits set by the firm, workers choose the way in which they use their own resources. Managerial complaints about worker productivity are really arguments for changing the limits management has established. The more the limits shift toward management priorities, the more management can predict the level of worker output, and thereby begin the process to limit its cost.

Management theory indirectly addresses this distinction by outlining strategies that trade outright quantifiable efficiency for morale and "environmental factors." The root of the issue is concern over labor productivity. Whereas management literature blandly describes this problem as one requiring increases in labor input without corresponding increases in labor cost, radical theory emphasizes the *power relations* that come into play. Workers do not willingly give up control over the direction and pace of work. To do so would be to give up whatever power they have over

their job. Radical theory examines such transfer of power from workers to managers. It also looks at the reactions of workers and their methods for regaining control. According to radical theory, productivity is not the neutral term management theory paints it to be. Increases in productivity require shifts in control, which do not occur without a struggle.

Stephen Marglin, for example, looked at the shifting power relations in his historical study of the rise of the factory system. He concluded that the "success" of the factory system of labor organization was not solely based on its technical efficiency—it did not necessarily produce more in quantitative terms. Rather, he argues, the factory system allowed management to coordinate and thereby control workers under one roof, in essence providing an environment where work *discipline* and *control* could be enforced. The basis of this form of discipline is management's ability to control factors that affect labor productivity.[46] Marglin's conclusions about pretwentieth-century labor organization have been confirmed by others studying specific time periods. What emerges is a pattern that outlines the shifting power relations transferring control from workers to managers and the formation of a *social system in which discipline and control of people are corequisites and, at times, prerequisites of the drive for increased quantitative efficiency*.

I want to highlight briefly those aspects of radical theory that correspond to the management concerns discussed earlier.

Labor process. In *Labor and Monopoly Capital*, Harry Braverman examines the sources of the degradation of work. He explores aspects of the division of labor that attempt to remove knowledge from worker activities, and he makes an all-important distinction between this type of labor division and that found in society:

> The division of labor in society is characteristic of all known societies; the division of labor in the workshop is a special product of capitalist society. The

> social division of labor divides society among occupations, each adequate to a branch of production; the detailed division of labor destroys occupations considered in this sense, and renders the worker inadequate to carry through any complete production process. In capitalism, the social division of labor is enforced chaotically and anarchically by the market, while the workshop division of labor is imposed by planning and control. . . .
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> While the social division of labor subdivides *society*, the detailed division of labor subdivides *humans*, and the species, the subdivision of the individual, and while the subdivision of society may enhance the individual, when carried on without regard to human capabilities and needs, is a crime against the person and against humanity.[47]

Braverman's point, and that of Marx before him, is that people must be treated as whole human beings if they are to think and act for their own satisfaction and that of society. *Work that subdivides thoughts and actions is anything but natural; it is a method of social control.*

Marx explains that the difference between human labor and the activities of animals is the human ability to think and create:

> A spider conducts operations that resemble those of a weaver, and a bee puts to shame many an architect in the construction of her cells. But what distinguishes the worst architect from the best of bees is this, that the architect raises his structure in imagination before he erects it in reality. At the end of every labor-process, we get a result that already existed in the imagination of the laborer at its commencement.[48]

When the activities of the head are separated from those of the hands, the result, says Marx, "attacks the individual at the very roots of his life."[49] What is done in the name of

capitalist efficiency is in fact crippling for the functioning of the individual. Marx's blazing critique of the division of labor in his lifetime is picked up by Braverman in his study of Frederick Taylor's Scientific Management. Braverman explains that Taylor's principles were attempts to accomplish the following: (1) "dissociation of the labor process from the skills of the worker"; (2) "separation of conception from execution"; and (3) "use of this monopoly over knowledge to control each step of the labor process and its mode of execution."[50] The slicing of conception (thought) from execution (action) leaves the worker potentially defenseless against the encroachment of managerial rules and control.

Worker Behavior. Richard Edwards reiterates the theme of discipline and control in his contemporary studies of large bureaucratic enterprise. He finds that "three principal modes of compliance—that is, work habits or 'behavior traits' which are 'appropriate' responses to the enterprises's power and facilitate its control"—have emerged.[51] These modes of compliance mold corporate workers to demonstrate "rules orientation," "habits of dependability and predictability," and "internalization of the enterprise's values."[52] In short, corporate workers must be shaped into behavior patterns that are open to observation and quantification. Workers who sufficiently "internalize" the corporate goals do not need to be forced or coerced into following orders. Workers who demonstrate "good work habits" such as dependability and punctuality require less supervision.

Samuel Bowles and Herbert Gintis trace the roots of these behavior patterns within the school system, describing how the school systems have been geared to produce disciplined workers—those who exhibit "appropriate" attitudes about work.[53] Indeed, calls for these work habits have been heard from corporate managers who complain that, although workers may enter the labor market with more years of schooling, they still lack the required work habits. Much of the criticism of today's schooling centers precisely around this point: schools may be failing to produce people who can read, write, and compute—but, according to management, they are also failing to produce "good" worker behavior traits.

Managerial attempts to shape appropriate work behavior are aimed at molding the consciousness of workers. When Marxists use terms like "class struggle," they mean more than the potential battle between those who control the wealth and those who work—for this struggle also involves controlling one's own consciousness. There may be nothing wrong with obedience, dependability, and predictability. All societies require some behavioral guidelines to frame the relations between people. The problem, however, is the purpose to which these behavioral patterns are put. Behavior control that focuses on inserting interchangeable individuals into interchangeable job functions clearly delimits individual power. The powerlessness and helplessness felt by many workers is intensified by rigid job ladders that keep workers on the "right" behavioral tracts. Jeremy Brecher and Tim Costello interpret promotional hierarchies within large corporations:

> While ostensibly benefiting the employees, they actually serve as a means to motivate workers to work in the present by dangling before them the carrot of future advancement. At its most effective, this technique can lead workers not only to perform as their employers desire, but to adopt the attitudes they think their employers would like them to hold.[54]

Not only do job ladders help to motivate workers, they also provide a mechanism for dividing and conquering the work force:

> It can likewise turn workers against one another in a scramble for each other's jobs. Many of the conflicts on the job between different age, race, sex and other groups grow out of competition for the more favored ranges of the job hierarchy. Job stratification even has powerful effects off the job, determining much of the inequality of income and status that mark our society at large.[55]

Shape of Management Organization. To the extent that

management strategies are able to strip workers of their knowledge and their power, this process increases worker dependence on the coordination and control functions of management.[56] Divided work performed by divided workers must be put back together in some organized way. Today, business organization is characterized by hierarchical structures that are arranged according to bureaucratic procedures. According to Max Weber, bureaucracy is a structure with clearly defined social relations as well as formal rules and procedures. The formality of the structure can be used to build efficient operations:

> To modern ears, the claim that a bureaucracy moves with greater speed and precision than any other type of organization may seem strange. We are accustomed to think of bureaucracies as slow and inefficient, bound down by red tape. However, Weber's point was that bureaucracy substituted a rule of rational law for rule by the whims of those who happened to be in charge.[57]

Richard Edwards argues that the "efficiency" of bureaucratic enterprise lies, not in its claim to speed or output, but rather in its control of the relations within the structure. He sees bureaucratic control as a means to institutionalize power:

> With bureaucratic control power became institutionalized by vesting it in official positions or roles and permitting its exercise only according to prescribed rules, procedures, and expectations; rules governing the exercise of power were elements of the work criteria defining supervisors' jobs. Since there were formally established criteria for evaluating the exercise of power, it also was made accountable to *topdown* control.[58]

These "imbedded power relationships" reinforce the objectives of management science. They create an environment where predictability and reliability are the keynotes of performance. Emphasizing *depersonalized* relations, this form of organization gives the illusion that rules and procedures have replaced control by "the boss," but, in reality, the institutionalization of rules and procedures serves to mask and strengthen the power of the "boss."[59]

Technology. Another area masking power is technology. The importance of demystifying its role cannot be underrated. If anything reinforces worker images of helplessness, it is the notion that "the machine did it." Coupled with the idea that fragmented jobs result from depersonalized administration, the ideology of technological determinism is a pervasive form of social control. Brecher and Costello describe it this way:

> It is an illusion, however, that machinery per se dictates such a pattern of work. Rather it is the way in which today's machines are designed and used. If workers controlled the design and use of the machinery, it would be possible to create far different schedules and rhythms. The subservience of many workers to "their" machines is a product of their subservience to their employers. *It results from the deliberate effort of employers to use machines as a way to control those who work for them.*[60]

More than one hundred years ago Karl Marx wrestled with the same illusion and came to the same conclusions. Although most of his opponents and some of his supporters have labeled him a "technological determinist," his writings taken as a whole demonstrate that "Marx is insistent that technology has to be understood as a social process."[61] He saw technology as an extension of the objectives of a society. Clearly, no imperative labels it "good" or "evil." For Marx, history is the interaction of the social relations of production and the forces of production. The social relations outline the power relations in the society and specify, on the base of those power relations, the organization of work. Forces include the tools and mechanisms of the society. In other words, the forces, of which technology is a part, are geared to insure a status quo in the power base of the economy. Both technology and the social relations of

production are closely bound together. As one changes, so does the other: "Social relations are closely bound up with productive forces. In acquiring new productive forces men change their mode of production; and in changing their mode of production, in changing the way of earning their living, they change all their social relations."[62]

The relationship between the social relations and forces is a dialectical one; it describes the push and pull of historical developments. David Noble continues Marx's logic into the twentieth century: "Insofar as the emerging capitalist relations between classes make possible the creation of a social surplus, they make possible as well the development of more sophisticated productive forces which both *reflect and reinforce the social relations.*"[63] Certainly, technological developments do not arrive on the work scene by themselves. Like the organization of labor and the organization of management functions, they are shaped to discipline workers so that predictability and control become self-governing aspects of the workplace.

Management Theory and Data Processing

Computer technology affects and is affected by the functions of the company using it.[64] The organization, as analyzed by Edward Tomeski, is composed of three types of resources—human, physical, and informational. He explains that information technology plays the key role in finding the right "mix" of these resources. Information technology involves more than just computers, for it is concerned with methods and procedures for coordinating and controlling the systematic use of information. He defines information technology as "the disciplines of planning, systems design, systems analysis, operations research and computer programming.[65] In other words, it is the harnessing of information to the objectives of management science. Both the computer and the computer worker are involved in this process.

Information technology requires prior planning and analysis. Before information can be used effectively by management it must be studied and shaped to fit the needs of the organization. In a case study of United Airlines, for example, it was found that computers would not affect the organization as much as systems analysis, which must *precede* computer use.[66] C. Wright Mills found this to be the case (before the introduction of computers) in his study of white-collar work.

> Under the impetus of concentrated enterprise and finance, when the office was enlarged during the first decade of the twentieth century, a need was felt for *systematic arrangement of business facts*. . . . As the army of clerks grew, they were divided into departments, specialized in function, and thus, *before machines were introduced* on any scale, socially rationalized. The work was reorganized in a systematic and divided manner. . . .
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> Thus, machines did not impel the development, but rather the development demanded machines, many of which were actually developed especially for tasks already socially created.[67]

In the first decade of computer use, the only applications that could be adapted to computer processing were those, such as payroll and accounting procedures, in which the work processes had already undergone extensive division of labor and specialization. Computerization of a process requires that the steps in that process be defined in *extreme detail* so that computer programs can be written that will imitate the actions of the workers. *As long as the work process is controlled by the private knowledge of the workers involved, the application of information technology is impossible.*

Information technology, therefore, reinforces the "increased emphasis on quantification of information . . . and attention to making explicit the assumptions" used in decision models. The upshot is an organization that can be controlled and predicted because decision-making becomes increasingly "*rationalized and explicit and less and less intuitive.*"[68] Running throughout management literature are arguments for prior analysis and rationalization of functions in order to remove arbitrary judgments and increase predictability.

The impersonal nature of bureaucratic rules for predictability and control affects workers and the work process. For the individual workers, information technology means an increase in the depersonalized aspects of the job as well as greater management control over their actions through "time discipline," which influences the pace of production and the physical mobility of the worker.[69] The labor process is affected by the demands of prior rationalization, which result in further specialization, standardization, simplification, and speed-up.

Information technology has also influenced organizational structure by renewing interest in the issue of decentralization versus centralization.[70] Prior to the introduction of information technology most large firms relied on centralized structures in order to exert overt control over all operations. Decentralized operational functions became more attractive when upper management could "monitor continuously . . . the effectiveness of the decentralized units in contributing to the overall corporate objectives."[71] The continuous monitoring became possible as operational functions and decision-making patterns became more precisely defined. Systems analysis played the critical role in defining functions, and computers provided the "monitor" by allowing continuous (or at least routine) reports to be generated for management.

In addition to centralized and decentralized organizations, a matrix or multidimensional structure has emerged, which lets the firm control all *policy* decisions centrally at the top level and "pass down" the *operational* and pre-established decisions to middle and lower management.[72] This synthesis gives upper management the power to control and predict all essential policy from a central vantage point and at the same time delegate the routine operational decisions to decentralized units. Such structures are supported by distributed data processing whereby each corporate department and/or function can have its own small-scale computing power for processing its routine functions, effectively distributing computer use throughout the firm.

The application of information technology hinges on the procedures for systematizing the decision-making process. The manner in which information is collected and organized is not dictated by specific requirements of computers but by the needs of the organization: "The structure of business organizations and the content of management jobs within them reflect the organization's process of decision-making and the flows of information used to reach those decisions."[73] Herbert Simon's studies of decision-making lead him to believe that information technology can be increasingly applied to decision-making theory. As decisions are made more routine, they can be incorporated into computerized processing:

> An organization can be pictured as a three-layer cake. In the bottom layer, we have the basic work processes. . . . In the middle layer, we have the programmed decision-making processes, the processes that govern the day-to-day operation of the manufacturing and distribution system. In the top layer, we have the nonprogrammed decision making processes, the processes that are required to design and redesign the entire system, to provide it with its basic goals and objectives, and to monitor its performance.
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> Automation of data processing and decision-making will not change this fundamental three-part structure. It may, by bringing about a more explicit formal description of the entire system, make the relations among the parts clear and more explicit.[74]

Management science builds on the foundations of Scientific Management and human relations theories, but extends their limits by including new methods for controlling complex organizations. Chief among these new methods is

the concept that management must go beyond cost-reduction of individual functions and beyond morale of individual workers to the development of models for predicting and controlling all barriers to continued growth.

By providing the quantitative tools and analytical methods, management science has become a developing set of theories that allows managers to make trade-offs between objectives—objectives that seek to decrease cost and at the same time minimize labors' resistance. For data-processing managers the literature of management science provides the framework for remodeling occupational change.

The application of management theory to the problems of managing data-processing workers did not fully begin until the 1960s when the increasing number of workers and the functions they provided began having an impact on the firm. From that time to the present, the issues concerning management of data-processing workers have paralleled the central issues in management theory. Of course, management practitioners differ in their approaches to the "how-to-manage" question, but they are in agreement in their acceptance of the philosophy and techniques of management science. Generally, the literature of data-processing management perceives that the knowledge and skills of data-processing workers must be rationalized so that it can be more fully controlled by management.[75] The main debate in this literature centers on the question of whether computer work is similar to other occupations and, therefore, whether computer workers can be controlled by the same policies. Some authors stress the fact that the intangible nature of the product—computerized system—hinders the ability to control data-processing workers. Others feel that data-processing workers can be entirely eliminated, and with them the unorthodox problems they create.[76] The main line of literature, however, follows the path of management theory, borrowing and adapting methodology to the "growing pains" of computer work processes.

If the problems of managing labor are complex, then those involved in data-processing management are indeed extraordinary. During the 1960s most computer projects could be characterized as overbudget, late, and ineffective.[77] Complaints centered on the actions of computer workers rather than on the functioning of computer equipment. *In a sense, the machine was ready, but the work process was not.* Managers worried that their investment in computers could not pay off until "computers and their applications can be managed reliably in an economic sense."[78] But this economic accountability was difficult as long as computer workers controlled computer skills and the computer equipment. A report by the McKinsey consulting firm warned that companies could not "abdicate control of their computers to staff specialists."[79] Computer workers seemed to have sprung up as the keepers of the technology gate. Over and over again management literature warned that as long as the techniques of data processing remained locked in workers' heads, the workers would continue to make "independent decisions" and thus avoid fiscal control by management.[80]

By borrowing the tools and theories of management science, data-processing management was better equipped to address this issue. Step by step, the process of observing, defining, and quantifying data-processing tasks was begun. In general, it was agreed that these procedures were necessary *before* management could begin to tackle the question of cost reduction. Data processing was not the first "intangible" occupation to go through this transformation. David Noble outlines the same developments in the transformation of the engineering profession at the turn of the century.[81] Indeed, in order to reach the objective of cost reduction, it was clear that the prerequisite was control, which according to management science had to include the ability to measure the steps in the labor process and the actions of the workers.

Management science recognizes that the accomplishment of its objectives is not easy, for trade-offs have to be made between achieving straightforward quantifiable efficiency (more output) and keeping the reactions and demands of workers under control. In scientific terms, for every action there is a reaction. The literature of management science

attempts to give managers the tools to overlay this environment with the identification and control of variables that allow them to predict and thus plan for continued growth. As Reinhard Bendix argues, "all ideologies of management have in common the effort to interpret the exercise of authority in a favorable light."[82]

But the scientific sound of "controlling variables" and "predicting reactions" masks the very real changes that occur when management seeks to implement policies of control. Management theory indicates that division of labor and hierarchical structures are inevitable, but when we examine these processes on the shopfloor we find that they are superimposed on a totally different form of social organization.

Part II looks at the four types of change that have been used by management to alter data-processing work. The changes reflect attempts by management to rationalize the labor process, to control the behavior of workers, to mold data processing into the bureaucratic organizational pattern, and to shape the technology to meet management objectives. In general, there is no fixed historical progression to the four forms of management control. In some situations ideological control of worker behavior has had to precede work process changes, and in other situations just the reverse has been true. Sometimes, management organizational structure has had to be remolded before work process changes could be implemented. Often these strategies appear inseparable, for they are brought into practice at the same time. The choice of strategy and point of time at which it is used are, of course, influenced by the business environment of the firm.

In the data-processing field, division of labor seems to have been the historical prelude to other forms of change. Division of labor and work process rationalization were not successful in increasing worker productivity until they were accompanied by other changes, most noticeably those aimed at controlling worker behavior.

Each strategy will be viewed from an historical perspective within the data-processing field, looking at management theory, worker response, and the synthesis of management practice. Although management practice is usually modified by the reactions of workers, management objectives hold fast to those outlined by management theory. As the theories of management are applied by the practitioners of middle to lower management the social relations of the workplace are built. These social relations emerge in an environment in which increased quantitative efficiency (output) is matched and molded to fit qualitative efficiency (social control). The way work and workers are organized reflects the power relations within a society.

PART II

Shopfloor Practice