California. University. Institute of Industrial Relations (Los Angeles)

A LONGITUDINAL STUDY OF AUTOMATED AND NONAUTOMATED JOB PATTERNS IN THE SOUTHERN CALIFORNIA AEROSPACE INDUSTRY

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INTRODUCTION

Statement of the Problem

Those engaged in research on technological change as it affects man and his institutions are reminded repeatedly of an age-old paradox: how fast we learn about things and how little we learn about people; how astonishingly rapid is the rate of progress in the physical sciences, and how agonizingly slow is the increase of directly useful knowledge in the social sciences.

There is also a striking imbalance between the vast sums allocated for research and development of our new technologies and the relatively small sums devoted to investigation of the social and economic consequences of these new technologies. If this imbalance should continue, there could be a real danger that the socio-economic problems created by such technological innovations as automation will grow far more rapidly than our capacity to understand and control them.

If we look upon the history of civilization as also the history of technological change, we find that we may currently be experiencing an industrial revolution of somewhat new dimensions. Potentially, automation has staggering implications for our society. However, the basic problem is not that technology changes man and his institutions; rather it is our failure to understand and deal with the nature of these changes and their consequences until we face grave crises and severe dislocations. It was for this reason that Congress passed the Manpower Development and Training Act, which, among other things, provides for a broad program of research in the field of manpower utilization. By enacting this statute, Congress reaffirmed the basic principle that society as a whole must assume responsibility for ameliorating the burden as well as receiving the benefits of technological progress.

Already, the fast pace of technological change, coupled with an unusually rapid growth of the work force, has created serious problems of imbalance in the labor market. Despite the critical need for more and better trained workers in many job classifications, there are still major pockets of unemployment. Many older persons with obsolete skills, or skills of declining importance, as well as many young people with little or no skills, are simply unable to get jobs.

Faced with these problems, appropriate measures must be taken to assure that the labor force will possess the kinds of skills and specialized knowledge required for tomorrow's, as well as for today's, world of work. Improved planning and expanded research efforts, therefore, must assure that men, women, and young people will be trained and available to meet shifting employment needs. To attain this objective, we must undertake more intensive investigations of human behavior under the impact of technological change.

Most research activities by social scientists in the area of technological change have focused on employee displacement and the complex problems resulting therefrom. Less attention has been devoted to the kinds of adjustment problems faced by workers transferred from conventional jobs to new positions arising from the introduction of automated equipment; and to the study of adjustment problems on the part of those whose total work experience has been confined to automated equipment. This study is an attempt to fill the gap in this vital area.

Description of the Project

In July of 1965, the U. S. Department of Labor entered into a contract with the UCLA Institute of Industrial Relations to conduct a longitudinal study of automated and nonautomated job patterns. The laboratory selected for this research project was the Southern California aerospace industry located principally in Los Angeles and Orange Counties. The six firms included in this study represent several of the largest in the industry and among the top defense contractors with total employment in excess of 300,000. These firms are: Douglas Aircraft Co. (now McDonnell Douglas Corp.), Lockheed Aircraft Corp., North American Aviation, Inc. (now North American Rockwell), Aerojet-General Corp., Hughes Aircraft Co., and Northrop Corp.

The major feature of this project may be summarized as follows:

1. The study is concerned with two major concepts of technological change: (a) factory automation, considered in terms of the introduction of numerical control (NC) of machine tools, and (b) office automation, considered in terms of the introduction of electronic data processing (EDP) equipment.
2. The research is designed to focus primarily on the social and psychological adjustments, as well as some economic consequences of these forms of technology.
3. The investigation uses the longitudinal rather than the trend analysis method of studying patterns of change.

Definitions

Any discussion of "automation" or the nature of "automated jobs" runs up against the inevitable problem of definition. It is well-known that there is no general agreement even among the experts concerning the meaning of these terms. However, for purposes of this study, "automated jobs" will refer to those duties arising from the introduction of Numerical Control Machines (NC) and Electronic Data Processing Equipment (EDP). "Nonautomated jobs" are defined as those classifications where the same or similar work is performed as in "automated jobs," but with conventional equipment or methods which preceded the introduction of NC or EDP.

A. Numerical Controlled Machine Tools

Numerical control is probably the most significant new development in manufacturing technology in over fifty years. Although the use of this method to operate machine tools and other equipment represents only one application of this concept, it has reached its greatest effectiveness in metal working. According to available evidence, NC was developed in response to certain unique production requirements in the aerospace industry. Its evolution has been described as follows:

> Numerically controlled machine tools are a direct outgrowth of the increasing need in the aerospace field for a method of automatically producing a variety of machined parts in small production runs on general-purpose machine tools. The first numerically controlled machine tools were placed in operation in 1957. Initially, the aerospace and defense industries constituted the major market for this equipment because of the unique nature of the manufacturing require-

ments of these industries; this market will continue to be an important outlet for this equipment in the foreseeable future. However, sales of numerically controlled machine tools to other segments of the metalworking field have increased rapidly in the last few years as industry has become more aware of the economic advantages of numerical control.[1/]

It was predicted there would be approximately 12,000 NC machine tools in operation at the time (1967).[2/] However, this seemingly large number represents only one percent of all machine tools presently installed.[3/] Various industry sources estimate that by 1970 about 75 percent of all new machine tools purchased will be equipped with NC.[4/]

Numerical control is basically the operation of a machine tool by coded numerical instructions on punched tape which direct the equipment. The instructions refer to specific distance, position, motion, or function of the machine tool in relation to the part worked upon.

1/ Technological Change: Its Impact on Industry in Metropolitan Chicago, a report by Corplan Associates of IIT Research Institute, Chicago, 1964, p. 1.

2/ Outlook for Numerical Control of Machine Tools: A Study of a Key Technological Development in Metalworking Industries, U. S. Department of Labor, Bulletin No. 1437, March, 1965, p. 2.

3/ Ibid.

4/ See N. 3, supra.

One way of highlighting the essential nature of the new technology is to compare the duties of an operator under the two types of equipment. With conventional machine tools, such as a drilling or milling machine, the operator examines an engineering drawing, positions the part on the machine, and then guides the tool according to the information on the drawing. The efficient operation of the equipment depends primarily on the operator's skill. He selects the proper machining speeds and feeds, controls the flow of the coolant, and varies the work pace according to personal and production needs.

The duties of the NC operator are significantly different. In the first place, he no longer studies the drawing because the relevant information has been converted into appropriate code numbers by engineers or draftsmen. These numbers represent every movement, path, and action that the tool must take to properly machine the part according to the specifications on the drawing. The duties of the NC operator will vary depending upon the type of equipment in use. In some cases he may be limited to pushing buttons and monitoring a panel of gauges or lights. In other situations he attaches the cutting tool, installs the workpiece, and inserts or changes the tape. In the event of suspected malfunctioning, he may be able to "override" the automatic controls and operate the machine manually. At all times, he must remain keenly alert to insure the desired production result.

The tasks and skills associated with NC fall into three main categories:

1. operator activities, including loading the workpiece, inserting the control mechanism, monitoring the machine to insure proper functioning

2. programming, translating the engineering drawing into a program to control the machine tool, and

3. maintenance, involving mechanical and electronic servicing, repair, and preventive maintenance activities.

It is important to note that the study is concerned with all these occupational groupings and not just that of the NC operator.

B. Electronic Data Processing Equipment

The other major form of technological change with which we are concerned has literally revolutionized the processing of information and has profoundly affected what is called "the office industry." Conceptually the electronic computer is a fairly simple machine that can recognize and add discrete electrical impulses. What makes it unique, and thus qualitatively different from all previous mechanical computers, is the fact that calculations can be made at unprecedented electronic speeds, and the computer can be programmed to perform a number of logical decision-making functions.

Although the electronic computer is associated primarily with automatic data processing in business, industry, and government, it has important applications in many other fields including education (teaching machines), medicine (diagnostic aids), and law (crime detection and law enforcement as well as codification and retrieval of legal data). Computers are also used in weather forecasting, language translation, control of air and surface traffic, and even in the selection of mates for companionship and marriage! However, this research project is limited to a study of the use of computers for automatic data processing in the office to deal with such business functions as accounting.

inventory control, payroll computation, and equipment scheduling.

Unlike numerical control which has only slightly displaced conventional machine tools, the introduction of electronic computers in the office virtually eliminates the old manual systems of record keeping and record handling. Particularly vulnerable to technological displacement are accountants, bookkeepers, filing and ledger clerks, as well as accounting machine operators, statisticians, and typists. In their place a whole new occupational structure has been created consisting of such job categories as programmers, analysts, systems engineers, computer operators, keypunch operators, and computer maintenance personnel.

The EDP jobs may be analyzed in terms of four major functions:

1. conceptual, as those involved in transforming "raw," real-world information into computer language or of manipulating symbols in computer inputs and outputs, or the design and development of systems and equipment to facilitate these symbol transformations and manipulations
2. mechanical, as converting data into physical formats amenable to computer use as in keypunching and related clerical tasks
3. operating, including actual running of computerized equipment and monitoring tape-controlled machinery, and
4. maintenance and quality control, including installation, repair, and maintenance of automated equipment and operations.

The drastic impact of the electronic computer on the office industry labor force and on methods of operation precipitated the first major dilemma in carrying out the research study. Originally, the total population under investigation consisted of four groups: (a) those on factory jobs using NC - automated, (b) those on equivalent factory jobs using conventional machine tools - nonautomated, (c) those in office jobs using EDP equipment - automated, and (d) those in equivalent office jobs using pre-EDP methods - nonautomated. The nonautomated departments in factory and office were conceived to be "equivalent" categories where analogous tasks were performed by the older techniques.

While it was relatively simple to find "equivalent" factory jobs, it was very difficult to locate "equivalent" office jobs because in many cases they no longer existed. Where the work had been taken over completely by EDP operations, it could no longer be identified as a separate entity. However, there remained limited areas where the old record-keeping methods were still in use. After careful consideration of several alternatives, the dilemma was resolved by combining the two "equivalent," or nonautomated, segments into one category. The total population now consists of: (a) automated factory jobs (NC), (b) automated office jobs (EDP), and (c) "equivalent" nonautomated jobs in factory and/or office.

Research Methodology

A The Longitudinal Approach

In recent years, interest has grown in the longitudinal as opposed to the trend analysis method for studying patterns of change in behavior. The longitudinal method analyzes individual or group change over time. Each person in the sample is followed up at given intervals. The information thus obtained is considered in terms of individual change as well as in relation to the other case histories in the sample. Research on change* and behavior patterns based upon trend analysis involves a different sampling of respondents each time the survey is taken; the longitudinal method relies on the same sample of individuals, each of whom is traced over a period of time. The longitudinal method depends on the equivalent of many individual case histories, whereas trend analysis obtains its facts from different groups as of a single point in time. Trend analysis is static in nature; the longitudinal method is dynamic.

The longitudinal method was adopted for this study because, among other reasons, it permits evidence to be accumulated on possible divergent patterns in occupational and educational histories as between NC and non-NC groups, and, hopefully, between the EDP and non-EDP categories. The longitudinal approach also permits analysis of the effects of new technological methods in factory and office upon possible changing patterns of social interaction and attitudes toward working conditions, job duties, and sources of work satisfaction. Related research indicates that employee attitudes toward automation do change significantly over time.

B Population and Sample

Data for this study were gathered largely from personal interviews in depth with a probability sample of employees drawn from lists submitted by the six firms. Selection criteria included employment on "automated" jobs (i. e., NC machines and/or EDP equipment), and work on nonautomated jobs designed to perform the same or similar tasks.

The first series of employee interviews, referred to as Administration I, were held in the summer and early fall of 1966. A total of 509 interviews were completed during that period. The interviews averaged about an hour in length and were all held on company time at or near the employee's workplace.

The second series of interviews, referred to as Administration II, were held approximately 18 months later in the spring of 1968 at which time a total of 443 interviews were completed.

A summary of the population, sample, and response rates is given below:

Population, Sample, and Response Rates

	Population N	Admin. I Initial Sample n_1	Admin. II Response n_2	%
NC	720	151	134	88.7
EDP	2,318	169	145	85.8
Equ	4,488	189	164	86.8
		509*	443	87.0

No. of cases in analysis categories

	Admin. I	Admin. II	Response %
Male NC	146	129	88.4
Male EDP	97	89	91.8
Male Equ	146	133	91.1
Female NC**	5	5	100.0
Female EDP	72	56	77.8
Female Equ	43	31	72.1
	509	443	87.0

* Respondent unavailability less than 5%

** Not used in analysis because of small number of cases.

Findings of the study should be of value in at least two principal areas of application:

1) to provide relevant data and concepts on which to base public policies for short and long term training and retraining programs;

2) to provide data and specific propositions on which to base a restructuring of educational and vocational training programs in the expectation of continuing technological change.

C <u>The Interview</u>

The interview utilized a combination of structured and unstructured modes of inquiry. Making use of insights obtained in the pre-test stages, the interview began with a series of general introductory questions, followed by inquiries concerning non-threatening objective-demographic characteristics, normally "expected" by the respondent. The major body of the interview focused on cognitive-attitudinal questions followed by direct and indirect psychodynamically-oriented inquiries in the later interview stages.

Special attention was given to the following variables, hypothesized to be of particular significance in differentiating training requirements and changes through time in automated and nonautomated positions:

(a) Objective-demographic characteristics, particularly the worker's educational and training background, and his employment history;

(b) The worker's cognitive-attitudinal characteristics, exploring how he views the "worlds" of his job and his "self." Here, the study sought to probe the personal meaning or absence of meaning that the worker experiences in his present job, whether he regards his job as complex or simple, whether he sees himself as "in control," impotent, or indifferent with respect to his work.

The worker's feelings toward the socio-technical-economic forces, as contrasted with "objective" measures of these forces were explored, i.e., did the worker see himself as living in "good times" or hard times, in a community that is booming or depressed, or in a congenial or harsh environment.

Further, this phase of the interview investigated the worker's positive and negative feelings concerning his educational background, training and vocational choice, his evalustion of his career history to date, and his orientation toward past, present, and future, i.e., particularly his sense of optimism or pessimism toward "what tomorrow holds."

(c) Aspects of the worker's psychodynamics as related to automation readiness, particularly as related to the worker's need for control, his tolerance for ambiguity, and his capacity to adapt to changing circumstances.

(d) A succinct inventory of the worker's major technical skills, and a comparison of these skills with his perception of skills that he actually used on the job.

D <u>Survey of Supervisory and Management Personnel</u>

Although these have at times been considered together, they are in fact two separate groups and a different interview approach has been followed with each category.

1. <u>Supervisors</u>. At the conclusion of Administration II, a sub-sample was drawn of group, section, and department heads who were in a line supervisory relationship with the employees interviewed in Administrations I and II. The number of supervisory interviews in the analysis categories

is presented below:

NC Supervisor	. . . . .	20
EDP "	. . . . .	32
Equ "	. . . . .	45
Total	. . . . .	97*

*Respondent unavailability less than 5%

2. Management personnel. This population consists of five categories of operating and staff executives at both corporate and plant locations. A description of these categories and the number in each are detailed in Part B of this Report. These interviews were conducted in an informal, less structured manner. The approach was one of seeking assistance in interpreting the findings of the worker and supervisor surveys, and of soliciting both "theoretical" and "practical" observations from fellow professionals considered experts in the field. A total of 94 such interviews were held in the fall of 1967 resulting in approximately 600 pages of transcript.

E Employment Record Survey

In the spring of 1967, a survey of personnel records in all six firms was carried out for the following purposes:

1. To verify data obtained in personal interviews
2. To secure more information on specific aspects of the employee's work, history, education, and training
3. To supplement general data sought in the interview which were difficult to obtain completely because of the one-hour limitation.

This survey yielded information of considerable richness, showing in some detail the patterns of education, training, and employment of the workers in our sample. The gathering of this data made it possible to relate these characteristics to the results of the worker surveys.

F <u>Survey of Related Literature and Annotated Bibliography</u>

Volume II of this Report consists of an extensive analysis of recent literature (1956-1967) pertaining to the impact of automation on individuals and jobs. Published and unpublished studies included in the survey were selected on the basis of the following criteria:

1. The focus was primarily on empirical investigations based upon field interviews.
2. Priority was given to studies concentrating on:
    a) The effects of automation on skill requirements and employee attitudes.
    b) The significance of basic education and specialized training to job placement.
    c) The impact of automation on work assignment, job content, and physical environment.
    d) Automation readiness, i.e., the employee's personal and social characteristics affecting his attitudes.
    e) Automation supportiveness, i.e., the firm's reaction to change, its manner of introducing change, and its approach toward employee training for "automated" assignments.
3. Priority was given to studies issued subsequent to 1956.

SUMMARY OF FINDINGS AND CONCLUSIONS

1. Perception of Automation

The concepts of "automation" or "automated jobs" represent many dimensions to those interviewed. There is obviously no general agreement on the meaning of these terms. The various definitions offered by the respondents seemed to depend largely on their frame of reference, or on the degree to which they wished to register a feeling of security or insecurity about recent technological changes in their work environment.

Many respondents stressed that automation, however defined, does change the nature and content of many jobs. In particular, they noted less control over the equipment and over the work operations; more demands for alertness and attention on the job; and a need for additional training or retraining to acquire new or modified skills. There was also some acknowledgment of the impact automated equipment has on patterns of social interaction, affecting relations with fellow workers, maintenance personnel, supervisors, and a variety of technical specialists who appear on the scene from time to time.

There appeared to be no widespread concern about the introduction or consequences of the new technology. Most employees interviewed did not look upon automation as a threat to their job. On the contrary, a large group preferred automated to nonautomated tasks. It may well be that the lack of large-scale layoffs due to automation and the ease of retraining existing personnel for new tasks created by automation account for the relative optimism about the new developments. The apparent affluence of the economy and the rapid growth of many industries in Southern California have mitigated any fear that could be engendered by the new technology.

Instead of wholesale dismissals, there has often been the hiring of additional personnel even during conversion from the old to the new technology.

Technological changes have different effects depending on the nature of the new equipment. In the office there is greater impact on the labor force in terms of complete change in method of operation, job displacement, and development of new occupational categories. In the factory the consequences have not been so extensive. The older technology continues to predominate as the method in carrying out the production process.

2. Patterns of Training

The study inquired as to additional training received during the interval between Administrations I and II. Two principal findings emerge: First, those in automated employment generally were more likely to have received supplemental training than those in nonautomated employment. Second, males were substantially more likely to have received further training than females.

By far the most favorite "target group" for training is the male EDP's; more than 60 percent did have the benefit of additional courses or other educational programs in the specified period. At the other extreme, only some 13 percent of females in Equ employment had such training.

In interpreting these findings, one may surmise that the industry responds directly to the prevailing state of technological change as a spur for instituting training programs. In the EDP area, with the exceptionally rapid flux in technology and procedure, the need for frequent updating and supplemental learning is well recognized. This holds particularly for the male EDP group, in part because the males are currently employed in positions most specifically related to technological innovation, such as development of new computer hardware and software. The females in the EDP group, however, more typically are employed as keypunch operators (though there are some programmers and analysts as well), and therefore appear to be receiving less training attention than their male counterparts. It is likely that implicit attitude patterns by staff responsible for development training may be related to the sex differential noted; it may be that, particularly for the younger female subpopulation, on-the-job or in-plant technical training for automated tasks is regarded as a less suitable corporate investment, considering turnover related to marriage, child-bearing, and residential mobility.

The question was raised as to the patterns of training appropriate for preparing the employee for his present job. For the most part, female employees, whether or not engaged in automated positions, are satisfied to have training confined to one principal method--on-the-job training exclusively. The male respondents, though also desirous of on-the-job training, more typically ask for some combination with other procedures, especially including in-plant training courses and technical training outside the plant in the desired training pattern. Male NC's particularly favor the combination of on-the-job training with in-plant courses, while EDP's, who frequently are the most eclectic in searching for complex training combinations, also express some positive response toward a mix of in-plant and supplemental outside-plant training arrangements.

In-plant training courses were considered to be appropriate by some 40 percent of male NC's and male EDP's--the principal "automated" skilled employee groups. As borne out by their experience, in large measure such training courses have indeed been instituted. To a lesser extent, and with some variation across job categories, technical training outside the plant and academic courses (the latter primarily for the male EDP group) are regarded as appropriate. Academic degrees, however--with a notable exception in the male EDP group--appear less relevant to the present jobs, according to the respondents in the other job categories.

3. Perceived Discrepancy between Actual Training Received and Appropriate Training

Some feeling of lack is expressed concerning on-the-job training for males and females, in greatest measure by the Equ's and least by the EDP's. A prior analysis noted the relatively high percentage, particularly for male EDP's who had received additional training in the period between Administrations I and II. This no doubt included on-the-job training, perhaps accounting for the somewhat higher ratio indicating the smallest imbalance--and relative satisfaction for this method. For in-plant courses a slight excess appears for the male EDP's. For all other job categories, with the exception of the female Equ's, a relatively satisfactory balance is evident.

The male NC's report a lack of technical training outside the plant, while the female EDP's report a relative excess.

With respect to academic courses, it would appear that all respondent categories indicate a slight excess of academic courses as relevant to their present jobs. Perhaps reaching somewhat beyond the available data, it might appear that academic courses in some measure fail to prove responsive to the actual job requirements, as seen through the workers' eyes.

While academic degrees are not considered appropriate training prerequisites for most of the job categories such discrepancies as exist suggest a generalized feeling by NC, EDP and female Equ respondents that they did not obtain sufficient formal academic validation of their skills. This may be viewed as an indirect indication of regret by some of the respondents, manifesting their desire for more formal academic degrees. On the other hand, the female EDP's report an excess of academic degrees, saying in substance something to the effect "so we've got the degree, what good is it doing on this job?"

The male and female EDP's appear to be relatively least discrepant in their assessment of actual and appropriate training to which they have been subject. This does not express the kind of subjective, phenomenological sense of comfort or discomfort with training that may be obtained by direct inquiry. Rather, it represents an emergent measure of an item-by-item analysis of reality and appropriateness--a kind of analytic sum total of the various training experiences.

4. Differentiating Nonautomated from Automated Employment

Whatever the formal distinctions between "automated" and "nonautomated" positions in accordance with the job description, and whatever the similarity and differences of the functions in jobs so distinguished, there remains a further question: What are the experiences reported by the workers themselves concerning their operations of automated equipment?

Two hypotheses are suggested: First, that over a period of time (as from Administration I to Administration II) a greater proportion of respondents will report that they have had experience in operating automated equipment, and, second, that a generalized characterization of the job as "automated" by the respondents (particularly for the NC and EDP categories as defined) will decline.

These relationships are expected for the following reasons: First, the current trend to further installation of automated equipment results in increased exposure to such equipment and therefore to further reports by respondents, indicating that they have had experience with equipment of this kind. Second, the more stereotypic description of "automated" will be less cogent as the worker becomes further engaged in the specific tasks required by the "automated" job.

Proportions reporting experience in operating automated equipment increase as expected for the male NC, male EDP and female EDP categories. No such consistent trend appears for the Equ's. The proportions describing their job as automated declined for the male NC's, male EDP's and female EDP's during the interval from Administration I to Administration II. It would appear, therefore, that the simple label "automated" wanes in significance as the worker gains further experience in the operation of automated equipment. This suggests that the descriptive label "automated" and the emotional loading sometimes attached to this word is dissipated to some extent as the worker actually takes hold of the specific tasks involved.

5. Impact and Affect of Job Change

There has been considerable concern with respect to the possible significance of the transition from nonautomated to automated employment. The respondents were asked whether their experience when first taking a job requiring the operation of automated equipment represented a major change, a minor change, or not much of a change. There is general agreement that the transition represented a major change. The range of proportions of those so responding exceeded seventy percent. Evidently, whatever the nature of the equipment and the predispositions of the respondents, shifting from conventional assignments to those requiring operation of technologically new equipment does represent a subjective "moment of truth." Clearly, a re-learning process is experienced. However, such re-learning is not necessarily accompanied by emotional fear or active rejection of the new task.

Respondents were asked whether they like or dislike an automated job. Sixty percent or more in the EDP and NC categories indicated that they like "very much" or "fairly well" tasks required in automated employment. Even the proportion expressing such preference in the Equ group hovers near fifty percent--less than that for the EDP's and NC's, but nonetheless substantial. We may conclude that the Equ's, most of whom have not actually been employed in assignments requiring operation of automotive equipment, typically do not stand in awe of such yet dimly perceived tasks. It does appear, however, that the relative proximity of scores to the fifty-percent mark apparently indicates the potential ambivalence and ambiguity that surround the preference judgment of those employed in conventional jobs.

6. <u>Perceived Levels of Skill, Responsibility, and Communication</u>

From Administration I to Administration II all respondent groups reported increases in their levels of skill and responsibility and in the extent to which their jobs require communication.

When asked whether their skill level was in the top 5 percent in the company, on the average 19.1 percent of the EDP's, 38.8 percent of the NC's and 31.9 percent of the Equ's so indicated. Greatest proportions of increase in perceived skill level, as measured by this criterion, appeared for the EDP's and Equ's. The EDP's, perhaps regarding themselves on the way up, presented the most dramatic increase. However, the NC's, who have had longer average tenure on their jobs, continued to reveal the highest proportion of confidence in their skill level.

The picture for perceived responsibility level is similar. Again, the EDP's and Equ's showed the highest proportion of increase from Administration I to Administration II, while the NC's continue to regard themselves in greatest measure as holding the most responsible positions.

With respect to the level of communication required, the most dramatic rise in demand for communication is indicated by the NC's. Lesser increases appear for the EDP's and Equ's. We may surmise that, as time goes on, substantial expansion in the range of personal competence and control is experienced by employees both in "automated" and "nonautomated" positions. Levels of skill and responsibility are perceived to rise as is the need for communication--a measure of relatedness to the social fabric of the organization. Apparently, continued employment in an "automated" job, as defined here, is often seen as a positive, rather than as an alienating experience, individually and in the organizational context.

On the whole, then, the upswing in self-perception of skill, responsibility and communication does not appear to be linked to the EDP-NC versus Equ distinction, i.e., the increases seem to have little connection as to whether or not a job is classified as "automated."

7. <u>Survey of Supervisory Personnel</u>

A subsample survey of 97 supervisors, linked to the workers included in the NC, EDP, and Equ study phase, was conducted, augmenting the worker responses.

Differences in the number of subordinates supervised are moderate. The largest average subordinate group appears for the NC supervisors, with approximately 40 subordinates. For the EDP's, the corresponding number is 30, while the Equ's occupy an intermediate position with about 37 subordinates. The introduction of automated equipment has not drastically altered the quantitive range of supervision, though there is some tendency for the EDP supervisor to guide a smaller number of subordinates than his colleagues do in other categories.

It does appear that the EDP supervisor functions within a more clearly automated situation, as suggested by the view of some 59 percent in this category to the effect that all their subordinates are employed in automated positions.

Supervisory patterns as found in this study suggest that current automation levels in the Southern California aerospace industry do not lead directly to a major increase in the number of subordinates in the charge of a given supervisor. Here, the image of a vast number of button-pushers, guided by a single, trouble-shooting overseer, remains a yet unreal science fiction concept.

Both NC and EDP supervisors perfer work in and supervision of automated jobs, by margins ranging from about 50 to 70 percent. Even Equ supervisors favor supervision of automated jobs by a small margin, but the plurality would prefer working directly in nonautomated positions.

Again,these views support the finding that among those studied "automation" is not notably regarded as something to be avoided--indeed, it is clearly preferred by a majority of EDP and NC supervisors and, in more mixed pattern, endorsed by many Equ supervisors.

PART A

SYSTEMATIC SURVEY

1. Basic Description of Study Populations: Employee Characteristics

A clear differentiation among the job categories is immediately evident. For fundamental variables such as sex, marital status, and age, significant distinctions appear; as shown in Tables 1 and 2.

TABLE 1*

Sex and Marital Status

	NC	EDP	Equ
Male	97.3	56.1	76.5
Female	2.7	43.9	23.5
	100.0	100.0	100.0
Married	87.3	67.4	79.6
Single**	8.1	17.4	10.8
Widowed	0.7	2.3	1.6
Divorced	2.7	11.1	5.4
Separated	1.3	1.7	2.6
	100.0	100.0	100.0

*Percentages reported in this and subsequent tables are based on the number of cases shown in the Population, Sample, and Response Rate Summary, set forth in the Introduction.

**Never married

Virtually the entire NC group is male. Indeed, the number of females in this category is so small that no further analysis for NC females will be attempted. The EDP group is fairly evenly divided between males and females, with the former holding a slight majority. The Equ group, serving as a "benchmark" for a basis for comparison with the NC and EDP groups, is slightly more than three-fourths male.

TABLE 2

Age Distribution

	Male			Female	
	NC	EDP	Equ	EDP	Equ
20-29	18.1	34.2	16.2	32.5	11.8
30-39	22.2	48.8	23.0	30.0	11.8
40-49	33.4	10.1	28.4	25.0	35.3
50-59	15.2	2.4	24.4	7.5	41.2
60, up	8.3	0	8.2	0	0
No data	2.8	4.5	0	5.0	0
	100.0	100.0	100.0	100.0	100.0
Mean	41.6	32.6	44.2	35.0	45.2

As to marital status, a pattern of differences persists. The NC's most typically are married (87.3 percent), followed by the Equ's (79.6 percent married), and by the EDP's (67.4 percent married). Some hint of prevalence of socio-emotional problems is provided by the rather high rate of divorce and separation among the EDP's--12.8 percent, as compared with 8.0 percent among the Equ's and 4.0 percent for the NC's.

As to the age distribution, we find that the EDP's are relatively the youngest among the study groups: the mean ages are, for males 32.6 years, and for females 35.0 years. The NC's (henceforth considering the males only, as noted) and the Equ's reveal ages in the early and mid-forties.

There are few aged (sixty-years-old and over) in any categories of the work forces studied, and aged are noticeably lacking in the EDP groups. Significantly, among the male EDP's, 83 percent are under forty.

Data concerning ethnic composition appear in Table 3. It is, of course, difficult to specify "expected" or "appropriate" proportions of minority groups in a given job category. Consideration of the complexities of minority employment and their relation to existing education and skill levels, supplemental training and derivable social benefits is, of course, not the principal purpose of this project. Further, the lack of definitive minority population figures (prior to the 1970 census), on a small-area basis, further complicates interpretation of the data.

TABLE 3

Ethnic Composition

	Male			Female		Theoretic*		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Negro	5.4	4.5	6.8	1.8	6.5	3.2	5.4	6.7
Mexican-American	3.1	2.2	6.0	1.8	3.2	2.0	3.1	4.6
Oriental	1.6	4.5	0.8	3.6	0	4.1	1.6	0.4

*Henceforth abbreviated as Th.

Assuming as a theoretic projection, with an even sex ratio--50 percent males and 50 percent females--"theoretic" values of the proportions and scores are given in selected tables. This is done to highlight a generalized mean tendency, as may emerge regardless of sex distribution for the major job categories studied. For the NC group, however, the male figure only is shown, as data for females are too scant to provide basis for a projection.

However, the following findings may be of some interest: It appears that Negroes constitute a relatively small proportion of the EDP workforce, 4.5 percent of male EDP's and 1.8 percent for female EDP's.

The corresponding figure is somewhat higher for the NC's, 5.4 percent, and highest for the Equ's, about 6.7 percent. On this basis, recognizing the limitations of the sample as confined to a particular industry type in a given geographic area, it appears that employment conditions in the southern California aerospace industry have not resulted in a significant influx of Negro employees into "automated" positions as contrasted with comparable conventional positions.

A similar pattern appears for Mexican-Americans; in EDP two percent are Mexican-American. On the other hand, Orientals, though their numbers are smaller in the total population, compose a higher proportion--some four percent of the EDP total.

Proportions of Negro and Mexican-American employment are somewhat greater for the NC category, respectively accounting for five and three percent. Relatively few Orientals are employed in NC and Equ positions in the industry examined here. It may be noted parenthetically that supplemental data derived from a study of supervisors (not shown in Table 3), reveal that there are virtually no Negroes or Mexicans engaged in supervisory positions related to the NC and EDP categories. A small proportion of Negroes, 2.2 percent, appears in supervisory positions for Equ jobs.

Significant distinctions appear once more in the education patterns and in the age of entry into the labor market as shown in Tables 4 and 5.

TABLE 4

Years of Schooling

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Mean Years	11.6	14.3	12.0	12.5	12.3	13.4	11.6	12.2
Schooling beyond high school graduation	33.6	76.3	36.3	26.4	25.6	51.4	33.6	31.0
Schooling ranks	3	1	2	4	5			

TABLE 5

Age at Entry into Labor Market

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
18 years or under	31.4	42.1	36.5	44.4	30.8	43.3	31.4	33.7

Education level is highest for the EDP category (Th EDP mean, 13.4 years*). It is highest of all for the <u>male</u> EDP's, 14.3 years. The Equ's average out at a figure very near high school graduation, at approximately 12 years, while the NC's fall slightly below this figure, 11.6 years.

Examining education level in somewhat different terms, slightly more than fifty percent of the EDP group (Th EDP) attained an education level beyond high school, with corresponding figures for NC's and Equ's at 33.6 percent and 31.0 percent, respectively.

In view of this relatively high education level on the part of the EDP's, one could expect that a greater proportion of this group might have delayed entry into the labor market to a somewhat later time in life. With a broad definition of labor market entry, however, the figures show otherwise. More than forty percent of the EDP's became gainfully employed at age eighteen or under. Corresponding figures for NC's and Equ's are in the low thirty percent range. Seeking interpretations somewhat beyond these data, we may speculate that the prevalence of slightly greater drive and "get up and go" in certain areas of life--both in education and work--is more pronounced for the EDP's than for the other job categories.

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*See footnote, Table 3.

2. Occupational and Training History

Further confirmation of the "get up and go" syndrome, noted above, is provided by data on job mobility and years on the job.

Tables 6 and 7, respectively, summarize information on job changes in the last five years and on years on present job. Both in Administration I and Administration II, the EDP group, and particularly the males in this group, showed high proportions of job change. Among the male EDP's, about one-third changed jobs three or more times within the specified five-year interval. The figure was somewhat smaller for female EDP's, with about 21 to 23 percent making three or more job changes in that period. In both Administrations, the EDP's emerge as the most mobile, with little indication that the amount of mobility has declined. In Administration I, the NC's and the Equ's appear similarly mobile (20.8 percent and 18.1 percent). A slight change appears in Administration II for these two groups, with some tendency for "settling down" in evidence for the NC's; only 16.4 percent now having made as many as three job changes in the preceding five-year interval.

TABLE 6

Job Changes in Last Five Years
Index: "Three or More Changes"

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Administration I	20.6	32.9	19.8	23.6	16.3	28.3	20.6	18.1
Administration II	16.4	33.7	17.6	21.5	19.4	27.6	16.4	18.5
Difference	-4.2	+0.8	-2.2	-2.1	+3.1	-0.7	-4.2	+0.4
Job Mobility Ranks								
Administration I	3	1	4	2	5			
Administration II	5	1	4	2	3			

TABLE 7

Years on Present Job

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
1 year or less	15.1	29.8	21.9	23.6	27.9			
2-5 years	37.1	54.6	50.0	61.1	46.5			
6-9 years	14.4	11.1	12.3	7.0	18.6			
10 years, up	33.3	4.5	15.8	8.3	7.0			
	100.0	100.0	100.0	100.0	100.0			
Mean	7.8	3.3	5.0	3.7	3.3	3.5	7.8	4.2

It follows that the EDP's have, by and large, relatively less extensive tenure in the present job, as of Administration I. The EDP's average 3.5 years on the job, compared with 7.8 years for the NC's and 4.2 years for the Equ's. It must be observed, however, that the EDP's are usually younger than those in the other job categories and though many entered the labor market early, they nonetheless have had fewer years available for employment in this or other jobs. However, the differences are accounted for by an interplay of many factors, including those of age and intrinsic motivation tending toward job mobility, noted earlier.

3. Patterns of Training

The study inquired as to additional training received during the interval between Administrations I and II of the research instruments. The figures appear in Table 8. Two principal findings emerge: First, those in automated employment generally were more likely to have received supplemental training than those in nonautomated employment--as indicated by the comparisons of scores for Th EDP, NC, and Equ. Second, males were substantially more likely to have received further training than females.

TABLE 8

Additional Training Received; Period between Administrations I and II

Male			Female		Th		
NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
38.0	62.9	29.3	26.8	12.9	44.9	38.0	21.1

By far the most favorite "target group" for training is the male EDP's; more than 60 percent did have the benefit of additional courses or other educational programs in the specified period. At the other extreme, only some 13 percent of females in Equ employment had such training.

In interpreting these findings, one may surmise that the industry responds directly to the <u>prevailing</u> state of technological change as a spur for instituting training programs. In the EDP area, with the exceptionally rapid flux in technology and procedure, the need for frequent updating and supplemental learning is well recognized. This holds particularly for the male EDP group, in part because the males are currently employed in positions most specifically related to technological innovation, such as development of new computer hardware and software. The females in the EDP group, however, more typically are employed as keypunch operators (though there are some programmers and analysts as well), and therefore appear to be receiving less training attention than their male counterparts. Further, we may speculate that implicit attitude patterns by staff responsible for development training may be related to the sex differential noted; it may be that, particularly for the younger female subpopulation, on-the-job or in-plant technical training for automated tasks is regarded as a less suitable corporate investment, considering turnover related to marriage, child-bearing, and residential mobility.

The question was raised as to the patterns of training appropriate for preparing the employee for his present job. Results appear in Table 9.

TABLE 9

Perception of Appropriate Training Patterns
for Present Job

	Male			Female	
	NC	EDP	Equ	EDP	Equ
On-the-job training, only	19.4	19.1	23.3	44.6	48.4
Training courses in plant, only	0.8	0	1.5	1.8	3.2
Technical training outside plant, only	0	1.1	0.8	5.4	3.2
Academic courses, only	0	2.2	0	0	0
Academic degrees, only	0	0	0.8	0	0
On-the-job training and training courses in plant	21.7	10.1	9.0	5.4	16.1
On-the-job training and technical training outside plant	12.4	11.2	11.3	25.0	6.5
On-the-job training and academic courses	4.7	7.9	6.0	1.8	19.4
On-the-job training and specific academic degrees	0.8	3.4	3.0	0	0
On-the-job training and training courses in plant and technical training outside plant	17.8	7.9	11.3	8.9	0
Other combinations	22.0	36.8	32.6	7.2	3.2

For the most part, female employees, whether or not engaged in automated positions, are satisfied to have training confined to one principal method—

on-the-job training exclusively. The male respondents, though also desirous of on-the-job training, more typically ask for some combination with other procedures, especially including in-plant training courses and technical training outside the plant in the desired training pattern. Male NC's particularly favor the combination of on-the-job training with in-plant courses, while EDP's, who frequently are the most eclectic in searching for complex training combinations, also express some positive response toward a mix of in-plant and supplemental outside-plant training arrangements.*

Tables 10 and 11 are concerned with a comparison of training approaches deemed appropriate to those actually available. Table 10 reaffirms the nearly unanimous endorsement of on-the-job training as an appropriate method. This holds for males and females, and for all job categories. Lesser proportions, ranging from about one-half to two-thirds of respondents, have been involved in on-the-job training in preparation for their present positions.

In-plant training courses were considered to be appropriate by some 40 percent of male NC's and male EDP's--the principal "automated" skilled employee groups. As borne out by their experience, in large measure such training courses have indeed been instituted. To a lesser extent, and with some variation across job categories, technical training outside the plant and academic courses (the latter primarily for the male EDP group) are regarded as appropriate. Academic degrees, however--with a notable exception in the male EDP group--appear less relevant to the present jobs, according to the respondents in the other job categories.

*Information concerning appropriate training patterns for present job, as reported, is based on Administration II interviews, in order to provide a more extensive experiential basis for the judgments made by the respondents.

TABLE 10

"Appropriate" vs "Actual" Training for Present Job: Major Training Types

	Male						Female			
	NC		EDP		Equ		EDP		Equ	
	App.	Act.	App.	Act.	App.	Act.	App.	Act.	App.	Act.
On-the-job training	92.5	58.2	93.8	67.0	93.2	54.8	93.1	62.5	93.0	53.5
Training courses in plant	41.8	40.4	43.3	48.5	26.7	21.9	18.1	15.3	16.3	9.3
Technical training outside plant	39.7	19.2	23.7	19.6	30.1	24.7	22.2	29.2	18.6	16.3
Academic courses	15.8	19.9	28.9	34.0	11.0	12.3	9.7	11.1	14.0	16.3
Academic degrees	2.7	0.7	15.5	8.2	5.5	1.4	2.8	4.2	4.7	2.3

TABLE 11

Discrepency Ratios: Actual/Appropriate Training Types*

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
On-the-job training	.63	.71	.59	.67	.58			
Training courses in plant	.97	1.12	.82	.85	.57			
Technical training outside plant	.48	.83	.82	1.31	.88			
Academic courses	1.26	1.18	1.12	1.14	1.16			
Academic degrees	.26	.53	.25	1.50	.49			
Mean discrepancy score**	.38	.25	.32	.29	.33	.27	.38	.33

*Low figure (less than 1.00) indicates training gap ("deprivation"); high figure (more than 1.00) indicates over-training ("excess"). Relative satisfaction, .70-1.30, underlined.

**$\frac{1.00 \pm \text{ratio}}{5}$; low score indicates relative satisfaction.

We may wish to inquire further as to the discrepancies between actual training received and appropriate training types, as viewed by the respondents. For this purpose, Table 11 reports a series of "discrepancy ratios." The discrepancy ratio simply is the percentage of actual training received divided by the percentage of training considered appropriate, for a given training type. By the way of example, the discrepancy ratio for male NC's with respect to on-the-job training is 58.2 divided by 92.5, or 0.63. Obviously the perfect balance between the "actual" and the "appropriate" would yield a ratio of 1.00. Therefore, ratios of less than 1.00 may be interpreted as representing a relative negative imbalance, reflecting a perceived lack in use of a certain method, while a ratio in excess of 1.00 represents a positive imbalance, or a perceived excess in use of the particular training type.

Considering the set of discrepancy ratios, the following findings appear: Some feeling of lack is expressed concerning on-the-job training for males and females, in greatest measure by the Equ's and least by the EDP's. We will recall a prior analysis which noted the relatively high percentage, particularly for male EDP's who had received additional training in the period between Administration I and II. This no doubt included on-the-job training, perhaps accounting for the somewhat higher ratio (ratio .71), indicating the smallest imbalance--and relative satisfaction for this method. Indeed, for in-plant courses a slight excess appears for the male EDP's (ratio 1.12). For all other job categories, with the exception of the female Equ's, a relatively satisfactory balance (ratios ranging from .82 to .97) is in evidence.

The male NC's report a lack of technical training outside the plant, while the female EDP's report a relative excess.

With respect to academic courses, it would appear that all respondent categories indicate a slight excess of academic courses as relevant to their present jobs. Perhaps reaching somewhat beyond the available data, it might appear that academic courses in some measure fail to prove responsive to the actual job requirements, as seen through the workers' eyes.

While academic degrees are not considered appropriate training prerequisites for most of the job categories (Table 10) such discrepancies as exist suggest a generalized feeling by NC, EDP and female Equ respondents that they did not obtain sufficient formal academic validation of their skills. This may be viewed as an indirect indication of regret by some of the respondents, manifesting their desire for more formal academic degrees. On the other hand, the female EDP's report an excess of academic degrees, saying in substance something to the effect "so we've got the degree, what good is it doing on this job?"

By a mean discrepancy score, showing the total amount of imbalance whether positive or negative (with a low score indicating satisfaction), we note that--though the differences are small--the male and female EDP's appear to be relatively least discrepant in their assessment of actual and appropriate training to which they have been subject. It must be emphasized that this measure does not express the kind of subjective, phenomenological sense of comfort or discomfort with training that may be obtained by direct inquiry. Rather, it represents an emergent measure of an item-by-item analysis of reality and appropriateness--a kind of analytic sum total of the various training experiences.

In fact, an over-all subjective measure of satisfaction with education and training as career preparation (Table 12) reveals a rather different picture. It does, however, concern career preparation as a whole, rather than training specifically for the present job. The former certainly influenced by the latter, but is not synonomous with it.

TABLE 12

Satisfaction with Education and Training
as Career Preparation
Mean Scores*

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Administration I	3.21	3.19	3.18	2.96	2.81	3.08	3.21	3.00
Administration II	2.81	2.87	2.55	2.36	2.52	2.62	2.81	2.54
Difference**	.40	.32	.63	.60	.29	-.46	-.40	-.46
Satisfaction Ranks								
Administration I	5	4	3	2	1			
Administration II	4	5	3	1	2			

*Five-point scale: 1-very satisfied to 5-very dissatisfied; low score indicates high satisfaction.

**Reduction (minus sign) indicates increase in satisfaction.

Employing a five-point scale, with 1.00 indicating "very satisfied" and 5.00 "very dissatisfied," it appears that, both in Administrations I and II, the male EDP group ranks at or near the bottom in general satisfaction with education and training as career preparation. On the other hand, female employees, both EDP's and Equ's rank high in this respect. Granting the limitation of the data, including the modest differences among the mean discrepancy scores, it may seem that the findings of Tables 10 and 11 are somewhat contradictory. Most significantly perhaps, the male EDP's who "on the record," as revealed by an analytic procedure (Table 11), appear to have had fairly satisfactory training experiences (affecting their present job) are rather near the bottom of the list in satisfaction with their learning experiences related to their total careers. On the other hand, the female EDP's and Equ's, with somewhat greater discrepancies between actual and appropriate training, appear quite satisfied with their patterns of total career preparation. It may be that the young, well-educated group, with the "get-up-and-go" syndrome noted earlier, has higher education and training aspirations than the others. Therefore, male EDP's may remain subjectively dissatisfied in some measure, even in face of objectively fairly adequate training and school experiences.

Satisfaction with career education and training consistently rises through time, for all job categories.

4. Operational Definition of Contrasting Study Populations

Personnel and industrial relations specialists in the companies designated for inclusion in the study were requested to provide rosters of employees characterized as engaged in "automated" and generally equivalent "Nonautomated" positions. The study's basic orientation was explained, but the personnel and industrial relations staff was given every opportunity to use their judgment, as based on company experience and job descriptions, in specifying the jobs to be included.

Table 13 shows the description of principal job title categories for the automated (NC and EDP) and nonautomated (Equ) positions. Table 14 shows a grouped listing of job title categories, giving the detail of job titles and the combination derived for study purposes. The distribution of job title groupings by company size appears in Table 15.

TABLE 13

Job Title Categories

NC (149)		EDP (172)		Equ (187)	
Electrical maintenance technician	13.4	Key punch operator	29.7	Milling machine operator	16.0
Maintenance mechanic	12.8	Computer operator	6.4	Accounting clerk	10.2
Milling machine operator	12.8	Data processing analyst	5.8	Structural assembler	7.5
Machinist	8.8	Programmer	5.2	Drill press operator	5.4
Numerical control programmer	4.7	Systems programmer	4.7	Planner	3.7
Drill press operator	4.7	Programmer analyst	4.1	Maintenance mechanic	4.3
Industrial electrician	4.0	Data processing specialist	4.1	Machinist	3.7
Electronic technician	4.0	Computer programmer	4.1		
		Computer engineer	4.1		
Other	34.8	Other	31.8	Other	49.2

The most common job titles in the NC rubric are (1) electrical maintenance technicians, (2) maintenance mechanics, and (3) milling machine operators. Together these three job titles account for slightly less than 40 percent of all NC jobs in the firm's study.

By far the most frequent job title in the EDP rubric is that of keypunch operator, accounting for slightly less than 30 percent of the total. Other jobs in this category further relate to computer operation and programming.

The Equ rubric, by design a heterogeneous one to take into account equivalences both with NC and EDP positions is headed in number by milling machine operators (16.0 percent) and accounting clerks (10.2 percent).

It is, of course, apparent that certain job titles appear both in the automated and nonautomated job title categories. Perhaps most noticeably, milling machine operators are found under the NC heading and under the Equ heading. The same holds true for drill press operators, maintenance mechanics, and machinists. It may be noted that in some companies the question of whether or not a position is "automated" is explicity avoided. Efforts are made in these companies to treat uniformly the positions here classified separately as NC or EDP, in part to avoid the automation issue in collective bargaining.

As per Table 14 (pp. 38-39), respondents in our sample may be grouped into eight major categories, cross-cutting the EDP, NC, and Equ headings. These grouped sets of jobs are:

I. Keypunch operators
II. Programmers
III. Analysts
IV. Engineers
V. Computer operators
VI. Clerks
VII. Technical and maintenance personnel
VIII. Manufacturing personnel

As is shown by Table 15 (p. 40), almost invariably keypunch operators fall in the EDP category, while programmers in some measure cut across both the EDP and NC categories.

Analysts of various kinds constitute a more heterogeneous grouping with some representation "across the board," a situation similar to that found for the relatively small number of engineers represented here. Not surprisingly, computer operators are primarily within the EDP category.

TABLE 14

Grouped Listing: Combination of Job Title Categories

I. Key Punch Operators

II. Programmers *et al*

Associate - Business Computer Programming
Associate - NC Programming
Computer Programmer
NC Programmer
Program Technician
Programmer
Programmer Analyst
Programmer
Programmer Systems-Analyst
Systems Programmer

III. Analysts *et al*

Analyst - Automate Mater. Requirement
Associate Automate Mater. Requirement
Computer - Analyst
Computer - Coding Analyst
Cost Analyst
Data Processing Analyst
Materials Requirements Man
Management Systems Specialist
Material Checker
Material Investigator
Mathematician
Numerical Control Analyst
Operations Analyst
Operations Control Analyst
Planner

IV. Engineers *et al*

Computer Engineer
Industrial Engineer
Manufacturing Engineer
Systems Engineer
Tool Design Engineer
Tool Designer
Tool Engineer

V. Computer Operators *et al*

Computer Operator
Computer Specialist
Data Processing Equipment Operator
Data Processing Specialist

V. Computer Operators et al (continued)

Data Transmission Technician
EDPM Operator
EDPM Specialist
Data Processor
Processor - Automates Materials Requirements
Tab Machine Attendant
Tab Control Man
Tab Machine Operator

VI. Clerks et al

Accounting Clerk
Clerk - Materials Records
Comptometer Operator
Data Clerk
Data Reduction Clerk
Librarian - Data Processing
Paymaster
Technical Report Clerk
Technical Clerk
Typist - Programmatic

VII. Technical and Maintenance Personnel

Computer Maintenance
Electrical Maintenance
Electronic Technician
Industrial Electrician
Industrial Electronic Technician
Maintenance Mechanic
Production Machine Mechanic

VIII. Manufacturing Personnel

Automatic Screw Machine Machinist
Automatic Screw Machine Operator
Drill Functions
Duplicating Functions
Engine Lathe Operator
Fabricator - Circuit Boards
General Machinist
Jig Borer Operator
Linesman
Machine Machinist
Machine Tool Rebuilder
Milling Machine Operator
Punch Press Operator
Skin Mill Operator
Structural Assembler
Tube Bender
Turret Lathe Machinist
Turret Lathe Operator

TABLE 15

Company Size and Job Title Groupings

		EDP Large	EDP Small	NC Large	NC Small	Equ. Large	Equ. Small
I.	Keypunch operators	27.9	34.9	0.0	0.0	0.7	3.0
II.	Programmers, *et al*	17.8	25.6	11.6	3.6	0.0	0.0
III.	Analysts, *et al*	17.9	14.0	0.8	10.7	9.8	15.2
IV.	Engineers	7.0	2.3	5.0	7.1	5.9	6.1
V.	Computer operators	23.3	21.0	1.7	0.0	2.6	0.0
VI.	Clerks	3.9	2.3	0.8	0.0	13.6	39.4
VII.	Technical and maintenance personnel	0.0	0.0	43.0	21.4	15.0	3.0
VIII.	Manufacturing personnel	0.0	0.0	37.2	57.1	52.6	21.2
IX.	Unspecified	2.3	0.0	0.0	0.0	0.0	12.1
		100.0	100.0	100.0	100.0	100.0	100.0

Three largest occupation subcategory titles

EDP Large	EDP Small	NC Large	NC Small	Equ. Large	Equ. Small
Key Punch Operators	Key Punch Operators	Maintenance Mechanic	Machine Machinist	Milling Machine Operator	Data Reduction Clerk
27.9	34.9	15.7	21.4	18.2	15.2
Computer Operators	Data Processing Analyst	Milling Machine Operator	General Machinists	Accounting Clerk	Accounting Clerk
6.2	11.6	15.7	10.7	10.4	9.1
Systems Programmer	Programmer	Electrical Maintenance	Numerical Control Analyst	Structural Assembler	Scatter
6.2	11.6	14.9	10.7	9.1	

Clerks, on the other hand, constitute the collection of job titles most characteristic of Equ employment. Technical and maintenance personnel, and manufacturing personnel appear principally in the NC and Equ categories. Further, Table 15 provides comparisons between large and small companies.*

In EDP, the general distribution of grouped job titles between the large and the small companies are fairly similar, with somewhat greater proportions of keypunch operators and programmers appearing in the small, and conversely, greater proportions in evidence in the large for analysts and computer operators. For NC, there are proportionately more programmers and technical and maintenance personnel in the large companies with the reverse situation prevailing in the small for analysts and manufacturing personnel.

One may speculate that the large employers are at a stage in which, to an extent greater than that found for small employers, relatively more advanced automatic equipment has been installed. However, it may be that in this introductory phase a considerable technical and maintenance force is required and that tasks related to NC operations inherently are regarded as a form of "maintenance." The small employer, initially venturing to the use of automated equipment, must concentrate on its direct productive utilization, with certain maintenance functions carried out directly by the manufacturing personnel. And the equipment that he chooses may be simpler and less venturesome than that introduced in the large firms.

"Equivalent" classifications inevitably represent a melange. Functions viewed as similar to those carried out under the EDP and NC labels fall primarily within the clerical, technical and maintenance, and manufacturing categories for large companies, while the analysts, clerical and manufacturing

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*Based on size of payroll, the large companies are: Lockheed, McDonnell Douglas, and North American Rockwell. The small companies are: Aerojet-General, Hughes, and Northrop.

categories predominate for the small. One may surmise that mechanical tasks involving data inputs, as those performed by keypunch operators in EDP positions, are carried out principally by personnel classified as clerical in equivalent work. Further, when the task is conventional, conceptual operations, as performed by programmers in EDP and NC positions, are rarely in order. Presumably the clerk often performs similar activities in the normal framework of the job.

Manufacturing operations in the NC category generally may be regarded as representing more or less direct replacements for similar conventional tasks. For instance, numeric tape-controlled procedures may be used in lieu of conventional manual control, employed previously.

An interpretation of data shown in Tables 13, 14, and 15 suggests that a substantial proportion of jobs regarded as "automated," including those now classified as EDP and NC, presently are far removed from the popularly assumed "push-button" stereotype. The nearest approximations to this stereotype perhaps, are certain simple, tape-controlled manufacturing operations. For many other positions the underlying distinction between automation and nonautomation remains unclear. The psychological consequences of keypunching numbers from code may not be too dissimilar to those of a clerk routinely typing letters or stamping insurance policies. Technical and maintenance personnel, though appearing under the rubric of Numerical Control, may perform tasks somewhat similar to those that they would perform in a conventional maintenance operation after an initial transition; it may make little fundamental difference to them whether their task involves maintaining a tape-driven or manually operated machine, except, of course, that additional training has been required to re-qualify them for maintenance (and, occasionally, for control) of electronic equipment.

5. Differentiating Nonautomated from Automated Employment

Whatever the formal distinctions between "automated" and "nonautomated" positions in accordance with the job description, and whatever the similarity and differences of the functions in jobs so distinguished, there remains a further question: What are the experiences reported by the workers themselves concerning their operations of automated equipment?

Two hypotheses are suggested: First, that over a period of time (as from Administration I to Administration II) a greater proportion of respondents will report that they have had experience in operating automated equipment, and, second, that a generalized characterization of the job as "automated" by the respondents (particularly for the NC and EDP categories as defined) will decline.

These relationships are expected for the following reasons: First, the current trend to further installation of automated equipment results in increased exposure to such equipment and therefore to further reports by respondents, indicating that they have had experience with equipment of this kind. Second, the more stereotypic description of "automated" will be less cogent as the worker becomes further engaged in the specific tasks required by the "automated"job.

As is shown in Table 16, proportions reporting experience in operating automated equipment increase as expected for the male NC, male EDP and female EDP categories. No such consistent trend appears for the Equ's. Further, as is indicated by Table 17, the proportions describing their job as automated (in accordance with a five-point scale) declined for the male NC's, male EDP's and female EDP's during the interval from Administration I to Administration II. It would appear, therefore, that the simple label "automated" wanes in significance as the worker gains further experience in the operation of automated equipment. This suggests that the descriptive label "automated" and the emotional loading sometimes attached to this word is dissipated to some extent as the worker actually takes hold of the specific tasks involved.

TABLE 16

Experience in Operating Automated Equipment

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Administration I	61.0	70.1	38.4	77.8	34.9	74.0	61.0	36.7
Administration II	68.2	78.7	37.6	91.1	38.7	84.9	68.2	38.2

TABLE 17

Perception of Present Job as "Automated" or "Nonautomated"

Index: "Percent responding in 'automated' range of five-point scale"

	Male			Female		Th "Automated"		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Administration I	50.7	57.8	33.6	83.3	23.3	70.6	50.7	28.5
Administration II	37.2	39.4	25.6	75.0	25.8	57.2	37.2	25.7

At any rate, it appears that substantial ambiguity surrounds the "automation" concept, as viewed by the workers--the people who, after all, are closest to jobs so characterized on an a priori basis. Though at the time of Administration I somewhat more than one-half of the male NC's and male EDP's described their jobs as automated--and though these positions were so classified by the personnel specialists making the initial selection--the fact remains that the other half did not describe their jobs in these terms. Indeed, as time went on, during the period from Administration I to Administration II, the proportions describing their jobs as "automated" declined further, for the male NC's and for the male EDP's, now generally holding in the high thirty percent range. At this point a substantial majority failed to characterize their jobs as "automated," the NC and EDP categorization notwithstanding.

The situation is somewhat different for the female EDP's, many of whom, we recall, are keypunch operators. For this respondent category the proportion describing the job as "automated" remains relatively high throughout, though a small drop does appear from Administration I to Administration II. At the second check point, three-fourths continue to describe their job in terms of the "automated" concept. It is likely the mechanical aspects of the task are implicitly equated as having to do with an automated procedure. This view is strengthened by the close relationship between this mechanical endeavor and computer operations which are, of course, often described in automation terms.

With respect to the Equ employees, while, as expected, rather small proportions have had experience in the operation of automated equipment and chose to describe their jobs as automated, some measure of ambiguity persists. Again, a substantial minority, roughly one-fourth, continue to describe their presumably "conventional" Equ jobs as automated.

6. Impact and Affect of Job Change

There has been considerable concern with respect to the possible significance of the transition from nonautomated to automated employment. The respondents were asked whether their experience when first taking a job requiring the operation of automated equipment represented a major change, a minor change, or not much of a change. As is indicated in Table 18, there is general agreement that the transition represented a major change. The range of proportions of those so responding (with one anomalous exception, perhaps, due to small number of cases) consistently exceeded seventy percent. Evidently, whatever the nature of the equipment and the predispositions of the respondents, shifting from conventional assignments to those requiring operation of technologically new equipment does represent a subjective "moment of truth." Clearly, a re-learning process is experienced. However, such re-learning is not necessarily accompanied by emotional fear or active rejection of the new task.

TABLE 18

Perception of Change When First
Taking Job Using Automated Equipment

(Data for those only who report experience in operating automated equipment)

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Major change								
Administration I	82.6	95.4	76.3	76.4	73.4	85.9	82.6	74.9
Administration II	78.2	88.3	70.0	72.0	25.3	80.2	78.2	47.7
Minor change								
Administration I	9.8	1.5	6.0	5.9	6.6			
Administration II	12.6	8.8	16.0	12.0	25.3			
Not much of a change								
Administration I	7.6	3.1	17.7	17.7	20.0			
Administration II	9.2	2.9	14.0	16.0	49.4			

The respondents were asked as to whether they like or dislike an automated job (See Table 19). Sixty percent or more in the EDP and NC categories indicated that they like "very much" or "fairly well" tasks required in automated employment. Even the proportion expressing such preference in the Equ group hovers near fifty percent--less than that for the EDP's and NC's, but nonetheless substantial. We may conclude that the Equ's, most of whom have not actually been employed in assignments requiring operation of automative equipment, typically do not stand in awe of such yet dimly perceived tasks. It does appear, however, that the relative proximity of scores to the fifty-percent mark apparently indicates the potential ambivalence and ambiguity that surround the preference judgment of those employed in conventional jobs.

TABLE 19

Like or Dislike of Automated Job

(Index: "Like very much, or Like fairly well")

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	ELP	NC	Equ
Administration I	60.3	60.8	55.5	77.7	41.8	69.3	60.3	48.7
Administration II	72.1	59.6	48.8	78.5	51.6	69.1	72.1	50.2
Difference	+11.8	-1.2	-6.7	+0.8	+9.8			

Another view of the pattern of preferences appears in Table 20. In Administration I, the NC's and EDP's, by a slight margin, express preference for automated over nonautomated jobs, while as expected, the Equ's prefer nonautomated employment, both in Administrations I and II.

TABLE 20

Preference for Automated ("A") or Nonautomated ("NA") Job

	Male			Female	
	NC	EDP	Equ	EDP	Equ
Administration I	A (50.0)	A (54.6)	NA (54.1)	A (66.7)	NA (60.5)
Administration II	A (52.7)	NA (53.9)	NA (58.6)	A (67.9)	NA (64.5)

Of some interest is the slight shift toward a preference for nonautomated employment by the male EDP's in Administration II, which parallels a small decline in their liking for such jobs from Administration I to II, according to Table 19. As has been observed, certain personal characteristics of the EDP's, their relative youth and upward striving suggest the possibility that some members of this group may become disillusioned with their assignments as time passes and as realistic problems are encountered.

For most respondent groups (with a slight exception for the male Equ's), proportions regarding a hypothetical "ideal job" as "automated" increase from Administration I to Administration II. (See Table 21). Particularly, female EDP's are most likely to describe the "ideal job" as "automated." For other groups, significantly less than half identify their personal utopian job with the term "automated."

TABLE 21

Is "Ideal Job" Automated?

(Index: "Percent responding in 'automated' range of five-point scale")

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Administration I	19.2	38.1	26.1	47.2	14.0	42.7	19.2	20.1
Administration II	30.2	47.2	19.6	71.4	32.3	59.3	30.2	26.0

The pattern of findings suggests that automation is not necessarily viewed as a subjective threat, hovering as an incubus over the lives of the workers, nor is it equated with Nirvana. Rather, the word "automation" continues to be something of a puzzle: for those employed in or near EDP and NC jobs, it stands neither for clear-cut preference nor for absolute rejection. It is a label used with many meanings, often stereotypic, and perhaps appropriately replaced by more precisely defined concepts.*

7. A Factor-analytic View of "Automation"

A factor analysis, examining associations among items in the survey questionnaire, reveals that for present jobs the terms "automated" and "routine" are rarely linked, i.e., appear in separate factors. (See Tables 22 and 23).

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*While not studied specifically in this inquiry, there is some question whether the term "technological change" or "technological innovation" is more suitable. Presumably these terms deal with a context broader than that encompassed by "automation," including changes and innovations created by simple, evolutional--and even minor--modifications in technology.

"Automated" does relate primarily to concepts such as "use of numerical controls," "close supervision," "use of computers," and "use of machinery."

TABLE 22

Factor A: "Automation" Factor: Present Job

Factor loading*	Scale Description (one end only)
.71	Automated
.68	Uses NC
.41	Closely supervised
.38	Uses machinery
.34	Uses computer

*"Factor loading" may be interpreted roughly as the extent to which the scale description concept shows strength of association with the factor as a whole.

TABLE 23

Factor B: "Challenge" Factor: Present Job

Factor Loading	Scale Description (one end only)
.69	Challenging
.68	Gives a chance to use my potential
.64	Interesting
.62	Room for personal initiative
-.61*	Not dull
.61	Exciting
.53	Complex
.52	Has lot of prestige
.50	Requires much judgment
-.49	Not simple
.48	Requires close cooperation and coordination with others
.45	Highly specialized
-.46	Others really care . . . .
-.40	Does not make me feel alone
-.38	Requires much thinking
-.37	Not at all routine

*Absolute number is significant; minus-sign merely shows direction of association, e.g., "challenging" job is regarded as "not dull."

It is worth noting that a more salient aspect of a job, and one conceptually independent of "automation," is the challenging and fulfilling opportunity offered by the task, as suggested by the meaning of Factor B. This factor accounts for 20 percent of the variance--the total explanatory power--while Factor A, "Automation," accounts only for 7 percent. In this sense, "automated" jobs, in and of themselves, are not regarded as either dull or challenging; the oft-assumed equivalence of "boredom" and "automated work" is not supported.

Thus, aerospace employees, whether or not engaged in automated jobs, do not appear to experience automation as a particularly depressive force. The data suggest that current jobs are not typically perceived as dull and automated, or dull because they are automated. Rather, though the automated elements are often regarded as potentially beneficent, the degree of challenge or boredom inherent in the job is viewed as something quite distinct from automation, not as its consequence.

8. Perceived Levels of Skill, Responsibility, and Communication

Through time, from Administration I to Administration II, all respondent groups reported increases in their levels of skill and responsibility and in the extent to which their jobs require communication. (The data appear in Tables 24, 25 and 26.)

When asked whether their skill level was in the top 5 percent in the company, on the average 19.1 percent of the EDP's, 38.8 percent of the NC's and 31.9 percent of the Equ's so indicated. Greatest proportions of increase in perceived skill level, as measured by this criterion, appeared for the EDP's and Equ's. The EDP's, perhaps regarding themselves on the way up, presented the most dramatic increase. However, the NC's, who have had longer average tenure on their jobs, continued to reveal the highest proportion of confidence in their skill level.

TABLE 24

Perceived Skill Levels--Present Job

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Top 5 percent in company								
Administration I	23.3	11.3	22.6	5.6	7.0	8.5	23.3	14.8
Administration II	38.8	20.2	44.4	17.9	19.4	19.1	38.8	31.9
						+125*	+ 67*	+116*
Upper quarter**								
Administration I	27.4	46.4	21.9	20.8	14.0			
Administration II	41.9	59.6	31.6	41.1	38.7			
Average or below***								
Administration I	49.3	42.3	55.5	73.6	79.0			
Administration II	19.3	20.2	24.4	41.0	41.9			

*Relative increase (percent of percent)
**But not top 5 percent
***Above average plus average (Administration I); above average (Administration II); and below average and unskilled (Administration I and Administration II); proportion "below average" negligible.

The picture for perceived responsibility level is similar. Again, the EDP's and Equ's showed the highest proportion of increase from Administration I to Administration II, while the NC's continue to regard themselves in greatest measure as holding the most responsible positions.

With respect to the level of communication required, the most dramatic rise in demand for communication is indicated by the NC's. Lesser increases appear for the EDP's and Equ's. We may surmise that, as time goes on, substantial expansion in the range of personal competence and control is experienced by employees both in "automated" and "nonautomated" positions. Levels of skill and responsibility are perceived to rise as is the need for communication--a measure of relatedness to the social fabric of the organization. Apparently, continued employment in an "automated" job, as defined here, is often seen as a positive, rather than as an alienating experience, individually and in the organizational context.

TABLE 25

Perceived Responsibility Level--Present Job

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Top 5 percent in company								
Administration I	26.7	18.6	21.9	5.6	14.0	12.1	26.7	18.0
Administration II	41.9	19.1	45.9	33.9	35.5	26.5	41.9	40.7
						+119*	+57*	+126*
Upper quarter**								
Administration I	29.5	33.0	28.1	20.8	39.5			
Administration II	41.1	61.8	30.8	25.0	22.6			
Average or below***								
Administration I	43.8	48.4	50.0	73.6	46.5			
Administration II	17.0	19.1	23.3	41.1	41.9			

*Relative increase (percent of percent)

**But not top 5 percent

***Above average plus average (Administration I); above average (Administration II); and below average and unskilled (Administration I and Administration II); proportion "below average" negligible.

On the whole, then, the upswing in self-perception of skill, responsibility and communication does not appear to be linked to the EDC-NC versus Equ distinction, i.e., the increases seem to have little connection as to whether or not a job is classified as "automated."

TABLE 26

Perceived Communication Level--Present Job

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Top 5 per cent in company								
Administration I	13.7	28.9	17.1	13.9	20.9	21.4	13.7	19.0
Administration II	37.2	40.4	41.4	23.2	29.0	31.8	37.2	35.2
						+49*	+171*	+73*
Upper quarter**								
Administration I	22.6	27.8	21.9	11.1	14.0			
Administration II	27.1	33.7	26.3	28.6	32.3			
Average or below***								
Administration I	63.7	43.3	61.0	75.0	65.1			
Administration II	35.7	25.9	32.3	48.2	38.7			

*Relative increase (percent of percent)

**But not top 5 percent

***Above average plus average (Administration I); above average (Administration II); and below average and unskilled (Administration I and Administration II); proportion "below average" negligible.

9. Salary and Perceived Upward Mobility

Data concerning beginning salary and current salary at the time of the study, gathered on the basis of personnel records during the interval between Administration I and Administration II, are reported in Tables 27 and 28.

TABLE 27

Beginning Salary*

	Male			Female	
	NC	EDP	Equ	EDP	Equ
Under $6,000	46.5	33.3	54.2	67.9	100.0
$6,000-7,999	44.2	12.5	25.0	21.4	0
$8,000-9,999	9.3	20.8	14.6	3.6	0
$10,000, up	0	33.3	6.3	7.1	0
	100.0	100.0	100.0	100.0	100.0

*Data available for 63 percent of sample.

TABLE 28

Latest Salary*

	Male			Female	
	NC	EDP	Equ	EDP	Equ
Under $6,000	1.7	3.3	8.1	10.7	37.5
$6,000-7,999	68.3	36.7	66.1	71.4	62.5
$8,000-9999	28.3	10.0	12.9	7.1	0
$10,000, up	1.7	50.C	12.9	10.7	0
	100.0	100.0	100.0	100.0	100.0

*At or near mid-point of interval, Administration I to Administration II; data available for 80.4 percent of sample.

The highest initial and current salary levels appear for the male EDP group: one-third began employment with the company at a salary of $10,000 and up, and the current proportion in this category is 50 percent. Corresponding proportions in the $10,000 and up salary bracket, both for beginning and current basis, are very considerably smaller for the other job categories. The group with the lowest salary level are the female Equ's. The beginning salary was consistently under $6,000 for two-thirds of this group, while the current salary level falls in the next bracket, $6,000 to $7,999, including 62.5 percent of the group. Next lowest are the female EDP's, some 68 percent, starting at the under-$6,000 level, with a roughly equivalent percent currently falling into the $6,000 to $7,999 range.

Table 29 provides a measure of upward mobility as perceived by the respondents. It indicates proportions who believe that two years from now their earnings will increase "a great deal," or "somewhat."

TABLE 29

Perceived Upward Mobility: Earning Changes
Expected Two Years from Now
Index: "Expectation that earnings will increase
great deal or somewhat"

	Male			Female		Th		
	NC	EDP	Equ	EDP	Equ	EDP	NC	Equ
Administration I	55.5	83.5	62.3	58.3	55.8	70.9	55.5	59.1
Administration II	65.2	78.7	75.2	57.1	54.8	67.9	65.2	65.0

At Administration I, by far the greatest amount of optimism concerning future earnings is in evidence for the male EDP's; more than 83 percent in this group have expectations of significant increase in earnings. All other groups, male and female, NC, EDP, and Equ, appear somewhat less sanguine as to their chances for considerable earning increase. Corresponding percentages are in the 50 to 60 percent range.

At the time of Administration II, the pattern remains generally similar, though the differential, particularly between the male EDP's and the male Equ's, is narrower. The lessened optimism of the male EDP's may reflect the encountering of occupational hurdles by a subgroup within this category, discussed earlier.

Looking at the groups as a whole, as indicated by the "Th" measure, a slight decline in perceived optimism appears for the EDP's, while some moderate rises in expectation of higher future earnings appear for the NC's and Equ's. At Administration II, the EDP's, NC's, and Equ's differ little from one another in this respect. We may conclude, therefore, that, although objective salary levels vary significantly among these three groups, the level of their respective faith in future increases in earnings is relatively the same, regardless of the automated/nonautomated distinction.

10. Survey of Supervisory Personnel

A subsample survey of 97 supervisors, linked to the workers included in the NC, EDP, and Equ study phase, was conducted, augmenting the worker responses. Table 30 reports the supervisory patterns for this group.

TABLE 30
Supervisory Pattern

A. Average Number of People Supervised

	(n)	
NC	(20)	39.9
EDP	(32)	30.4
Equ	(45)	36.5

B. Proportion of Subordinates in Automated Jobs: Percent of Supervisors' Response

	All Subordinates Automated	Some Automated	None Automated
NC	15.0	45.0	40.0
EDP	59.4	25.0	15.6
Equ	6.7	51.1	42.2

Differences in the number of subordinates supervised are moderate. The largest average subordinate group appears for the NC supervisors, with approximately 40 subordinates. For the EDP's, the corresponding number is 30, while the Equ's occupy an intermediate position with about 37 subordinates. It would seem, therefore, that at present the introduction of automated equipment has not drastically altered the quantitive range of supervision, though there is some tendency for the EDP supervisor to guide a smaller number of subordinates than his colleagues do in other categories.

It does appear that the EDP supervisor functions within a more clearly automated situation, as suggested by the view of some 59 percent in this category to the effect that all their subordinates are employed in automated positions.

Supervisory patterns as found in this study suggest that current automation levels in the Southern California aerospace industry do not lead directly to a major increase in the number of subordinates in the charge of a given supervisor. Here, the image of a vast number of button-pushers, guided by a single, trouble-shooting overseer, remains a yet unreal science fiction concept.

Table 31 indicates the supervisors' personal preferences concerning automated and nonautomated jobs. Both NC and EDP supervisors prefer work in and supervision of automated jobs, by margins ranging from about 50 to 70 percent. Even Equ supervisors favor supervision of automated jobs by a small margin, but the plurality would prefer working directly in non-automated positions.

TABLE 31

Personal Preferences Concerning Automated/Nonautomated Jobs*

A. Re Supervising Automated/Nonautomated Jobs	NC	EDP	Equ
Prefers nonautomated	40.0	18.8	35.6
No difference	10.0	9.3	13.3
Prefers automated	50.0	71.9	51.1
	100.00	100.00	100.0
B. Re Working on Automated/Nonautomated Jobs	**NC**	**EDP**	**Equ**
Prefers nonautomated	35.0	25.0	44.0
No difference	5.0	12.5	13.3
Prefers automated	60.0	62.5	42.2
	100.0	100.0	100.0

*"Majority" or "plurality" preference underlined.

Again, these views support the finding that among those studied "automation" is not notably regarded as something to be avoided--indeed, it is clearly preferred by a majority of EDP and NC supervisors and, in more mixed pattern, endorsed by many Equ supervisors.

As is shown in Table 32, dealing with the sense to which the present job is viewed as automated or computer-linked, the majority of EDP supervisors describe their jobs as automated and as making use of a computer. It is interesting to note that more Equ's describe their supervisory jobs in these terms than do NC's. This somewhat anomalous perception, possibly due to sampling variations, also may be a function of computer-like office equipment, increasingly utilized in jobs under their supervision.

TABLE 32

Is the Present Job Automated, Computer-linked?
Index: Percent describing job in terms of 'automated'-range (1 and 2 on five-point scale)

	NC	EDP	Equ
"Automated"	10.0	50.0	17.8
"Uses computer"	25.0	84.4	33.3

As is shown in Table 33, supervisors in all categories are quite willing to play a role in the training of their subordinates. The highest proportion of readiness to do so appears for the Equ's, with the percentages for the NC's and EDP's somewhat smaller. Throughout, there is only a minority ranging from 11 to 25 percent who are in some sense reluctant to participate in training the people in their work group. On this basis, it appears that the supervisors represent a viable resource in the training of employees--a resource that may be useful particularly in training efforts required by the introduction of new technologies.

TABLE 33

Feelings about Training People in Work Group*

	NC	EDP	Equ
Would like very much	60.0	43.8	71.1
Would like fairly well	25.0	31.3	17.8
Wouldn't mind	5.0	18.8	0
Would not like	10.0	6.2	11.1
	100.0	100.0	100.0

*For present job

What of the future? As shown in Table 34, the supervisors believe that their companies are actively seeking to move forward with the installation of automated equipment. This tendency is expressed most distinctly by EDP supervisors, and with relatively the least certainty by Equ supervisors. Still, there are very few who doubt that their companies will, in some way, continue to aspire to more widespread introduction of automated technology.

TABLE 34

Supervisors' Belief That Company Actively Seeks to Install Automated Equipment

		NC	EDP	Equ
Definitely	(1)	45.0	62.5	26.7
	(2)	45.0	25.0	60.0
	(3)	10.0	9.4	8.9
	(4)	0	3.1	4.4
Definitely not	(5)	0	0	0
		100.0	100.0	100.0

With this trend continuing, the supervisors believe that, in the future, some additional jobs under their supervision (which at present are not automated) will in fact be converted to automated form. However, while the prevalent expectation exists that automation will proceed, there is only a very small minority (5 to 11 percent) who foresee that all non-automated jobs under their supervision eventually will be automated.

TABLE 35

Supervisors' View of Proportion of Nonautomated Jobs under Their Supervision Likely to be Automated in Future

	NC	EDP	Equ
None likely to be automated	20.0	9.4	15.6
Some likely to be automated	65.0	84.4	66.7
All likely to be automated	5.0	6.2	11.1

In summary, we note that no cataclysmic automation revolution is anticipated by the supervisors. The tendency toward the conversion of conventional technology to "automated" technology is expected to continue, affecting--no doubt selectively--various elements of the organization's workforce. Further, these developments, unquestionably bringing with them the need for coping with change, are far from being regarded with unmitigated horror, either by those now involved in automated task or by those now engaged in conventional assignments. The benefits of "automation" are widely recognized, even by the latter group, though understandably their enthusiasm for changing technology is not always as great as that of their NC and EDP colleagues.

Finally, prevailing ambiguities in usage indicate that a series of alternate concepts may be required to replace the congerie of notions currently subsumed by the label "automation."

PART B

AUTOMATION RESEARCH PROJECT--SUMMARY AND ANALYSIS OF MANAGEMENT INTERVIEWS

The decade of the '60s has seen a rapid increase in the rate of technological change in American industry. Although still affecting only a relatively small portion of total industrial capacity, there is general agreement that the accelerated pace of changing technology has had a significant impact on people, jobs, and operating methods. Not clear, however, is the nature of this impact and its economic and social implications. In more specific terms: how does technological change and automation affect skill levels, training programs, educational policy, employee recruitment and placement? How do industry executives interpret the impact of such change in terms of their own managerial adjustments? What problems arise when major forms of technological change are introduced and how are they resolved? How do industrial executives perceive automation and its varying impact upon employees?

In the fall of 1967 a series of interviews were held with industrial-personnel relations and operating executives of the six aerospace companies included in the broader research study. Each firm was asked to submit a list of names in the following five categories at both corporate and plant locations:

1. high level staff executives in the area of personnel administration, industrial relations, etc., who are concerned with formulating policies regarding manpower utilization and projection,

2. high level line executives with major responsibility for directing and coordinating manufacturing and business operations,
3. relatively subordinate staff personnel with major responsibility for implementing management policies concerning recruitment, selection, placement, and training of personnel for automated jobs,
4. specialized officials engaged in or responsible for the design and implementation of existing or proposed numerical control production systems or EDP information and accounting systems,
5. individuals responsible for such tasks as scheduling, cost estimating, feasibility analyses, etc., concerning utilization of or conversion to automated functioning.

A total of 123 names was submitted of which 94 persons were actually interviewed. This represents a response rate of 76.5 percent for this group of informants. The complete list of names, titles, and company affiliations of all interviewees is appended. However, the number of those in each category is given below:

Designation	Number of Those Interviewed
Industrial and personnel relations administrators	34
Production executives and managers	28
Specialists in recruiting, training, and manpower development	15
Supervisors of numerical control and EDP operations	12
Industrial engineers	5
Total	94

In each interview the focus of attention was on the nature of automation as <u>perceived</u> by the informant, and his evaluation of its impact on employees, jobs, skill, training, and related aspects. The interviews were conducted privately, usually in the executive's office. They took from one to three hours although the average interview lasted about 90 minutes. In most cases the interviews were conducted individually. However, in a few instances group interviews were held with two, three, and in one case five management personnel.

The areas of exploration in the interviews may be summarized as follows:

I. Concept of "automation"--interviewees understanding of the term

II. Impact of automation on the nature of work and jobs

III. Effects of automation on:

- a. skills
- b. size and composition of the work force
- c. recruitment, selection, and placement policies
- d. training and retraining programs
- e. organization and methods of operation

IV. Attitudes toward automation by:

- a. top management
- b. key plant personnel
- c. middle management

The following is intended to be a summary statement of findings. It should be stressed that these "findings" are impressionistic rather than the result of a complete content analysis of the interviews. A more comprehensive evaluation of the responses is being undertaken and will be made available.

Perception of Automation: The term "automation" is a nebulous one having varying meanings for almost every individual. Each person perceives a different aspect or view of what automation entails and its effects. The common view was that automation is a process, an automatic process, in which the sequences of an operation are controlled by machines rather than by individual craftsmen. The emphasis was on the automatic process; the lack of human control and judgment over that process; the substitution of machines for manpower; the mechanization of mental and sensory activities.

Many stressed the positive benefits of automation, focusing on automated equipment as a new instrument that frees man from repetitive and monotonous tasks so that he may develop and use his creative talents.

Others stated that some kind of typology was necessary to describe the many varieties of automation. The typologies varied from description of the organization of the processes (linear, cyclical, etc.), to its use in different industries (oil refineries compared with aerospace), and to a division of labor for a given machine (NC), or for processes within the aerospace industry (engineer-scientist, factory, clerical). All of these descriptions added to and refined the definition of automation as "automatic control."

Effects of Automation: The introduction of a major new process or new equipment gives rise to a chain reaction involving changes in many aspects of production. A modification in the basic method of doing a job, producing a part, or processing data, affects and alters other aspects of work--its organization, skills required, personal relationships, training, and work force composition. As a pebble tossed into a pond generates many concentric circle waves, so a modification in technology produces widespread changes and some disruptions; none of which can be evaluated as isolated events.

A recurring observation on the effects of automation centered on its limited penetration in the aerospace industry, which could never be completely automated because of the nature of its products. Aircraft--planes, missles and space vehicles--are essentially custom-built, requiring limited quantities of many differing parts. Automation is practical only when many varied assemblies require the same parts. However, a substantial segment of the work in aerospace is directly affected by automated equipment. Without computers, for example, much of the research, new techniques, and even the missile-space programs, would be virtually impossible.

Skills: Automated devices alter skill levels and training requirements of those affected. The general consensus was that the skill level of the designer and programmer would increase while that of the machine operator would decrease. Most felt that one effect, therefore, would be to create a bimodal distribution of the labor market related to automated jobs.

Several modifications of this model were stressed by many interviewees. It was often noted that this description indicates how automation would theoretically affect skill levels. In practice, however, the results could be quite different. Difficulties in adapting to new machines and equipment breakdowns necessitated employment of highly qualified operators. The firms would often place their most skilled operators of conventional equipment on the automated machines. After the initial installation, these individuals would be replaced, but again, by highly skilled workers. Advances in technology and better performance of the equipment were cited as necessities before unskilled or even less skilled operators could be hired and assigned to these jobs.

Several of those interviewed gave a more detailed categorization of occupations whose skill levels were affected than the simple operator/programmer dichotomy. Some focused on the maintenance mechanic's skills which are altered considerably by the introduction of automation. The maintenance of the new equipment requires a considerably higher or broader skill level, including the addition of an entirely new kind of skill--electronic maintenance. The maintenance technician must have sufficient knowledge of mechanical, electrical, and especially electronic aspects of computers and automated equipment to effectively "trouble shoot" and keep them in working order.

Other distinctions were made within three groups, i.e., programmer, operator, and maintenance. The part programmer required less skill than the computer programmer (scientific and business) and the computer technician. In addition to programmers there is a need for analysts to interpret and plan various projects, and to contend with interface problems. One executive projected that product programmers who deal entirely with applications will become obsolete. Rather, more systems design people able to visualize and understand the entire scope will be needed. Programming of languages of the future, for example, will become so complex that one will be able to write program applications from decision tables.

What are the different types of skills that automated equipment requires? When one speaks of a higher or lower skill level, what is being referred to? Those who felt that operator skills were decreased asserted that the automatic controls of the machine reduced the need for judgment and the number of operator decisions to be made. The basic decisions on speeds, feeds, depth, and width of cuts, etc. were made by the parts-programmer and were contained on the tape. Although the NC operator can override the tape, if necessary, he is generally no longer called upon to make qualitative judgments in the machining of a part. The need for the computer operator's knowledge of the computer mechanism is declining. He is no longer required to know the details of how the computer works, but only how to start or restart it. In essence, the computer operator is like the automobile driver who does not need to know much about the internal mechanism which powers the vehicle.

The programmers, on the other hand, require a variety of new and more demanding skills. The parts programmers for NC equipment need an extensive math background plus advanced understanding of cutting and tooling principles. He must be able to visualize the cause and effect of the entire sequence that the equipment must follow in order to machine a piece of metal. Thus, the requirements for mental and visual ability have increased considerably.

There is, moreover, a third category closely related to the programmer--that is the systems analyst and/or computer technician. These individuals must be generalists--understand everything about the computer and function also as public relations men. They must meet all interface problems, as well as plan and analyze data processing results. These are the men who wear "many hats." They must have the ability to communicate well, maintain good rapport with fellow workers, operators and customers, understand computer operations, and visualize complex operations in their entirety.

Finally, maintenance technicians are required to obtain training or schooling in several new types of skills. Maintenance is neither mechanical nor electrical, but requires a combination of skills to effectively "trouble shoot" automated equipment. The technician working on such equipment, is therefore, more knowledgeable and has a broader range of skills than one who maintains conventional machines.

One informant observed that the definition of a "skilled worker" was undergoing change. Skill and skill levels were being redefined. Skill now revolves around one's relationship to NC or EDP programming. This new definition of skill may erode traditional skill titles and alters one's perception of the term.

Ideal Type Employee: A number of informants presented a profile of the qualities and characteristics of the "ideal" employee. The specifics varied according to the type of job used as an example and the preparation necessary for its adequate performance. Nevertheless, several generalizations and significant observations can be drawn from these typologies.

Of all the characteristics desired, motivation--interest in advancement--was the most important quality an individual could possess. Education, training, and experience hurdles could be overcome if a person were sufficiently motivated. On the other hand, lacking proper motivation, these requirements could constitute insuperable obstacles. Other attributes of the "ideal" employee related to his stability and reliability. Married men with families were often preferred as reflecting such attributes.

Desired educational levels ranged, of course, according to the position cited as an example. Several interesting observations were made about hiring college graduates. In many occupations, such persons were considered poor risks because they seek prestigious positions too quickly. One interviewee stated it took the same amount of time to train a machinist in mathematics as it did to train a college-degree mathematician in the practical aspects of machine operation. The mathematician tends to leave the department sooner for a more prestigious status whereas the journeymen machinist will tend to remain for a much longer period of time.

Finally, concerning the question of an "ideal" employee, one must redefine the term "ideal." Do we want such qualities to relate to efficiency or to those of an ideal person? It is questionable if one can be, at the same time, an ideal human being and the ideal efficient person that industry seeks. Dedication and ability to lose oneself in work--narrowing and specialization--are the qualities of the efficient worker. To the extent that the individual removes himself from tradition, nature, etc., he is considered less of an ideal human being. One comment concerned the paradox of these two conceptions of "ideal." The aim of efficient production has been the basis of industrialized society; while the philosophical values of the good life are important for the welfare and happiness of the individual. The conflict between these two concepts must be appreciated in any discussion of the "ideal" employee.

Personnel Composition: Automation introduces many changes in the organization of the production process and the particular demands made upon employees. What has been the effect of automation on the general composition of the work force in a company? Have there been significant changes in the characteristics of people working for the firm--older vs. younger, women vs. men, skilled vs. non-skilled, etc.?

The general consensus of those interviewed was that automation in itself has not resulted in any marked change in personnel composition. Certain tendencies were noted, but many of the current changes were attributed to other more immediate factors, such as a tight labor market or reorganization of the company. Nevertheless, some significant changes in composition of the work force did take place at these plants as summarized below:

1. Ratio of blue- to white-collar workers. This ratio has changed substantially in the last decade. At one large aerospace firm the percentage of engineers had increased from 10 percent to 25 percent of the company's payroll in the past 15 years. The numbers of clerical personnel and white-collar support for production workers are steadily increasing, concurrent with a general upgrading of skill levels. One interviewee in a medium-sized firm stated that in the last 15 years the ratio of engineers to other personnel had increased from 25 percent to 60 percent. Others noted the same trend. In 1962, 55 percent of the employees in aerospace were directly connected with manufacturing; in 1967 this number declined to 48 percent. The engineers have increased in both numbers and skill levels. Respondents from all six firms agreed that the ratio of direct/indirect production had altered significantly. About 60 percent of the work force today is support for the direct labor production. Thus, direct labor has increased, and the ratio of blue/white-collar workers has declined.

2. Education level. The consensus on changes in education level within a company was that automation had upgraded the labor force, had increased specialization and required more education and specialized training of its employees.

3. Ratio of younger to older workers. In general, there was a substantial increase in the numbers of younger workers in all firms. However some informants doubted that this trend could be attributed to the effects of automation. Other factors such as expansion of facilities, reorganization, and a tight labor market were cited as possible causes for the influx of younger employees. One might speculate, however, on the relationship between reorganization and expansion and the impact of automation. Has the advance in automated technology contributed to or made possible such expansion?

There were two contradictory observations regarding the quality of today's younger worker. Some believed that he was ill-prepared for the current needs of industry; whereas others argued that the younger employees were better suited to the demands of automation than were older or middle-aged persons.

Some General Conclusions

1. Since the aerospace industry continues to be a "growth" industry, little difficulty has been experienced in absorbing employees displaced by automation. The more drastic changes in manpower requirements (sometimes involving large scale layoffs) are more often the result of changes in governmental policy (particularly military) than of changes in technology.

2. One executive interviewed observed that: "the average man in the aerospace industry should go through three to five careers during his lifetime with the company." This comment was intended to reflect the speed with which conditions change in the industry. The aircraft and aerospace industry has had a history of rapid changes in methods, technology, and end products.

3. Even though aerospace probably has more automated equipment in office and factory than most other industries on the West Coast, the rate of technological change has not been so rapid as to seriously impede personnel and occupational adjustments.

4. There seems to be a reluctance to increase the pace of automation particularly in manufacturing processes. Numerical control machines require a tremendous investment in fixed equipment. An adequate payoff from this investment requires almost constant utilization. Unless NC machines can be kept functioning almost around the clock and virtually seven days a week, the operation becomes uneconomical. Furthermore, down-time on automated equipment is much more costly than on non-automated technology.

5. Recruitment of personnel for NC jobs has been largely accomplished by transfers within the plant. In most firms highly skilled machinists and engineers have been selected and assigned to work on automated jobs, especially in the case of NC equipment.

6. The maintenance mechanic has become more important than the operator in both NC and EDP areas. Keeping the equipment in constant use and minimizing down-time are primarily the responsibility of the maintenance mechanic rather than of the machine operator.

7. Company sponsored training programs for automated jobs vary considerably depending upon whether the job involves NC equipment or EDP computers. Most firms support elaborate training programs for numerical control jobs. However, very few conduct courses for EDP jobs. Training for the latter is quite expensive because substantial machine time is required and there is a need for using the larger computers. Another

factor limiting company training programs for EDP jobs arises from the general instability of the skilled EDP programmer. Job mobility is characteristic of this classification and few firms are inclined to invest large amounts of time and money in training someone who may leave for a better paying job within a few weeks after completion of the program. Furthermore, most manufacturers of EDP equipment (particularly IBM) maintain extensive training programs of their own. The high turnover rate among programmers has created a critical shortage problem for many firms. Competition is keen, pirating of manpower is widespread, and salaries have been escalating rapidly.

8. The situation is not so acute in jobs related to NC. Nevertheless, NC programming has a serious problem in that it has become a relatively routinized task. Several NC production supervisors stated that unless an NC programmer possessed another skill or took steps to acquire other skills, he would soon find himself automated out of existence. New generations of computers, as well as the natural language techniques utilized, all indicate that NC programming will be obsolete within a few years. In some cases the NC programmer has already been reduced to a status little better than that of a clerk.

9. There seems to be a reluctance on the part of top management in some firms to increase the pace of automated technology. Some observers noted that many representatives of management were not prepared to make proper use of the new technology. This feeling reflected itself in statements of frustration by higher level of NC and EDP supervisors. They considered that top management was unwilling or unable to make the best use of the tools and techniques available. There was concern that some

levels of management do not yet know what questions to ask, nor how to exploit the tremendous potential of the automated systems which they have at their disposal.

10. Top management respondents were aware of the situation referred to above and acknowledged its existence. However, it was noted that they must cope with a number of other problems such as cost factors, recruitment, and training, etc. They agreed that their colleagues were somewhat behind the times when it came to understanding the significance of automated equipment and welcomed the opportunity to be better informed. Some respondents stated that the industry automates only when it must, meaning that if a particular job cannot be effectively performed by conventional production methods, then automation will be encouraged in order to accomplish the necessary function. This situation has been accentuated in recent years as the customer has increased his knowledge of the new technology. The customer may demand production that can be accomplished effectively only by modern automated equipment. A chain reaction seems to have been set off among the firms in the industry since most compete with one another in order to obtain particular contracts. One respondent said: "Given the choice, we would never go to automation. We would always prefer to use manpower as against machinepower whenever that is possible." A significant factor has been the growing tendency on the part of the federal government, the largest customer of the aerospace industry, to insist upon fixed-price as opposed to cost-plus contracts. Under the constraints of a fixed-price arrangement, many firms have found it essential to maximize labor and cost savings. The results have led to increased automation.

11. Automation has had a considerable impact on recruitment policies. Some firms have found it possible to simultaneously raise and lower their sights in the hiring of new personnel. One tendency is the attempt to get the most qualified persons, the "top" specialists and technicians, to work with the new technology--raising the sights. At the same time, however, the greater use of automated equipment has made it possible to recruit persons with lower skills, to up-grade them through training, and thus provide a broader entry into the labor force which can be a major factor in employing the disadvantaged and minority populations--lowering the sights.

12. The impact of automation on skill levels varies with the length of time the automated equipment has been in operation. The early phases of automated operation tend to have greater adverse effects on those persons in the lower and middle skill levels. However, in the later phases of automation the adverse effects tend to be on those at the upper skill levels and at middle management.

13. Personnel and training officials considered that the transition to NC equipment and automation in general has been an important factor in motivating many employees to seek higher educational levels. These employees are then able to qualify for higher skill ratings, better jobs, and increased pay. Accordingly, the transition to automation has been viewed as a positive factor in the minds of many aerospace employees.

14. Different levels of educational attainment and experience were sought for NC jobs in sharp contrast to EDP related positions. For EDP, it was almost axiomatic that at least a Bachelor's degree in physics or mathematics was required as well as some grounding in philosophy and logic. Additional experience with computers and programming was greatly desired.

For NC jobs, however, the optimum level of educational attainment was considered to be about two years of college. NC programming requires a person beyond high school, but not necessarily completion of college work. Two years at college would tend to give an applicant a better background in mathematics and assist him in more logical ways of approaching and solving problems. However, no significant increase in effectiveness for NC programming jobs could be obtained by higher educational achievement. Thus a college graduate, or one with a Master's degree, would generally be no better qualified for NC work than would a man with only two years of college. On the contrary, the additional education might be a detriment in that he would find NC work insufficiently challenging.

15. Many respondents noted that automation is still a relatively small factor in aerospace production. Some estimated that no more than 10 percent of all manufacturing could be considered automated in terms of using NC equipment. Other frequent observations concerned the limited possibility of increasing the number of NC machines. Some stated there would never be a time when more than 50 percent of all production would be performed with NC technology. Even this estimate was considered much too high by others.

16. However, with respect to office and clerical work, the situation was completely different. There was general agreement that EDP computers would continue to take over and completely replace persons in white-collar and clerical jobs. Automation in aerospace has been most evident in EDP and its application to office, clerical, and control functions. However, even here there has not been too much adverse impact in terms of employee displacement. The introduction of computers has tended to increase the

amount of work to be performed. There is the concomitant need for personnel to operate and maintain the equipment and perform related tasks.

17. An interesting observation was that the trend toward automation has created a counter action away from automation. Automation has created a greater need for such products as buses and trucks resulting in an increased demand for production and maintenance skills. Greater production means more personnel is required in performing non-automated tasks such as those involved in transporting the finished products.

APPENDIX

MANAGEMENT INTERVIEWS: NAMES, TITLES, AND COMPANY AFFILIATIONS

Aerojet-General Corporation

1. Andrews, Charles F., Materials Manager
2. Bromlee, Jack, Manufacturing Specialist, Aircraft Structures Department
3. Cook, F.M., Foreman, Electronic Manufacturing
4. Cramer, E.S., Supervisor, Education and Training
5. Delich, F.P., Numerical Control Specialist
6. Eggleston, R.W., Manager, Data Processing Operations
7. Green, Philip, Director, Data Processing
8. Howell, R.D., Manager, Industrial Engineering
9. Johnson, E.J., Corporate Manager, Labor Relations
10. Knabb, William, Manufacturing Manager
11. Lucas, S.D., Manufacturing Engineer
12. Martin, John Leo, Personnel Manager for Mark 46
13. Mead, John L., Vice President, Industrial Relations
14. Murphy, Walter J., Corporate Manager, Employment
15. O'Flaherty, Daniel, Corporate Manager, Organization and Employee Compensation
16. Paine, George, Assistant Controller
17. Porter, W.D., Operations Control General Supervisor
18. Riccioni, D.E., Supervisor, Manufacturing Engineers, Manager of the Mark 46, Electronic Manufacturing
19. Sharp, M.K., Manager, Mechanical Production Control
20. Shupe, H.C., Information Systems Supervisor

21. Thompson, Larry, Personnel Manager

22. Tulloss, W.B., Senior Staff Assistant, Personnel Problems

23. Vance, Charles F., Manager, Electronic Manufacturing and Electronic Systems Division

24. Wiseman, Martin R., Corporate Manager, Employee Services

Hughes Aircraft Company

25. Biddle, Charles, Manager, Industrial Engineering, Ground Systems

26. Bigelow, John A., Manager, Industrial Relations, Services Division

27. Brenner, Walter, Manager, Data Processing Operations

28. Buchoz, Mark, Head, Benefits and Research, Industrial Relations

29. Carlile, Robert W., Manager, Industrial Dynamics, Ground Systems

30. Cox, James C., Manager, Personnel Administration, Corporate Industrial Relations

31. Lincoln, Norman, Head, Education and Training

32. Lucas, Paul V., Superintendent, Metal Fabrication, Ground Systems

33. Maluy, Tack, Manager, Management Systems Operation

34. Martin, Robert A., Head, Employees Services Division

35. Miller, Keith I., Manager, Management Methods, Ground Systems

36. O'Connor, James, Head, Personnel Staffing

37. Steinhoff, Harry W., Jr., Chief, Industrial Engineering

38. Theissen, Wilhelm J., Head, Project Development Section, Business Data Processing Operations

Lockheed Aircraft Corporation

39. Banfield, Philip, Training Coordinator

40. Brenner, Jack, Testing and Research Administrator

41. Bruner, William, Wage and Salary Manager

42. Des Lauriers, Eugene, Employment Manager

43. Durr, Robert, Training Specialist

44. Forth, Carl, Industrial Engineer

45. Guerin, John, Hourly Occupations Supervisor

46. Hodgson, James D., Corporate Director for Industrial Relations

47. Johnson, Norvell, Electronic Data Processing Manager

48. Kadushin, Jack, Supervisor of Training

49. Knox, William, Training Specialist, Numerical Control and Metal Trades

50. Kunze, Karl, Manager, Training and Employment

51. Landon, John, Supervisor, Numerical Control in Metal Trades Training

52. Patterson, Donald, Personnel Unit Supervisor

53. Pettefer, J. Carroll, Labor Relations Manager

54. Pote, Fred, Employee Representative of Salaried Workers

55. Ross, Ray, Numerical Control Manager

56. Winston, Harry, Branch Director, Industrial Relations

57. Yates, J.D., Employee Representative of Hourly Workers

<u>McDonnell Douglas Corporation</u> (formerly Douglas Aircraft Company)

58. Ballew, W.R., Staff Employment Representative

59. Cavaness, A.E., Wage and Salary Administration

60. Counts, J.C., Vice President, Employee Relations

61. Faulks, R.H., Staff Employee Development

62. Hays, Clint, General Supervisor, Numerical Control

63. Healy, P.D., Production Cost Supervisor

64. Hutchinson, D.H., Manager, Manpower Training

65. Kinney, Walter, Manager, Manufacturing Facilities and Equipment

66. McCleary, S. Vincent, Manager, Government Manpower Programs

67. Peterson, Russell, Assistant Director, Employee Relations

68. Rawlins, H.C., Assistant Director, Employee Relations

69. Willis, F.F., Director, Manufacturing Engineering

70. Woods, M.N., Supervisor, Numerical Control

North American Rockwell (formerly North American Aviation, Inc.)

71. Brunetti, Eugene, Employment Functions

72. Cunningham, Robert, Manager, Personnel Relations

73. Edwards, Robert, Manager, Wage and Salary

74. Frantz, Ernest, Staff, Manpower Development

75. Hill, H.S., Manager, Manpower Development

76. Jarvis, Norman, Administrator, College Education

77. Johnson, W.B., Numerical Control Coordinator, Facilities and Industrial Engineering

78. Leseman, W.J., Director, Facilities and Industrial Engineering

79. McPherson, Eugene, Personnel Development and Training

80. Pietrowski, J.W., Manager, Personnel Services

81. Rogers, J.J., Manager, Plant Services

82. Wilson, Dr. R.K., Vice President and Corporate Director, Facilities and Industrial Engineering

83. Zook, Dwight R., Corporate Director, Personnel Services

Northrop Corporation

84. Aggen, Richard, Unit Supervisor, Numerical Design

85. Herrman, David T., Chief, Programming Support

86. Jeffcoat, Jack, Compensation Administrator

87. Judd, Leonard, Project Head, IMS

88. Lotz, Sidney, Director of Operations, Data Processing

89. Morris, Robert, Assistant Unit Supervisor, Numerical Design

90. Thompson, Reece, Head, Systems Analysis Division

91. Thornton, Glenn, Chief, Programming Area

92. Walton, Larry, Chief, Personnel Development and Training

93. Wilson, Ed, Supervisor, IMS Project

94. Yamashita, Tak, Director of Programming

APPENDIX II
SAMPLE INTERVIEW WITH MANAGEMENT PERSONNEL
UCLA AUTOMATION STUDY MANAGEMENT SURVEY

An aerospace company, Los Angeles

Date of interview: November 17, 1967

Persons interviewed: H.R., Assistant Director, Employee Relations and D.H., Manager, Manpower Training

Persons interviewing: Dr. Paul Prasow and Sharon Nichols

R's definition of automation was as follows: "My general philosophy of automation is that you would be accomplishing things by automated means which were normally done manually."

Mr. H's definition was: "I have a great deal of difficulty with the word 'automation.' I try and avoid it. I prefer to think of automated systems as one of the types of systems within our organization that have some impact on the field."

Mr. H went on to say that it was the continuous use of machines, but he explained that his experience has been with business and engineers not with machines. There has been some impact of automation in business and engineering but most of it is felt in the manufacturing end of the company.

Computers can be used for problem solving in data processing, engineering data processing, in all data systems, and in collecting data from satellites. Automation is that smaller part of the impact of information technology on manufacturing.

Automation is used in scheduling, budgeting, cost, obtaining status reports, timekeeping, payrolls, etc. This newly developed methodology is oriented toward the missile and space systems. The use of computers is growing up at the same time as program methods are coming into being.

Many of the things that could not have been done before automation (computers) has given rise to many new technologies especially in the space industries that have in turn created new demands and requirements that could not have been met or handled before automation.

Mr. R. stated that the computer operator classification was first made in 1956.

Mr. H. gave three areas in which automation has been felt. They are: analysis, design, and testing.

Analysis

There is analytic type of engineering in the space science area and it is used in future systems (directive) and in testing and designing. Also, computers are used in problem solving such as: flight control, certain types of control surfaces, shape of missile, etc. The development has also gone from hand computers to electronic computers.

Design

There is less automation in the actual designing of something. Automation is mainly used in the business end of things. The problem of keeping track of the flow of drawings and the release system became automated first, leaving the actual designing or drawing to come later. The impact of automation first felt in the drafting area, the routine areas, but not in the engineering department.

Testing

Automation (computers) is often felt in the testing and experimental fields. It can be used in relation to: stress data, flight data, experiment on environment and hardware, etc. Computers are used to convert the information received into forms that can be used by the people who need or want it.

Mr. R. said that NC machines were used in the fabrication department on parts for which a long run was required. If it is a one-of-a-kind product it is a waste of time and could be done cheaper by hand than to use NC machines.

Basically, when we started in using NC equipment we were experimenting. We started with machinists that were on a similar level with the other machinists. We found that it didn't require a master machinist's skill to run these machines but a much lower level man because he was only required to monitor the machine in case of a problem. Because of this we have brought in people with no background whatsoever in machine shop and they have been able to run these expensive machines. In the manufacturing department there is on-the-job training, the previous or present operator teaches the new man how to run the machine and what to do in case of problems.

The maintenance required for these NC machines has increased and so has the skill requirements for maintenance men. This has brought about an upgrading for maintenance men but also for the less skilled operator on NC machines.

The maintenance men are getting their extra training to handle NC machines from representatives of the company from whom the machines were bought. At first they were taught outside the company, but now there is such a demand they have an in-house class but with an instructor from the outside. NC use is mushrooming but the problem is to find programmers for these machines.

The following are some observations about NC operators by Mr. R.

- he has to know what the machine should be doing and can do (its parameters)

.he has to know what problems might be encountered

.he has to know very little about the console next to the NC machine
.he needs to know the safety rules with high speed cutters
.he should be able to take quick action

.he will be more isolated because the machine is larger physically

.there will be less contact with the people in the area because they will be twice as far apart

.he will interface with programmers and high level mechanics

.he will probably be supervised more closely because of the expensive equipment and technical need of these machines

.he will probably do only short runs because the space industry is more specialized and there are not very many long runs connected with it

Mr. H. felt that the impact of automation was really on operating these machines. There is a great difference in the type of people required. The people who ran the calculators, etc., are now beginning to change their skills--they have to begin to understand data processing. They are beginning to interface with data processing people and now their work requires that they are constantly in touch with the computer room. This brings about an interchange between business machine operators and computer operators when they discuss their problems. There is presently a great need to define the vocabulary being used and to understand the user's problems.

A programmer is concerned with the use of setting up a system and testing it out. He designs the instructions and sees how it works. A systems analyst will have a BA degree and usually has prior experience in the area of direct interface and testing.

When prospective programmers are interviewed,the first objective is to find out if their interests are in this field. If they are hired they go through a training program with emphasis on the equipment used by our company. When interviewing is done for the engineering department, we look at his mathematical qualifications and also at his interest in the subject matter. In the training classes we primarily teach them a system for programming and run through exercises to see how they do. Later we give them problems to do on their own.

According to Mr. R. there is a continuing high demand for well-qualified maintenance people because there will be more of it and it will become more complicated than it is today. There is also a need for a middle-skilled operator for the new equipment.

You cannot put everything on NC equipment in our line of business so we must keep some highly-skilled machinists to handle this one-of-a-kind work.

Key punch operators will probably diminish as voice instructed computers are developed.

In regards to schools, there will probably be many changes in the curriculum of secondary and trade schools. Training will have to be adjusted to the trends of the day. The great need will come in teaching people the parameters of the equipment.

IS	Eng.	Bus.	Mfg.	T.C.
man becomes a specialist in any one of these functions (not in line flow with other managements--distinctive career separate from the organization)	Ad. Syst. Research Design Analysis Test	Financial Ad.	Fab. Assemb. Tooling Procurement Reliability Planning (detailed production planning)	apply all of them here

If you are a specialist in administration there will be interface between the IS man and the administration man and soon they both become quite knowledgeable in each other's fields.

This interaction is definitely felt and put into practical use.

APPENDIX III

SAMPLE OF RESPONDENTS' PERCEPTION OF AUTOMATION CONCEPT

Question: Just what does the word "automated" mean to you?

When the tool or device that's used appears to have some unguided intelligence, guided by some numerical things actually. Anything that's automated meakes more problems for me, meaning need more people to do my kind of work. Makes more work for us in the repair of these.

Self-operated, requiring little attention, except for breakdowns. Machines are operated with tapes, but need maintenance (more than conventional).

Tape controlled. Cutters are governed by the tape--just like a tape recorder--sends back impulses. Only company I've worked for where I've worked around automated machines.

Something that's creating higher skilled jobs--for me it opened the door up--that's where my opportunities came in--can open door to a lot of new and interesting jobs. If it hadn't been, then I would have been laid off three years ago. If a job is automated, it would have to be produced 10 times quicker than a regular job--speed up in production probably 10 times. Means my job title--means my bread and butter--without it I would be stuck in a machine shop for the rest of my days and would, more than likely, have been in laboring class--rest of my days.

Machine set up to operate alone with minimum amount of human labor and skill. Less physical labor and less mental.

A machine does the thinking for a person and a lot of the manual labor is taken out. Mass producing of large quantities. Means don't have to have as many set-ups to make a part. Makes identical parts, little variance.

Tape machines--something where a job is done through no effort by the operator. One that requires little or no skill. Machine work done through the use of programmed tapes.

Machine that can run itself if you start it. No automation in my present job. More money to the company--machines pay for themselves and they are required in some jobs.

Require very little work to operate it, all work done for you, push-button. Like my job now, before was in automation job, thinking of quitting.

Something done with machinery. Job makes me feel important. Everybody can't do it. Have to know how to handle the machinery you work with on this job. Don't really know.

Turning products out in an automative form (least of shop aids). Higher production. Advance.

Would be completely done by one person--machine operated by one person that used to be done by many. Work done by many is done by one. I don't know.

I'm not quite sure--I can't explain--I can't tell you--I'm sorry, I can't say. (Respondent became very uncomfortable and simply could not define the word.)

Most of machinery is electrically controlled--tape controlled. Automated equipment requires a little more concentration because machinery is more complicated.

To me, it means my work. To me, means a person should know how to read the prints and to do a particular automated job. Looks up to the company and wants to do a good job for them.

Controlled by tape or electronics. Have to work on automated machines. Have to decide difference between automated part and electrical part.

Machinery is more accurate than a human if you can get it to do what you want it to do.

Machine where you can put a tape in and machine runs by predetermined tape; actually all it is, is a machine where all you do is feed it parts. Something which has been computerized, pre-programmed, something taking very little initiative on part of employees to do. Means my paycheck, lack of timekeepers, ability to machine more complex parts, more rapidly and easily. Whole new skill needed--more ability--where need to know more math.

Less manual labor; taking place of physical labor. Running tape machines cut down the time you would have to take to do a job. Running these is physically as tiring as regular machines. Sups. don't realize this.

Closer related to machinery--anything that moves. Automatically working to plan procedures, make a set-up on a machine so that it works automatically. They're very well equipped automatically.

Less hard work, more work done by machines. Will make job easier. Better and faster work.

VOLUME II

THE IMPACT OF AUTOMATION ON INDIVIDUALS AND JOBS

A Review of Recent Literature

(1956 - 1967)

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THE IMPACT OF AUTOMATION ON INDIVIDUALS AND JOBS:
A Review of Recent Literature

INTRODUCTION

The Study of Skilled Workers in the Los Angeles, California Aircraft Industry is concerned with adjustment problems of employees who have transferred from conventional to automated jobs. It is longitudinal in design to assess changes over time in the attitudes of workers assigned to automated jobs. To obtain a broader perspective and to report on recent scholarly contributions in this field of inquiry, this annotated bibliography on related literature is presented.

In the past decade there has been a growing literature on automation, ranging from detailed case studies of particular firms or industries to generalizations of its revolutionary impact on political and social values, and on the economic institutions of our society. In reviewing the numerous studies on automation,[1] we selected only those published since 1955. We also restricted our selection to investigations based upon empirical research, and which focus on specific aspects of the phenomenon popularly called "automation." Earlier studies appear to have limited relevance as to fundamental changes and new findings that have emerged from recent research, and as to their rigorous differentiation between the concepts of automation and technological change.

The stress on empirical research was considered desirable because much of the literature deals with general aspects of automation, including value judgments as to its present and potential effects on man and society. While such judgments are important, it is difficult to assess their validity without objective criteria and without some consensus on what automation entails. Our interest is primarily in case studies based upon research methodology similar to that used in this project including reliance on questionnaires, interviews, and observation as primary data gathering techniques. Longitudinal studies which provide comparative data over time are especially relevant.

Finally, in accordance with our research design, our focus here is limited to certain specific aspects of the broad spectrum of automation:

1. The nature of change in work assignment, job content, skill requirements, and physical environment.
2. The effect of change in job duties on individual attitudes and interpersonal relations.
3. Automation readiness, i.e., the personal and social characteristics affecting attitudes.
4. Automation supportiveness, i.e., the firm's reaction to change, its manner of introducing change, and its attitude toward training.

This review, therefore, will exclude studies concerned with other important aspects of automation. For example, we are not directly concerned with structural unemployment, deficient aggregate demand, or training programs for the unemployed. We must also omit studies on the implications of automation for social and political change, and the impact of technological change on bureaucratic organizations. We are not now concerned with the effects of automation on collective bargaining, or on job evaluation, intriguing as these subjects may be. Finally, we do not intend to make any prescriptive or policy suggestions. This chapter is essentially a survey and description of those investigations on automation that are considered directly relevant and supplementary to the findings of our study.

At the outset it is necessary to arrive at some common definition of "automation" and distinguish this concept from other types of technological change and mechanization. Unfortunately, there is little agreement among the experts as to precise definitions which delineate the main traits, characteristics, and boundaries of these terms.

> This lack of understanding [of the impact of technological change] stems from a confusion of tongues--a failure to define terms and a tendency to lump all technological developments under one increasingly meaningless term: automation. A paucity of statistical data and a tendency to ignore that which does not square with cherished preconceptions is also to some extent responsible. A final element has been the natural tendency of every expert to examine only his own part of the elephant. [2]

Automation has become a popular word to describe almost any kind of technological change. This label has been applied so indiscriminately that the term has relatively little value as an analytical concept; its use generates ambiguity rather than clarity of meaning. Only when a more meaningful and acceptable definition becomes available will this concept be useful for systematic research. This definition should contain a classification system appropriate for analyzing the many forms of technological change, as well as a general theoretical model to accommodate the interrelationship of these various forms. An attempt is made here to categorically define and differentiate specific types of automation and to develop a usable classification scheme. On a general level, many authors have sought to distinguish the onset of automation as arising from either an evolutionary or a revolutionary process.

The evolutionary approach describes automation as a logical extension of the substitution of mechanical for human power that began when man first developed tools to harness the forces of nature. James Bright, for instance, devotes an entire chapter in his book, Automation and Management, to the history and evolutionary nature of manufacturing.[3] In his introduction he quotes Leonardo da Vinci, who, almost 500 years ago, believed that men were working on "automation."[4] E. R. Crossman observes that automation constitutes the second stage of the Industrial Revolution. To distinguish this phenomenon from general technological progress, he defines automation as "the replacement of human information processes by mechanical ones."[5] He further proposes a taxonomy of jobs, based on abstract analysis, a scheme akin to chemistry's Periodic Table, where future jobs could be identified and their characteristics predicted. This taxonomy would indicate the nature of further developments and effects of automation on society.[6] Although he denies that automation has existed for more than 500 years, he nevertheless sees it as an extension and logical development of the Industrial Revolution of the 18th century.

Other writers perceive technological developments of the last few decades as constituting significant breaks with the past, having revolutionary effects on society and organization of work. Automation is considered not merely an extension nor rationalization of an earlier process -- it is seen as based on an entirely different principle. The varied applications of electronics, for example, are considered to have altered human perception, experience, and reaction to the world.

Charles Killingsworth states that automation differs significantly from earlier forms of technology. He defines it as "the mechanization of sensory, thought, and control processes." 7/ The mechanization of these processes differ greatly in their impact from the mechanization of human labor power. He warns that the importance of this distinction is being too often neglected:

> There are a great many people who argue that there is no difference between present-day automation and what we have always known as technological change. Some people would even say that automation began when the first cave man picked up a flint or a stone and used it as an ax. I think that these people are missing the point, and that their belief is a major source of error in trying to discover the problems growing out of automation. 8/

The revolutionary effects of automation are found in its broader applicability, its speed and the fact that it is the product of a new source of invention -- basic science.

John Diebold also discusses the revolutionary nature of the automative processes we are witnessing today. The term, Industrial Revolution, is used not so much to describe the revolutionary machinery of the era but rather to indicate that these machines created a completely new environment for man, a new way of life and a new outlook. He sees today's machines as instruments of revolutionary change:

> Today's machines are far more powerful agents for social change than those of the first Industrial Revolution. For they result from a new found ability to build systems that process and communicate information, translate from one language to another . . . the technology of automation is a tool that vastly extends the range of human capability and that will fundamentally alter human society. 9/

The very nature of this technology will force many to reconsider our whole approach to work, society and life itself.

Marshall McLuhan is perhaps the most vocal and controversial commentator on the revolutionary nature of technological change. He sees each new technology or "medium" as an extension of a part of the human body. The extension of any one sense alters the relationship among all the senses and thereby transforms the style, content, and perception of life. "Speech, writing, and now seeing" are noted as the revolutionary changes in the medium which have caused fundamental societal change. Automation, therefore, represents a totally new kind of technology:

> Automation is not an extension of the mechanical principles of fragmentation and separation of operations. It is rather the invasion of the mechanical world by the instantaneous character of electricity. 10

Automation is considered a total break with past technology; it orients man's work, actions, and perceptions in a novel way.

Viewing the problem in historical perspective may be of value in two ways: (a) it may help determine an appropriate classification system to analyze and categorize the various dimensions of automation; and (b) it may provide useful clues on how one studies the very phenomenon of automation. If the revolutionary approach is accepted, then perceptions and attitudes toward reality are altered significantly. The motivation of man's action in the future will be based on considerations different from those now considered valid. If automation is indeed a revolutionary break with the past, then the studies developing present categories and concepts are useless and irrelevant for predicting what society will be like or what effect automation will have on worker attitudes. The development of the phenomenon called automation is then analogous to a change in the rules of the game. The very basis of rationality changes; the definition of reality and one's orientation to it is changed. On the other hand, an evolutionary approach affirms a linear concept of history and a positive notion of the value of progress. Therefore, it is of utmost importance that we recognize and delineate the implications and consequences of both schools of thought.

Another significant approach to the study of automation involves making a distinction between the replacement of physical human power and mental control, and a new organization of work and production. S. A. Fine, for instance, distinguishes three types of automation: the substitution of machines for 1) physical abilities, 2) mental abilities, and 3) a combination of these abilities.[11] Professor Killingsworth states that automation has become the mechanical equivalent for the sensory organs and extends man's hands and feet -- in essence, his power.[12] J. F. Reintjes agrees with Fine by defining automation as embracing any change that reduces the amount of human effort, mental or physical, required to do a job.[13] The development of feedback control or "servomechanisms" adds a new dimension to automation -- one that parallels the human neuromuscular system. Bright agrees and defines automation as "something significantly more automatic than previously existed in that plant, industry, or location."[14] In order to determine if "something is significantly more automatic," Bright developed a scale of mechanization levels distinguished according to the source of power and the nature of control.[15] Variations are discussed in terms of the level or degree of automaticity, the span or spread across the total sequence of required activities, and the penetration of automation into the supporting operations. These categories are meant to measure the degree of automation, not to distinguish automation from nonautomation. There are no clear-cut criteria of what is an automated job; there are only relative and comparative scales. There is no basic difference between automation and general technological change: they are considered identical forces in a dynamic industrial society.

An alternative method of defining automation, as introduced in industry, focuses on its unique organizational characteristics. Michael Crozier and Georges Friedmann note that automation does not provide man with a new instrument or give him some definite material power, but rather that it consists of a new method and a different approach to tackling those problems inherent in the organization of production.[16] D. J. Davies identifies automation with production planning, as does P. F. Ducker, who observes:

> Automation is a concept of the organization of work. It is therefore as applicable to the organization of distribution or of clerical work as to that of industrial production. [17]

John Diebold was the first to link the word automation to the concept of the automated factory.[18] He calls it a new approach to production:

> It is no longer necessary to think in terms of individual machines, or even in terms of groups of machines; instead, for the first time, it is practical to look at an entire production or information handling process as an integrated system and not a series of individual steps. . . . Automation is more than a series of new machines and more basic than any particular hardware. It is a way of thinking as much as it is a way of doing. [19]

Automation is, therefore, seen in terms of organizational change rather than as an extension or substitution of human power or sensory organs.

We have emphasized these concepts and definitions not simply to illustrate the diversity of approach, but to stress the importance of how this pehnomenon is perceived and defined. The selection of one particular perspective highlights certain problems, but may ignore others just as fundamental in their impact on society. The problem of definition is underscored here because a more structured and explicit conceptualization is highly desirable and may lead to clarification of some major inconsistencies and conflicts found in the literature. In reviewing the current writings, however, we are necessarily working within the structure erected by the various authors.

At the outset technological change will be treated as a "shock" to the social system of the firm. The section following is concerned with the changed content of jobs and the resultant effects on requisite skills and physical environment. Their impact on workers' attitudes and social relationships will be taken up in the second section; and we will also consider both the technological and human aspects of automation which create adjustment problems for the individual and the firm. The third section discusses those factors that influence worker effectiveness in coping with change -- his "automation readiness." The last section focuses on the ability of the firm to adapt successfully to technological change -- i.e., "automation supportiveness."

I. THE NATURE OF CHANGE IN JOB CONTENT AND SKILL REQUIREMENTS

Automation introduces some basic changes in job content and skill requirements which have a significant impact on the worker. By definition automation affects a wide variety of occupational categories. Fundamental questions explored by students of our contemporary economic society are:

(1) What is the impact, i.e., the scope and penetration of automation in our society?

(2) What is the real nature of the change in automated jobs?

(3) Has work under automation become more interesting, complex, skilled, demanding--or is the reverse true?

(4) In specific situations, what are the trends in the change of job content?

(5) Have requisite skill levels increased, decreased, bipolarized, or converged?

(6) Has the traditional classification of jobs into unskilled, semiskilled, skilled, and professional occupations become obsolete?

(7) What classifications now call for different or higher educational and training requirements due to automation?

(8) Are there significant training and skill differences between operator and maintenance positions?

(9) Is it valid to consider changed skill levels as a problem unique to automation?

(10) Finally, are there significant changes in the employee's physical working environment due to installation of automated equipment?

In treating the changing nature of job content and skill requirements, we are concerned primarily with the following: (1) The impact of automation, its scope and penetration; (2) Changes in job content; (3) Changes in job classifications; (4) Changes in training and in types of skills; and (5) Changes in the physical working environment. Although these topics are covered in many studies of automation, our selection in limited to those reports which have devoted primary attention to them.

1. Automation: Its Scope and Penetration

Over the past decade, many writers have expressed alarm at the rapid advance of automation and have speculated as to its potentially devastating impact on man and society. Although the phenomenon of automation *per se* is important and its effectsmay be revolutionary, there is little concrete evidence to support the conclusion of wholesale and rapid penetration of automation in our society. On the contrary, most studies dealing with the quantitative aspects conclude that the spread of automation in contemporary American industry is slow and relatively limited. The gulf between what is scientifically possible and what is economically feasible remains very great.

Estimates of the trend toward automation, or of its total impact, vary from one writer to another. Mansfield states that the average rate of technological change in the United States is 1.5 percent to 2.5 percent per year, but he quickly adds that this rate varies from industry to industry.[207] Silberman, attempting to refute the "myths" of automation, refers to statistical data that indicate an opposite trend, i.e., an increase in blue-collar employment. If so, this trend poses some fundamental questions about the speed of automative penetration.[21] Others prophesy that automation will spread rapidly--much more so than major technological advances of the past.[22] Such sharp diversity of opinion reflects the controversy over terminology as well as the scope and size of the problem and the difficulty of quantifying the momentum of automation's spread. It also highlights the limited research in this highly complex and confused area. However, in identifying changes in skill level as well as their impact on the labor force and in formulating effective training programs, the question of automation's scope and penetration must be faced realistically if we are to develop adequate manpower policies for the future.

2. Changes in Job Content

A number of researchers have assumed that the introduction of complex equipment must be accompanied by an increase in demand for higher skilled workers to operate and maintain the new facilities. However, a more careful scrutiny of the evidence indicates this assumption must be questioned.

A slightly modified version of this approach appears in the recent literature on automation. Bok states that rather than dramitically raising skill requirements, automation does not call for significantly greater skills; it indirectly helps to raise skill levels because displaced workers were engaged in low-skill tasks. Van Auken concludes that a shift to higher skill levels take place over time; that the relative proportion of skilled jobs is increased.[23] Sultan and Prasow, in The Skill Impact of Automation, cite Bureau of Labor Statistics studies indicating that the introduction of computers in offices does involve upgrading of skills, but that this upgrading is achieved by less extensive use of unskilled workers rather than by a significant increase of skilled workers.[24/]

S. A. Fine as well as Sultan and Prasow suggest that the introduction of automation causes, paradoxically, a simultaneous increase and decrease in the skills required for automated jobs. They propose a bipolarization theory of the work force. In a longitudinal study of 132 workers from electronic tube computers and steel manufacturing companies, Fine found a bimodal split into "low and high functional level jobs." The former required less education, ability, responsibility, and training; whereas the latter called for a significant increase in knowledge and intellectual capabilities.[25/] Likewise, Sultan and Prasow conclude that the skill impact of automation follows the contours found in the bimodal distribution of skills:

(A) (B)

less skill more skill[26/]

However, Crossman, Laner, Davis and Caplan challenge the bimodal distribution of skills theory and conclude that there is a convergence instead. They state that the absence of lower skill levels is due to the fact that other processes were already highly mechanized. They note that at the other extreme, absolute per unit-labor requirements in top skill groups decreased, thus establishing that advanced technology does not substantially raise requirements for highly skilled personnel. They found that the mean skill levels increased except in the technologically highly developed aerospace industry.[27/]

3. Changes in Job Classification

Other authors argue that changes in skill levels involve differences in kind, not in degree. Goodwin, in his study of automation pilot projects, finds inappropriate the entire concept of higher skill requirements. Rather, the changed skill requirements reflect the altered composition of the work force in an automated plant.[28/] Walker also states that automation calls for skills different in kind, not in degree.[29/] He further suggests that jobs should be designed and engineered in a novel way that will eliminate much of the difficulties now found in automated production; jobs should be redesigned and redefined to reflect skill and task changes.[30/]

L. Levine, after reviewing nationwide case studies for the U.S. Department of Labor, proposes a completely new scheme of job classifications to assimilate and reflect the changing nature of jobs in an automated society. Results of his studies indicate that the changed occupational structure has altered the association of certain vocations with specific industries. He notes that many job classifications now have an inter-industry character, which allows for worker mobility among distinctly different industrial processes. Technological change is transforming the very content of occupations. Recognizing this change in job content, the U.S. Department of Labor, Bureau of Employment Security, revised its Dictionary of Occupations and abandoned the traditional occupational classification structure of unskilled, semiskilled, and skilled. Instead, all occupations pertaining to a particular work method are listed in the same group and are ordered by levels of complexity.[31/] The revised Dictionary of Occupations also relates jobs more closely to the education, work method, and technical knowledge required. The groupings represent a more accurate picture of possible job ladders from entry through maximization of particular skills and promote greater worker adaptability and ease of transfer from industry to industry where given skills are relevant. This revision represents a significant break with past concepts of the occupational hierarchy.

4. Changes in Types of Skills: Operational vs. Mechanical

In the above discussion, the impact of automation on skill levels was explored in terms of its general effect on the labor force. However, little effort was made to accurately define the term "skill level." If we examine closely the components of this term, as was done in many recent case studies, we find that skill is a blending of several elements--manual dexterity, knowledge of the art, knowledge of theory, comprehension, and decision-making ability.[32/] In another study "skill" is described as including general educational development, specific vocational preparation, aptitudes, temperaments, and worker functions.[33/] The required skills vary from one industry to another and from job to job.

Several case studies make important distinctions in the skill requirements for different types of job as to the components of the job and the classification of skills. The majority of studies conclude that skill requirements for operator jobs (direct labor) have decreased, whereas those for maintenance and mechanical jobs (indirect labor) have noticeably increased.[34/]

The authors of two research reports disagree with this conclusion; they conclude that there has been no substantial change in occupational content.[35] Horowitz and Herrenstadt compared skill requirements of the late 1940's with those over the next fifteen years--five industries, same occupations--and found that overall changes during that period had been remarkably small. Although they acknowledged there was considerable change in specific occupational requirements, their findings were considered inconclusive with respect to overall skill levels.[36] Their studies indicate that in some cases skill levels have increased and others have decreased. This dichotomy again emphasizes the distinction between operational and mechanical skills. The conclusion that skill levels have not changed during the fifteen year period would indicate the limited penetration of automative techniques, rather than a refutation of the possible differences and changes in skill levels in those jobs that have been automated.

Closely related to the matter of determining the change in skill level is the problem of distinguishing between partial and fully automated plants. The skill levels demanded of workers depend largely upon the extent of automation in the plant. Bright suggests that the gulf between partially and fully automated plants significantly affects skill requirements.[37] Lipstreu and Reed conclude that for those jobs where humans are the "closing control loop" the skill demands are higher; automated tasks, including complete feedback, have lower skill requirements.[38]

Thus, the determination of a change in skill requirements depends upon: (a) the type of task in question, i.e., operational or mechanical; (b) the penetration of automation in production methods; and (c) the degree of automation in a given plant. In the case studies mentioned, there is general agreement that required skills for <u>operators</u> have decreased, while those for maintenance and mechanical tasks have increased. Although this conclusion does not lead to any comparable generalization as to the impact of automation on society as a whole or on skill levels in general, these small changes do have an important effect on training, retraining, and educational requirements, to be examined in greater detail in Section IV.

5. Changes in Physical Environment

So far we have discussed changes in the content of automated jobs--skill, as well as intellectual, attitudinal, and temperamental characteristics. However, the change from a nonautomated to an automated job obviously involves more than a possible change in skill level. The new method affects the physical environment and surroundings in which the individual works. Environmental factors, such as lighting, noise level, safety, ventilation, and cleanliness can all have an important impact on the worker's attitude toward his job.

Many of the researchers refer to environmental changes as constituting significant differences between automated and nonautomated jobs. Automated plants are noted for their newness, better space arrangements, improved lighting, cleanliness, and more desirable safety and health conditions.[39] Many automated jobs are performed in air-conditioned monitor rooms where tasks are performed by means of remote control; such mechanization inevitably results in better safety and health conditions. Ventilation, temperature, humidity, and noise thus may become less significant in affecting the workers' performance. A cleaner and healthier working environment can be considered a positive contribution of automated jobs.

In this section we have discussed the nature of change in the automated job--its content and physical environment. The direction of change in skill levels is still strongly debated. The experts have reached little agreement on the controversy of bipolarization or convergence of skill levels due to automation. Others reject the evolutionary view of skill changes and argue for an essentially revolutionary position, i.e., the skills have been altered so radically that questions pertaining to degree or level of change is unrealistic.

At a lower standard of abstraction, researchers generally concur that the skills required of operators have decreased, whereas those for maintenance employees have increased. However, the scope and penetration of automation itself may seriously limit any implications or conclusions that can be drawn from this statement. Again, research findings are too fragmentary, concepts too ambiguous, and scope is inevitably time-bound.

We focused on the nature of modification in job content in order to explore fundamental changes that may affect attitudes of the worker toward automation. These changes constitute important variables that should be considered in any long-range planning of educational and training programs, as well as in the introduction of automation itself. We now turn to an analysis of the effects of task change on employees' attitudes toward their job and fellow workers.

II. EFFECTS OF BASIC CHANGE ON INDIVIDUAL ATTITUDES AND INTERPERSONAL RELATIONS

The worker's attitude towards his job is influenced by many factors. In this section the impact of automative change on the employee's working environment and job content will be examined as it affects his attitudes to his job, his work community, and his own social relationships.

Changes in the Individual's Relationship to his Work

We have reviewed literature relevant to the following questions: 1) Does the worker enjoy and want "larger," more complex, and more varied tasks? 2) Do the new jobs involve more or less repetitious tasks? 3) Can the worker identify more easily with the overall production process and organization? 4) Do the new tasks increase or decrease boredom? 5) Are the responsibilities of the worker increased by automation? 6) Does he experience increased anxiety and tensions? 7) How does the technological change alter his perceptions of his prospects for advancement?

We have already discussed the implications of technological change on level and type of skills. But requisite skills are only one aspect of what industrial relations specialists mean by "job enlargement," a concept which includes the freedom the worker has to bring his abilities to bear on more complex and varied tasks. Job enlargement is also often associated with a number of more objective characteristics, such as the rate and repetitiveness of the tasks, their relationship to the total production process, the worker's degree of autonomy to vary his work, and the amount of personal interaction allowed.

Production-line jobs are usually considered to be extremely "small," and some writers have viewed automated production in terms of "saving" the worker from the specialization and the forced pace of assembly-line tasks. Two questions arise in this regard: First, do workers really want enlarged jobs? Second, how does automation affect the "size" of tasks? From interviews of workers in a radio-television assembly plant, M. D. Kilbridge concludes he found reason to doubt that workers either desire more encompassing jobs or want to work at their own pace. It is possible, however, that research methodology and open-ended questions have influenced this conclusion and contributed to these results.[40/] Turner and Lawrence have devised another method of approaching the problem.[41/] Based on the assumption that the technological elements are crucial in determining the content of jobs, they developed a requisite task attribute index based on quantifiable characteristics of jobs. The general elements considered in the index were activities, interaction with others, and mental states. The worker's responses were measured in terms of two dependent variables, his attendance and his expressions of satisfaction. The researchers hoped that this approach would lead to generalizations that extend beyond a single technology, industry, or region. A sample of 500 workers was chosen from 47 jobs in eleven different companies. High values on the index, generally, were associated with high attendance rates and strong expressions of satisfaction. C. R. Walker, in a similar approach, suggested eight criteria for evaluating job enlargement. They extend beyond the requisite task attribute index and include such elements as the style of supervisory and managerial control as well as the relationship of the work to personal development.

Walker reviewed a number of completed case studies of plants in various industries which employed diverse technologies and found a general relationship between job enlargement and worker satisfaction.[42]

While research continues on the relationship between job enlargement and worker satisfaction, the second question, "How does automation affect the 'size of tasks?' "needs to be answered. Many writers have commented on specific aspects of that problem. We will discuss their findings in relation to some of the more important elements associated with "job enlargement."

Production-line methods that were introduced into an increasing number of industries during the first half of this century divided the work into simple and repetitive tasks. While much professional interest has now shifted to production processes that involve "feedback," production-line methods have nevertheless been extended. For example, Baumgartel and Goldstein report on the change in workers' attitudes after limited assembly-line processes were introduced into an airline repair shop.[43] They observed increased worker dissatisfaction, a lower evaluation of skill levels, and a reduction in aspiration levels. Alain Touraine _et al_ have identified this process as a phase, "the fragmentation of work, in the process of technological change, in which the worker loses his autonomy and control over his work."[44] They argue that a second stage, the reintegration of work tasks, follows, in which the machinery becomes autonomous of the worker and he loses some aspects of his occupational specialization. In this phase the unit of production would no longer be the job, but a more composite entity. However, Walker cautions that a high-level of technological development may be necessary before such reintegration takes place, noting that in the steel pipe plant which he studied "partial" automation of equipment retained a great deal of repetitious work assignments.[45] Where repetition can be eliminated, greater job satisfaction may result. Faunce, in his study of "Automation and the Automobile Worker" points to the elimination of routine material handling as the most positive influence on workers' satisfaction.[46]

Many researchers have also expressed the hope that as technological change continues and workers are increasingly freed from the repetitive nature of their tasks, they would experience greater job satisfaction through increased identification with the process as a whole and with the final product. Lipstreu and Reed, in their study of increased automation in a bakery, state, "an interesting generalization which may be drawn . . . is . . . that, as the degree of automation increases, more worker satisfaction and involvement may be generated."[47] Beaumont and Helfgott believe that the workers' opportunity to relate to a larger segment of the manufacturing process may not only increase their satisfaction directly, but also indirectly through the formation of and participation in more cohesive work groups. But they caution that the possibility of worker identification with the larger process depends not only on the technology, but also on the workers' ability to understand the production process in its entirety.[48]

There seems to be agreement that the repetitiveness of production-line work is extremely dull. But while the transition to automation may reduce the amount of routine work in a plant, it may also substitute one kind of boredom for another.[49] As the amount of technological change increases, equipment takes over more of the mechanical and sensory functions previously performed by the operator. His tasks shift from active involvement to passive observation and making such corrections as may be needed. Many operating jobs involve short periods of intensive activity, coupled with longer periods of idleness. If the worker is isolated from fellow workers, a topic that will be discussed later, the problem may be compounded. The boredom may affect maintenance personnel as well as operators. Maintenance work is minimal between breakdowns of equipment, but rapid action is needed when breakdowns occur in order to reduce "downtime."[50]

Another, more controversial, question is related to the change in the nature of jobs described above: Is the "responsibility" of operators increased by technological change? Faunce reports that workers in the automated plant he studied felt their jobs involved greater "responsibility" and caused increased anxiety.[51] For the purpose of this chapter, we have defined responsibility as the degree of decision-making authority delegated to an employee in the performance of his job. Although mistakes by an operator of automated equipment can be extremely costly, his permitted range of responses is usually limited. Since his decision-making authority remains highly circumscribed, he cannot be said to have general responsibility in the same sense as the term is used in management.

Nevertheless, operating personnel must remain continually alert for possible malfunctioning of an automated process and be able to act rapidly in order to prevent costly mistakes. It was consistently reported in the case studies reviewed that increased anxiety and tension resulted from operating automated equipment.[52] Beaumont and Helfgott indicated that this anxiety may be so great that former "operators" cannot adjust to automated jobs.[53] It is not clear whether the increased tension and anxiety are permanent phenomena or transitory effects accompanying the introduction of new equipment. Walker notes that while the demand for continuous alertness was at first the most repugnant aspect of the new jobs, it later provided the greatest source of satisfaction for the workers. It is not clear whether all, or only some, of the new jobs will increase the operator's feelings of tension. As mentioned before, Fine, in his discussion of bipolarization of skill levels, distinguishes between low and high functional jobs; the former can be expected to be less, and the latter more, tension producing than nonautomated jobs.[54] The increase in anxiety and tension may account for the fact that workers often find their jobs tiring after the introduction of a technological change, though the requisite physical effort has been greatly reduced. Lipstreau and Reed found in their study that the minimization of fatigue was completely offset by increased mental and emotional fatigue.[55]

Thus far we have discussed the worker's relationship to his job. Before proceeding to the literature on the worker's social relationships, we will mention a few studies that have dealt with the impact of automation on his perceptions of opportunities for advancement. Walker reports that workers in the steel fabricating plant he studied felt that their prospects for advancement were limited by technological change.[56] Lipstreu and Reed heard the same sentiment articulated by the workers they interviewed. These authors, perhaps overgeneralizing, argue that automation will widen the promotional "gaps" between various levels of an organization.[57]

Ida Hoos has found similar attitudes prevailing in a different industry. In her article "When the Computer Takes Over the Office," she tells of keypunch operators who see themselves in a dead-end occupation.[58] However, though technological change may diminish an employee's advancement possibility, it may increase his job security due to more rigid manpower requirements after the introductory period is completed.[59]

Changes in the Individual's Social Relationships

The impact of technological change is not limited to its direct effect on the worker; it can also operate indirectly by modifying his relationship with his fellow workers, his supervisor, his family, and the community in which he lives. The discussion of the relevant literature will focus on a few basic questions: What is the impact of technological change on the cohesiveness of the employee's primary work group? How does it affect his relationship with his supervisor? How will it influence his family life? Does technological change affect his perceived status in the community.

Little is known of the impact of technological change on the cohesiveness of the primary work group; no general trend is yet discernible from case studies of plants in various industries. The answer to the question appears to be highly dependent on the specific nature of new technology introduced. In their study of the conversion from shop to semi-production line methods in an airline repair shop, Baumgartel and Goldstein found that employees' freedom and ability to interact were restricted.[60] Faunce, in his study of technological change in an automotive engine block factory, which primarily involved reduced handling of materials concludes ". . . there was a decrease in opportunity for social interaction, that the interaction which occurred took place within smaller groups of workers, and that there was less apt to be identification with a particular work group in the automated plant." [61] He further found a high correlation between the amount of social interaction reported and workers' expressed level of job satisfaction. Beaumont and Helfgott visited the same factory in preparing Management, Automation and People. While both management and workers admitted that there was some truth in Faunce's conclusion, a majority of the operating personnel interviewed indicated that they preferred their present automated job. [62] Walker, in his study of a "semi-automated" steel pipe mill, noted that the employee's primary work group maintained its cohesiveness. [63] In the bakery, studied by Lipstreu and Reed, the "level of automation" achieved varied from one department to another. No department had a completely self-regulating process when the conversion was completed. The authors observed that after the change the amount of communication between workers had been drastically reduced, a fact that they attribute to the greater physical isolation caused by the new machines. [64] On the other hand, Mann and Hoffman, in their study of automation in an electric power plant, observe that workers had greater opportunity for interaction than at a comparable conventional facility. [65] They further argue that the mutual problem of mastering the new technology resulted in greater interdependence among workers. [66]

Evidence of the impact of automation on foremen and first-line supervisors is more conclusive. As early as 1955, H. C. Craig recognized that supervisory adjustments were among the most difficult personnel problems created by the transition to automation. [67] Bright also found strong evidence that the impact of automation on foremen was more significant than on workmen. [68] Automation demands both greater technical knowledge and social skill of the supervisor. To retain the confidence of his work group, he must acquire a fundamental understanding of the new process.[69] He also is likely to be given additional responsibilities. The advanced scheduling of productive activities often must be more precise, and frequently the supervisor's responsibility is enlarged.[70] It is not surprising that, as Lipstreu and Reed observed, the new processes shifted the foreman's attention from people to machines, and the workers felt that no one was concerned about them.[71] At the same time much more is demanded of the supervisor's human relations skills. Technological change often decreases his span of control and increases his interdependence with those he supervises.[72] Lipstreu and Reed note that after the transition workers were more likely to go to their foreman rather than to their union steward when a difficulty occurred.[73] Mann and Hoffman found in their study of electrical power plants that employee satisfaction showed a higher correlation with the supervisor's human relations skills than with his technical or administrative competence.[74]

With these greatly increased demands on both the technical and social skills of the supervisor, it is not surprising that both managers and workers have complained about his performance. Bright reports that some managers felt that "old" foremen lacked alertness, perception, and judgment regarding the new equipment and did not understand the complications of "downtime."[75] Several studies have reported dissatisfaction, in one way or another, of workers with their supervisor's behavior.[76]

Our survey of the literature has left at least two important questions regarding adjustment problems of supervisors unanswered. We found no discussion of whether the increased demands on the supervisor are temporary or permanent. After he has mastered the new technology, does he again orient himself to human relations? Or are the demands such that he must continually devote a larger proportion of his time to problems like planning and scheduling? It is also not clear to what extent the problem of supervisory adjustment is peculiar to automation. Baumgartel and Goldstein, in their study of a much "lower" level of technological change, found similar difficulties.[77]

A worker's social relationships extend beyond the plant to his family and his community. While the impact of technological change on these relationships will probably be less intense, it may be more pervasive. A few of the more important implications are noted.

Automation involves a more continuous production process and a more intensive capital structure. The high cost of capital and the increased expense of starting and stopping the production process usually make shift work more likely,[78] in offices as well as in factories.[79] Increased shift work may make family and social life more difficult; it may also interrupt the pattern of the worker's life. Technological change may further affect the worker's perception of his status in his community. Lipstreu and Reed note that the employees' evaluation of the company's community image showed a significant decline during the transition to automation.[80] While these authors believe that this reaction is due to increased employee dissatisfaction, Clark Durand finds that a reduction in workers' pride in their work may also be associated with a reduction in the level of skills required by their jobs.[81]

III. AUTOMATION READINESS:

PERSONAL AND SOCIAL CHARACTERISTICS AFFECTING ATTITUDES

Thus far we have summarized our current knowledge of the impact of technological change on the physical and social environments of the worker. In this section we will discuss the literature pertaining to some individual characteristics of the worker, which may influence his success in meeting change.

An individual brings many personal characteristics to his job. They include his age, his character, his socio-economic background, and his educational achievement. From our readings we find that their effects on the worker's ability to meet the challenges of technological change have not been systematically investigated. Rather, comments on one or another aspect of the problem are scattered throughout the literature. The following is a summary of what appear to be the most relevant and important personal and social characteristics, which influence attitudes towards change.

Age

Technological change creates problems for both young and older workers. Perhaps because the difficulties of the latter are generally considered to be greater, the literature has devoted more attention to them. No definite conclusions, however, have emerged. In A Study of the Impact of Automation on Federal Employees, age is found to be a "prohibitive factor" in adjusting to change.[82] On the other hand, Olive Banks found that age was not a significant factor in worker resistance to many job alterations caused by technological change.[83]

Going beyond general judgments of older worker adaptability, the researchers concur that older workers have particular difficulties with retraining which impedes successful adjustment to change. Often their levels of general education are below that of younger people, and, consequently, their abilities to benefit from a rapid retraining program are more limited.[84] Since younger people learn faster, older workers, if retrained in a group that includes all ages, are likely to find this experience particularly frustrating.[85] Automation, moreover, often requires a higher propostion of maintenance personnel. Lipstreu believes that the older worker may not be well oriented to retraining for this type of work. He argues that consequently plant managers will be faced with the unpleasant choice of either having inadequate maintenance personnel or downgrading older workers.[86]

Younger people have other advantages in adapting to technological change. They are generally more mobile than older workers.[87] In addition, it has been found that boredom and tension often associated with automated jobs do not affect them as adversely as they do the older workers.[88] However, because they usually have less seniority, they are the first to be laid off if technological change entails a reduction in the work force.[89]

Age is directly correlated with both mobility and expectations of the value, desirability, and prestige of a new job. It is a significant factor in determining attitudes towards change. Studies have shown that occupational mobility is inversely related to the worker's age.[90] The advantages of seniority, limited job expectations, and a consideration of prestige and job security all combine to induce the older worker to remain stationary -- to maintain the status quo. Although his job expectations are not necessarily lower, they are different in content, and in general he is more opposed to technological change.

Personality Characteristics

In their study of bank clerks, Dean Champion and Edward Dager attempted to correlate scores on Cattell's personality questionnaire with successful adjustment. They found positive relationships for such characteristics as "aloof and cold," "enthusiastic," and "thick-skinned."[91] Although these are interesting results, they may not be representative of workers undergoing automated change because of the small sample size involved.

The worker's mental ability must also be considered. After reviewing psychological trends on the relationship between intellectual capacity and occupation, Henry Winthrop concludes that most semiskilled production workers either have too low a minimum critical range in IQ to permit successful retraining for skilled maintenance positions, or they do not employ their maximum ability in their present jobs.[92] In the latter case, he wonders whether such workers have levels of aspiration sufficient to motivate retraining. It should be noted that Winthrop's conclusion concerning the possibilities of retraining depends on his assumption as the nature of change in skill levels.

Socio-economic Characteristics

The more "visible" socio-economic characteristics have been investigated in greater detail than personality factors. There is general agreement among experts that automation adversely affects women workers. Advanced technology has a detrimental impact on female factory employees, Beaumont and Helfgott assert, largely because it decreases the number of semiskilled machine operator jobs -- occupations in which traditionally a large proportion of the female labor force was employed.[93] Women may also be displaced in the office as well as the factory due to the introduction of automation. Ida Hoos has estimated that for every five office jobs eliminated by automation only one is created.[94] When layoffs occur, the relatively lower mobility of women makesadaptation more difficult.[95] Also, they may be adversely affected by the increase in shift work that often accompanies automation, because some states restrict women's hours of work.[96]

Another socio-economic variable hindering adjustment to automation is race. Beaumont and Helfgott suggest five reasons why Negro employees may be disadvantaged by technological change:

1. Nondiscriminatory hiring policies are of rather recent vintage, and Negro employees are, therefore, invariably the low men on the seniority pole and thus most vulnerable to displacement.

2. Company efforts to aid displaced Negroes in finding other employment locally often run into discriminatory practices in the wider home community, particularly among small companies and among some craft unions.

3. Although Negro employees, particularly the younger ones, are most willing to accept interplant transfers, some companies have found the citizenry of the community to which they are being relocated quite vocal in its objections.

4. The employment of Negro workers in manufacturing industry has been concentrated in unskilled and semiskilled job categories -- the precise areas that are shrinking the fastest.

5. Even where companies are willing to upgrade employees into skilled trades, and engage in retraining to do so, they find that vast numbers of Negro employees lack the educational background to qualify for such training. [97]

However, when Negroes can retain a position within a plant, they may be more satisfied with their automated jobs.[98]

Other socio-economic variables have also been evaluated. Faunce, in a study of employees of a midwestern insurance company, found that a higher social class position was associated with a more favorable attitude towards change.[99,100] He concludes that individuals who identify with the working class may be more conservative towards change affecting their jobs. Faunce also discovered that a rural background correlated with a less favorable attitude towards change.[101] This result agrees with findings in his study of an automotive engine block factory, where workers with rural backgrounds were more dissatisfied with automated jobs and preferred nonautomated ones.[102]

A higher level of education aids the worker in coping with the problems of technological change. As mentioned in connection with older workers and Negroes, it often contributes to the success of retraining programs. Also, more education is positively correlated with greater mobility, another factor that facilitates adjustment.[103] Faunce found the more highly educated were more likely to accept willingly a change in job content.[104]

IV. AUTOMATION SUPPORTIVENESS AND WORKER TRAINING

The firm's managers are usually the individuals who instigate and communicate the introduction of technological change. They must plan ahead and be ready to meet the problems of change when they arise. Two areas where much can be done to make the conversion to technological change more successful are the method of introduction and worker training.

F. C. Mann and L. K. Williams, among others, have recognized that organizations vary in their capacity to absorb new technology without serious disruption.[105] They argue that difficulties are likely to occur when an organization has serious morale problems, a history of failure to manage innovation, or managerial talent adequate only to maintain existing operations.

Method of Introduction

The method of introducing automated equipment can have permanent as well as transitory effects on the firm.[106] Good planning and the amount of information given to employees about an impending technological change can aid successful adaptation. The researchers cite a number of examples of increased employee resistance and a decline in morale where rumor and uncertainty have developed, either because of a deliberate policy of secrecy or because of unexpected delays in implementing the change.[107,108] On the other hand, preliminary information allows the individual to "build his security." The effectiveness of communication varies with the stage reached in the process of introducing automated equipment. It has been shown that its influence is greatest when the individual is just becoming aware of the possibility of change.[109]

Management need not limit itself to the usual information channels. A pilot project often helps employees visualize the new working conditions.[110] Another useful technique is employee counseling.[111] Preparing a work group for the introduction of automated equipment can extend beyond providing information; workers may be allowed to participate in the planning and decision-making processes, which may reduce resistance to change, increase job satisfaction, and minimize the decline in productivity that usually accompanies a technological change.[112]

The majority of studies favors and recommends a close working relationship between managers and operators, and an early involvement of operating personnel in both the design and implementation stages. The worker's reaction to automation depends upon how clearly he perceives automative change and accepts its causes, consequences, and goals. The crucial role of participation is underlined by Edgar Huse in his study of an Integrated Manufacturing System (IIS) that was introduced into a non-automated plant. He quotes a production clerk on the significance of involving operating personnel:

> It is probably the most essential recommendation of all, since the IIS will succeed or fail as a result of the acceptance by users, not by top management.[113]

The "hard work and sincere effort" of affected workers does not guarantee the success of an automated program.[114] The involvement of employees at all levels is necessary to gain acceptance and generate positive attitudes; but, it is most important to make the worker "see" the new system so that necessary modifications can be made in design and implementation procedures.

Huse further hypothesizes that the necessity of training varies proportionately with the amount and intensity of work-force involvement:

> The types and kinds of training that are given to operating personnel will depend, in large measure, upon the degree of involvement of the operating personnel in the design of the program.115/

The existence of an integrated team effort may render training programs unnecessary.

However, the success of this approach may be negated by a high mobility rate among employees and managers. Huse cites the high turnover in the task force, more than 100 percent, as a crucial factor in the low efficiency and slow progress of IIS. Mass exodus of employees means a significant loss of information and data, a time lag as new personnel relationships must be established, and a repetition of the entire process of negotiation since a new man is likely to be suspicious of any commitments made by previous employees.116/

Furthermore, the timing of introducing automated equipment may decisively influence its successful operation. Several studies point to difficulties caused, for instance, by strict adherence to a time schedule despite technical difficulties and delays in programming and computer performance. The strain on the programmers was exacerbated by pressure from management.117/ Huse recognizes the significance of the timing factor and the need for modifying the implementation of programs after their initial installation. It is desirable to establish realistic goals and expectations which allow for flexibility not only in production but also in personal adjustment. The cost of too much pressure can be high--as that sign in that office said--

> Why is there never time to do it right the first time?
> and
> Always time to do it over?118/

Worker Training

Training and retraining problems arise in the work force due to specific changes in skill levels, heightened by the degree of general penetration of automation in our society. In discussing individual adjustment problems to automated change, we will focus on the following areas: (1) Training requirements for automated jobs; (2) Types of training programs; (3) Who should be trained; (4) Effects of training programs on workers' attitudes.

There are numerous studies of training programs, many devoted to an analysis of government-sponsored retraining programs, both in the United States and abroad. Retraining has been a general governmental policy to eliminate structural and temporary unemployment, but these aspects of the problem are not considered in this brief review. Rather, we are concerned with training programs which firms have developed and implemented as part of company policy to relocate workers displaced by the introduction of automation, and to train new employees for automated jobs.

1. Training Requirements for Automated Jobs

When automated equipment is introduced into a given plant or industry, certain skills are needed to operate and service this equipment. Management is faced with the following questions: Can the present labor force be trained, or is it necessary to hire new employees? Is training a requisite for employment? If so, how does the training requirement differ from the general educational requirements of the job?

The concepts of training and education are closely related. Education refers to the general background and schooling completed before entering employment; it encompasses formal schooling rather than personal growth or ad hoc courses given by employers. Training, on the other hand, conceptualizes specific instructions for a particular task in the factory. Education and training are interrelated, and a certain level of education is often a requisite for training programs.

For automated jobs this interrelationship becomes crucial. Researchers agree on and stress the need for greater technical competence, greater skill flexibility, and more general knowledge for such jobs. Flexibility in knowledge and attitude allows the affected worker to adapt more readily to automated change. Fine notes that higher education is needed for automated jobs, but he also stresses the desirability of a broad understanding of the production process.[119/] Faunce, in a statement before Congress, emphasizes the necessity of a broad education that allows for flexibility in assuming a wide variety of tasks.[120/] As mentioned before, the U.S. Department of Labor, Bureau of Employment Security, has revised its Dictionary of Occupations, listing specific educational requirements for a number of jobs.[121/]

This "coupling" of education and training has also been stressed in the Manpower Report to the President. The authors express the hope that the "population's educational level will accelerate and future labor force entrants will have the necessary general educational prerequisites for skills, training and employment."[122/] The emphasis on general educational advancement reflects the necessity of flexibility in attitude and skills that is mandatory for automated work. Automated jobs require greater understanding with more emphasis on why rather than how.

It is further significant to note that studies of the changes in skill levels show that educational requirements have increased while training requirements have decreased.[123] While these findings may affect only a small portion of the labor force, researchers continue to report on the educational increase/training decrease dichotomy and recommend that training for technical occupations be left to the general educational system.[124] This observation would indicate that education itself may be more important as an adjustment to automated jobs than specific classroom or on-the-job training provided by the industries.

2. Types of Training Courses

The necessity of more education does not eliminate training needs. In some instances specific training becomes more valuable as a means of orienting an individual with a general education and theoretical understanding of a process to a more specific and concrete task. Or, training can be of a psychological nature aimed at adjusting the individual to his new surroundings and duties. Training courses can be classified either as to what is taught, i.e., motor, cognitive, or behavioral skills,[125] or as to who is taught, i.e., vocational training for adults who have never had any specialized skill or training, retraining of persons possessing an obsolescent specialized skill, or further training programs for persons whose skills have become rusty or require adaptation to changes in technology.[126] Both approaches are interesting; each type highlights a different set of problems and factors that need to be considered.

Should training focus upon skill requirements or psychological and behavioral adjustments? Training is most often considered in terms of acquisition of new skills. However, in several recent studies the importance of psychological adjustment training has been stressed. Lipstreu and Reed observe:

> Psychological adjustment training for employees, particularly the older workers, seems every bit as important, if not more important, than technological training.[127]

The psychological adjustment involved in overcoming the fears and anxieties associated with new skills or responsibilities may be as difficult, if not more so, than the acquisition of the skill itself.[128] This adjustment, moreover, is a crucial factor in the employee's relations with fellow workers and his satisfaction with a given job.

The skill content of training courses varies according to industry and firm. The duration of courses again varies radically in different organizations. For some, training reflects a general attitude towards learning, skill perfection, and self-improvement. Ida Hoos, for instance, suggests that a whole organization should become "training-minded."[129] For others, it is a necessity and requisite for satisfactory performance on a job.

As L. Williams points out, however, few distinction have been made among the conditions and problems peculiar to specific areas of training. He identifies three such areas: motor, cognitive, and behavioral learning.[130] Motor learning refers to operating skills, cognitive learning to the acquisition of new information, and behavioral learning to new ways of responding to people and objects. Each skill involves separate problems. Failure to distinguish among the types of learning may lead to confusion and contradictory conclusions about what can be expected from a given training effort. Williams feels that content-skill training efforts must be developed in accordance with educational and learning theory, if meaningful results are to be found.

Traditionally, one means of acquiring technical knowledge has been apprenticeship. G. Strauss, in Apprenticeship: An Evaluation of the Need, notes a general decline of apprenticeship programs except in the electrical, pipe, and sheet metal trades. These three have successful training programs because they are specialty trades, require a fair amount of intellectual ability, and have an expanding employment.[131/] However, apprenticeship programs in other trades are declining. Strauss finds it difficult to separate cause and effect--is it the shortage of journeymen that has resulted in dependence upon new techniques, or have overall skills declined because employers have no longer any need for them?[132/] Again, the degree of penetration of automation and its resultant effect on skill levels may have serious consequences for traditional training programs.

3. Who Should be Trained

In addition to types of training courses, we must consider who participates in these courses and their efficacy as a method for relocating workers displaced by automation. The major areas of controversy focus on training of older workers and retraining of operators. Lipstreu and Reed stress the difficulties of retraining older workers and state that it is poor policy to retrain these workers for higher skilled maintenance positions. The learning speed and motivation of older workers to apply their knowledge is generally found to be lower than that of younger workers.[133/] Modifications in training programs and special attention to the problems of older workers might alleviate this limitation to training effectiveness. Indeed, some empirical evidence has already been gathered showing favorable outcome of such training programs for retrained workers.[134/]

Many writers have warned against retraining operating personnel in mechanical skills. There is much speculation that those workers lack the basic mental abilities to be retrained. General educational and I.Q. requirements are proposed as necessary requisites for participation in training.[135] Lipstreu and Reed concur:

> Attempts to upgrade marginally qualified, incumbent employees to technical positions is a serious error which may be difficult to correct after the fact.[136]

They feel that retraining is limited only to those who qualify in terms of "automation readiness." However, such a view does not consider the possible potential and motivational factors that an individual may possess. If training applies more to those with minimal skill than those with superior skill, as Van Auken concludes, the impact of training programs would be most effective on the "marginally qualified."[137]

Among people considered for retraining, supervisors were often mentioned as likely and important candidates. It is generally concluded that the training and selection of managers become more difficult in automated plants because of the increase in educational requirements.[138] Lipstreu and Reed note, too, that supervisors need greater technical competence, because workers in the plant studied increasingly lost confidence in their supervisor's skill.[139] Training, therefore, is necessary to improve the quality of supervision and maintain satisfactory labor-management relationships.

4. Effects of Training Programs on Workers' Attitudes

The evaluation of training programs and their particular effects on distinct groups of the labor force is incomplete without assessing the resulting impact upon the attitudes and morale of the workers themselves.

Mann and Hoffman underscore training as having a significant influence on workers' attitudes. They state:

> The successful functioning of a new automated system will depend in a large part on the adequacy of the training given to their men, and this training must take into account the fact that the workers need to acquire new skills and knowledge as well as adapt to new types of jobs.140/

The timing of conversion to automation must allow for a break-in period of relative inefficiency during which the behavior and perceptions of the workers are altered.141/ But, training is vital to the success of conversion to automation. The "sink or swim" method, or even "book learning" alone, provides inadequate preparation for people responsible for the operation of automated equipment. Note, however, that the power plants studied relied on retraining of present employees as the main source of recruitment and supply of workers in their newly automated plants. The character of the training program thus assumed crucial importance in affecting the perceptions and attitudes of these workers.

The U.S. Department of Labor, Bureau of Employment Security, sponsored a study of training programs, in which the authors concluded that there was a high positive correlation between training programs and work satisfaction, between high morale and greater stability of a continuous work force within the company. It was found that training costs for each employee were less than the sum required for laying off "nonautomated" workers and then hiring outsiders. Moreover, training programs resulted in high morale and stable labor and community relations.142/ The desire of the workers to improve their job status was combined with company objectives to develop qualified personnel for new processes, create cooperation and teamwork among the employees, and give them a broader viewpoing of their work, their supervisors, and the company. The training program insofar as it demonstrated that the company was interested in the welfare of its employees and their individual desire for improvement and promotion, showed positive results--greater satisfaction and ease in adaptation to automated tasks.[143]

This general positive conclusion of the effect of automation on workers' attitudes is challenged by several studies. Rosen, Williams, and Foltman, for instance, find that in terms of overall attitudes, retrainees reported a sharp decline in satisfaction with their employer immediately after retraining ended, especially when jobs were not available to utilize their new abilities.[144] Thus, factors of demand for new skills may have an important effect on the attitudes of the trainees.

In the studies reviewed the significance attributed to educational and training factors vary radically. There are many distinctions and variables that must be pondered before the effects and desirability of a given training program can be judged. One should consider educational prerequisites, the types of training involved, who should be trained, the motivation for training, and finally, satisfaction and attitudinal changes that may result from such a program.

CONCLUSION

This review of recent literature was undertaken to increase our knowledge and understanding of the effects of automation on jobs, workers' attitudes, and training programs. One may feel frustrated reviewing the variety of findings and diversity of answers to questions originally asked, without ever arriving at, or finding some general conclusion. As with so many problems in the social sciences, there are no easy answers or unanimous opinion concerning the aspects of automation under consideration. Research seems spotty, conclusions are tentative, and results strongly debated. However, this lack of conclusive evidence rather than causing despair, may well spur enthusiasm and perseverance in the investigation, reflection, and formulation of imaginative approaches to existing gaps in our knowledge.

At this point it might be appropriate to delineate and emphasize some implications of the reviewed material; and to raise some relevant questions concerning the nature of a future (more) automated society.

The orientation, analysis, and prescriptive suggestions of any automation study are largely governed by the basic approach of the investigator--evolutionary or revolutionary. These two positions were sketched briefly in the introductory section, but the implications of either view are so fundamental to research efforts and basic comprehension of the phenomenon of automation that they warrant further treatment.

An evolutionary orientation to the study of automation is perhaps the most natural one to adopt. Technological change in the past fifty years has been so rapid and so extensive that, as a society, we have learned to adapt quickly and assimilate new information, different methods of work, recreation, and education, and to utilize these techniques to improve man's well-being. These adaptations are pervasive and taken so much for granted that we are often astonished when some express awe and disbelief at the many "gadgets" surrounding us. Automation, then, is considered simply a more modern, more highly developed, and more effective means to accomplish certain production tasks. Our societal frame of reference, our values, and our national goals remain the same. Automation, like other historical changes that have been culturally absorbed, requires adaptation and adjustment. Textile factories replaced home weaving activities; auto service stations replaced blacksmiths' shops; now automation technology is replacing assembly-line production methods. . . . "Progress is our most important product."

Once the problem has been delineated in this manner, the particular adjustments that must be made follow logically. Changes in job content and skill requirements must be determined through more extensive statistical sampling and analysis of empirical data. Findings in these areas give rise to new training programs, changes in curricula and educational systems; and administrative planning techniques are devised to accommodate and qualify the affected segments of the labor force to the changed environment.

As to the individual and his adjustment problems or reaction to automation, the "evolutionary" adherents stress those aspects of planning, methods of introduction, and psychological preparedness, that smooth the transition to new work conditions and engender a positive response to Pregress *per se*. Once an accepting attitude to Progress is developed, the stresses and problems of transition become almost minor and mechanical. The "technician" helps "straighten the bumps" or "take out the bugs" so transition and adjustment proceed smoothly, quickly, and efficiently.

Again, the basic goals and values of the individual are not significantly altered, and little though or discussion is given to the possibility of a changing system of values. Adjustment must be made in the entire socialization process in order to derive the major benefits from automation. But societal norms, values, goals and ideals remain the same. Automation is a progression or an evolutionary step in the mechanization processes begun with earlier harnessing of nature's power.

While the "evolutionary" writers stress the continuity and linear development of technology, many other observers express great concern over the revolutionary implications of automation. The latter do not consider automation an extension of an earlier process nor a rationalization of an earlier principle within a given system of social values. The techniques of automation appear as abrupt, distinctly different processes with grave consequences for society, its value system and its organization.

The reasoning of the "revolutionary school" is necessarily different in focus, in level of analysis, and in nature of verification. The persuasive evidence is philosophical in content. The arguments span centuries and highlight general underlying trends that have appeared in history. The perspective cannot remain limited to one society or to one epoch; the perspective must be general and broad enough to encompass man's entire experience. The breadth of this conceptualization, its judgmental character and lack of probable empirical verification, lead modern scholars to discount and often ignore such an approach. To articulate a revolutionary position in regard to automation means to step out of the basic frame of reference and fundamental orientation that characterize contemporary endeavors and analyses. Current categories and prevalent concepts are inadequate to deal with the major significance of the phenomenon "automation." Thinking must be reoriented, reality seen from a new perspective. The theories advanced by John Diebold, Charles Killingsworth, Marshall McLuhan, and Hannah Arendt may be only partially applicable and true in some respects. However, the problems they pose and the questions they attempt to answer cannot really be ignored by any serious student of automation's impact. As Kenneth Boulding notes: "It is perhaps typical of very creative minds that they hit very large nails not quite on the head."145/ For all of the shortcomings of these analyses, they offer new avenues for thought and suggest radically different methods of conceptualizing, studying, and responding to automation.

Automation's "revolutionary" impact can be analyzed at various levels of abstraction. First, it represents a fundamental change in societal norms and organizations. Second, at the individual level, it means a new perception of reality, a new relationship to work, a different level or kind of skill, and a new basis for associating with and relating to other human beings. In essence, automation elicits a response to a new way of life. Those cited above in the context of these various concerns, delineated some of the ramifications and novel relationships that could be established. However, some of the more intriguing consequences for future society were not mentioned, nor explored.

These basic changes in relationships among men and in their attitudes to work have important consequences for the future. The Protestant Reformation introduced worldly aceticism and stressed its primary importance. Work became the basis for a calling--a vocation. Fulfillment of duty and life-task became and continues to be a religious and societal criterion for determining the worthiness, goodness, and very identity of the individual. If the very meaning and value of work changes, what happens to our standards, both societal and individual? If creativity or even the necessity of full-time work diminishes, what will replace the feeling of satisfaction and accomplishment for a job "well-done"? How are we going to make constructive use of leisure hours and not simply watch television to "kill time"?

Another area greatly affected by the introduction of automation is our evaluation of economic systems and our attitudes towards welfare programs. Sharp distinctions between the capitalistic, free-market system and the socialistic system can no longer be rigidly maintained. The very impact of technological change transforms the heretofore assumptions of the ideal "free-market" model. Joseph Schumpeter's Capitalism, Socialism and Democracy, in which he analyzes the relationship of the two economic systems and the political form of a democracy, may suddenly take on new significance.

Traditional and deeply held political values are also challenged by some forms of automation. For example, what is happening to privacy? Areas of man's privacy have already been significantly affected by the widespread use of computers in business and government. A compilation of electronic dossiers on each citizen may well bring society close to the conditions described by Orwell in 1984. Although the new methods and procedures may be more efficient and in some cases permit more objective treatment of each individual according to his qualifications in lieu of subjective or arbitrary judgments, their use in the hands of the unscrupulous could be disastrous and could support the most pervasive tyranny man has ever known. Not only privacy, but also individualism, freedom, and other values stemming from the English liberal tradition are being redefined. These cherished values could very well become incompatible with automated society.

Education has already changed significantly, but the method and style of learning are due for further revision. Robert Davis hypothesizes that with the increased advance of automation, specialization, as we know it, will end. Specialization does not meet the demands of the automated age; problems can no longer be solved by any one discipline. If solutions are to reflect the complexity of reality, and thus more closely approach it, the cooperation and joint effort of many experts possessing various skills become necessary. Automation is an integrative process in which only a view of the whole has meaning and imparts understanding. The inter-relationship of the parts rather than the segments themselves becomes significant.

These are some of the more obvious areas in which the impact of automation could initiate change and trasnform relationships and standards. A confrontation with these problems requires imaginative thinking, initiative, and a willingness to question, and discard if necessary, prevailing concepts and values. Fundamental choices must be made as to the orientation of action, the nature of morals, and the types of problems that are delineated for further investigation. The possibilities presented by automation are staggering and awe-inspiring. To ignore them is to risk loss of control over any portion of man's future. To tackle them is to deal with man's very existence, identity, and purpose.

As stressed throughout this review, it is not yet clear what will be the overall consequences of automation. The basic question to be answered before any really comprehensible and meaningful analysis can be attempted is: Is the nature of today's automation evolutionary or revolutionary? At this point in time the actual penetration of automation into society has been limited to few industries, especially electronics and space, and has, therefore, affected only a small portion of the population. Trends are difficult to perceive. But, if any type of direction or control is to be exercised over its effects, much creative thinking and planning must be done, and done quickly, before it is too late to cope with the whirlpool of forces unleashed by automation which has a potential for both great good and great evil. How to secure the most good from that potential is the real challenge of our modern age.

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