R E P O R T R E S U M E S

ED 020 355 VT 004 625

THE SKILL IMPACT OF AUTOMATION. REPRINT NO. 136.

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CALIFORNIA UNIV., LOS ANGELES

PUB DATE 64

EDRS PRICE MF-$0.25 HC NOT AVAILABLE FROM EDRS. 22P.

DESCRIPTORS- *AUTOMATION, *LABOR ECONOMICS, EMPLOYMENT, *UNEMPLOYMENT, *JOB SKILLS, IMPROVEMENT, EMPLOYMENT PATTERNS, EMPLOYMENT PROBLEMS, WORK SIMPLIFIC TION, EDUCATIONAL NEEDS, VOCATIONAL RETRAINING, LABOR SUPPLY, *PRODUCTIVITY, LABOR MARKET,

THIS SAMPLING OF COLLECTED TESTIMONY WAS INTENDED TO ILLUSTRATE SOME OF THE DIMENSIONS OF MANPOWER PROBLEMS FACED EVEN IN EXPANDING LABOR MARKETS. A REVIEW OF SELECTED "STRUCTURAL" ASPECTS OF EMPLOYMENT ANALYSIS GAVE PARTICULAR ATTENTION TO THE IMPACT OF AUTOMATION ON EMPLOYMENT WHEN CONSIDERATION WAS GIVEN, NOT TO THE AMOUNT OF LABOR DEMANDED, BUT TO THE QUALITY OF LABOR THAT MUST BE SUPPLIED. SO LONG AS PARITY IS PRESERVED BETWEEN THE TOTAL OF JOB OPPORTUNITIES AND THE NUMBER IN THE LABOR FORCE, UNEMPLOYMENT REFLECTS THE PROBLEM OF MATCHING THE SPECIFIC QUALITIES OF LABOR DEMAND WITH THE SPECIFIC ATTRIBUTES OF LABOR SUPPLY. THIS MATCHING PROCESS IS IMPEDED BY AN ACCELERATION IN THE PACE OF TECHNOLOGY AND A "GESTATION" BARRIER, REPRESENTED BY THE LENGTH OF TIME REQUIRED TO DEVELOP SKILLS DEMANDED. A SECOND MAJOR POINT OF THE STUDY WAS THAT AUTOMATION INVOLVES NOT ONLY SKILL-UPGRADING BUT SKILL-DOWNGRADING AS WELL, SINCE MANY JOB FUNCTIONS ARE "DILUTED" TO ADJUST TO CHANGING TECHNOLOGY. THE SKILL IMPACT OF AUTOMATION IS TO INCREASE THE PRODUCTIVITY OF A SMALL NUMBER OF SKILLED WORKERS WHILE DECREASING THE PRODUCTIVITY OF A LARGER NUMBER OF LESS-SKILLED WORKERS. THE IMPLICATIONS OF THESE SUGGESTED FINDINGS WERE RELATED TO EDUCATIONAL PROGRAMING, WAGE POLICIES, RECRUITMENT, TURNOVER, AND OTHER ASPECTS OF MANPOWER POLICY. THIS IS A REPRINT FROM "EXPLORING THE DIMENSIONS OF THE MANPOWER REVOLUTION, VOLUME 1 OF SELECTED READINGS IN EMPLOYMENT AND MANPOWER," COMPILED FOR THE SUBCOMMITTEE ON EMPLOYMENT AND MANPOWER OF THE COMMITTEE ON LABOR AND PUBLIC WELFARE, U.S. SENATE, 1964. SINGLE COPIES OF THIS DOCUMENT ARE AVAILABLE WITHOUT CHARGE FROM INSTITUTE OF INDUSTRIAL RELATIONS, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA 90024. (ET)

INSTITUTE OF INDUSTRIAL RELATIONS

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by

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Reprint No. 136

UNIVERSITY OF CALIFORNIA
LOS ANGELES 24, CALIFORNIA
1964

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(Continued on inside back cover)

THE SKILL IMPACT OF AUTOMATION

By

Paul Sultan

and

Paul Prasow

Reprinted from

Exploring the Dimensions of the Manpower Revolution, Volume 1 of Selected Readings in Employment and Manpower, compiled for the Subcommittee on Employment and Manpower of the Committee on Labor and Public Welfare, ~~United~~ U.S. States Senate, 1964

THE SKILL IMPACT OF AUTOMATION

(By Paul Sultan, Claremont Graduate School, and Paul Prasow, Institute of Industrial Relations, University of California, Los Angeles)

Much of the present diagnosis of current unemployment has tended to polarize on two explanations: Unemployment is said to reflect either the inadequacy of demand or the inadequacy of labor force adjustments to "adequate" demand. That distinction, in effect, attempts to attribute unemployment to dislocations on either the demand or the supply side of the labor market, or to establish the labor market's more important cutting edge. While that dichotomy draws attention to the complexities of the employment problem to be found on both sides of the market, and is obviously a crucial distinction in any discussion of remedial action, it does more to encompass than transcend traditional explanations for unemployment. As a consequence, it has somewhat inhibited the full consideration of the wisdom found in existing employment theories, simply because in much of traditional analysis, demand and supply are not usually regarded as competing or mutually exclusive determinants of employment. The purpose of this paper is to review some aspects of employment analysis rooted in supply considerations, and more particularly the range of opinion regarding the impact of automation when consideration is given, not to the amount of labor demanded, but to the quality of labor that must be supplied.

Unemployment that is not explained by a lack of demand is labeled structural unemployment, and since this category is pressed into service to explain everything not explained by a lack of demand, it is not surprising that confusion and uncertainty surround its meaning and cause. It is said to be unemployment not quite synonymous with technological, frictional, or even hard-core forms. Indeed, much of the conjecture on structural unemployment suggests that it involves something more than a reclassification of conventional doctrines: Rather, it categorizes a form of unemployment that is quite distinctive in substance from anything we have faced in the past.[1]

[1] Concepts of unemployment may be developed within the framework of a particular economic theory or, as a pragmatic alternative, to categorize available unemployment data. The "structural" designation has both causual and descriptive pretensions. It is said to be caused by pronounced shifts in the direction of consumer expenditure, technical changes that involve a radical alteration in the form and location of production functions, "administered" wage and price adjustments, and impediments or delays in labor adjustment to labor-market requirements. Since structural unemployment reflects the lag of supply adjustments to demand, it is "identified" by its very persistence. It is further isolated by the heavy incidence of unemployment in those industries, occupations, and regions most affected by change, and by the increasing incidence of unemployment for those components of the labor force with particular age, skill, educational, race, and sex characteristics least willing or able to accommodate themselves to change. It is not surprising that a "theory" of structural unemployment that would encompass the complex of forces affecting the quality and quantity of labor supply, as well as the quality and location of labor demand, has yet to be developed. For discussion, see "Unemployment: Terminology, Measurement, and Analysis," Subcommittee on Economic Statistics of the Joint Economic Committee, 87th Cong., 1st sess. (1961).

There are several reasons for the current attention given to the supply side of the labor market, or, more specifically, to the structural unemployment explained by these supply considerations. First, the collective bargaining process has been increasingly involved with adjustments to automation, or the adjustments of labor supply to the "uncontrollable" shifts in labor demand. But while the levels of aggregate, industry, or corporate demand usually appear well beyond the influence of the parties to the bargaining process, contract terms designed to cushion labor from the impact of technology are not; these are now emerging as the "gut" issues of collective bargaining. There is growing evidence of employer willingness to collaborate with unions on setting up early warning systems, to implement programs for labor relocation and retraining, to phase the introduction of technology in a manner designed to minimize human hardship. A consensus has emerged that every effort must now be extended to increase the volume and improve the distribution of economic intelligence on job vacancies, to encourage the mobility of labor, to undertake the task of upgrading labor skills. And where corporate, union, and personal resources appear insufficient to meet the cost of the adjustment process, there seems to be less resistance to the use of public funds designed to speed the reeducation, retraining, and relocation process.[2]

The hope of reducing unemployment by adjustments in the quality and location of labor supply has been further nurtured by the growing volume of statistical evidence pointing up the high correlation between education, job skill, income, and job security. Such evidence, together with the eloquence of those with a vested interest in extending our investment in human capital, gives further authority to the hypothesis that we can expand employment by upgrading labor skills.

America's balance-of-payments crisis is also relevant to the structural unemployment issue. The efforts of fiscal and monetary authorities to sustain the buoyancy of an economy constantly overloaded with upward cost-price adjustments now seem to be weakening. As we appear to be running aground on the reef of foreign competition, few feel it is prudent to raise the keel of exchange rate stability and even fewer are willing to see the Nation jettison additional amounts of domestic employment. It is not surprising, then, that hope has developed that we can contrive those structural alterations in the ship of state that would allow for both stability and buoyancy. Ironically, the confidence we now have in the capacity of the Government to provide full employment emerges at a time when these fiscal instruments to stimulate demand and employment must be employed cautiously. Barred (to employ the Keynesian analogy) from moving the piano stool to the piano, we are now involved in the tedious task of moving

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[2] Unions, of course, have strongly favored such programs. There was striking evidence of agreement at the American Assembly Conference on Automation, Palm Springs, Nov. 8–11, 1962, when both union and management representatives gave full support to the retraining principle. A dispute developed, however, when two educators took issue over the relative importance of the liberal versus the applied programs offered by the schools they represented. A unionist quipped: "Why don't these fellows settle their jurisdictional dispute elsewhere?" Emerson P. Schmidt of the U.S. Chamber of Commerce testified to a congressional committee: "We suspect that a dollar spent on retraining has many times the impact of a dollar spent on loans and grants for industrial or community facilities. We would not be surprised if the $5 million appropriated for retraining in the depressed areas measure approved by the House does more good than the rest of the appropriations combined." "Impact of Automation on Employment," hearings before the Subcommittee on Unemployment and the Impact of Automation of the House Committee on Education and Labor, 87th Cong., 1st sess. (1961), p. 472.

the piano itself. Or, to put the case more directly, the constraints represented by our balance-of-payments require that we give attention to adjustments of labor supply rather than to problem adjustments of labor demand.

Further attention to structural unemployment has developed by those who see cost-push inflation as the cause of cost-push unemployment.[3] In this view, the increase of labor costs has compelled some labor displacement in the short run, and as it encourages the substitution of capital for labor in the long run, it compels even further labor displacement then. The resulting unemployment is said to be structural inasmuch as it reflects the pressure of structural blocs pushing for gains that cannot be supported by industry.

The designation of unemployment arising from this source as "structural" has not inhibited union use of the same term. But in the union view, structural unemployment reflects structural flaws in the pricing mechanism, and more specifically the insensitivity of prices to expanding capacity and expanding labor productivity.[4] Price rigidity denies that stimulus to market demand necessary to absorb expanding supply. Structural unemployment emerges because of malfunctions in the pricing mechanism, because of the structure of product market concentration, or even because of the capital-intensive innovations that provide dramatic economies in the use of labor.

Although the usefulness of this category of unemployment is weakened when it becomes a term meaning all things to all people, or when a single label is used to explain conflicting or contradictory causes of unemployment, that confusion does not allow us to retreat from the full examination of remedies for unemployment that can be located in the supply side of the market.

In approaching the employment problem from the supply side, one would expect to be confronted immediately with proposals to reduce wages, or to alter the location of the labor supply schedule so that it might intersect the labor demand schedule where higher levels of employment can be obtained. While there is today general support for the proposition that wage adjustments must somehow be

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[3] L. E. Gallaway finds only limited statistical support for the structural unemployment argument, but he is unwilling to surrender to the lack-of-demand alternative. "Rather the findings at the microeconomic level offer the possibility that the impact of union market power may be disrupting the labor-market allocative process at the interfactor level; i.e., that the relative price of labor in general has been increased by the actions of labor unions to a level that generates widespread unemployment." "Labor Mobility and Structural Unemployment," American Economic Review, vol. L–III, No. 4, September 1963, pp. 714–715. Harold Demsetz concludes his statistical analysis: "Minimum-wage laws and union wage rates make it impossible or difficult for a growing component of our labor force to offer its services at wage rates sufficiently low to be employed." "Structural Unemployment: A Reconsideration of the Evidence and the Theory," Journal of Law and Economics, vol. 4, October 1961. p. 90.

[4] Solomon Barkin contends that price-setters in administered-price industries are confident that governmental monetary and fiscal action will support their decisions to raise prices; they are subject to no compelling pressure to lower prices. In his view, this explains the "chronic imbalance between productive capacity and consumption." Impact of Automation on Employment, op. cit., p. 196. In more technical analysis, Sylos-Labini attributes price rigidity and its byproduct of economic stagnation to technological discontinuities within oligopolistic industries, contending that the alternative to prices that allow large firms substantial profits is sheer chaos. "Oligopoly and Technical Progress" (Cambridge: Harvard University Press, 1962).

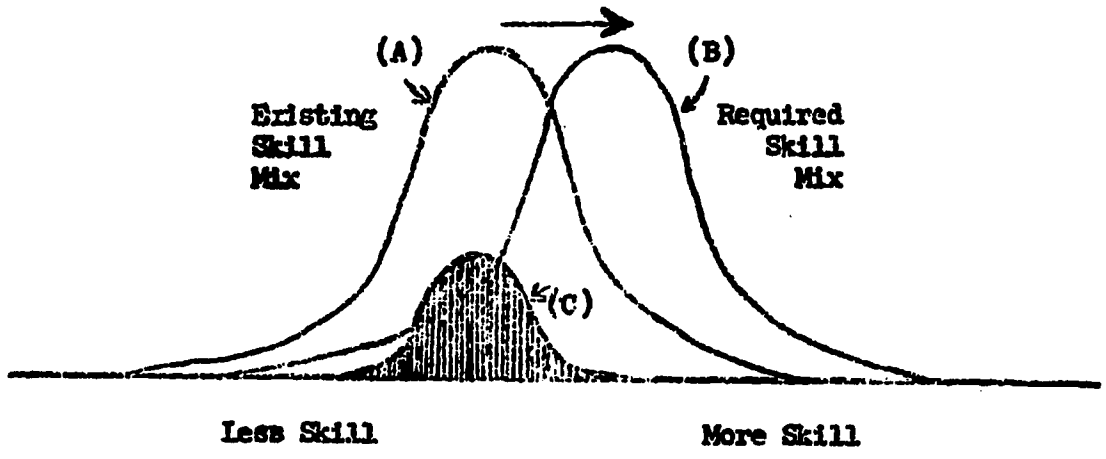
kept within the limits of labor productivity, the hypothesis that wage reductions can encourage employment, or even inhibit the pace of capital-intensive innovation, has not yet received much support. But the attention usually reserved for the cost of labor is now given over to the quality of labor.

Even though wage policy and skill upgrading programs are in no sense indentical, both can be analyzed in terms of their influence on the labor supply, or, to put the case more directly, in terms of the employability of labor. Policies of wage reduction or skill upgrading are somewhat analogous in their employment generating consequences, for both are presumed to lower unit labor costs. In the first case, the reduction of hourly wage rates, with labor productivity unchanged, obviously reduces unit labor costs; in the second case, increases of labor productivity, with hourly wage rates unchanged, have a similar effect. And so long as we admit some measure of elasticity in the demand for labor, the reduction of unit labor costs by either device should encourage the employment of labor. In the thirties, Keynes offered a convincing rationale for reducing the "real" cost of labor by increases in prices rather than through the painful struggle to reduce money wages. In the sixties, we still hope to bypass the hostile reception that would follow any exhortation that money wages be cut, by programs to increase labor's productivity or skill. Inhibited as we are—and for good reasons—from tinkering with money wage levels, and inhibited further by the discipline of foreign competition from adopting an overt inflationary policy, it is not surprising that we should turn hopefully to the remaining expedient: devices that would increase the employability of labor through the upgrading of labor's skill. There is, therefore, an analogy between the hope of the thirties that everyone might be reemployed if wages (or prices) were set at levels that would allow for their profitable employment and the hope widespread in this decade that everyone might be employed if skill levels were so upgraded that employers could not resist the utilization of such talent.

What, then, are the prospects for minimizing unemployment by speeding labor's accommodation to the requirements of industry, by upgrading labor's skill levels? The range of responses to this question is indicated in charts I, II, and III.

In chart I, frequency distribution A represents a hypothetical skill mix possessed by the existing labor force. In order to preserve the distinction between lack-of-demand and structural arguments, we shall arbitrarily assume that automation does nothing to reduce the number of job opportunities in industry. In other words, to focus on the skill issue alone we shall isolate our analysis from conjecture that automation reduces the total number of job opportunities (viz, reduces employment to the shaded distribution C in chart I). So long as parity is preserved between the total of job opportunities and the number in the labor force, unemployment reflects the problem of matching the specific qualities of labor demand with the specific attributes of labor supply.

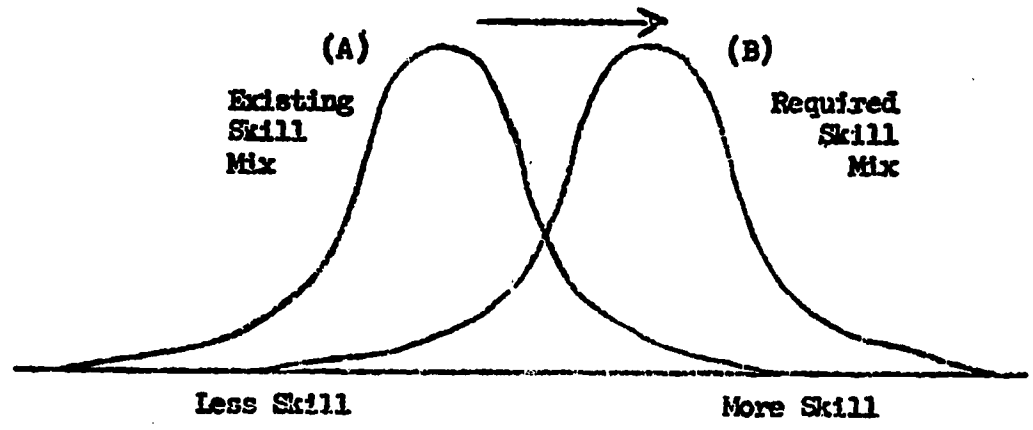
CHART I



How are the skill requirements of industry affected by automation? In the conventional view, automation involves a substantial upgrading of labor skills, an upgrading that can be represented in chart I with the hypothetical skill distribution B. There is no lack of testimony to support such conjecture on the skill impact of automation. Drucker, for example, avows that automation will bring with it "* * * the greatest upgrading of the labor force ever seen."[5] In this situation, the unemployed are not involved in a demoralizing search for jobs that do not exist; rather, unemployment reflects only labor's delay in acquiring the location and skill attributes required by industry.

A chilling shadow has been cast on the optimism in the skill distribution of chart I, mainly because of the very persistence of unemployment. Not all who are fully aware of the seriousness of the problem reject the contention that automation involves an upgrading of skill; some suggest, however, that we have not yet fully comprehended or absorbed the intensity of the changes taking place. Their anxiety is reflected in chart II by the wide, and widening, chasm between labor's existing skill mix (A) and that mix (B) now required by industry. What are the specific sources of such anxiety?

CHART II



[5] Peter F. Drucker, "Integration of People and Planning," Harvard Business Review, May–June 1955, p. 38; see also John Diebold, "Automation: The Advent of the Automatic Factory" (New York: Van Nostrand, 1956), p. 164.

There is a distressing variety of considerations advanced to explain the persistence of this skill gap. To some, the increasing tempo of change is the prime difficulty, a problem reflected in a recent New Yorker cartoon in which the personnel manager's handshake with the new job applicant is interrupted by the production manager: "Hold it, Frank; that job's been replaced by a machine." In brief, the acceleration in the pace of technology makes less certain the form and application of future innovation, and less reliable the estimates of the labor coefficient required for future production functions. How, then, can we establish now the appropriate educational program to meet the unspecified manpower requirements of the future? Deficiencies of current educational programs seem obvious enough when it is realized that two-thirds of all young labor force entrants have neither college nor vocational training.[6] But can we be certain that the attention now given to the expansion of vocational training will also encourage the development of multipurpose skills necessary for the "revolving" nature of future job requirements? In computer automation, for example, we are told that the use of magnetized tape is eliminating the need for keypunch operators, and that the use of microwaves will eliminate the need for those who punch magnetized tapes.[7] Obviously workers with single-purpose skills will be poor candidates for the adaptations that such continuing innovations require. Technical change alters the skill mix required by industry; but rapid change makes the analysis of the ingredients in that unstable mix both difficult and tentative.

In addition to this "tempo of change" barrier, we witness a "gestation" barrier, represented by the length of time required to develop skills. The talent most eagerly pursued today is acquired through years of rigorous and intensive training, not provided in a retraining program of a few weeks' duration. The pressures to obtain such talent today may, unfortunately, complicate the task of providing for such talent tomorrow. Many teachers able to impart knowledge to those students who would meet the skill shortages in the future are being lured away from teaching to private employment. As a case in point, Louis N. Ridenour, director of research for Lockheed Aircraft's Missile Systems Division in Palo Alto, confided to a congressional committee:

> I paid last year Federal income tax in an amount slightly greater than my total salary as dean of the Graduate College at the University of Illinois, 5 years before.[8]

Financial and motivational barriers operate at the student level too. Only 7 out of 10 high school graduates in the genius class—those with IQ's of 163 and above—go on to college. Half of the dropouts do not continue studies for alleged financial reasons.[9] Furthermore, only 45 percent of the top 30 percent of the ability distribution of society

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[6] Sar A. Levitan, "Vocational Education and Federal Policy" (Kalamazoo: W. E. Upjohn Institute for Employment Research, May 1963), p. 1.

[7] Testimony of Howard Coughlin, president, Office of Employes International Union, in "Impact of Automation on Employment," op. cit., p. 407.

[8] "Instrumentation and Automation," hearings before the Subcommittee on Economic Stabilization of the Joint Economic Committee, 84th Cong., 2d sess. (1957), p. 163. For purposes of this discussion "skill" is defined very broadly to include all levels of competence, professional as well as technical.

[9] Testimony of Erick A. Walker, president, Pennsylvania State College, in "Instrumentation and Automation," op. cit., p. 118.

graduate from college.[10] Estimates further indicate that in this decade some 7½ million young people—over one-half of the net increase in the labor force—will be persons who have dropped out of high school. A sample study of the Office of Education of such dropouts indicates that only a small percentage within this group lack the mental competence to "make it academically."[11] But even for those who continue their education, it is not certain that incentives are adequate to encourage their registration in the "hard" programs that technical and scientific training requires. Only 4 percent of American high school students study elementary physics, 7 percent chemistry, 27 percent algebra, and 13 percent geometry.[12]

While the incentives to acquire an education may be lacking for some with ability to learn, it has been pointed out that the ability to learn is missing in some who are eager to learn. Emerson P. Schmidt of the chamber of commerce testified:

> In a typical population, roughly 23 percent have IQ's of less than 90; most of these cannot expect to become highly skilled or to be entrusted with responsible jobs; 7.3 percent have IQ's below 80; most of these are at best marginally employable. And 2.7 percent have IQ's below 70; most of these latter are strictly unemployable. Every indication we have of the shape of the future shows rising requirements of employability, and therefore a growing percentage of any age group which is unemployable.[13]

Whatever the impediments to the upgrading process—whether lack of ability, lack of financial incentive, lack of enthusiasm for difficult courses, lack of instructional programs, or lack of appropriate counseling—the skill gap between supply and demand postulated in chart II is not likely to diminish in the near future. In this decade, for example, it is estimated that the demand for professional and technical labor will increase by 40 percent, whereas the demand for unskilled labor is not expected to increase at all.[14] The outlook for those 7½ million entering the labor market without completing high school, and for those 2½ million who will not complete their elementary schooling appears bleak indeed.

But if the task of defining and undertaking the appropriate investment in youth necessary to meet future labor-market requirements is perplexing, the problem of retraining displaced workers is even more so. For example, Henry Winthrop wonders if those unskilled and semiskilled workers who have been content to work for years below their "latent" ability would be motivated to undertake retraining programs. But more important, he contends that all talk of extensive upgrading may be "so much poppycock" when the development of electronics and engineering talent calls into play "* * * intellectual abilities only sparsely distributed among the semiskilled and unskilled * * *."[15] Even if the basic ability estimates offered by Schmidt and Winthrop are discounted, the 1960 census reveals that over 11 million Americans 24 years of age and older have less than 6 years of schooling,

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[10] Cited by D. W. Wolfle, executive director, American Association for the Advancement of Science, in "Manpower Problems," hearings before the Subcomimttee on Employment and Manpower of the Senate Committee on Labor and Public Welfare, 86th Cong., 2d sess. (1960), p. 46.

[11] Testimony of Seymour Wolfbein, in "Manpower Problems," op. cit., p. 29.

[12] Statistics cited by Arnold O. Beckman, in "Instrumentation and Automation," op. cit., p. 27.

[13] "Impact of Automation on Employment," op. cit., p. 473.

[14] "Manpower: Challenge of the Sixties," U.S. Department of Labor (1960), pp. 11, 16.

[15] "Some Psychological and Economic Assumptions Underlying Automation," American Journal of Economics and Sociology, vol. 17, No. 4, July 1958, p. 401.

while 2½ million adults are unable to read or write.[16] Since unemployment hits the less educated workers severely, the task of imparting labor skills to some in this group may also require programs to improve their basic literacy.

The efforts to relocate displaced Armour employees have frequently been cited to illustrate the problems of retraining. Of 400 workers laid off by the closing of the Armour plant in Oklahoma City, 170 took advantage of the employment tests and counseling offered by the Oklahoma Employment Service. Of these 170, only 60 gave evidence of being able to benefit from additional training; 58 enrolled for training, and 7 found work at their new skills.[17] Even the skilled worker may be a poor candidate for retraining, particularly if his existing skills draw upon a narrow range of his abilities and have a low degree of transferability. For retraining purposes, he too may have to be treated as an unskilled worker.

There are, of course, several institutional impediments to labor adjustment which may reinforce the ability barriers analyzed above. For example, wage structures may not be sufficiently sensitive to the relative scarcities and surpluses of labor in various markets, and thus may not serve as an effective allocator of labor. The employee who has accumulated considerable seniority is likely to believe that the value of the "certain" income stream of his present job is greater than the value of the uncertain income stream of alternative jobs, wage disparities notwithstanding. That conviction does not readily evaporate, even with the loss of his job; the uncertain prospect of gaining work elsewhere reinforces the hope that he will be rehired at his old job. It is not surprising, then, that prolonged unemployment exists in those geographic areas suffering a pronounced sag, if not collapse, of general labor demand. An employer interviewed in the course of this research explained the force behind the "social barrier" to adjustment operating in such areas:

> Look at it this way: Most workers are apprehensive about changing an employer, or even taking on a new job with an old employer. But now we expect some men to make three or four major shifts simultaneously; to shift to a new job, to a new employer, to a new industry, and perhaps to a new community. How many are willing to do that?

He was not optimistic that those who were confronted with such a coincidence of adjustment demands would rise to the challenge, particularly in view of the self-doubts that displaced workers so often develop about their basic abilities. Unfortunately the defeatism that corrodes the moral and economic status of the unemployed in depressed areas may not be fully reflected in existing unemployment data, for persons not looking for work (nor volunteering information as to why this is the case) are excluded from the ranks of both the labor force and the unemployed.

And finally, there is the "informational" barrier to adjustment. No systematic collection of data on job vacancies has yet been undertaken and much of the information available in employment offices may not be reaching all unemployed persons searching for work.

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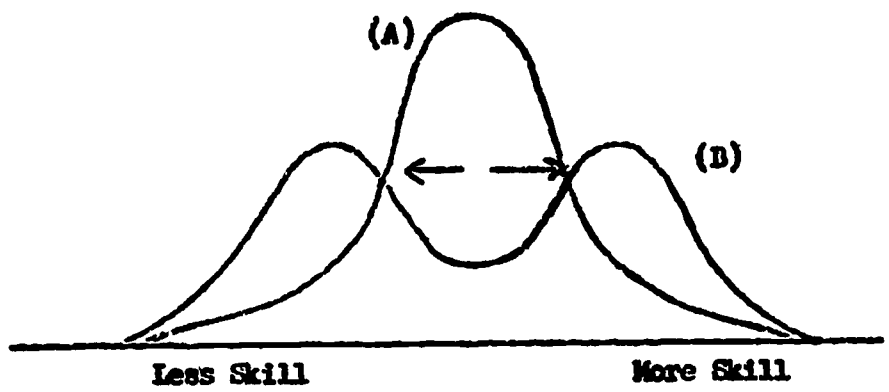
[16] "Adult Basic Education," hearings before the General Subcommittee on Labor and the Select Subcommittee on Education of the House Committee on Education and Labor, on H.R. 10143 and H.R. 10191, 87th Cong., 2d sess. (1962), pp. 9, 86.

[17] "Manpower Utilization and Training," hearings before the Subcommittee on Unemployment and the Impact of Automation of the House Committee on Education and Labor, on H.R. 7373, 87th Cong., 1st sess. (1961), p. 20.

The discussion to this point has emphasized problems related to the skill-upgrading requirement that automation involves. But it should not be concluded that automation involves only the upgrading of skills. Indeed, there is some evidence to support the contention that the skill impact follows the contours found in the bimodal distribution of skills (B) in chart III.

CHART III



This prospect can serve to minimize the pessimism of those who fear we cannot overcome the ability barriers alluded to above, for an intensive investment in human capital is not required of those who will be performing "diluted" job functions represented by the left hump of distribution (B). But this impact creates immediate problems for employees confronted with the downgrading rather than the upgrading of their work functions. Skilled artisans are likely to be sensitive to transfers into such catchall job classifications as an "automation equipment handler." If such adjustments involve not only a loss of pay and status, but also a shift to a new employer, industry, or labor market, the sources of resistance and discontent are self-evident.

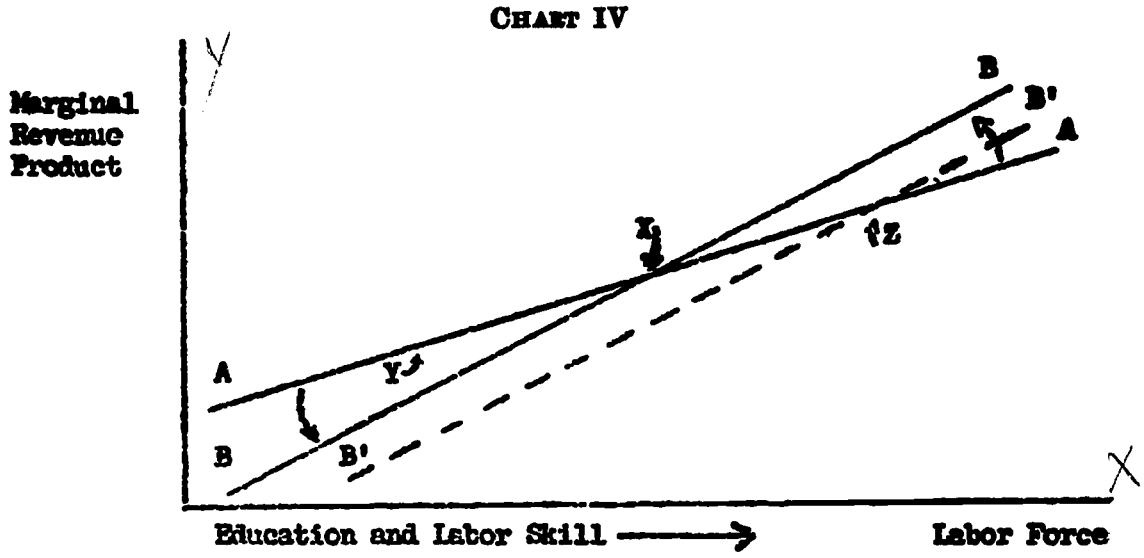
The more important issue, however, is not whether some jobs are downgraded by automation but rather the relative incidence of the upgrading and downgrading process. James R. Bright has concluded that we have given excessive attention to the way automation may upgrade skills.[18] Skill dilution is, in his view, a function of the stage of automation achieved; he employs both logic and field study analysis to support the contention that once a certain level of mechanization has been achieved, less rather than much more operator skill is required. Employers, as well as employees, are prone to exaggerate

[18] James R. Bright, "Does Automation Raise Skill Requirements?" Harvard Business Review, vol. 36, July–August 1958. William A. Faunce, testifying on his field study of automation in the auto industry, explained: "There is a higher proportion of skilled people because there are fewer people who are unskilled and semiskilled. * * * for the machine operators in this plant, there was no retraining program at all. They were simply transferred in, and the estimates of the workers themselves regarding how long it took them to learn their job indicated that very little new skill was required. * * * I am not saying that there are no new skills called for, but rather that the number of jobs created is small. "Impact of Automation on Employment," op. cit., pp. 326–327. Corrobative evidence was provided by Malcolm L. Denise, vice president of labor relations, Ford Motor Co. In introducing new technology in Ford plants, he indicated, on-the-job instruction was "quite adequate in training our production workers to operate new equipment." Formal and detailed training programs were not often necessary for that purpose. Further, he was not certain "generalized training programs" represented a fruitful solution to the unemployment problem. He agreed that from time to time particular skills—such as diemakers to staff a new stamping plant—were difficult to locate, but recruiting such talent from "far afield" was not often necessary. In analyzing the "really valuable skills" he explained: "You are talking about something that you do not pick up in 6 or 8 weeks." "Impact of Automation on Employment," op. cit., pp. 530, 550, 551.

their skill requirements, a delusion that can involve an extravagant overinvestment in manpower by the corporation.

But, at the other extreme, it is not likely that the priority employers give to the educated job applicant reflects only current fashion. Clarence Long, professor of economics at Johns Hopkins University, for example, has suggested that modern technology has probably increased the productivity of the skilled or educated employee, while working adversely on the contributions of the less educated.[19] Such a hypothesis is illustrated in chart IV.

CHART IV



Labor is arrayed on the X axis in terms of its educational attainment where such attainment, we shall assume, is a function of skill, and such skill a determinant of the marginal revenue product of labor, or the increment of revenue the added employee generates for the company. Such labor productivity before automation is indicated by the hypothetical product schedule AA, and that schedule, following automation, is titled around fulcrum X to productivity schedule BB. Productivity of labor to the left of point X is reduced, while labor productivity to the right of X is increased. In Long's view the heavy incidence of unemployment for the less educated may be caused by the downward swing in unskilled labor's productivity schedule and may be aggravated should egalitarian wage policies narrow the differential of rates between workers who are more educated and less educated, more skilled and less skilled, more productive and less productive.[20] Our concern here, however, is not with the possible causes of

[19] Clarence D. Long, "An Overview of Postwar Labor Market Developments," in "Studies in Employment and Unemployment," proceedings of the 4th annual Social Security Conference, Institute of Labor and Industrial Relations, University of Michigan-Wayne State University, and Labor and Industrial Relations Center, Michigan State University (Kalamazoo: W. E. Upjohn Institute for Employment Research, July 1962), p. 42. (See also, "A Theory of Creeping Unemployment and Labor Force Replacement," a paper presented by Professor Long before the Catholic-Economic Association annual meeting, on Dec. 27, 1960, in St. Louis, Mo.).

[20] Paul Samuelson has suggested that the negotiation by unions of the "standard rate" for the job has contributed in some measure to the unemployment we have, for the standardization of wage payments cannot always be reconciled with the fact that people are "unequal as productive instruments." He conceded, however, that to talk in these terms was to open a "Pandora's box." "Impact of Automation on Employment," op. cit., p. 132. The hostile reception afforded Long's paper by labor and union economists, department of employment personnel, and social workers attending the social security conference at which it was given is a case in point.

labor displacement, but with whether that fulcrum might actually operate at, say, point Y or, alternatively, at point Z. In other words, are more workers upgraded than downgraded?

There are some persuasive arguments for giving much more weight to the engineering analysis offered by Bright than to the more numerous lyrical projections of skill requirements that too frequently rest on mere assertion alone. Modern automation challenges almost every skill that the human agent offers to the production process. Those human capacities—including such senses as touch, sight, smell, hearing, the facility for calculating, remembering, learning, the capacity to exercise discretion—are attributes now challenged by the astonishing capacities of new mechanisms. The integration of information and production technology represents the essence of this innovation, a process that draws attention to the limitations of the human agent, now more than ever dismissed as the badly designed single-purpose machine tool. Machines have been taught to oil themselves, to adjust their worn parts, to replace their own cutting edges, to preserve through feedback mechanisms a uniformity and quality of product hitherto unknown to mass production. But more than this, automated machines are conversing with each other both to adjust the pace of production and to vary the product mix in the light of the inventory and other market data speedily digested by computers. The skill impact is suggested by labor's designation of its new job: "Now we're the baby-sitters for machines."

There is a possibility, too, that we may exaggerate the skill upgrading involved in the steady growth in the proportions of indirect labor to direct labor. The rapid expansion of computer technology promises substantial economies in the use of clerical, supervisory, and even middle-management personnel. While our analysis is arbitrarily bypassing the reduction of job opportunities that automation may involve, its quantitative effects are relevant to the skill issue. To take a hypothetical case, let us say that the distribution between the unskilled and the skilled labor force for a firm is 70 and 30, respectively, for the total of 100 employees. Following automation let us assume that the radio is reversed to 3 to 7, now favoring the skilled employee, but with only 10 workers employed. Certainly the skill level within the firm has been increased, but the upgrading of job requirements for 7 employees must be set against the displacement of 67 unskilled workers and 23 skilled employees. The Bureau of Labor Statistics studies of office automation indicates that the application of computers in offices does involve an upgrading of the skill level of office personnel, but that upgrading is achieved more by the less extensive use of unskilled than by any numerically significant increase in skilled workers employed to program and operate the computers.[21]

There is some possibility that a distorted view of skill requirements can develop from the recruitment efforts of defense and aerospace industries for college graduates. Where cost-plus contracts are operative, the marginal revenue product or demand for such labor is not only above, but also rises more rapidly than, the marginal cost for such labor. Riding up these schedules need not jeopardize the competitive position of any one firm so long as it does not get "out of line"

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[21] "Adjustments to the Introduction of Office Automation," U.S. Department of Labor, Bull. No. 1276 (May 1960), pp. 30–37. No date.

in making that advance, and so long as the urgency given to the delivery of hardware is not subject to precise or binding budget constraints. Such arrangements reflect, of course, genuine scarcities of technical manpower skills arising because of the "crash" character of many aerospace projects.

In markets where demand shifts are more intensive than supply shifts, equilibrium is obtained by rising prices. One suspects, however, that the salary adjustments offered engineering personnel already in the industry have not risen sufficiently to provide that equilibrium. But market pressures are not to be denied, and the excess of demand over supply at existing prices is manifest in the intense competition for engineering talent between firms. Such competition gives an upward lift to the salary structure not otherwise allowed by salary policies for labor within the firm. Substantial pay increases follow the promotions given those willing to shift from company to company. Firms intent on preserving existing levels of manpower must undertake a heavy recruitment effort to obtain new workers, for in this way they can fill the vacancies inevitably arising when their own employees respond to the attractions of employment offered by other firms. From the macroview, however, the energy expended in such recruitment does more to influence the present location of such talent than to increase its present overall supply. The upgrading of rewards for such skills does, of course, serve its genuine economic function in encouraging the expansion of the longrun supply, but equilibrating the market in the short run by advertising and turnover may not only be a rather poor device, considering the disruption this involves for production, but also creates the impression that massive armies of technical talent could be absorbed in the industry today.

There may be, too, some misallocation of high-level talent within the industry, particularly when the collection of an imposing inventory of manpower skills is an important consideration in awarding contracts. There is also the possibility that the chances of receiving a contract are improved if it can be demonstrated that such talent is not being fully utilized.

Further, there is a danger of describing the overall scarcity of creative engineering talent in terms of technical facilities that have yet to be created or perhaps even conceived. We must distinguish actual present and future needs from the conjecture that hypothetical technical talent—if it existed—would create hypothetical innovations that would require for their operation a hypothetical army of technicians.

These considerations, while in no sense exhaustive, give credence to the Bright hypothesis. Automation can surely involve both the job enrichment and the job dilution of demand and require both upward and downward adjustments of labor supply. Until further quantitative information is available on the skill mix required by industry, we should be willing to entertain at least the possibility that the fulcrum for automation's skill impact is closer to Z (in chart IV) than either X or Y. The productivity impact may follow schedule B′B′ instead of BB.

Because of the profound impact automation has on manpower, the Institute of Industrial Relations of the University of California, Los Angeles, has embarked upon a field study of manpower changes induced by technical change, a field study of actual manpower problems

and policies of individual firms undertaking technological changes of any kind. Twenty-five firms in the southern California area have cooperated with this institute project to review the changes undertaken and their implications for their own work force. These firms represent a wide range of industries, including the food processing, electronics, banking, motion picture, publishing, shipping, transportation, automotive, chemical processing, manufacturing, food and drug distribution, and aerospace industries. Information has been collected covering a wide range of issues, including the inducements for labor-saving innovation, labor problems involved with the change in production methods, warning systems and other collaborative procedures found useful in introducing change, and the various rewards, anticipated and unanticipated, arising from new production methods. Data have also been collected on the impact of change upon total employment, and on the details of relocation and retraining programs with particular emphasis on the characteristics of labor upgraded and relocated. The generous investment of time given this project by senior corporate officials and personnel directors in the frontline of change attests to the significance attached to analysis of the manpower issue. While the survey is broad in scope and is still in its early stages, the information gathered to this date provides several promising clues on the impact of change on job design. Even the process of data gathering has proved instructive, for it has pointed up the problem of isolating the manpower impact of technical change from other concurrent economic influences, such as swings in the level of product demand. It has revealed, too, the complexities involved in efforts to "lay your bare hands" on the skill issue. One suspects that the "factual desert" regarding the impact of technology on job design reflects neither the insignificance of the issue nor the indifference of students to it, but the illusive nature of skill itself.

Firms cooperating with this venture had an advantage in manpower planning not available to all firms; they were located in growth industries or in a growth area and were thus able to absorb the displacement caused by engineered economies in unit labor requirements through the employment required to support additional production. In only one firm were substantial layoffs reported, but this firm operated within an industry that had bought out union resistance to automation, an industry making payments to the union stabilization fund to cushion employees from such displacement. The absence of layoffs was so uniformly reported that it seemed difficult to reconcile with the current concern over unemployment.

Several procedures were found useful in minimizing necessary manpower adjustments where the output increases alluded to above were not sufficient to absorb displaced labor. First, the average lead-time in introducing change was approximately 1½ years; firms relied heavily on the "A. & P." (attrition and pregnancy) solution to reduce manpower needs in that interval. Second, changes were introduced, where possible, during an upswing in the cycle of economic activity. Third, changes that affected only a portion of corporate operations gave the firm the opportunity to relocate surplus labor in unaffected areas. Contractual commitments promising no reductions in force were more the exceptions than the rule, although it was made clear, through the plant newspaper, bulletin-board announcements, special

meetings, and newsletters, that every effort would be made to preserve the job and income levels of present employees. In almost every case collaboration with the union and workers proved effective in minimizing formal resistance to change. One company that had agreed contractually not to reduce its labor force because of technological improvements conceded that hiring now involved a much more judicial scrutiny of new job applicants and company manpower needs. The obligations created for the company when new workers had worked beyond the 3-month period to be eligible for such security were not taken casually. This same company reported a blacklog of technical changes in the blueprint stage; their introduction was being phased to pace the anticipated attrition of its labor force, an attrition that, ironically, appeared to be dampened because of the company's enlightened manpower policies. The determined efforts of cooperating companies to preserve the job rights of existing employees suggested, however, that any adverse employment effects were more likely to fall upon the young worker seeking his first job.[22]

The gap between existing and required labor skills hypothesized in charts I, II, and III appears rather tenuous in the light of collected evidence. There was little evidence that substantial numbers of highly skilled personnel would be absorbed, if available, because of unmet manpower needs in automated sections of the plant. Certainly there was no evidence of new technology idled because of manpower bottlenecks.

Only one firm spoke of the problem of securing labor sufficiently competent to assure the smooth running of automated equipment. In planning for the change in production method, it appeared that as much attention was given to manpower as to technical requirements involved. Retraining programs were undertaken well in advance of changes, staffed by company personnel with experience or briefing on the mechanisms, or by the staff of the computer manufacturer. Tests were employed to determine employees most suitable for the retraining programs. However, companies were not generally swamped with applicants eager to participate in retraining programs. Some employees were reported to be apprehensive about their capacity to score well on the tests and about their ability to holddown the new job. What seemed more important, they worried about the reliability of the new mechanism and their job status should the new operation prove unworkable. A broad variation in time, ranging from 2 hours to 4 years, was reported in this retraining effort. Most programs were conducted on the job. For those who did not complete such retraining programs, physiological deficiencies such as lack of mechanical or motor coordination, or lack of depth perception, appeared more important than the lack of ability to comprehend the tasks related to the new job.

But if the inability to locate skilled labor did not appear as a barrier, either to the introduction of the new method or to its subsequent operation, were not the "deficiencies" of labor, including the burden of wage costs, considerations that encouraged the introduction of change? Surprisingly, wage levels were not assigned a central role

[22] Testifying on the incidence of unemployment, Abraham Ribicoff indicated that of 5 million unemployed, about one-third were under 22 years of age, and one-half of those had not held a job since leaving school. "Manpower Problems," op. cit., p. 105.

in the testimony regarding the impulse for automation, although reference was made to the problem of labor turnover, particularly by firms using computers to reduce reliance on the services of unmarried girls who made up a substantial part of their clerical staff. When, at an American assembly conference, a corporate official described how such labor turnover encouraged his firm to pioneer in the development of automated equipment, a labor economist asked why the company had not experimented instead with wage increases to determine if this would reduce the turnover. The economist reversed the usual capital substitution argument by suggesting the possibility that, in such a situation, if wage policies justified automation it was not because wages were too high, but because wages might be too low.

There was no evidence of general and persistent manpower scarcities, but evidence was provided on the efforts of workers to obtain jobs. One personnel officer pointed to a stack of applications many times greater than the anticipated employment expansion, applications made as a result of the decision to "confide" to existing employees that employment might expand in the near future. He described the skill level of the applicants in this way: "I never have seen so many gas station attendants in my life."

Apart from the cost related to labor turnover, there was some evidence to suggest that labor may have been a neutral or passive element in the decision to change production methods. Stress was given to the role of intensified competition, domestic and international, actual or impending. In some cases it was clear that the decision to automate was not made by comparing the marginal productivities and costs of capital and of labor, but rather by comparing the marginal productivities and costs of existing capital with those of a new technology soon to be adopted by competitors. Some respondents indicated they had no choice but to automate. While the advantages of automating were not altogether clear before the fact, there seemed little doubt in their minds about the risks of not automating.

Beyond this, the random nature of forces that encouraged new production methods was indicated by one respondent who described the revolution in technology that followed the hiring of two Harvard Business School graduates. Company operations had been profitable even though technology had been unchanged for 20 years, but the new employees labored with uncontained energy to introduce innovations in production methods that were proving highly successful. In another case, an industrial engineer described the radical production change he had pioneered as simply a "routine" function; it was his job to exercise an unrelenting curiosity about ways to improve the efficiency of every job.

The pressure didn't come from the top. In fact, it worked the other way. My biggest job was to sell the idea, to prove the equipment would pay for itself in 3 years.

These considerations do not, of course, allow the conclusion that wage costs and manpower problems were irrelevant to the decision to alter the capital structure or capital-labor inputs, even though wage costs and manpower problems were not identified as the immediate or prime causes for change.

The companies were generally successful in preserving wage standards for relocated labor even if the skill requirements of their new

jobs were not sustained. It is this process that unions have labeled as "horizontal downgrading." There was evidence that the jobs involving the use of automated equipment drew upon a different order of skill than many conventional functions, frequently giving priority to attentiveness, concentration, and accuracy, while reducing the arduous elements of the job. Grievances reflected the contention that income increases did not match the worker's enhanced stream of output. Seniority disputes were common when new work groups were carved out of old units. One company official described their difficulties as a classic example of what not to do:

> Before the precise nature of the change had been specified and the manpower requirements detailed, foremen had sought to placate anxious workers by making informal assurances to them. Most employees considered these as firm commitments by the company, and the results proved explosive when the company found it could not deliver on all the "promises" thought to have been made. It required the authority of the international to restore order within the local, and to assist the company in mediating the disputes between factions within the work force bitterly competing for job interests.

The respondents were not reluctant to stress that these innovations often involved job simplification; while there was added responsibility attached to some jobs in the sense that labor operated with intricate equipment, worker anxieties reflected the initial adjustment problems. When the rhythms of the new industrial operation were established, they felt workers were much more content with the new rather than the old production methods. One respondent described the demise of an old craftsman whose function was to mix the ingredients for the industrial product, an intuitive skill with a long and noble tradition. That function had been taken over by instrumentation, providing a sharp increase in the quality and uniformity of the product.

On the matter of education, one official humorously described his company as "nuts on the subject," adding that he had just returned from Stanford where he had attended an executive session involving the use of computers in corporate decisionmaking. He explained that education served as a standard in recruiting labor at all levels of the company operation:

> If we needed 3 men, we would review, shall we say, the current 20 applications on hand, and if everything else was equal, pick the 3 with the most education. If we needed more men, we would just keep digging deeper and deeper into the barrel.

This analysis suggests why correlations between education and employment should be interpreted cautiously. Unless we can be certain that the quality of the 20 job applicants determined whether more than 3 would be hired, it is possible that education may determine the incidence of employment and not its cause. Certainly education or even skill should not be treated as the single, independent, and sufficient determinant of the "employability" of all labor.

The emphasis on education was obvious in all field studies with one exception. One corporate official explained that recently graduated high school students were poor candidates for their apprenticeship program.

> Now we look for the high school graduate who has been pushing a broom for a year or so; perhaps a fellow who is married and with a child. He sees the world pretty clearly from the end of a broom.

This sampling of collected testimony is in no sense definitive, but is offered to illustrate some of the dimensions of the manpower problems we face even in expanding labor markets. The absence of reported manpower bottlenecks in the automated areas of company operations represents a sobering consideration when skill upgrading is so frequently identified with the automation process. Needless to say, the benefits of automation that involve increased leisure and improved living standards can set in motion new activities with their own separate mix of manpower and skill requirements. Such activities have not been the focal point for this study.

This analysis suggests, too, that the complete solution to structural unemployment is not likely to be realized by measures that would upgrade labor skills. The nature of unemployment is sufficiently severe to require bold and expanded pressures on both the supply and the demand side of the market. Labor relocation and skill upgrading may well be a vital necessary step for labor reabsorption, but it is hardly a sufficient step. The bromide offered in the 1920's by Foster & Catchings may have some relevance to the structural employment problem of our decade: "A willing buyer doesn't have to wait long; a willing seller may have to wait forever." Unless skill upgrading programs are general, they may do more to redistribute the incidence than to remedy the cause of labor displacement; they may draw a tighter line around those willing sellers of labor service who have already been waiting some time for a job.

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while 2½ million adults are unable to read or write.[16] Since unemployment hits the less educated workers severely, the task of imparting labor skills to some in this group may also require programs to improve their basic literacy.

The efforts to relocate displaced Armour employees have frequently been cited to illustrate the problems of retraining. Of 400 workers laid off by the closing of the Armour plant in Oklahoma City, 170 took advantage of the employment tests and counseling offered by the Oklahoma Employment Service. Of these 170, only 60 gave evidence of being able to benefit from additional training; 58 enrolled for training, and 7 found work at their new skills.[17] Even the skilled worker may be a poor candidate for retraining, particularly if his existing skills draw upon a narrow range of his abilities and have a low degree of transferability. For retraining purposes, he too may have to be treated as an unskilled worker.

There are, of course, several institutional impediments to labor adjustment which may reinforce the ability barriers analyzed above. For example, wage structures may not be sufficiently sensitive to the relative scarcities and surpluses of labor in various markets, and thus may not serve as an effective allocator of labor. The employee who has accumulated considerable seniority is likely to believe that the value of the "certain" income stream of his present job is greater than the value of the uncertain income stream of alternative jobs, wage disparities notwithstanding. That conviction does not readily evaporate, even with the loss of his job; the uncertain prospect of gaining work elsewhere reinforces the hope that he will be rehired at his old job. It is not surprising, then, that prolonged unemployment exists in those geographic areas suffering a pronounced sag, if not collapse, of general labor demand. An employer interviewed in the course of this research explained the force behind the "social barrier" to adjustment operating in such areas:

> Look at it this way: Most workers are apprehensive about changing an employer, or even taking on a new job with an old employer. But now we expect some men to make three or four major shifts simultaneously; to shift to a new job, to a new employer, to a new industry, and perhaps to a new community. How many are willing to do that?

He was not optimistic that those who were confronted with such a coincidence of adjustment demands would rise to the challenge, particularly in view of the self-doubts that displaced workers so often develop about their basic abilities. Unfortunately the defeatism that corrodes the moral and economic status of the unemployed in depressed areas may not be fully reflected in existing unemployment data, for persons not looking for work (nor volunteering information as to why this is the case) are excluded from the ranks of both the labor force and the unemployed.

And finally, there is the "informational" barrier to adjustment. No systematic collection of data on job vacancies has yet been undertaken and much of the information available in employment offices may not be reaching all unemployed persons searching for work.

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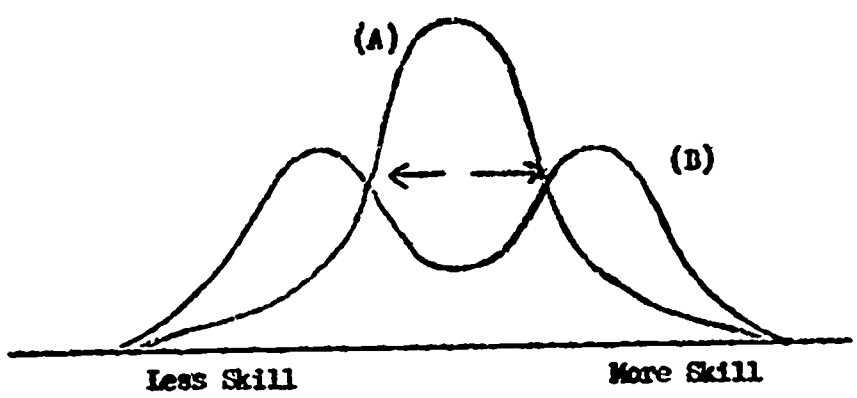
[16] "Adult Basic Education," hearings before the General Subcommittee on Labor and the Select Subcommittee on Education of the House Committee on Education and Labor, on H.R. 10143 and H.R. 10191, 87th Cong., 2d sess. (1962), pp. 9, 86.

[17] "Manpower Utilization and Training," hearings before the Subcommittee on Unemployment and the Impact of Automation of the House Committee on Education and Labor, on H.R. 7373, 87th Cong., 1st sess. (1961), p. 20.

The discussion to this point has emphasized problems related to the skill-upgrading requirement that automation involves. But it should not be concluded that automation involves only the upgrading of skills. Indeed, there is some evidence to support the contention that the skill impact follows the contours found in the bimodal distribution of skills (B) in chart III.

CHART III



This prospect can serve to minimize the pessimism of those who fear we cannot overcome the ability barriers alluded to above, for an intensive investment in human capital is not required of those who will be performing "diluted" job functions represented by the left hump of distribution (B). But this impact creates immediate problems for employees confronted with the downgrading rather than the upgrading of their work functions. Skilled artisans are likely to be sensitive to transfers into such catchall job classifications as an "automation equipment handler." If such adjustments involve not only a loss of pay and status, but also a shift to a new employer, industry, or labor market, the sources of resistance and discontent are self-evident.

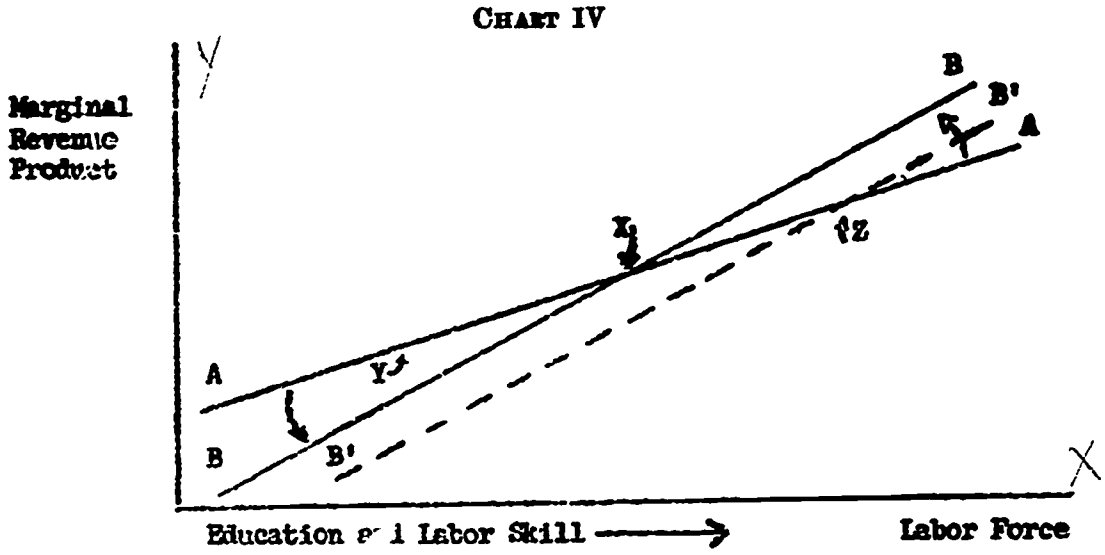
The more important issue, however, is not whether some jobs are downgraded by automation but rather the relative incidence of the upgrading and downgrading process. James R. Bright has concluded that we have given excessive attention to the way automation may upgrade skills.[18] Skill dilution is, in his view, a function of the stage of automation achieved; he employs both logic and field study analysis to support the contention that once a certain level of mechanization has been achieved, less rather than much more operator skill is required. Employers, as well as employees, are prone to exaggerate

[18] James R. Bright, "Does Automation Raise Skill Requirements?" Harvard Business Review, vol. 36, July–August 1958. William A. Faunce, testifying on his field study of automation in the auto industry, explained: "There is a higher proportion of skilled people because there are fewer people who are unskilled and semiskilled. * * * for the machine operators in this plant, there was no retraining program at all. They were simply transferred in, and the estimates of the workers themselves regarding how long it took them to learn their job indicated that very little new skill was required. * * * I am not saying that there are no new skills called for, but rather that the number of jobs created is small. "Impact of Automation on Employment," op. cit., pp. 326–327. Corrobative evidence was provided by Malcolm L. Denise, vice president of labor relations, Ford Motor Co. In introducing new technology in Ford plants, he indicated, on-the-job instruction was "quite adequate in training our production workers to operate new equipment." Formal and detailed training programs were not often necessary for that purpose. Further, he was not certain "generalized training programs" represented a fruitful solution to the unemployment problem. He agreed that from time to time particular skills—such as diemakers to staff a new stamping plant—were difficult to locate, but recruiting such talent from "far afield" was not often necessary. In analyzing the "really valuable skills" he explained: "You are talking about something that you do not pick up in 6 or 8 weeks." "Impact of Automation on Employment," op. cit., pp. 530, 550, 551.

their skill requirements, a delusion that can involve an extravagant overinvestment in manpower by the corporation.

But, at the other extreme, it is not likely that the priority employers give to the educated job applicant reflects only current fashion. Clarence Long, professor of economics at Johns Hopkins University, for example, has suggested that modern technology has probably increased the productivity of the skilled or educated employee, while working adversely on the contributions of the less educated.[19] Such a hypothesis is illustrated in chart IV.

CHART IV



Labor is arrayed on the X axis in terms of its educational attainment where such attainment, we shall assume, is a function of skill, and such skill a determinant of the marginal revenue product of labor, or the increment of revenue the added employee generates for the company. Such labor productivity before automation is indicated by the hypothetical product schedule AA, and that schedule, following automation, is titled around fulcrum X to productivity schedule BB. Productivity of labor to the left of point X is reduced, while labor productivity to the right of X is increased. In Long's view the heavy incidence of unemployment for the less educated may be caused by the downward swing in unskilled labor's productivity schedule and may be aggravated should egalitarian wage policies narrow the differential of rates between workers who are more educated and less educated, more skilled and less skilled, more productive and less productive.[20] Our concern here, however, is not with the possible causes of

[19] Clarence D. Long, "An Overview of Postwar Labor Market Developments," in "Studies in Employment and Unemployment," proceedings of the 4th annual Social Security Conference, Institute of Labor and Industrial Relations, University of Michigan-Wayne State University, and Labor and Industrial Relations Center, Michigan State University (Kalamazoo: W. E. Upjohn Institute for Employment Research, July 1962), p. 42. (See also, "A Theory of Creeping Unemployment and Labor Force Replacement," a paper presented by Professor Long before the Catholic-Economic Association annual meeting, on Dec. 27, 1960, in St. Louis, Mo.).

[20] Paul Samuelson has suggested that the negotiation by unions of the "standard rate" for the job has contributed in some measure to the unemployment we have, for the standardization of wage payments cannot always be reconciled with the fact that people are "unequal as productive instruments." He conceded, however, that to talk in these terms was to open a "Pandora's box." "Impact of Automation on Employment," op. cit., p. 132. The hostile reception afforded Long's paper by labor and union economists, department of employment personnel, and social workers attending the social security conference at which it was given is a case in point.

labor displacement, but with whether that fulcrum might actually operate at, say, point Y or, alternatively, at point Z. In other words, are more workers upgraded than downgraded?

There are some persuasive arguments for giving much more weight to the engineering analysis offered by Bright than to the more numerous lyrical projections of skill requirements that too frequently rest on mere assertion alone. Modern automation challenges almost every skill that the human agent offers to the production process. Those human capacities—including such senses as touch, sight, smell, hearing, the facility for calculating, remembering, learning, the capacity to exercise discretion—are attributes now challenged by the astonishing capacities of new mechanisms. The integration of information and production technology represents the essence of this innovation, a process that draws attention to the limitations of the human agent, now more than ever dismissed as the badly designed single-purpose machine tool. Machines have been taught to oil themselves, to adjust their worn parts, to replace their own cutting edges, to preserve through feedback mechanisms a uniformity and quality of product hitherto unknown to mass production. But more than this, automated machines are conversing with each other both to adjust the pace of production and to vary the product mix in the light of the inventory and other market data speedily digested by computers. The skill impact is suggested by labor's designation of its new job: "Now we're the baby-sitters for machines."

There is a possibility, too, that we may exaggerate the skill upgrading involved in the steady growth in the proportions of indirect labor to direct labor. The rapid expansion of computer technology promises substantial economies in the use of clerical, supervisory, and even middle-management personnel. While our analysis is arbitrarily bypassing the reduction of job opportunities that automation may involve, its quantitative effects are relevant to the skill issue. To take a hypothetical case, let us say that the distribution between the unskilled and the skilled labor force for a firm is 70 and 30, respectively, for the total of 100 employees. Following automation let us assume that the radio is reversed to 3 to 7, now favoring the skilled employee, but with only 10 workers employed. Certainly the skill level within the firm has been increased, but the upgrading of job requirements for 7 employees must be set against the displacement of 67 unskilled workers and 23 skilled employees. The Bureau of Labor Statistics studies of office automation indicates that the application of computers in offices does involve an upgrading of the skill level of office personnel, but that upgrading is achieved more by the less extensive use of unskilled than by any numerically significant increase in skilled workers employed to program and operate the computers.[21]

There is some possibility that a distorted view of skill requirements can develop from the recruitment efforts of defense and aerospace industries for college graduates. Where cost-plus contracts are operative, the marginal revenue product or demand for such labor is not only above, but also rises more rapidly than, the marginal cost for such labor. Riding up these schedules need not jeopardize the competitive position of any one firm so long as it does not get "out of line"

[21] "Adjustments to the Introduction of Office Automation," U.S. Department of Labor, Bull. No. 1276 (May 1960), pp. 30–37. No date.

in making that advance, and so long as the urgency given to the delivery of hardware is not subject to precise or binding budget constraints. Such arrangements reflect, of course, genuine scarcities of technical manpower skills arising because of the "crash" character of many aerospace projects.

In markets where demand shifts are more intensive than supply shifts, equilibrium is obtained by rising prices. One suspects, however, that the salary adjustments offered engineering personnel already in the industry have not risen sufficiently to provide that equilibrium. But market pressures are not to be denied, and the excess of demand over supply at existing prices is manifest in the intense competition for engineering talent between firms. Such competition gives an upward lift to the salary structure not otherwise allowed by salary policies for labor within the firm. Substantial pay increases follow the promotions given those willing to shift from company to company. Firms intent on preserving existing levels of manpower must undertake a heavy recruitment effort to obtain new workers, for in this way they can fill the vacancies inevitably arising when their own employees respond to the attractions of employment offered by other firms. From the macroview, however, the energy expended in such recruitment does more to influence the present location of such talent than to increase its present overall supply. The upgrading of rewards for such skills does, of course, serve its genuine economic function in encouraging the expansion of the longrun supply, but equilibrating the market in the short run by advertising and turnover may not only be a rather poor device, considering the disruption this involves for production, but also creates the impression that massive armies of technical talent could be absorbed in the industry today.

There may be, too, some misallocation of high-level talent within the industry, particularly when the collection of an imposing inventory of manpower skills is an important consideration in awarding contracts. There is also the possibility that the chances of receiving a contract are improved if it can be demonstrated that such talent is not being fully utilized.

Further, there is a danger of describing the overall scarcity of creative engineering talent in terms of technical facilities that have yet to be created or perhaps even conceived. We must distinguish actual present and future needs from the conjecture that hypothetical technical talent—if it existed—would create hypothetical innovations that would require for their operation a hypothetical army of technicians.

These considerations, while in no sense exhaustive, give credence to the Bright hypothesis. Automation can surely involve both the job enrichment and the job dilution of demand and require both upward and downward adjustments of labor supply. Until further quantitative information is available on the skill mix required by industry, we should be willing to entertain at least the possibility that the fulcrum for automation's skill impact is closer to Z (in chart IV) than either X or Y. The productivity impact may follow schedule B′B′ instead of BB.

Because of the profound impact automation has on manpower, the Institute of Industrial Relations of the University of California, Los Angeles, has embarked upon a field study of manpower changes induced by technical change, a field study of actual manpower problems

and policies of individual firms undertaking technological changes of any kind. Twenty-five firms in the southern California area have cooperated with this institute project to review the changes undertaken and their implications for their own work force. These firms represent a wide range of industries, including the food processing, electronics, banking, motion picture, publishing, shipping, transportation, automotive, chemical processing, manufacturing, food and drug distribution, and aerospace industries. Information has been collected covering a wide range of issues, including the inducements for labor-saving innovation, labor problems involved with the change in production methods, warning systems and other collaborative procedures found useful in introducing change, and the various rewards, anticipated and unanticipated, arising from new production methods. Data have also been collected on the impact of change upon total employment, and on the details of relocation and retraining programs with particular emphasis on the characteristics of labor upgraded and relocated. The generous investment of time given this project by senior corporate officials and personnel directors in the frontline of change attests to the significance attached to analysis of the manpower issue. While the survey is broad in scope and is still in its early stages, the information gathered to this date provides several promising clues on the impact of change on job design. Even the process of data gathering has proved instructive, for it has pointed up the problem of isolating the manpower impact of technical change from other concurrent economic influences, such as swings in the level of product demand. It has revealed, too, the complexities involved in efforts to "lay your bare hands" on the skill issue. One suspects that the "factual desert" regarding the impact of technology on job design reflects neither the insignificance of the issue nor the indifference of students to it, but the illusive nature of skill itself.

Firms cooperating with this venture had an advantage in manpower planning not available to all firms; they were located in growth industries or in a growth area and were thus able to absorb the displacement caused by engineered economies in unit labor requirements through the employment required to support additional production. In only one firm were substantial layoffs reported, but this firm operated within an industry that had bought out union resistance to automation, an industry making payments to the union stabilization fund to cushion employees from such displacement. The absence of layoffs was so uniformly reported that it seemed difficult to reconcile with the current concern over unemployment.

Several procedures were found useful in minimizing necessary manpower adjustments where the output increases alluded to above were not sufficient to absorb displaced labor. First, the average lead-time in introducing change was approximately 1½ years; firms relied heavily on the "A. & P." (attrition and pregnancy) solution to reduce manpower needs in that interval. Second, changes were introduced, where possible, during an upswing in the cycle of economic activity. Third, changes that affected only a portion of corporate operations gave the firm the opportunity to relocate surplus labor in unaffected areas. Contractual commitments promising no reductions in force were more the exceptions than the rule, although it was made clear, through the plant newspaper, bulletin-board announcements, special

meetings, and newsletters, that every effort would be made to preserve the job and income levels of present employees. In almost every case collaboration with the union and workers proved effective in minimizing formal resistance to change. One company that had agreed contractually not to reduce its labor force because of technological improvements conceded that hiring now involved a much more judicial scrutiny of new job applicants and company manpower needs. The obligations created for the company when new workers had worked beyond the 3-month period to be eligible for such security were not taken casually. This same company reported a blacklog of technical changes in the blueprint stage; their introduction was being phased to pace the anticipated attrition of its labor force, an attrition that, ironically, appeared to be dampened because of the company's enlightened manpower policies. The determined efforts of cooperating companies to preserve the job rights of existing employees suggested, however, that any adverse employment effects were more likely to fall upon the young worker seeking his first job.[22]

The gap between existing and required labor skills hypothesized in charts I, II, and III appears rather tenuous in the light of collected evidence. There was little evidence that substantial numbers of highly skilled personnel would be absorbed, if available, because of unmet manpower needs in automated sections of the plant. Certainly there was no evidence of new technology idled because of manpower bottlenecks.

Only one firm spoke of the problem of securing labor sufficiently competent to assure the smooth running of automated equipment. In planning for the change in production method, it appeared that as much attention was given to manpower as to technical requirements involved. Retraining programs were undertaken well in advance of changes, staffed by company personnel with experience or briefing on the mechanisms, or by the staff of the computer manufacturer. Tests were employed to determine employees most suitable for the retraining programs. However, companies were not generally swamped with applicants eager to participate in retraining programs. Some employees were reported to be apprehensive about their capacity to score well on the tests and about their ability to holddown the new job. What seemed more important, they worried about the reliability of the new mechanism and their job status should the new operation prove unworkable. A broad variation in time, ranging from 2 hours to 4 years, was reported in this retraining effort. Most programs were conducted on the job. For those who did not complete such retraining programs, physiological deficiencies such as lack of mechanical or motor coordination, or lack of depth perception, appeared more important than the lack of ability to comprehend the tasks related to the new job.

But if the inability to locate skilled labor did not appear as a barrier, either to the introduction of the new method or to its subsequent operation, were not the "deficiencies" of labor, including the burden of wage costs, considerations that encouraged the introduction of change? Surprisingly, wage levels were not assigned a central role

[22] Testifying on the incidence of unemployment, Abraham Ribicoff indicated that of 5 million unemployed, about one-third were under 22 years of age, and one-half of those had not held a job since leaving school. "Manpower Problems," op. cit., p. 105.

in the testimony regarding the impulse for automation, although reference was made to the problem of labor turnover, particularly by firms using computers to reduce reliance on the services of unmarried girls who made up a substantial part of their clerical staff. When, at an American assembly conference, a corporate official described how such labor turnover encouraged his firm to pioneer in the development of automated equipment, a labor economist asked why the company had not experimented instead with wage increases to determine if this would reduce the turnover. The economist reversed the usual capital substitution argument by suggesting the possibility that, in such a situation, if wage policies justified automation it was not because wages were too high, but because wages might be too low.

There was no evidence of general and persistent manpower scarcities, but evidence was provided on the efforts of workers to obtain jobs. One personnel officer pointed to a stack of applications many times greater than the anticipated employment expansion, applications made as a result of the decision to "confide" to existing employees that employment might expand in the near future. He described the skill level of the applicants in this way: "I never have seen so many gas station attendants in my life."

Apart from the cost related to labor turnover, there was some evidence to suggest that labor may have been a neutral or passive element in the decision to change production methods. Stress was given to the role of intensified competition, domestic and international, actual or impending. In some cases it was clear that the decision to automate was not made by comparing the marginal productivities and costs of capital and of labor, but rather by comparing the marginal productivities and costs of existing capital with those of a new technology soon to be adopted by competitors. Some respondents indicated they had no choice but to automate. While the advantages of automating were not altogether clear before the fact, there seemed little doubt in their minds about the risks of not automating.

Beyond this, the random nature of forces that encouraged new production methods was indicated by one respondent who described the revolution in technology that followed the hiring of two Harvard Business School graduates. Company operations had been profitable even though technology had been unchanged for 20 years, but the new employees labored with uncontained energy to introduce innovations in production methods that were proving highly successful. In another case, an industrial engineer described the radical production change he had pioneered as simply a "routine" function; it was his job to exercise an unrelenting curiosity about ways to improve the efficiency of every job.

The pressure didn't come from the top. In fact, it worked the other way. My biggest job was to sell the idea, to prove the equipment would pay for itself in 3 years.

These considerations do not, of course, allow the conclusion that wage costs and manpower problems were irrelevant to the decision to alter the capital structure or capital-labor inputs, even though wage costs and manpower problems were not identified as the immediate or prime causes for change.

The companies were generally successful in preserving wage standards for relocated labor even if the skill requirements of their new

jobs were not sustained. It is this process that unions have labeled as "horizontal downgrading." There was evidence that the jobs involving the use of automated equipment drew upon a different order of skill than many conventional functions, frequently giving priority to attentiveness, concentration, and accuracy, while reducing the arduous elements of the job. Grievances reflected the contention that income increases did not match the worker's enhanced stream of output. Seniority disputes were common when new work groups were carved out of old units. One company official described their difficulties as a classic example of what not to do:

> Before the precise nature of the change had been specified and the manpower requirements detailed, foremen had sought to placate anxious workers by making informal assurances to them. Most employees considered these as firm commitments by the company, and the results proved explosive when the company found it could not deliver on all the "promises" thought to have been made. It required the authority of the international to restore order within the local, and to assist the company in mediating the disputes between factions within the work force bitterly competing for job interests.

The respondents were not reluctant to stress that these innovations often involved job simplification; while there was added responsibility attached to some jobs in the sense that labor operated with intricate equipment, worker anxieties reflected the initial adjustment problems. When the rhythms of the new industrial operation were established, they felt workers were much more content with the new rather than the old production methods. One respondent described the demise of an old craftsman whose function was to mix the ingredients for the industrial product, an intuitive skill with a long and noble tradition. That function had been taken over by instrumentation, providing a sharp increase in the quality and uniformity of the product.

On the matter of education, one official humorously described his company as "nuts on the subject," adding that he had just returned from Stanford where he had attended an executive session involving the use of computers in corporate decisionmaking. He explained that education served as a standard in recruiting labor at all levels of the company operation:

> If we needed 3 men, we would review, shall we say, the current 20 applications on hand, and if everything else was equal, pick the 3 with the most education. If we needed more men, we would just keep digging deeper and deeper into the barrel.

This analysis suggests why correlations between education and employment should be interpreted cautiously. Unless we can be certain that the quality of the 20 job applicants determined whether more than 3 would be hired, it is possible that education may determine the incidence of employment and not its cause. Certainly education or even skill should not be treated as the single, independent, and sufficient determinant of the "employability" of all labor.

The emphasis on education was obvious in all field studies with one exception. One corporate official explained that recently graduated high school students were poor candidates for their apprenticeship program.

> Now we look for the high school graduate who has been pushing a broom for a year or so; perhaps a fellow who is married and with a child. He sees the world pretty clearly from the end of a broom.

This sampling of collected testimony is in no sense definitive, but is offered to illustrate some of the dimensions of the manpower problems we face even in expanding labor markets. The absence of reported manpower bottlenecks in the automated areas of company operations represents a sobering consideration when skill upgrading is so frequently identified with the automation process. Needless to say, the benefits of automation that involve increased leisure and improved living standards can set in motion new activities with their own separate mix of manpower and skill requirements. Such activities have not been the focal point for this study.

This analysis suggests, too, that the complete solution to structural unemployment is not likely to be realized by measures that would upgrade labor skills. The nature of unemployment is sufficiently severe to require bold and expanded pressures on both the supply and the demand side of the market. Labor relocation and skill upgrading may well be a vital necessary step for labor reabsorption, but it is hardly a sufficient step. The bromide offered in the 1920's by Foster & Catchings may have some relevance to the structural employment problem of our decade: "A willing buyer doesn't have to wait long; a willing seller may have to wait forever." Unless skill upgrading programs are general, they may do more to redistribute the incidence than to remedy the cause of labor displacement; they may draw a tighter line around those willing sellers of labor service who have already been waiting some time for a job.

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