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PREFACE

The productivity of the American economy may prove to be a decisive factor in shaping tomorrow's world history. We need high productivity to meet the threat of inflation at home and the threat of the cold war abroad. We are offering help to our friends both in the products we ship and in the production know-how that comes from our own experience.

When high productivity is of such critical importance, we need to examine the factors upon which it is based. Advances in productivity seem to depend upon research, technological change, managerial skills and organization, worker- and union-management adjustment, and the motivations and attitudes of all those involved in the productive process. Clearly the subject has many facets and demands many-sided analysis by all of the groups interested in industrial relations.

In the chapters that follow, representatives of various disciplines have undertaken to summarize some of our current knowledge concerning productivity. Each author has written so as to interest both the specialist and the reader with a general interest in the topic.

If we gain better understanding of the factors influencing American productivity, we shall become stronger at home and better able to help our friends abroad. The Editors hope that this volume will make at least some small contribution toward that end.

SOLOMON BARKIN
HIRAM DAVIS
BENEDICT SAURINO
WILLIAM FOOTE WHYTE

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THE MEANING AND MEASUREMENT OF PRODUCTIVITY[1]

HIRAM S. DAVIS
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IT IS COMMON PRACTICE to define productivity as "output per unit of labor time expended." The popularity of this definition undoubtedly rests on widespread interest in labor saving because such saving can affect costs, prices, profits, jobs, wages, and even a nation's military security and level of living. Nor is it without consequence that labor time itself is more readily measured than other inputs and possesses an apparent universality regardless of production unit, industry, or nation. Moreover, definition by measurement is extremely appealing when one is using a word that arouses many different and conflicting interpretations.

The definition of productivity simply as "output per unit of labor time expended" has not, however, removed confusion either from analysis or interpretation, and the reasons are twofold. This mathematical definition is as applicable to the saving of other inputs, such as mechanical energy, as it is to the saving of labor time; and the meaning of the ratio is not fixed. Unless qualified, it can denote, over time, changes in such diverse factors as character of output, rate of operation, or quality of management, as well as the changes in technology and worker application so often emphasized in discussions of productivity. In fact, the ratio of output to labor time expended, whether for a job or for a nation, is a reflector of all of these changes unless its ambiguity has been reduced by so calculating the ratio that the influence of one or more of the factors has been removed.

Has it really been necessary to abandon the verbal definition of productivity for a supposedly simple mathematical formulation? If we must end up by spelling out in some detail the meaning of the simple ratio in order to insure its comprehension both by ourselves and others, surely there is need for reconsidering the basic concept involved.

Basic Meaning

In the most general sense, productivity denotes "the quality or state of being productive" or the possession or use of power to create, to

[1] The author is greatly indebted to his colleagues, Anne Bezanson, Charles M. James, Miriam Hussey, and Gladys L. Palmer of the Industrial Research Department for helpful comments in the preparation of this chapter.

bring forth, or to make.[2] Thus one could speak of the productivity of such diverse subjects as a landscape painter, a fruit tree, or a factory. But this power to create is intangible; its presence and use has to be inferred from the results. It is often true that the productive power of a particular painter, fruit tree, or factory can be judged merely by observing its characteristics and the circumstance in which each is situated, but such judgment would be based on past observations of results forthcoming from other painters, trees, or factories.

Since the use of creative or productive power can be measured only by its results, it follows that such use cannot be measured separately for two or more subjects or factors that cooperate in production. If the results are joint, they can measure only the productive power of the joint undertaking.

In the mining of coal, for example, how can one separate output into those parts for which such inputs as labor, engineering, managerial direction, machines, and power are responsible? Suppose one compared the results from a particular mine before and after the mechanization of the loading operation and found that the daily output of the mine had increased substantially. Such increase could not have been the sole product of the loading machines for they could not have operated without power, labor, and the exercise of some managerial direction. In fact, in such a situation it could not be definitely determined from comparisons of "before" and "after" outputs whether the mechanization was worth while; total costs per ton mined before and after would have to be considered also. Even such reduction as may have occurred in cost per ton would not measure the results attributable exclusively to the loading machines and therefore would not measure the productivity of the loading machines *per se*.[3]

As with coal in the illustration, so virtually all goods and services today are the result of the combination of many inputs. Consequently the output of such products cannot be used in measuring the productivity of any one of the inputs but only of their joint power to bring

[2] See *Webster's New International Dictionary*, second edition, unabridged, 1937.

[3] It is likewise true in theoretical economic analysis that productivity *per se* (specific productivity) of separate inputs like labor cannot be determined. The "marginal" technique in theoretical models shows only how much the output is changed by varying units used of particular inputs and, therefore, not the input's specific power to bring forth results, but the limit of the amount that the entrepreneur would pay for an extra input, and therefore under perfect market conditions, what he would pay for all units of the input. See Raymond T. Bye, *Principles of Economics, a Restatement* (New York: F. S. Crofts & Co., 1941).

forth results. In other words, it is possible to use output in judging the productivity of a coal mine or the coal industry, but not that of the labor, capital, or other inputs employed in such production.

Productivity in the very general sense is of course indicated if any output ensues, for that would denote a "quality or state of being productive." Such knowledge, however, is not usually the important information wanted; nor are figures on volume of output alone considered satisfactory. A farm, mine, or factory is not regarded as necessarily having a higher productivity than another simply because it happens to be larger. Rather the critical fact is the relation between the results achieved and the power exercised. Whether the comparative "higher" or "lower" is applied depends on whether there is evidence that the results were more or less in one case than in another for the productive power used. In other words, common application of the term "productivity" involves a notion of the rate or degree with which the power to create or make is utilized. Instead of "quality or state" the suffix "-ity" has come to mean "degree" when added to productive.

Measurement of the rate at which the power to produce is utilized depends upon having some indication of the power itself—some measure of the power expended. Then the product obtained can be related to the power expended to find the rate. As pointed out earlier, however, the power to produce is intangible. Both its presence and its expenditure have to be represented by something measurable. The most obvious thing to take as a measure of such expenditure is the input required to make the product or provide the service.

Defining productivity as the results obtained for the productive power expended may seem to be the same as a definition of efficiency. It depends upon one's concept of efficiency. There are many instances in economic literature in which the ratio of output to resources expended is referred to as "efficiency," but there are probably far more instances in common usage, especially in the field of industrial relations, in which "efficiency" refers to the relation of actual results to those set as a standard. Thus it is highly desirable to indicate clearly in using the word "efficiency" whether a "productivity" or an "industrial engineering" meaning is intended.

In the light of this conceptual review, the meaning of productivity in the economic field may be stated as the degree to which the power to make or provide goods or services having exchange value is utilized as measured by the output obtained for the resources expended. As pointed out earlier, so far as the resources or inputs are concerned, their output is joint if more than one input is involved to any significant extent, and consequently their productive power must also be regarded as joint. In other words, there is no direct way from output and input data to determine the productivity of any particular class of input such as labor.

Input Measurement

It is now time to consider what light this exploration into the meaning of productivity may have cast on its measurement. The first impression may well be that of increased complexity rather than clarity. If the thing being measured is that of the degree to which productive power is being utilized, and if that is represented by the output obtained for the resources expended, the problem is immediately raised of how resources are to be measured. They obviously consist of such different things as labor time, managerial direction and planning, and various kinds of capital goods—yet these inputs cannot be immediately added together because they are expressed in diverse physical units. Nor is the measurement of output any easier if products of different kinds are involved.

The measurement of the change in a composite group of diverse items like the inputs used in production can be accomplished in at least two different ways: (1) some common basis can be found for aggregating all the items, or (2) changes in one of the items can be taken to represent those in the total. It is the latter method which has been most widely employed in productivity analysis—the use of labor time expended to represent all input.

Labor Time

Probably the use of labor time to represent all input in the ratio of output obtained to resources expended has come about less because of actual recognition of the representation being attributed to the input and more because of great interest in labor saving *per se.* Perhaps at times the use of labor input in this fashion has even been inspired by a desire to measure the productivity of labor *per se,* but this interpretation of the ratio of output to labor time has been pretty well discredited. Increasingly, publications dealing with productivity point out that the ratio does not measure the specific contribution of labor, although now and then some reports offset the effect of such explanations, at least for the casual reader, by referring to the ratio as measuring "labor productivity." [4]

For labor time to be taken as fully representative of total resources expended in a productive undertaking, one of two conditions must prevail—either labor time expended must be so large in relation to the other resources that the total is changed appreciably only by changes in the labor item, or changes in the other resources inputs must move in the same direction and at the same rate as labor. The first condition is only reasonably well met in the case of certain services such as a law office, but here the important consideration is not so much time expended *per se* as the quality of the time, as represented by the different skills of the persons providing it. That the second condition probably seldom exists has not prevented the widespread use of the ratio of output to labor time to gauge industry productivity, almost regardless of the relative labor time expended or the direction in which other inputs are moving. Such use seems to be predicated on the assumption that to a considerable extent some saving in other inputs, although not necessarily of the same degree, go hand-in-hand with those in labor, and that even when other inputs have to be increased to save labor, the saving on labor will more than offset any additional inputs of other items.

Probably in many cases such assumptions could be justified, but at best the result is a rough approximation of whatever productivity change occurred. At any rate, those who use the ratio of output to labor time to measure the productivity of an industry, firm, or establishment certainly have an obligation to show what facts in a given situation warrant their making this use of the ratio.

But even though the labor-time ratio may be an uncertain measure of the productivity of industry or of the producing units which compose it, the ratio has an importance in its own right. It is a measure of labor requirements and therefore is a valuable piece of information for such purposes as projecting the demand for labor and assessing the progress of mechanization. It is not without significance in this connection that most of the industry ratios on the relation of output and labor time now published by the United States Bureau of Labor Statistics are referred to as "labor time expended per unit of output," emphasizing the "labor requirements" aspect. This practice is to be commended, because it is likely to lead to much more discerning use

[4] *Methods of Labor Productivity Statistics,* International Labour Office (Geneva: 1951). (Studies and Reports. New Series, No. 18.)

of the relationships of output to labor time than would continuance of the use of the ratio in the "productivity" form, even with constant admonitions concerning its shortcomings.

The use of labor time to represent the input of all resources stands on a somewhat different footing at the national than at the industry level. For a nation it is possible to give some representation of what would be material, fuel, and service inputs at the industry level by including all labor time expended in the nation and relating it only to the total output of final goods and services—that is, omitting on the output side the production of goods which during the year or time period used are consumed in the production of still other goods or services.[5] This procedure is now commonly employed in measuring national productivity, with the total ouput of final goods and services expressed in constant dollars and called "gross national product" because it includes not only the production of consumption goods and services but also the production of durable capital goods without any deduction for durable capital goods consumed during the year.[6]

Even at the national level, however, it can be questioned whether labor time is sufficiently representative of all the productive resources used to give a fully adequate measure of national productivity. In view of our vast and technically complicated industrial plant, one can hardly regard real capital input as insignificant in the United States. Over a short period of years at least such input could vary in rate and direction as compared with labor time. Circumstances might lead, for example, to a widespread wave throughout a country of investment in new equipment and plants that emphasized labor-saving, with the result that the real capital input would immediately increase substantially while labor time expended might even decline until new opportunities opened up for the saved labor. The result in this situation would be that the ratio of gross national product to man-hours

[5] The same result cannot be obtained for an industry in a productivity sense by using the ratio of value added in constant dollars to industry man-hours because "value added" as a measure of industry output would imply that the productive power of materials, etc., can be separated from those of other inputs which, as already pointed out, is not true; so long as more than one type of input is involved, the product is joint and cannot be separated into the proportions for which each input is responsible.

[6] Gross private product is used by the National Income Division of the Department of Commerce which is gross national product less gross government product because so far it has not been possible to measure government product except by the labor input involved. George Jaszi and John W. Kendrick, "Estimates of Gross National Product in Constant Dollars, 1929-49," *Survey of Current Business,* January 1951, p. 7.

expended would overstate national productivity by neglecting the increased real capital input, although it would give a reliable and valuable indicator of the national trend of labor requirements.

Ordinarily it is recognized that national output per man-hour is a rough measure of national productivity and should, at best, be regarded as a measure of long-term trend. Difficulties of measuring output probably contribute more to this recognition than the inadequacy of labor time as a measure of resource use, and there is good reason that they should, since familiarity with the almost continual changes in the composition and character of production will quickly remind one of the problem of measuring national output.

Aggregate Input

Now and then there occurs in the literature a suggestion that the way to overcome the deficiencies of labor time as a measure of total input is to include not only the labor time immediately expended in current production but also the labor time which is embodied in the production of materials, fuel and power, durable capital goods, and business and other services used in current production.[7] The practical difficulties of giving substance to this idea are particularly great in the case of the input of durable capital goods, whether an attempt is made to estimate (1) the labor which had actually gone into the production of the machinery and plant or other durable capital in question, or (2) the labor which would now be required to build the plant, etc., to provide the output currently obtained. It might appear that application of this technique waits on the development of separate ratios of output to labor time for all industries. Then for any particular industry the labor time embodied in materials, etc., could be readily computed. Even that procedure does not automatically give the man-hours expended in the production of the durable capital goods used. Moreover, even if the practical problems of arriving at embodied labor time were solved, the result would still be labor time, and more than that input alone is necessary for production to occur.[8]

[7] John R. Commons, *Institutional Economics* (New York: The Macmillan Co., 1934).

[8] For an interesting experiment in using the amount of labor time embodied in materials, machinery, etc., to measure changes in labor requirements growing out of the economic and technological changes occurring in a particular industry see National Research Project on Reemployment Opportunities and Recent Changes in Industrial Techniques. *Productivity and Employment in Selected Industries: Beet Sugar; Brick and Tile.* (WPA National Research Project in cooperation with National Bureau of Economic Research). (Philadelphia, 1938 and 1939.)

Because it is not possible to express all the resources used by industry in terms of one input like embodied labor time, it does not necessarily follow that no system of aggregation is available. After all, there is one system in common use which was really devised to express quite different things in terms of a common unit—the system of money values. If actual money values are used to aggregate input, however, the influence of price change is carried into productivity measurement. In the face of this fact, the procedure that can be followed has already been suggested by the statisticians who derive a measure of national or other composite output by the process of converting actual dollars into constant dollars.

The constant dollar technique applied to measuring aggregate input of a plant, company, or industry, requires the revaluation of each class of input at the prices which it commanded in some selected base period, preferably by major price classes, especially if shifts have occurred from one grade of goods to another. The result is to weight the quantity used of each grade of an input by its relative value in the base period and thereby provide a more sophisticated measure of labor input than is obtained when all man-hours are added together without differentiation as to degree of skill involved.

So far, this technique of measuring the productivity of a firm, industry, or nation has been more discussed than applied,[9] doubtless in part because the revaluing of investor input (or what appears as interest and profit before taxes or dividends on the usual income statement) requires the rather onerous revaluation of all the capital used in the conduct of the production under study. Such revaluation is necessary to provide annual figures on average capital employed in constant dollars to which the base period rate of investor gross return can be applied. Use of this technique has also been delayed by concern over the meaning of changes in the ratio of total output to total input, when both are revalued in constant dollars. As put to the author by the executive of one company which has been experimenting with the technique, "Where you can apply it and understand it [simple one-quality, one-product operation] you don't need it, and

[9] M. A. Copeland and E. M. Martin, "The Correction of Wealth and Income Estimates for Price Changes," *Studies in Income and Wealth,* vol. II, part II; Hiram S. Davis, "The Measurement of Productive Efficiency," *The Industrial Study of Economic Progress,* 1947; and John W. Kendrick, "National Productivity and Its Long-Term Projection," Conference on Income and Wealth, May 1951.

where you need it [multi-quality, multi-product operation], you can't understand it."

Output Measurement

It is easy to get the impression that the only problem in measuring output for productivity purposes is to find some way of adding together diverse kinds of products when a whole nation or an industry like electrical goods manufacturing is involved with products ranging from giant generators to tiny electronic tubes. After all, there are many industries for which some simple physical unit is commonly used to gauge volume of output such as number of automobiles, yards of cotton textiles, or tons of coal. These simple physical measures, however, are not necessarily the appropriate ones to use with input for gauging productivity performance, for they do not necessarily reflect the results achieved when the input resources were being employed.

There are several ways in which an ordinary physical measure of output may be inadequate for productivity purposes even if only one product is involved. First, the output of a plant, company, or industry is commonly thought of as the volume of completed product, but this approach neglects work in process which is just as much a "result" of input application as is the completed product. So the longer the period of time covered by a process and the shorter the time period for which productivity change is being measured, the greater is the need for measuring output by work accomplished during the productivity period rather than by product completed.[10]

A second and related defect of customary volume measures of production is that they will not reflect changes in degree of process integration although such changes will be immediately reflected in volume of input. For example, if a meat packing company shifts from selling dressed meat in bulk to selling it packaged ready for self-service sale to the consumer, its input, especially of labor, is bound to rise and yet output would show no rise if pounds of dressed meat continued to be the gauge of output.

A third problem that arises in using customary output data is that they fail to show changes in the product which may have required marked changes in input; that is, what would appear to be a change in

[10] Even for general purpose use the production period may be so long that output is measured by work accomplished rather than by product completed, as for example, the Census practice of using value of work done during a year to measure the output of the shipbuilding industry.

productivity might only be a change in a product's specifications. Thus, if a particular kind of cotton cloth were made in constructions that varied considerably in number of threads per inch, as does print cloth, yardage for the type as a whole would not reflect any shift in construction although labor and other input requirements might have to be changed considerably.

Still another difficulty with ordinary data on volume produced is that it fails to reflect the output of associated services which may have no bearing on current production. Possibly the most striking example is that of the experimental laboratories which are now maintained by many companies. The product of such work is an addition to technical knowledge that may require years of further research and testing before it results in commercial output. If any recognition is to be made of this product in present productivity analysis, probably the most practicable way would be to deduct the manpower and other resources from the input side or in other words omit both the input and output involved and not just the output. The need for such an adjustment of input would obviously only become cogent if the input denominator were total input, along lines described earlier, rather than merely labor time.

Weighting

In general, the problems of output measurement that can arise for one simple product in productivity analysis are best solved by the same method that has to be used when quite different products are involved, such as the generator and electronic tube already mentioned. This method is that of combining the different products (or the different qualities or stages of the same product) by weighting—that is, assigning some measure of importance according to a common scale, either to the quantities involved or to the quantities converted to relative numbers—and aggregating. Various scales of importance might be used, but only two are usually pertinent for productivity purposes. In considering the results obtained for the resources expended, one is interested in knowing either their importance in terms of their exchange value or their input requirements—sales value or cost value.

Probably the most common systems of weighting representing these two different values in compiling output aggregates for productivity analysis have been weighting by value added and by labor requirements. Value added is essentially a sales-value weight, for it is sales value less cost of materials. Labor requirements, on the other hand, are a "cost" weight although, if expressed in labor time, they are a form of "real" cost.

Whether a sales- or cost-value weighting system is used will depend on what one wants to measure. If the shifting of resources from lower to higher value product is to be included as an increase in output, then a sales-value system such as value added should be used. If, however, only the effect of a change in the resources used to produce a good or service, free of the influence of product shifts, is to be included, a cost or input-requirement weight should be used. In this latter case, if productivity is being measured by the ratio of output to labor time expended, output components over time should be weighted by labor time required in the period chosen as the base; and if the ratio of output to total input—both revalued at constant prices—is being measured, output should be weighted or revalued by base-period prices, adjusted to full economic costs.

Standards vs. Productivity

Productivity measurement in contrast to work standards is a newcomer to the industrial relations field. This fact is probably largely explained by the development of industrial relations out of supervisor-employee relationships within a factory or other establishment. Consequently it has been only since wages and related collective bargaining issues have become industry- and even nation-wide in scope that productivity measurement has received attention in the industrial relations field. In other words, work standards and productivity measures are different tools, each adapted to certain purposes.

Within an establishment, it is important to know at all times how nearly production times and costs are keeping in line with what might be expected under given circumstances. But what might be expected is not necessarily indicated by comparing results obtained for resources expended at any given time with some previous time. That comparison would indicate the productivity change for the operation in question. Often performance could be expected to change simply because circumstances—perhaps the method of work, the character of the materials, the nature of supervision, machine, or process—had knowingly been changed. So it becomes important for day-to-day control of operations to compare actual time and costs with time and costs that are expected to be attained under the existing circumstances, that is, the comparison of actual with what have come to be known as "standard" times and costs.

Work and cost standards are not of much value, however, beyond the confines of one establishment, or at least beyond those of one company. They are necessarily based on a considerable amount of judgment and therefore experienced industrial engineers working with the same quantitative material can come to different conclusions.[11] Consequently it becomes almost impossible to compare time or cost standards on the same product for two or more producers, with the result that efficiency ratios based on such standards have little meaning beyond the company in which they originated. Yet it is now important in the industrial relations field to have a picture of the extent to which companies differ in their utilization of productive resources and of trends in such utilization—in other words, efficiency analyses are needed in the "productivity" as well as in the "engineering" sense.

It would be unfortunate, however, if internal analysis of company efficiency, based on standards, and external analysis of efficiency in the productivity sense were kept separate in water-tight compartments. Probably each type of analysis can gain from the other. It has been suggested, for example, that data on "should take" hours, with appropriate adjustments when these standards are changed because of changes in technology and other given conditions, could provide a useful measure of output in an expended ratio of output to labor time.[12] Moreover, the "productivity type" of ratio probably has greater utility when applied to each operation within an establishment than has been commonly realized. Unlike the internal standard measure of efficiency, labor time expended per unit of output at each stage of production within a plant can be compared with similar ratios for another plant to measure comparative performance. Pioneering work of this character is now being done by the U. S. Bureau of Labor Statistics in its factory performance studies for the Economic Coöperation Administration.

* * *

Productivity, then, is more than the ratio of output to labor time expended. That is just one way of measuring it and often a very rough way. In economic terms, productivity is the degree to which power to make or provide goods or services which have an exchange value

[11] The Society for the Advancement of Management has been sponsoring research on standardizing the measurement of basic work motions by use of motion pictures; see Society's journal, *Advanced Management*.

[12] Robert W. Burgess in a paper given before a Panel Session of the Productivity Conference, June 1, 1951.

is utilized. Such power is joint so far as modern industry is concerned, for none of the elements of production has any power to produce significantly without the aid of the others; that is, it takes labor of various capabilities, managerial planning and direction, equipment and facilities, materials or natural resources, and some degree of saving and risk-taking or investment in various combinations for production to take place. Therefore, when results obtained are compared with the input resources used, only the utilization of a joint power to produce is being measured—the joint power of the input elements combined. Thus an output/input ratio can be used to gauge the productivity of a factory or of an operation performed in the factory, but not of the separate productivities of the manager, workers, or machines involved.

Since the productivity of a factory or any organized effort can only be gauged by the relation of joint results obtained for joint resources used, it follows that there can be a variety of ways of gauging productivity because there are a number of equally valid ways of measuring both results and resources used. What measures are used for the output numerator and for the resource denominator depend entirely upon the question one is asking about productivity.

The practice of using output per unit of labor time expended to answer all questions about productivity performance has led to confusion, but the misunderstandings have not been without compensation. There is a growing recognition that productivity measures *per se*, however computed, provide little guidance for either public or private economic policy and that such measures only take on significance when the factors associated with the changes or differences shown have been analyzed. Even crude measures of productivity, if joined with an analysis of the factors responsible for the changes discovered, can be powerful tools of economic appraisal.

PRODUCTIVITY[1] TRENDS AND SOME ECONOMIC IMPLICATIONS

JOHN C. DAVIS[2]
Council of Economic Advisors

WHILE CONSIDERABLE WORK in the measurement of output per man-hour has been done by government and private research agencies—in the government, mainly by the Bureau of Labor Statistics, the National Income Division of the Department of Commerce, and the Bureau of Agricultural Economics, and outside government, mainly by the National Industrial Conference Board and the National Bureau of Economics Research. Nevertheless the basic information on past changes is still spotty. Some major components of the economy, such as construction, trade, service, the professions, and government have been given relatively little study, largely because of the tremendous difficulties of measurement encountered in these areas. We do not currently have any published "all-manufacturing" series on output per man-hour.

Productivity Problems at the National Level

Despite many gaps in our knowledge, there are informed estimates of the average increases in productivity (as measured by the ratio of output to labor input), for the economy as a whole for a few decades in the past. From 1939 through the first half of 1951, output per man-hour for the economy as a whole appears to have averaged an increase of about 2½ per cent compounded annually (see Chart I).[2a]

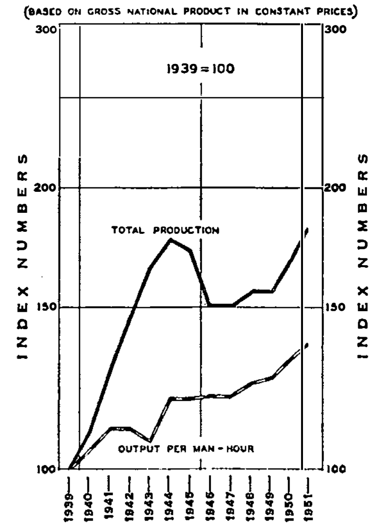
While output per man-hour for the economy as a whole has increased steadily, there have been varying degrees of change from one year to another (see Table 1). The data show no increase from 1941 to 1942, a decline in 1943 but a large jump in 1944. There was little change from 1944 through 1947, followed by significant gains in the years 1948, 1949 and 1950. The rise continued for the first half of 1951.

[1] The term "productivity" is subject to a variety of interpretations. In its generalized meaning, the word productivity is the ratio of output to input. This chapter uses the word narrowly to mean only the ratio of output to labor input. Obviously the term labor productivity should not be interpreted as implying any blame or credit to labor. For a fuller discussion of the concept see Chapter 1 of this publication.

[2] The opinions expressed are, of course, personal, and do not necessarily reflect the views of the Council.

[2a] We are indebted to the Statistical Department of the Sun Oil Company for the preparation of the charts in this chapter.

NATIONAL OUTPUT
TOTAL AND PER MAN-HOUR



SOURCE: COUNCIL OF ECONOMIC ADVISERS BASED ON DATA FROM THE DEPARTMENT OF COMMERCE.

CHART I.

These estimates are subject to a considerable margin of error. The accuracy of the index depends upon the validity of the data with respect to its various components—employment, hours, production and price data used for deflation. Most of the data used are collected on a sample basis and come from different sources. There are variations in coverage that may be important in the effect on the final results. Often revisions in these components, because of availability of more complete information, are considerable. As indicators of a trend over a considerable span of years, they are more reliable than when used to measure year-to-year changes.[3]

Manufacturing Productivity

From 1919 through 1939 the Bureau of Labor Statistics of the Department of Labor published an index of man-hour output for all manufacturing. These data show output per man-hour rising at an annual rate of about 3 per cent. The series was discontinued in 1939

[3] It should be noted that output per man-hour changes calculated on this over-all basis are attributable not only to labor, but include all the factors that affect productivity such as improved technology, increased capital, and better organization and management. Such figures also are affected by shifts of workers from one industry to another.

TABLE 1

National Output—Total and Per Man-Hour

Year	Index of output, 1939 = 100 [1]		Gross national product in 1st half of 1951 prices		Total employment, civilian and military (millions)	Hours worked per week	Total man-hours worked (millions)
	Total	Per man-hour	Total $ billion	Per man-hour ($)			
1939	100	100	178.7	1.7458	46.1	42.7	102,360
1940	110	105	195.9	1.8291	47.9	43.0	107,104
1941	128	111	228.4	1.9315	51.8	43.9	118,249
1942	146	111	261.1	1.9329	57.6	45.1	135,084
1943	165	108	294.2	1.8856	63.3	47.4	156,022
1944	177	119	316.7	2.0712	65.2	45.1	152,907
1945	172	119	307.0	2.0791	64.1	44.3	147,661
1946	151	120	270.3	2.0872	58.6	42.5	129,506
1947	151	120	269.1	2.0907	59.5	41.6	128,710
1948	156	124	278.5	2.1626	60.7	40.8	128,781
1949	156	126	278.3	2.2060	60.2	40.3	126,155
1950	168	132	300.2	2.3064	61.5	40.7	130,159
1951-1st half	180	137	322.0 [2]	2.3852	63.8 [3]	40.7	135,026

[1] Indexes are derived from gross national product (total and per man-bour) in constant dollars.
[2] Seasonally adjusted annual rate.
[3] Seasonally adjusted.
Sources: Department of Commerce and Council of Economic Advisers.

and currently we have no official government or reliable private labor productivity series that is published for manufacturing as a whole. However, the Bureau of Labor Statistics still publishes output per man-hour indexes for certain selected industries, but these are not yet considered sufficiently representative to be an adequate sample although the coverage, on an employment basis, is about 55 per cent.[4] A number of important industries such as apparel, printing and publishing, stone, clay, and glass, and fabricated metals are largely excluded.

Efforts are sometimes made to calculate an all-manufacturing output per man-hour index by relating the Federal Reserve Board index of manufacturing production to the employment and hours data of the Bureau of Labor Statistics or the Bureau of the Census. Such calculations are suspect, not only because of possible errors in the production,

[4] These indexes are now described as "labor time expended per unit of product."

employment, and hours data, which are not accurate enough to measure small percentage changes, but also because about 40 per cent of the Federal Reserve Board index of production is not based on records of physical output, but rather is an estimate of production based on Bureau of Labor Statistics employment data with a productivity factor assumed. Calculating output per man-hour from these data reveals only the Federal Reserve Board productivity assumptions. However, as quarterly, semi-annual, or annual production data are acquired, these series are revised on a physical production basis.

To eliminate the circular aspects of the above problems output per man-hour calculations are sometimes made by using only that part of the index of manufacturing production that is based on physical product data. Thus about 60 per cent of the industries covered by the index would be utilized.

According to the information available, the long-run trend of output per man-hour in manufacturing industries during the 1930's was somewhat higher than was true for the economy as a whole. From 1939 we have no official figures on an annual basis, but there have been various estimates. For example, Solomon Fabricant, in an interview published in *Business Week*,[5] ventured the opinion that the rate of productivity increase in manufacturing since 1940 has "fallen very sharply, perhaps to no more than 1 per cent per annum." Calculations derived from the recently released Census of Manufacturers data on output in manufacturing indicate that output per man-hour in manufacturing increased an average of only about 1 per cent annually from 1939 to 1947. Because of the marked shift in product mix and in quality during the war years and during the reconversion period, and because of the difficulty of securing comparable data particularly with respect to employment, there is no certainty that this figure is actually representative of productivity changes from 1939 to 1947. Since the Census of Manufactures data pertain only to the years 1939 and 1947, they do not, in any case, enable us to calculate the year-to-year changes within the period.

According to Bureau of Labor Statistics data, the number of man-hours required to produce a unit of product was lower in 1947 than in 1939 in 28 industries out of 42 studied. Productive efficiency declined during the early war years and man-hours expended per unit of output rose rapidly in many manufacturing industries. After 1944 labor productivity increased rapidly. The adverse effects of war-time

[5] *Business Week*, May 5, 1951, pp. 64-72.

shortages and reconversion problems were not entirely met by 1947, and increases in labor productivity from 1939 to 1947 for many industries were less than the normal rate for all manufacturing in prewar years.

There is, however, some evidence to suggest that by the second half of 1949, output per man-hour was increasing rapidly in many manufacturing industries. For example, figures derived by relating the physical product of the Federal Reserve Board index of production (excludes the portion wherein there is an imputed productivity factor) to employment and hours data of the Bureau of Labor Statistics show a considerable increase in output per man-hour in the first quarter of 1950 compared with the first quarter of 1949. Output per man-hour increased between 1949 and 1950 in 24 out of 26 manufacturing and nonmanufacturing industries, according to the Bureau of Labor Statistics. In 9 industries the increases were 10 per cent or more.

Productivity in Agriculture

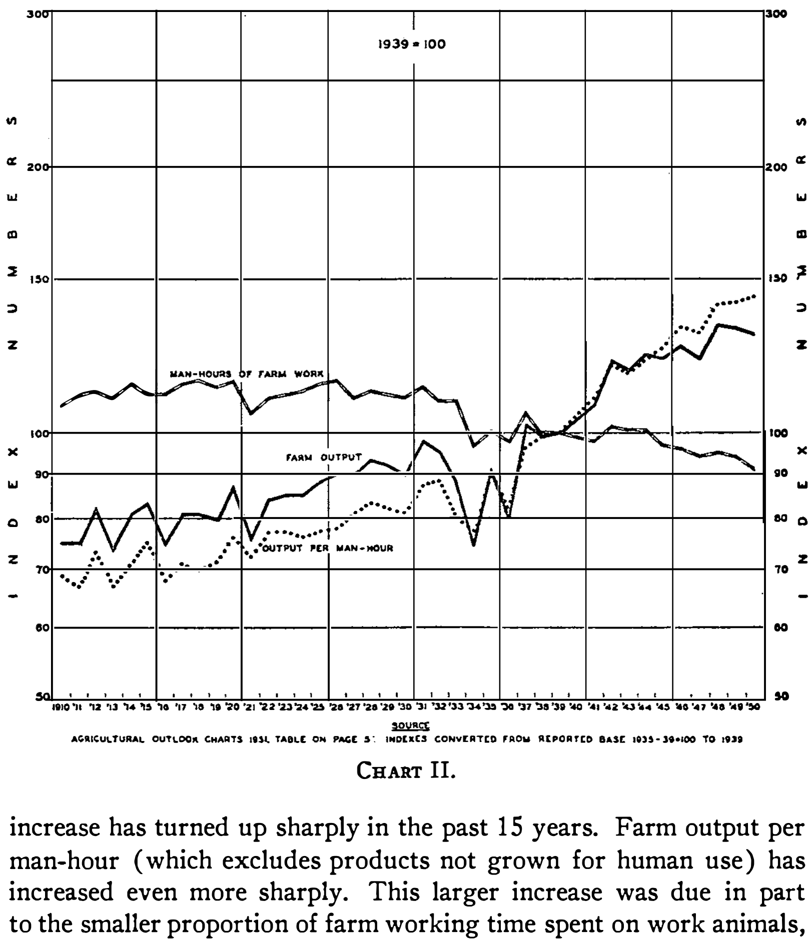
Productivity in agriculture has been moving upward for many years [6] (see Chart II). During the last 40 years, output per man-hour has more than doubled as a result of a sharp increase in total farm output and a moderate decrease in total man-hour requirements for farm work.[7] During the first decade after 1910, output per man-hour increased as total farm output rose and man-hours changed very little. After that period, man-hours spent in farm work decreased thus contributing to the increase of labor productivity, but the increase in production continued to be the most effective influence throughout the period. Both the volume of output and man-hour productivity in agriculture rose sharply in World War II and in the post war years. In 1950, output per man-hour was more than 50 per cent above the prewar level (see Table 2).

In 1948, farmers got over two-thirds more gross production for each hour of work than in 1910-14 (gross farm production includes the production of horses and mules for farm power) ; the rate of

[6] Reuben W. Hecht and Glen T. Barton, "Gains in Productivity of Farm Labor," Technical Bulletin No. 1020, United States Department of Agriculture, Washington, D. C., December 1950, Chart I, p. 2.

[7] For estimates of the ratio of real farm product to man-hours worked, see John W. Kendrick and Carl E. Jones, "Gross National Farm Product in Constant Dollars, 1910-50," Survey of Current Business, U. S. Dept. of Commerce, Washington, D. C., September, 1951.

TOTAL FARM OUTPUT, MAN-HOURS OF FARM WORK, AND OUTPUT PER MAN-HOUR



SOURCE
AGRICULTURAL OUTLOOK CHARTS 1951, TABLE ON PAGE 5: INDEXES CONVERTED FROM REPORTED BASE 1935-39=100 TO 1939

CHART II.

increase has turned up sharply in the past 15 years. Farm output per man-hour (which excludes products not grown for human use) has increased even more sharply. This larger increase was due in part to the smaller proportion of farm working time spent on work animals, as more and more of farm power has been produced in the form of tractors, and other mechanical devices, by urban people.[8]

The annual increase in farm output per man-hour of about 1.7 per cent since 1910 has resulted from factors which have both increased production and reduced labor requirements. On the production side, there are increased yields per acre and per animal. Labor requirements have been reduced by greater farm mechanization, and by the increase in size of the average farm. In addition,

[8] *Ibid.*, p. 33.

TABLE 2

Total Farm Output, Man-Hours of Farm Work, and Output Per Man-Hour, 1910-50

Index, 1939 = 100

Year	Farm output	Man-hours of farm work [1]	Output per man-hour	Year	Farm output	Man-hours of farm work [1]	Output per man-hour
1910	75	108	69	1930	90	110	81
1911	75	111	67	1931	98	113	87
1912	82	112	73	1932	95	109	88
1913	74	110	67	1933	88	109	80
1914	81	114	71	1934	75	97	77
1915	83	111	75	1935	91	101	90
1916	75	111	68	1936	80	98	82
1917	81	114	71	1937	102	106	96
1918	81	115	70	1938	99	100	99
1919	80	113	71	1939	100	100	100
1920	87	115	76	1940	104	99	105
1921	76	106	72	1941	108	98	110
1922	84	110	77	1942	121	102	119
1923	85	111	77	1943	118	101	117
1924	85	112	76	1944	123	101	121
1925	88	114	77	1945	122	97	125
1926	90	115	78	1946	126	96	132
1927	90	110	81	1947	122	94	130
1928	93	112	83	1948	133	95	140
1929	92	111	82	1949	132	94	141
				1950	130	91	143

[1] In terms of the time required by average male adult workers.
Source: Department of Agriculture (Agricultural Outlook Charts, 1951, table on page 5: indexes converted from reported base, 1935-39 = 100, to 1939 = 100.)

education and work simplification methods have reduced man-hour requirements. It is interesting, in this connection, to note that, according to Bureau of Census figures, there were 2.1 million fewer workers on farms in 1950 than in 1939.

Outlook for Productivity

Assuming the continuation of a defense economy similar to that presently in effect, it seems doubtful, from developments now foreseeable, that output per man-hour for the economy as a whole will increase during the next few years at a rate much faster than the approximately 2 per cent average annual increase of the past.

While there is considerable evidence to substantiate the belief that productivity in manufacturing made rapid advances in 1949 and 1950, there are already indications that the rate of increase since defense mobilization got under way has slowed down. Even if manufacturing showed larger increases in the immediate future than during the past, the effect on the average for the whole economy would not be great. In view of the heavy investment in capital equipment by manufacturing concerns, there is, however, every reason to believe that the long-run future increase in factory productivity will be at least as great as was true for the past.

Productivity in the farm segment of the economy should increase at a rate during the next few years not much different from the last few years. Gains from technological developments could be less in evidence, but increases through fuller utilization of farm labor and through shifts in crop production to areas more suitable for mechanization may well be pronounced.

Whether trade, service, government, and similar activities will keep step, productivity-wise, with manufacturing and agriculture is conjectural. There are too many unknowns to warrant drawing any definitive conclusions. Nothing now foreseeable suggests any phenomenal developments in productivity in these areas.

Some Economic Implications

Three major problems confront the student of productivity, each one somewhat different in nature. There is the problem of securing better data as to what has happened in the past. This is particularly important for those economists whose work necessitates estimating gross national product for future years. A slight error in the productivity factor chosen for calculating the projections will produce a cumulative error in the estimates, even within a five year period. But the size of the error is held down by independently estimating total production on an expenditure basis for the major expenditure groups and checking the productivity estimates implicit in these estimates against the over-all productivity estimate assumed. Frequently employment and hours projections have to be re-examined in order to bring the two estimates of gross national product in line.

It is even more important to know what factors influence productivity in order that productivity throughout the nation may actually be increased. To increase our standard of living in terms of goods and services, it is necessary to increase output relative to population.

This may be done in the following ways, separately or in combination: first, by increasing the labor force participation rate, that is, for a higher proportion of the total population to work; second, by having people work longer hours; and, third, by increasing productivity.

Thinking in terms of a peacetime economy, we cannot expect any great increase in the proportion of the population at work. During the last war we expanded employment, not only by reducing unemployment, but by drawing older people, women, and young people into the labor force. It is doubtful, however, that we should attempt in peacetime to stress this method of increasing output.

With respect to the length of the work week, there is every reason, given an economy at peace, to expect the long-run decline in hours that characterized the prewar economy to continue, rather than to expect our work force to work longer hours.

Productivity increases are a sound and durable method of increasing our national output. They raise the question, however, of how these gains should be shared. When productivity for the whole economy rises, there is no way to determine the extent to which each factor of production has contributed to the rise. Yet, an increase in productivity could provide each factor of production an increase in rate of return equivalent to the total productivity increase, without raising the costs of production. From this it follows that, given a certain productivity increase, unless each factor cost receives a return equivalent to the increase, some one factor will receive more in the way of added return than the amount of the productivity increase, assuming that product prices are not reduced.

The major question with respect to sharing productivity gains is: Shall such gains be distributed primarily through an increase in monetary incomes, or shall they be shared mainly through lowering prices?

The proposition that productivity increases should be shared through price decreases is an appealing one because, obviously, under this method the gains are more widely distributed. It is appealing, too, because income recipients outside the category of wage earners, e.g., fixed income groups, also benefit through price decreases.

The following arguments in favor of sharing such gains through increasing incomes may be cited.[9]

[9] For a more complete development of this idea see John C. Davis and T. K. Hitch, "Productivity and Wages," The Review of Economics and Statistics, November 1949, pp. 292-298.

(1) Rising incomes and stable price levels are more stimulating to business activity than are stable incomes and falling price levels.

(2) There is no assurance, particularly in the short run, that prices in an administered price economy will, in fact, be lowered as the result of productivity increases. On the other hand, labor organizations constitute a practical device for raising the money wages of their own members and thereby raising wages and salary rates generally over the long run.

(3) With relatively stable rates of exchange between various currencies of the world, international trade equilibrium would be aided by a wage-price policy which maintained fairly stable prices in this country, rather than a falling price level.[10]

(4) It must also be recognized that unless increased productivity results in increased money wages, employees will be generally dissatisfied. For wage rates to remain unchanged over a period of years, even though the price level were falling, would not provide the types of incentive to which American labor has become accustomed.

If productivity gains were shared through income rises, the returns to the factors of production would be raised by an amount equivalent to the annual over-all increase in productivity for the economy. However, to maintain a relatively stable price level, it would be necessary for those concerns that are experiencing larger gains than the average for the whole economy to lower the price of their product, as well as raise the payments to the factors participating in the enterprise, as an offset to the price rises on the part of firms who raise income shares commensurate with the over-all national productivity gains but whose rate of productivity increase is less than the average.

It is envisaged that in the application of this proposition to actual bargaining over wages, the burden of proof would be on employers who refused to agree to a wage increase commensurate with the average for the whole economy. If unions demanded wage increases in excess of this amount, the burden of proof would be upon them to justify the large demand. Even in a highly profitable firm, it must be recognized that to a considerable extent productivity gains are likely to accrue as the result of heavy investment in plant and equipment. The cost of such an investment must, of course, be met.

There are obviously other limitations involved in such a proposition.

[10] For a further discussion of this point see Sumner H. Slichter, The American Economy (First Edition; New York: Alfred A. Knopf, Inc.), October 1948, pp. 123-158.

At times, factors other than productivity should be the determinants of wage changes. In periods of intense inflation or deflation, or when there are maladjustments in wage-price-profit relationships that need correction, some other relationship may be more important.[11]

While sharing productivity gains as outlined above would not necessarily provide a stable economy, the adoption of such a policy would largely eliminate one of the unstable elements created when wages and salaries (by far the largest component in personal incomes) either lag behind or run too far ahead of productivity developments for the economy as a whole.

The above proposition has received considerable attention by economists, but much further work is needed in developing the idea, both with respect to its theoretical aspects and its practical application. If, in the future, this general approach were accepted by parties engaged in wage negotiations there would, of course, be an even more pressing need for better productivity data. We would particularly need to increase our knowledge of factors influencing productivity so that the short run trend could be more reliably projected.

[11] For a more complete discussion of the limitations of this proposition see Fritz Machlup, *Financing American Prosperity* (New York: The Twentieth Century Fund), 1945, pp. 431-435.

RESEARCH, TECHNOLOGY, AND PRODUCTIVITY*

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Advances in science are not automatically translated into advances in the practical arts. Far from it. Despite our engineering accomplishments, we have scarcely begun to put the latest advances in science to work in many industries.
W. RUPERT MACLAURIN, *Invention and Innovation in the Radio Industry*

NEITHER LEADERSHIP in science nor in technology guarantees leadership in productivity. Europe's supremacy in science did not keep its technology and productivity ahead of North America, nor did its technological leadership in many industries preserve superiority in output-per-man-hour and output-per-unit-of-capital.[1]

Despite the lack of correlation of leadership in science (knowledge of the laws of nature) with that in technology (knowledge of how to make and do things) in the past, progress in science is becoming a necessary condition for the betterment of technology. Industrial development staffs are finding it more and more essential to keep an eye on fundamental research as well as on needs and opportunities in industry in order to make contributions.

This intimate relationship of science and technology is new to the world. In the classical period, there was no connection. Technology was embedded in the skills of the lower classes; science was the possession of the upper classes. The lower classes performed the tasks of production; the upper classes used science primarily to develop marvelous toys. The late Middle Ages and the Renaissance saw science and technology become joint possessions, but technology continued its advance independently of science. Science was remade by technology in the seventeenth and eighteenth centuries, yet, not until the nineteenth century did scientific research begin to affect technology. Even then, little more than a casual absorption of scientific results in gas lighting and bleaching occurred. Only in the last quarter of the nineteenth century did really systematic application of science to industry begin. The coal tar dye and electric industries provide the first

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[1] See, for example, *Productivity Team Report on Cotton Yarn Doubling* (London: Anglo-American Council on Productivity, 1950), p. 65.

examples of the integration, with increases in productivity flowing regularly from the application of technical improvements which owed their development to basic research. This integration is now common, although in numerous fields science has not yet caught up with art.

The Sources of Increased Productivity

Technical advance is neither a sufficient nor a necessary condition for advance in productivity. Development of more productive techniques does not automatically lead to greater output-per-unit-input. And productivity may be raised in many ways besides adding to technical possibilities.

If the best techniques already known have not been *applied* in all possible uses, output may be increased by doing so. Where social barriers bar entry to markets, productivity may be increased by removing these barriers and carrying *specialization* and *competition* to the higher degree that would be made economic by doing so.[2] By increasing the supply of capital, output-per-man-hour may be increased through the further mechanization, instrumentation, and automatization this would make possible. Since accumulation of the capital necessary for such a project would require decades, if not centuries,[3] a cessation of technical advance (in the sense of addition to the spectrum of technical possibilities) would not necessarily inhibit growth in productivity in the near future.

This is not to suggest that we accede to demands for a moratorium on science and technology, such as are widely made in almost every depression, but only to place them in proper perspective in examining their role in increasing productivity. Improved techniques are a substitute (usually a superior one), in raising productivity, for reduced trade barriers and for more capital. By investing capital in research and development (and the resultant newly designed equipment), productivity may often be raised more than by direct investment in additional amounts of existing types of equipment.

Our task here is to examine (1) the process whereby new knowledge is translated into productivity increases and (2) the rate of trans-

[2] The various productivity team reports published by the Anglo-American Council on Productivity are very revealing in this regard. Team after team from the United Kingdom was struck by the beneficial effects of competition on productivity and the beneficial effect of the large American market on the possibility of standardization and specialization which, at the same time, still permitted great variety.

[3] R. W. Hartley estimates that $260 billion of capital, in 1940 prices (over $500 billion in 1950 prices), will be required in the 1950 decade to meet America's requirements as estimated in the Twentieth Century Fund study of *America's Needs and Resources*. See his *America's Capital Requirements* (New York: Twentieth Century Fund, 1950), p. 20.

lation. As basic research proceeds and knowledge accumulates, it may or may not lead to additions to *technical possibilities.* This may or may not lead to *innovation.* Only if successful innovation occurs and is widely imitated, with the consequence that society's *average technology*[4] advances, will productivity rise as a consequence of successful research.

Converting Research Results into Higher Productivity

Although we have come to regard basic research as the necessary foundation for technical advance, successful reconnaissance in the unknown does not automatically produce this result. The discovery of the fissionability of uranium did not produce a full-blown atom bomb. New discoveries applicable to industrial practice are not always used, according to the complaint of a former Secretary of the Department of Scientific and Industrial Research in England.[5] The United States, too, provides examples of failure to capitalize on the discoveries of science. Very recently U. S. drug manufacturers refused to use Russell Marker's discovery that the *cabeza* is an inexpensive source of sex hormones. This product of research was not applied until Marker organized his own firm.

The form of organization of research and development work influences, in important ways, the flow of research results into industrial practice. If only universities carry on scientific work, and if enterprises do not possess engineering and development divisions to translate new knowledge into new or improved products or methods for reducing costs, research will influence productivity but little.[6] If there are no applied research men close to the ear of management, results of research will be slow to leak into industrial practice.[7] Additional work must be done after the discovery of basic knowledge or the development of a technique to make use of research results. Beyond the stage of applied research, a technique must go through engineer-

[4] See Y. Brozen, *Social Implications of Technological Change* (New York: Social Science Research Council, 1950), ch. 3, for definitions of these levels of technology and a discussion of their interrelationships and their relationships to productivity.

[5] Frank Heath, *Government and Scientific Research* (London: British Association for the Advancement of Science, 1931), pp. 205-6.

[6] "Wanted: Realism in Research," *Magazine of the Future,* Feb.-Mar., 1951.

[7] W. Rupert Maclaurin, "The Sequence from Invention to Innovation," *Proceedings of the Conference on Quantitative Description of Technological Change* (New York: Social Science Research Council, forthcoming).

Someone must not only be in a position to call the attention of management to applicable developments through direct contact with management and with knowledge of new developments, but also they must be in a position to see practical needs. O. E. Buckley, "Some Observations on Industrial Research," *Bell Telephone Magazine,* Spring, 1950, p. 24.

ing development, production engineering, and service engineering. The effort required to bring a device to the point of commercial usefulness usually amounts to four to ten times the effort required to develop it.

Given a sufficient volume of basic research, applied research and developmental activity must occur on a wide scale if new knowledge is to be translated into utilitarian forms and these forms modified into a type suitable for industrial application. The Founding Fathers felt that the grant of a patent monopoly would serve as an incentive for such activity. And it has done so, the patent system serving as a mainstay for applied research organizations, such as Universal Oil Products, and for independent inventors. However, if the atmosphere is unfriendly to the introduction of new devices and practices, as is thought to have been the case in twentieth-century England,[8] even a patent system can do little more than occasionally induce the founding of a new firm to produce a new consumer good, assuming the unfriendliness does not extend so far that it blocks acceptance in normal channels of distribution. Also, if the economy is in a state of decline, returns to inventive activity will be low and there will be little incentive to engage in it.

What are the conditions that create receptivity to new ideas and lead to their use in production practice? Development laboratories are an essential link in translating research results into higher productivity. New knowledge must be translated into new or improved products and processes. These products of the industrial laboratory then must be made to work economically, redesigned to make their production or use economic, and service engineered to make them acceptable to users. We will, therefore, reformulate the question into an inquiry into the circumstances that lead to the establishment of organizations which undertake this work.

Applied research labortories have been established (and their output used) for both offensive and defensive reasons. Firms interested in increasing their profits[9] have undertaken development programs

[8] The innocent wonderment of an English productivity team at the "willingness-to-try-anything-once" it found in the American atmosphere points significantly to the lack of such an attitude in England. *Report of the Diesel Locomotive Industry Productivity Team* (London: Anglo-American Council on Productivity, 1950), p. 36. Reports of other productivity teams reflect the same outlook.

[9] Space precludes treatment of methods of generating a spirit of enterprise. I shall assume that it exists in sufficient quantity to produce the situations described here. The interested reader can consult such works as David Riesman's, *The Lonely Crowd* (New Haven: Yale University Press, 1950) for hints as to the necessary conditions.

designed to shift demand favorably or reduce costs.[10] Insofar as product improvements or price reductions made possible by cost reductions have infringed on the market position of other firms, some of them have undertaken research as a defensive measure. An illustration of the defense motivation is provided by the project selection

[10] The question may well be asked, "Why did not independent engineering and development organizations grow up providing such service to aggressive firms?" The answer is a multi-dimensional one, no single reason sufficing to account for this development. Perhaps the foremost reason is that even with independent sources of new techniques, a firm needs a staff member or department to choose among independent sources (to evaluate inventions offered by independent inventors) and to serve at liaison between the firm and its source of new techniques in deciding whether to apply a given new method and in adapting the method to the firm's constellation of policies with regard to customer relations, product design and sales, investment, labor, etc. This necessarily meant a technically trained staff within the firm operating almost at the level of applied research and an intimate relationship with the development organization that almost made it another division of the firm. In order to control this chain of development and application in a manner which would serve the firm's needs best, and in order to prevent non-patentable development work, which is an inevitable by-product of the attempt to apply new processes or designs, done by the firm itself in adapting techniques to its needs from leaking into the hands of competitors, the firm usually took control of the applied research organization where it could afford to do so.

Another way of saying the same thing is inherent in the answer given to the author by the officer of a large chemical firm who was asked, "Since investment in research is so profitable, why do you not expand your research program beyond the level where your own firm will take all the supply of results and license other firms to use the surplus, taking your return in the form of royalties instead of in profits from production?" His answer was that his firm made eight times the return it could make from royalties by using the results of its research in its own plants. This, in part stemmed from the fact that much was learned from the translation of research results into actual practice, from the fact that the experience was invaluable in leading to new developments, and from the fact that the original design was suited to the firm to which the research staff was oriented.

The second dimension lies in the self-banking nature of the corporation. Because of success in a product field, a producing firm is often in a position to raise capital at lower cost than an independent research and development firm, and it can, therefore, organize a division to compete successfully with such firms, in spite of other drawbacks, just as it often organizes another product division. Many corporations are not only self-banking but have actually become banking firms, witness the loans made by General Motors to various steel companies. Some reasons for this are discussed later in the body of the paper.

The third dimension lies in the nature of the sequences involved in economic growth. As industry begins in an area, it must perform many functions for itself because of lack of a market for specialized organizations offering such services. A firm in a new geographic area may generate its own power. After the area has become industrialized, power generation can then be turned over to a specialist firm serving *many* others. Similarly, in an industry in which research and development is a new function, a firm will have to do its own work. As the market for this service grows, specialist concerns can grow up serving many firms (although the particular developments they sell each firm may be unique to each). Such organizations are developing in the American scene and we already see some shedding of the development function by some businesses, although most of the growth has occurred through the growth in demand for the service rather than decline in self-performance.

method used by the director of the engineering and development division of one of America's largest corporations. When the author asked "What criteria are used in selecting projects?" the director brought out a large chart. On it was graphed the per cent of the total market sold by this company and the gross margin in percentage terms received on each of its products. If either of these began dropping, on any one, work was begun to improve the product, reduce its cost, or find a new item which would do the same job better or more cheaply.

Most applied research has been forced onto business as a defensive measure. Where one firm in an industry has been aggressive and used cost-saving and product-improving developments to improve its position, other firms have found their markets fading unless they followed a similar course. One aggressor has often forced many other firms to undertake applied research. The aggressor sometimes has not even been in the same territory. Firms in an industry have found the market position of the entire industry fading, and their own along with the industry, as a result of developmental efforts in another industry. An "eager beaver" in one industry has forced expenditures on applied research not only by others in the same industry, but, also, insofar as his industry then drained expenditures away from other industries, by firms in many other industries.[11]

The important point to be noted, in examining the structure for tanslating research results into greater productivity, is the influence

[11] The defensive nature of research programs undertaken both by individual firms and by industries is illustrated in the reasons given for the establishment of developmental programs quoted below from news releases.

"Other fasteners today are giving nails competition. That's why Independent Nail & Packing Co., Bridgewater, Mass., has assigned a development project to the research foundation of Virginia Polytechnic Institute." "The Humble, Ancient Nail Gets Fancier," *Business Week*, May 5, 1951, p. 46.

"Dan River is certain it has solved one of the first problems it set for itself 10 years ago—to make cotton good enough to compete with anything test tubes produce. To do the job, the company set up a research unit in 1942." "Dan River Mass Produces High Style," *Business Week*, April 21, 1951, p. 56.

The National Research Council's 1940 survey of 50 small companies having assets from $150,000 to $2,500,000 similarly shows many research programs are defensive. "Twelve out of the 50 companies said, 'If we should immediately cease all organized scientific fact finding effort, we should be out of business within one year.' Seventeen of the companies reported that they would suffer serious loss of their competitive position. Six of the companies reported that they would be liquidated within three years. Cited by Jesse Hobson, "Cooperative Research in Industry," *Illinois Conference on Industrial Research* (Chicago: Armour Research Foundation. 1948), p. 7.

A joint survey of 77 companies of all sizes by The Conference Board, American Engineering Council, and the National Association of Manufacturers reached the conclusion that one-third were carrying on research for aggressive purposes and the other two-thirds were forced into research for defensive reasons. *Studies in Enterprise and Social Progress* (New York: National Industrial Conference Board, 1939), p. 254.

of market organization on the establishment of the final links in the translation sequence. Firms whose place in the market is held fixed, whether by government regulation, by cartel agreement, by rigid buying habits, by a status system, or by a gentleman's agreement that no proper business infringes on any other, have no incentive to improve their product. A few firms may reduce costs, but this does not react on other firms to force them to advance technologically since these reduced costs are not translated into lower prices, more product for the same price, or more vigorous selling effort. The desire for profits and competition are the mainsprings of technical advance in industrial practice.[12]

Even if firms were to establish development laboratories without the spur of competition (perhaps, let us say, because government regulation requires a certain percentage of receipts to be spent on such work), desire for profits and competition still remain necessary to force the use of superior new practices. "Dr. Kettering, retired head of research for General Motors Corporation, has said that the best way to sell a new device to his company is to sell it to a competitor first." [13] The point is illustrated by the history of the development and introduction of the band oven in the baking industry. Although it was developed in the shops of the National Biscuit Company and an experimental oven in its Evanston plant demonstrated its superiority in 1936, the company continued to install the old reel oven. Not until competitors began using the oven and infringing on National Biscuit profits, which forced a change in management in 1945, did the company introduce it in its own plants.

Competition is necessary not only to *force* the use of superior new practices, but also to provide a *check* on mistakes in judgment. In the case of monopoly, whether private or public, a mistake by one committee or board would bar the introduction of more productive techniques. The cracking process for obtaining higher yields of desired products from crude oil, for example, was first laid before the board

[12] It may be asked why firms whose position is infringed upon become interested in increasing profits, after they have dropped, although they were not interested before. The reason probably lies in the changed marginal rate of substitution between profits and other sources of psychic income (leisure, the comfort of living by customary patterns, etc.) although it may also lie in a change in the ratio of the return to an extra increment of capital devoted to producing more profit in the firm to the return realized from other uses (whether pecuniary or non-pecuniary).

[13] W. R. Hainsworth, "Translating Research Results into New Products and Factory Procedures," *Research in Industry* (ed. by C. C. Furnas, New York: D. Van Nostrand Company, 1948), p. 380.

of directors of the old Standard Oil Company. The directors turned it down on the ground that the pressures needed would result in explosions and loss of life and property. This might have indefinitely delayed the use and further development of the cracking process but for the fact that the Standard Oil Company was broken into several parts to end its monopoly obtained in violation of the Sherman Anti-Trust Act. The same process was then laid before the board of Standard Oil of Indiana. It accepted its research director's recommendation and made successful use of the new technique.

Monopoly is often condemned because it is believed that monopolissts refuse to introduce techniques they know are feasible out of fear that the new methods will cause losses of sunk capital. What is less often realized is that the outcome of a "bet" on a new method is very uncertain and that decision-makers with the best interests of the public in mind would turn down (and have) many of the innovations which are of major importance in our economy today. The *Magazine of the Future* stated the case very well when it said:

> Any public body must be selective and conservative. The history of industrial progress shows that radical innovations have usually been established without help from the leaders of the industry and often in defiance of the collective judgment of industrial and professional opinion. New industries are created by men who are ready to put their shirt on the horse of their choice. Established firms and State corporations are perfectly justified in refusing to back their fancies with their shareholders' or the taxpayers' shirts, for most entries for the industrial stakes are non-starters and also-rans.[14]

Improvements are introduced less frequently under monopoly than under competition not only because mistaken refusal of an economically feasible technique may become permanent, but also because there are fewer decision-makers and fewer avenues of introduction. One man or board lacks the capacity to examine more than a few possibilities. In a competitive market, many decision-makers are at work. As some firms introduce new methods and designs, others also develop and introduce other improvements. Because of the numerous sources of novelty, the rate of advance tends to be more rapid than under monopoly.[15]

[14] *Op. cit.*, p. 30, See, also, C. E. Griffin, *Enterprise in a Free Society* (Chicago: Irwin, 1949), pp. 319, 335-6.

[15] The Servel Company is happy to see Rheem moving into the gas refrigeration field for this reason. It feels that many of the technical problems will be solved more rapidly and markets will expand enough to make room for Rheem and give Servel additional business. "When Everybody Loves a Competitor," *Business Week*, November 25, 1950, p. 68.

Even when government regulation is used as a check on monopoly, as in the telephone industry, it has not effectively served to give technological advance the same impetus as competition. If anything, a study of the telephone industry seems to indicate that regulation has retarded the application of devices which would have raised productivity. Carrier equipment developed in the 1930's in the Bell Telephone laboratories, which increased the capacity of long distance lines, was not applied at that time because of the adverse criticism in the 1939 FCC investigation of the presumed over-capacity that had resulted from the modernization program of 1929-30.

The policies of financially-cautious officers in the telephone industry also contributed to the failure to utilize better methods as they became economic. Interviews with AT&T personnel have left the author with the impression that telephone officials have looked backward at past earnings to learn whether they should invest in equipment which would raise productivity rather than looking forward to see whether the earning power of the equipment would contribute to the improvement of company earnings. Automatic message accounting seems to have been delayed primarily by this attitude.[16] If railroad officers had maintained this attitude through the late 1930's the diesel-electric locomotive and the streamliner would have been delayed until the mid-1940's. Their adoption of these advances was not the result of differences in regulatory practices, however, but a consequence of the competition offered by other forms of transportation.

Although delay in applying the findings of research is the usual criticism offered of the organization for translating research results into practice, too rapid a translation may slow the rise in productivity as well as too slow a translation. After the development of methods for beneficiating low grade iron ore, for extracting oil from shale, and for converting coal into liquid fuels, much pressure was exerted to put these methods to work immediately. Where decisions were made by non-profit motivated organizations, these new methods were prematurely applied with the consequence that capital and labor were diverted from more productive uses. Where the check of profitability

[16] A production line for automatic message accounting machines had been set up in a Western Electric plant and was ready to go into operation. Telephone officials canceled production plans and plans to introduce the equipment into the Illinois Bell Telephone Company exchanges when Illinois Bell failed to win a rate increase sufficient to raise its return to levels they believed necessary to justify further investment. The return on investment in the accounting machines was not changed by the rate situation since these were primarily cost-saving devices, although slight improvements in the quality of service would have resulted.

under competitive conditions was imposed, as in the case of the Pittsburgh Consolidation Coal Company's trial of conversion of coal to liquid fuels, techniques which did not make resources more productive were quickly abandoned to minimize losses.

The Paradox of Size Requisite for Research and Competition Requisite for Forcing Research

To induce a proper rate of flow of research results into production practice, it seems necessary to use competition. It serves both as a spur and as a check. This gives rise to the paradox that only fairly large concerns can afford (or have the incentive to institute) a development division,[17] but concerns which are large enough to afford such divisions may obtain dominant market positions which insulate them from competition.[18]

A resolution of this paradox is offered in three different directions. If a large enough market can be created, it can support *many* firms of a size sufficient to afford a research program. Large size and competition can exist simultaneously in a large market. Removal of artificial trade barriers and reduction of transportation costs created such a market in the United States. Insofar as firms can be large there is greater incentive to carry on research designed to increase productiv-

[17] No implication is intended that a firm must have a size comparable to that of American Telephone and Telegraph, General Motors, General Electric, or Dupont in order to be able to afford a development division. If an expenditure of $30,000 a year will finance a division sufficiently large for efficiency (a team of 3 professional investigators could be supported), then a firm with annual sales of $1,000,000 could afford such expenditure on research as a regular activity. It might even be argued that a concern of this size in some industries could not afford to do without a research division.

Of 203 firms reporting research expenditures, out of 892 which replied to a NAM questionnaire in 1940, many had sales of less than this amount. The smallest firms, in terms of capitalization, which did any research spent more in relation to sales than the larger firms (see National Resources Planning Board, *Research—A National Resource. II. Industrial Research,* p. 124). Median expenditure in the group of smallest concerns was 5% of sales while that in the group of largest concerns was less than 1%. (The implication might be read into this that a break-up of very large firms would increase developmental expenditures. This does not follow, however, if the large firms are the aggressors who have forced defensive research elsewhere. Large firms have, in some areas, grown large because they have been aggressive in research).

Large sales are *necessary* for the support of a development division only if firms must be self-banking and must be able to get tax advantages by "expensing" research. A small concern can afford a development division in which expenditures far exceed sales if it is investing capital in developments which it expects to sell, from which it expects to receive royalties, or which it expects to use in expanding itself.

[18] To the extent that such firms are self-banking, and investment in a research division whose output they use is more profitable than investment in another product division, competition is less necessary to force research.

ity since *small gains per unit of product on large runs give large enough returns to justify the cost of applied research.*[19] Insofar as the market is large enough to support many such firms and any one of them is aggressive, competition will force research on the industry.

A second direction is that of utilizing the threat of potential entry. If there are many potential entrants, no firm dares rest on a given technology for fear that new developments will be utilized by those who see an opportunity to seize a market from a sluggish giant. Creating conditions under which entry is easy and has great probability of occurrence tends, then, to keep industry technologically alive (or, alternatively, keeps its earnings low if it does not stay technologically alive).[20]

Technological vitality characterizes industries where entry is easy and where other characteristics are present which make industrial research profitable. This occurs not only because the threat of entry of new firms forces old firms to "stay on their toes," but also because the tendency to stay in old lines, although with much improvement, is offset by the fact that new firms will introduce the radically new techniques which old firms refuse.

> When the innovation is crude and has obvious shortcomings the (leading) concern may be a bit too ready to conclude that the idea has little prospect of commercial success. It cannot be only chance that the Western Union interests underestimated the telephone, that the Telephone Company was slow to appreciate the possibilities of radio, that it remained for newcomers to bring out the inexpensive table model radio receiver, that small concerns did much of the pioneer work in fluorescent lighting, and that one small concern made the first F.M. transmitters while a local network was the first commercial enterprise to install them.[21]

[19] It is this reason which accounts for the finding of G. Perazich and P. M. Field, *Industrial Research and Changing Technology* (Philadelphia: National Research Project, 1940) that "the largest research organizations are to be found in the mass-production industries in which production is concentrated in large enterprises," p. 18.

[20] In some industries, entry has been so very easy that they attracted a great many entrepreneurs who would otherwise have been unemployed laborers. Since the technology of these industries has been such that the use of technically trained personnel has not been essential, the entrance of non-technically minded firms has failed to spur technical advance, or has blocked it through ignorance and prejudice or lack of capital in the avenues through which it might enter, and has depressed prices to the point where investment that might have gone into development of the industry's techniques has been repelled by the lack of opportunity to profit. The coal mining and foundry industries are suspected of falling into this pattern. It would seem, then, that we must avoid pushing people into a no-man's land of unemployment, to prevent this situation from arising, or, alternatively, somehow make it necessary to have technically trained personnel somewhere in each firm.

[21] Frank Kottke, *Electrical Technology and the Public Interest* (Washington: American Council on Public Affairs, 1944), p. 127.

With respect to the maintenance of the threat of potential entry as a spur to advances in productivity, our tax laws seem to work simultaneously in opposite directions. They stifle the flow of venture capital to new firms. At the same time they make old firms (corporations) eager to find new lines of production, thus making them potential entrants into fields new to them, in order to use the funds they borrow at no cost from the federal government (by delaying the payment of dividends and thus delaying the payment of personal income taxes). Also, they minimize the taxation of earnings to their stockholders by converting profits into capital gains. (The flow of venture capital to *new* firms, which will be technological leaders, is being helped, although by very little as yet, by the organization of such concerns as American Research and Development Corporation and New Enterprises, Inc. These, also, have developed as a method of minimizing taxes by taking earnings as capital gains).

The threat of potential entry reacts on large firms not only through their fear that new entrants will introduce technical advances which will encroach on their markets, but also through their inefficiency in production (if they are *very* large firms). Their inefficiency makes them vulnerable to new entrants who do nothing more than produce the same product at lower cost and sell at lower price. In one case in which the author interviewed officers of a large corporation, the fact emerged that this enterprise usually began suffering losses on any product whose design had been stabilized. It had frequently been forced to yield to the competition of "fly-by-nights" and drop a product. It sometimes came back into a product it had dropped after its research division had discovered a method for improving it. Only by constantly being in a "new" industry, where price had not yet been driven down to the minimum average cost of the next prospective entrant, could this firm obtain large enough revenues to cover its high production costs.

The third direction in which lies the solution of the problem of size requisite for obtaining a pay-off from technical development is that of establishment of independent research organizations serving many firms. In some industries, firms have joined together to support a laboratory, particularly where it has been felt that all could gain by expansion of the industry's market through cost and price reduction and product improvement. Other research organizations have been established which serve firms as individuals. Their facilities and staff could not be maintained by any one or few firms. By serving many firms, although each is served individually, they can afford to keep specialists working full time by mobilizing many problems for them.

This latter approach suffers from certain drawbacks. Usually, applied research organizations serving many firms as individuals rather than as a group work only on problems brought to them. Their staffs do not look for or work on problems which have not occurred to management. They produce many induced inventions but few autonomous inventions. Since "serendipity" seems to be an important method of technical advance, and since research men are usually more productive when spending at least some of their time on problems they lay out for themselves, the productivity of these organizations may fall below that of those operating under the looser rein of a direct association with an enterprise or group of enterprises which can use nondirected research and will give support to such a program. To some extent, the patent system provides a method of profiting from nondirected research when no direct support is forthcoming. If a research organization has the necessary capital, it can invest in developmental research in the hope that patentable results will emerge. Some, such as the Universal Oil Products Company, do follow this procedure.

Motivating Conversion of Research Results Into Technological Improvements

Receptivity to new ways and a desire to use them are important if development programs are to be established which will translate the output of basic research into improved technology and higher productivity. An equally, if not more, important factor, however, is the profitability of improving processes and product. If applied research does not pay, there will be little incentive to carry it on. Desire for improved ways will be able to effectuate itself only through philanthropic activity.

An unfortunate feature of our present economy is the fact that the extent to which development pays depends upon the degree of monopoly that can be exercised over the application of new ideas,[22] where this development and application is not forced by defensive necessities. The conditions which maximize the social return from these programs reduce the private return to the investors to zero. If public subsidies are not to be used, then restriction of the social return is necessary to

[22] This is the main assumption of Professor Schumpeter's argument that monopolistic practices, in general, have helped to expand output in the long run, rather than to contract it.

give sufficient private return to induce the undertaking of inventive activity.

Private returns may be made available without public subsidy either by permitting monopolization of an industry or monopolization of the results of inventive activity. The Aluminum Corporation of America, in the days when it had a monopoly of the production of virgin aluminum, found it could obtain its return from improvement of or development of new uses for its products or from development of less costly methods of manufacture through its control of the price of aluminum. No other firm could copy its developments and force prices down to where no greater return was realized than would have been if no development program had been undertaken. The monopoly power possessed by Alcoa, however, could be, and perhaps was, used to extract from the public more than the returns required to motivate its research program. For this reason, as well as for others, monopoly cannot be tolerated. To do so tends to frustrate technological advance since it fails to bear fruit as abundantly as it does under competitive conditions. Invention may be better motivated,[23] but innovation and imitation (large scale use of inventions) are inhibited.

The patent grant of a temporary monopoly of an idea or design serves the purpose of motivating invention and inhibits the use of advances less than an industry monopoly, although it still suffers from the necessity of restricting the social return in order to yield a private return. It is, however, a necessary method, even with public subsidy of development work, if the economy is to advance at something approaching the optimum rate. We must retain the patent system, or at least its good features, to motivate the "wildcat" inventor who would not be recognized by agencies distributing public funds or accepted by applied research organizations under the usual rules of personnel recruitment and control.[24]

Subsidies, too, are necessary since private returns to inventive activity with or without a patent system, cannot be as great as the social

[23] D. Wallace argues that monopoly in the aluminum case prevented not only the more abundant fruit that would have been borne by technological advance under competitive circumstances, but that it also prevented technological advance from occurring at as rapid a rate as would have been the case if several large companies had been competing aggressively against one another. See *Market Control of the Aluminum Industry* (Cambridge: Harvard University Press, 1937).

[24] Sinclair Oil Co. has recently changed its recruitment procedure in recognition of the fact that inventions often are made by unexpected persons. It is offering the use of its laboratory facilities to anyone with an idea with only the provision that, in return, it be allowed to use the results of the research royalty free.

return from unrestricted use. Privately financed, profit motivated research will, therefore, always fall short of the socially optimal amount. Direct grants of aid from the public treasury are not wise, however, both because they tend to give greater returns to investors in some industries than in others (as it has in agriculture) and because no single agency can be sufficiently omniscient in as uncertain a field as applied research nor as devoid of pet interests as would be required of a board with such power selecting among so many alternatives. Perhaps grants for *basic research* avoid the first drawback inasmuch as such research "is so broad in its application and so indirectly related to any industrial process or . . . to any particular industry." [25]

Methods of subsidizing applied research which do not suffer from the pitfalls of the direct grant method are available, and one of the methods is in partial use. "Expensing" of developmental expenditures is permitted by the Bureau of Internal Revenue (although it sometimes bargains permission for expensing against some other disputed item) with the result that capital costs are reduced insofar as this results in borrowing from the Federal government without cost through a delay in tax payments to a later date. Also, insofar as ordinary profits are converted into capital gains by this procedure, taxes are reduced rather than simply delayed.

Tax reduction through a "depletion allowance" approach has much to commend it as a method of subsidizing research. By allowing companies to deduct from taxable income 25%, let us say, of the income attributable to an invention, a subsidy may be granted which requires no discretionary action by a government agency. By defining the income attributable to a new technique as the royalty rate obtained from a non-affiliated organization times the number of units produced with it, whether by the developer or others, the developer will be motivated not only to undertake research but also to spread the use of its research to at least one other concern.

Neither monopoly power (whether over an industry or through a patent on a device) nor public subsidy has been the moving force for much of the applied research carried on by American corporations. Oligopoly with product differentiation seems to have produced a competitive situation that has forced research on all the large firms in certain industries, such as chemicals and electrical equipment, in order to survive profitably. Any firm which does not continually improve

[25] The President's Scientific Research Board, *Science and Public Policy* (Washington: Government Printing Office, 1947), vol. I, p. 30.

its product and lower its prices in these industries soon loses its market position and suffer losses. Usually it has not been sufficient for these firms simply to copy the advances of others to keep their market positions. The first in the field with a given improvement or in a market segment with a price cut usually keeps a dominant position for the product variety in question. For this reason, the defense has had to take the form of a competitive improvement in product design of a different type, in order to keep the usual share of business, as well as incorporation of the advances of others.

The three economic characteristics of a market which seem to promote research and use of its results are the importance of market position in determining sales (the fact that a firm with a better market position can sell more at a given price with a given total selling expenditure and given unit production cost than another charging the same price, making the same selling effort, and devoting as much resource services to the production of each unit of product), the presence of an aggressive firm, and a (subjective) kinked demand curve. When the kink is convex (looked at from above), firms find it more economic to obtain increased sales by other means than price reductions, since the effect of the latter is (or is expected to be) quickly offset by the price reductions of rivals. Similarly, increases in selling effort are offset by increased selling effort of rivals, although not as quickly as a price reduction. Changes in product design are less quickly offset by changes in rivals' products, since it takes a fairly lengthy period to redesign and retool for mass production, particularly when the changes are fundamental rather than superficial labeling and appearance changes. Changing product design has become the characteristic method of the firm which aggressively attempts to increase sales when faced with a convex kink in its demand curve.

The fact of convexity in the kink means that rival firms act to prevent any deterioration of market positions. Since changes in product design by an aggressor threaten the position of rivals, they, too, will adopt the tactic of changing product design. Since to change product design only after the aggressor's design is changed may mean permanent loss of market position, rivals anticipate change and introduce their own variations as rapidly as the aggressor. The presence of a Ford or a Firestone, then, means that everyone in an industry becomes aggressive to preserve himself.

As periodic design changes become a regular part of the program of surviving firms, an aggressor will turn to cost-saving development as a method of obtaining the means of out-selling and out-designing others. This, in turn, will force other firms to adopt similar programs to protect their market position.

In a market with differentiated products and at least one aggressive firm, then, research and development become a necessary portion of marketing costs along with sales and advertising. This is especially true in the course of growth of a product not yet technologically stabilized. Once design becomes stabilized and product well standardized, expenditure for development becomes less necessary to maintain existence. At the same time, however, earning levels drop with the result that firms must look for methods of reducing cost, unstabilizing product design, or for new products if rates of return are to be maintained. Industries characterized by technological stability are low return industries. Research programs may be motivated, then, by a desire for returns in excess of those enjoyed by technologically dormant industries. Monopoly or patent protection are not necessary conditions for technological advance in the presence of markets of the type described above,[26] although they may be necessary, along with other devices, to produce advance at the optimum rate.

The Influence of the Market for Improved Methods

Payoffs for research outlays depend on other factors besides market position and convexly kinked demand curves. There will be little return to investment in new techniques if the market for improved or less costly equipment and consumer products is restricted by economic decline. Equipment may be developed which operates at lower cost than previously used methods, yet fail to sell well enough to return development costs.

If the industry that might use the new equipment is faced with contracting demand, price reductions to the level made possible by the newly developed methods may be insufficient to maintain a rate of demand high enough to absorb the capacity of the sunk capital in the industry. A declining rate of demand which cannot be arrested even with economically justified price reductions (economically justified from the point of view of individual firms attempting to maintain production at rates at which their marginal cost is equal to price) will give rise to a situation in which there will be few orders for replace-

[26] F. Kottke found that in the electrical apparatus industry, for example, there is a high correlation between the presence of competition of this character and the rapidity with which changes have been made that require replacement of substantial amounts of capital equipment. Where competition has been most vigorous, technological change has been less rapid. *Op. cit.*, p. 124.

ment equipment, much less for equipment for purposes of expansion. Worn out items will be replaced with those made idle by the contraction in demand.

An invention which would be economical for introduction in a growing industry may not be in a declining industry.[27] Potential investors in development programs will be repelled, then, if the industries to which new techniques may be sold are contracting rapidly and the age distribution of equipment in place adversely influences sales potentials.[28] Growing industries or those saddled with a large proportion of aged equipment will attract developmental investment. Growth, then, tends to promote further growth, through technological advance, and decline tends to promote further decline through technological stagnation.

The market for improved capital goods is not necessarily attractive when the industry which may use them is growing. If buyers of equipment are technically ignorant and do not seek expert advice, or if promoters of new firms can sell out to ignorant buyers, or if capital is difficult to obtain (and it is likely to be when an industry is growing since this is likely to occur when there is a large demand in many industries for expansion purposes), manufacturers of inferior equipment may be more successful in selling equipment by providing capital advances (and low priced items) than those who sink their capital in improvements and then are unable to offer attractive payment terms. Such a situation seems to have prevailed in the textile machinery industry in the last third of the nineteenth century when textile mills were being founded at a rapid rate in the South.[29] Also, if the demand for equipment is so strong that equipment producing capacity is strained, the return to effort devoted to the production of more equipment will pull capital away from the development of new techniques.

It may be argued that development programs are encouraged rather than restricted by an unfavorable age distribution of equipment in

[27] See Y. Brozen, "Invention, Innovation, and Imitation," *American Economic Review*, May, 1951, p. 246, for an analysis of the reasons for this situation.

[28] "There were economic reasons why more attention had not been given to doubling machinery. . . . If the industry were to re-develop the doubling frame, a great deal of money would have to be spent in replacing thousands of existing spindles which were still working satisfactorily. Economically, such a move would not pay, as, under conditions of normal trade, the industry used only about 70% of the available doubling spindles in the country." *Productivity Team Report on Cotton Yarn Doubling, op. cit.*, p. 66.

[29] T. R. Navin, "Innovation and Management Policies—The Textile Machinery Industry: Influence of the Market on Management," *Bulletin of the Business Historical Society*, March, 1951.

place or by contraction in the customer industry. If most equipment in place is fairly new and is durable, or if a slight contraction is being suffered, replacement sales will be low. In order to keep an apparatus business going, then, it becomes necessary to develop new models sufficiently superior to those in place to induce early replacement, assuming the apparatus firms in question cannot easily turn to the production of alternative goods.[30] It is only severe contractions or extreme lumping of age distribution of items in place at the new end of the scale which will cause a decline in developmental expenditures. Moderately influential circumstances of this sort may increase such outlays as a defensive measure.

The behavior of total expenditures by industry on applied research in the face of the decline in aggregate activity in the 1930's is not out of accord with the thesis that moderately adverse movements which have not been long continued may bring increased developmental activity as a defensive measure while greater declines cause reductions in such programs. Industrial research expenditures increased from $106,000,000 in 1929 to $116,000,000 in 1930 and $131,000,000 in 1931. The year 1932, however, saw research expenditures cut back to $120,000,000 and 1933 saw a drop to $110,000,000.[31] The years of increase in research were years of moderate decline in the sale of durable goods while the years of decrease were years of severe decline.

The years 1945-48, which were years of severe strain of productive capacity, saw few model changes and little increase in productivity, confirming the thesis that strong demand relative to capacity causes a decline in the flow of research results into industrial use. As growth in capacity began to catch up with the rate of demand at prices consonant with minimum average costs, model changes began to appear, stress was placed on the growth of efficiency rather than capacity, and the flow of research results into practice accelerated.

Barriers to the Introduction and Spread of Technical Improvements

New methods may come into use slowly because of economic reasons, in which case a more rapid introduction would reduce produc-

[30] The case of the Toledo Scale Co. illustrates this point. As *Business Week* (April 16, 1949, p. 84) put it, "The perpetual challenge to the Toledo Scale Co. is that it builds its products too well. Thus: (1) It has all but eliminated friction in its weighing machines to make them ultra-accurate, but (2) when you cut out friction, you cut out wear: the scale lasts almost forever. So Toledo over the years has tirelessly looked for more uses for scales, beat the bushes to sell improved machines to owners of old models, and kept a sharp eye open for products that can be made and sold along with weighing machines."

[31] V. Bush, *Science: The Endless Frontier* (Washington: Government Printing Office, 1945), p. 80.

tivity, and for non-economic reasons. Changing from an old to a new technique or product design often involves a large cost. This cost may be so great that it is more economic, from the social point of view as well as the private, to go on using old equipment.

The spread of technical advances is slow also because the quality and cost of new types of equipment improve with the passage of time. Under these circumstances, it may pay to wait. New techniques become more economic with the passage of time because "bugs" are eliminated, thus reducing operating costs, because the first cost is reduced, and also because the high obsolescence rate is reduced, thus diminishing depreciation costs.

But while there are good economic reasons for not bringing the average technology of the economy up to the level of the best technology that would be used by new firms, technological practice may fall short of even the economic level. The ignorance of capital suppliers sometimes prevents the flow of capital into superior uses embodying improved techniques. Banks refused to lend the capital required for soil conserving farming, for example, because they felt the yield would be insufficient to insure the return of the funds advanced. Only after the Department of Agriculture operated demonstration farms proving the productivity of such investment was capital readily furnished. Similarly, the lack of an intermediate capital market to supply middle-term loans in the textile industry until recently inhibited mill modernization which in turn inhibited the development of textile machinery.

Lack of information on the existence of better techniques or lack of "know-how" in using them inhibits the use of advanced practices. Secrecy, inadequate educational systems, and lack of incentive to spread knowledge to seeking better techniques, or to apply them, all contribute to this situation.

Social structure may inhibit the spread of desirable innovations. In a class divided society with income distributed on the basis of caste or power rather than on the basis of productivity, there is little incentive to invent, innovate, or imitate better technicways. Jacques de Vaucanson's textile machinery did not spread in eighteenth century France, which was characterized by such class and income division, while the inferior Arkwright inventions readily spread through British industry.[82] De Vaucanson would not even have performed his work had he not been appointed Inspector of the Silk Manufacturers. Prior to

[82] S. Giedion, *Mechanization Takes Command* (New York: Oxford, 1948), p. 36.

this appointment, he had mechanical interests but devoted them to the perfection of automatons.

Lagging technology is often the result of managerial and entrepreneurial decadence. Management and entrepreneurship may grow decadent because of the spirit of the whole society. The idea that old ways are better than new, that social status is a better qualification for managerial positions than ability or training, that no change should be undertaken which would force anyone to change his job, his occupation or his way of life can pervade the atmosphere and prevent the introduction of improvements.

Firms sheltered from competition by cartel arrangements, tariffs, or monopoly position are most often afflicted with managerial decay. Although it may be economic to use improved techniques, such firms often fail to do so. While management or entrepreneurship does not necessarily grow decadent when firms are sheltered, these conditions permit the survival of those which do.[33]

Management selection and training systems are an important element leading to decadence. Warren Scoville's study of the glass industry[34] hints that status systems result in entrepreneurial mediocrity which in turn results in technological fixity. He suggests that entrepreneurs recruited by ability rather than by birth and recruited from different industries provide the cross-fertilization conducive to rapid technological advance. English experience seems to confirm this.[35]

[33] "Industries with a localized market are shielded somewhat from intense competition, and this may account in part for the slow mechanization of such localized industries as building and the manufacture of brick." H. Jerome, *Mechanization in Industry* (New York: National Bureau of Economic Research, 1934), p. 351. See, also, A. Alchian, "Uncertainty, Evolution, and Economic Theory," *Journal of Political Economy*, June, 1950.

[34] *Revolution in Glassmaking* (Cambridge: Harvard Press, 1948).

[35] *Technological Stagnation in Great Britain* (Chicago: Machinery and Allied Products Institute, 1948). The reports of productivity teams from England, which focus attention on factors which cause American productivity to exceed English standards, confirm the fact that the use of status rather than ability in the selection of managers has hindered English technological advance. They make such statements as "all Americans accept as normal the competition to hold and improve their jobs. The competition becomes more intense the more senior the executive, whereas in Britain competition frequently becomes less intense with seniority" and "the very high level of efficiency shown by all representatives of American management . . . is (inspired by) the knowledge that only continuing satisfactory results maintain them in positions they hold or provide a basis for further promotion.

"Members of management in all plants visited displayed a fundamental knowledge of a great wealth of detail and a lively interest in each other's problems which are not generally found in Britain. The ready replies which were always given to questions without reference to subordinates or others gave ample evidence of the truth of this statement." *Report of the Diesel Locomotive Industry Productivity Team, op. cit.*, pp. 21, 34.

Methods of recruitment may be used which are based on ability and yet fail to produce men with innovating talent to staff decision-making positions. If, for example, there is an industry tradition of putting all executive and engineering trainees in the "shop" (as in the steel industry), talent may be repelled or, alternatively, thoroughly grounded in the prevailing techniques with a consequent stifling of freshness and originality. R. S. Sayer, recounting the factors leading to the invention of a heavy loom in 1925, tells us that, "This invention came from a young engineer who claimed that his success was because of his newness in the field and the fact that he was not obsessed by tradition enabled him to plan a new type of loom construction from the floor up." [36] T. R. Navin has pointed out that "traditionalism of the textile mill executives has actively discouraged machine builders from offering new designs" and that this traditionalism is the result of "recruiting primarily in the textile institutes of the country rather than in engineering schools. . . . As a result, the young men who have entered the nation's textile business carried with them a thorough enough knowledge of existing textile practices, but none of the theoretical skepticism that they might have brought with them from a school of engineering. Without this theoretical skepticism they have not as a rule been critical in any fundamental or constructive way of the basic designs incorporated in the equipment sold to their mills."

Market organization affects the rate of introduction of improved practices not only through its impact on the quality of management, but also through its impact on the slope of the demand curve facing the individual firm. Since more expansion will occur in markets where no firm will cause a drop in price by expanding, more rapid adoption of cost-saving equipment takes place where markets are more perfectly competitive. This also influences the rate of development of technical possibilities since there is a larger market for improved equipment under these circumstances.

Summary

Advancement in productivity comes from several sources. Application of technical improvements is one of the more important and one of the more efficient methods of increasing productivity. Since technological advance has become heavily dependent upon advances in science, with exceptions where the state of the art in an industry is

[36] "The Springs of Technical Progress in Britain, 1919-39," *Economic Journal*, June, 1950, fn. 5, p. 283.

still in advance of science, basic research must be promoted if gains in productivity from this source are to continue.

Large scale programs of fundamental research will not be financed by profit motivated investors, with a few exceptions (such as in the case of General Electric and American Telephone and Telegraph where the concerns involved have a dominant position and diversified interests within a research area with the consequence that they can utilize by-products of research and can get a major share of profit resulting from the expansion of their industries), since the pay-off on such research is usually too distant and diffused among too many industries to yield large enough present values to compete with other investments. The chemical and electrical industries are the exceptions where profit motivated fundamental research has occurred and has been financially successful. Here, periods of a scientific and industrial gestation have been shorter than those found in other fields although, even here, many programs have been unprofitable because of overly long gestation periods. Industry has supported fundamental research on a small scale because of the training and stimulus afforded to applied research personnel through contact with the work and with fundamental information.

Large scale support of basic research is necessary, but it is not a sufficient condition for technological advance. Research results must be translated into improved products and processes. Applied research programs must be supported, then, to undertake this translation. Such programs have been supported privately where large markets supplied by large firms have existed, where the position of these firms has not been fixed and held rigid by private, public, or sociological regulation and where at least some of the firms have been interested in increasing their profits, size, or power.[37] Also, where capital suppliers have been willing to *invest* in technical development for the sake of future royalties, applied research has been supported.

Publicly and philanthropicly supported development programs have not been as successful on as wide a frontier in converting research results into higher productivity as those financed by profit motivated investors. Applied research organizations directly connected with a commercial enterprise are better oriented to the problem of converting knowledge into marketable forms, i.e., forms useful enough to

[37] See Y. Brozen, "Invention, Innovation, and Imitation," *op. cit.* p. 256, for a summary discussion of the effect of market organization on rates of development and rates of application of new technology.

potential users that they will buy, and are closer to the decision-makers in industry. This orientation and connection seem necessary for quick, efficient translation of research results into wide-spread use.

Despite the fact that profit oriented enterprises will undertake and support applied and even fundamental research because such programs are profitable, they do not obtain a sufficient portion of the social return to such activities to motivate support at the optimum level. Firms which have made no contribution to the support of a development program may "horn in" on the profits by imitating the techniques used by supporters of research. As a consequence, a portion of the return to research is lost to imitators.

The patent system provides a means of forcing imitators to pay a return to those who finance a development, but it suffers from the drawback that it must be used to inhibit social returns in order to maximize private returns and from its limited applicability. Product identification has led to research on product improvement, but this suffers from the drawback that it may have diverted research from development of cost saving methods. Reform designed to induce investment in research at the optimum rate should take the form of easing tax burdens by permitting research expenses to be assigned to accounting periods which suit the convenience of investors and by exempting "depletion allowances" from taxation. (This should not be understood to imply that the author favors depletion allowances now granted in the mineral industries.)

Investment in research is inhibited not only by inability to funnel all returns to those who invest in such programs, but also by cyclical instability. Bad times dry up the market for equipment with the consequence that even improved equipment is saleable only with difficulty. To the extent that no equipment except that embodying advances can be sold, bad times may force the development and application of advances in order to get any sales. In boom times, the desire for equipment and the shortage of capacity leads to a moratorium on design changes since full capacity can be sold without the expense of such changes. A stable economy, or at least one in which occur only slow contractions, which tends to increase defensive development, and slow expansions, which makes research profitable through the provision of an expanding market, is conducive to a higher rate of advance in productivity than a widely oscillating system.

Stability is conducive to advance because of its direct effect on the equipment market and, also, because of its effect on labor and management attitudes. In times when alternative jobs are not readily available, labor resists labor-saving changes and management has little heart for the introduction of labor displacing techniques. When times are booming, attention is devoted to the expansion of output rather than to an increase in efficiency.

PRODUCTIVITY AND SOCIAL STRUCTURE

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IF WE ARE TO SEE clearly the interdependence of productivity and social structure, we need to become model-builders. We shall build our model around the regional metropolitan economy centered on Boston. It combines the time and space dimensions characteristic of a realistic model; by observing it, we can watch its social structure develop concurrently with changes in its productivity.

We cannot hope to examine the growth of this regional economy in any detail, but by observing regional changes in productivity and social structure as they are seen through the careers of the Storrow [1] family, we can relate the growth of an individual [2] to the growth of a region, and reduce our example to human scale. The Storrow family story is a capsule form of New England economic history which will indicate how, by a more detailed study of New England, a more comprehensive theoretical model might be built through watching practical model-builders like the Storrows at work.

By our choice of example, we are, of course, stating our hypothesis as to how productivity is related to changes in social structure; we believe that such changes occur within the setting of a community, under the impetus or leadership of certain outstanding individuals, and that these changes must be studied in context. In short, we assume that the approach of classical economics by way of the individual firm and by way of the market is inadequate to an understanding of the interdependence of productivity and social structure. We assume, also, that such changes must be studied over considerable periods of time and not merely observed as they spread through space. What we are studying is the growth of local, regional, and national communities. We choose to focus on a regional economy as the most comprehensive unit we can hope to study through the careers of three generations of a single family.

[1] Cf. Henry Greenleaf Pearson, *Son of New England: James Jackson Storrow, 1864-1926.* Privately printed at Boston, Massachusetts, in 1932; copyright by Helen Osborne Storrow. This essay relies heavily upon Pearson's biography of Storrow and his account of the careers of Charles Storer Storrow and James Jackson Storrow, Sr.

[2] Throughout this essay when we use the word "individual" or "personality," we are referring to the personality of an individual businessman whom we shall sometimes call an *entrepreneur*, meaning a business innovator who is helping to pioneer changes in the economy.

We do not ordinarily think of entrepreneurs as changing community structure, but a little reflection will show that this is their most basic function in our society. Entrepreneurs organize the factors of production, so as to turn out and sell goods and services in the market. Their ability to carry out their functions rests upon the sanctions of the community. We authorize them, by corporate charters and other legal sanctions, to organize the economic side of our existence, and in doing so they also transform many of our other social relationships.

These entrepreneurs are able to act to expand productivity or to centralize control over it within the regional economy because they stand at certain strategic points of decision-making within its social structure. In the course of time, their decisions alter the social structure of the regional community.

Because New England is the oldest industrial region in the United States, its community structure is more complicated than that of any other region. This makes our task of analyzing it much more difficult. By the same token, it makes us rely more heavily on economic history as a key to understanding present-day New England.

We have chosen to use the story of a single family as our introduction to its economic history over the past century, believing that this will simplify our task of analyzing the historical relationships of entrepreneurship, social structure, and productivity. Through this family and those older leading families of whose interests the Storrows were representative, we can see how New England was able to keep its important place in the national economy until after the First World War.

Three Generations of Model Builders:

During the hundred years between 1826, when Charles Storer Storrow, educated in France, entered Harvard College as a sophomore, and 1926, when his grandson, James Jackson Storrow, Jr., died as the senior partner of Lee, Higginson and Company in Boston, three generations of the Storrow family had played a leading role in the region of which Boston is the economic, political, and social capital city.

When we speak of building a model of a regional economy we are not merely describing an abstraction. The younger James Storrow was consciously a "model-builder." If we look at his published speeches and statements before public hearings, we shall see that he was highly self-conscious as to his role as a builder of New England, as the consolidator of New England. For instance, in the winter of 1925, he appeared at a hearing in the State House on a proposal to widen Exchange Street in the financial district of Boston. In the course of his testimony he said:

> I think the old captains of the clipper-ships that built up an international business were worthwhile, and, perhaps, in a smaller way, our efforts to keep Boston on the map in every country in Europe, which we are trying to do and are doing, are worthwhile and make Boston more of a place . . .

He was arguing that the speed of doing business in Boston would be affected by decisions about the handling of traffic and of pedestrians in the financial district, and he said: "The truth of the matter is, that 75 per cent of our business can be moved to New York tomorrow and probably done more easily and quickly." Storrow did not want to see his business move, but it was a fact that New York had become a more logical place in which to conduct much of this business. He intended to keep this business centered in Boston so as to maintain it as the economic capital of New England.

For generations it has been commonplace to say that New England, like old England, had few natural advantages for its economic leadership, except a head start, yet led the world in certain products. For a century, New England's most valuable asset was *ingenuity.* Like the people of a nation, those of a region operating under these handicaps have to run faster and faster to stay in the same place, in a world economy or a continental national economy where others are developing their own natural advantages. Textiles, shoes, machinery, and metal products were the backbone of local productive expansion. Thrift in previous generations ploughed the profits of these industries into trust funds. As Professor Seymour Harris of Harvard says [3] in his article on "New England's Decline": "New England relies heavily on interest and profits from past investments outside New England and to some extent on services."

Our story of the Storrows shows how New England came to rely on investment outside the region to provide interest and profits with which to pay for regional imports of food and raw materials after the Civil War. This reliance on investments elsewhere probably did not become indispensable to the New England economy, however, until the decade of the 1920's, when the textile depression began. If New England is a relatively "poor" region nowadays, it is because certain

[3] *Harvard Business Review,* (Spring, 1947).

things have happened in the past to New Englanders, and left their successors of today a legacy of social relations which tends to constrict their present opportunities.

We start our story of the century between 1826 and 1926 at the time when certain family groups were beginning to develop its textile cities and towns as satellites to Boston, to build the connecting railroads, to import mill workers from the rural areas at home and abroad, to hold sizeable amounts of local real estate, and often to own controlling shares in their local banks. The general expansion of the region enlarged the prosperity of these leading families, and provided them with the means for further investments inside and outside the region.

Chief among these leading family groups were the so-called "Lowell family connection," who have also been designated as "the Boston Associates." They had been intermarrying among themselves for many years; the leading family names included the Lowells, Higginsons, Cabots, Lees, and Jacksons. In the year 1836, Charles Storer Storrow [4] (at the age of twenty-seven) married Lydia Cabot Jackson, niece of Patrick Tracy Jackson who had founded the town of Lowell with Nathan Appleton fifteen years before.

Builder of Model Industrial Community:

In the spring of 1832, after studying in Paris at the French engineering institute, l'École des Ponts et Chaussées, Storrow had spent some months in England studying Stephenson's Liverpool and Manchester Railroad. Back in Boston he proved invaluable to P. T. Jackson, who had just undertaken to build the Boston and Lowell Railroad, but had never seen one in operation. Storrow became agent for the road.

In 1845 when the Boston Associates, by then including the great self-made merchant and manufacturer, Abbott Lawrence, decided to establish a new textile center on the Merrimack River, between Lowell and Boston, they turned to Storrow. He was already known, not only as a railroad builder, but for his book on waterworks, said to be the first of its kind in English. Storrow had for some time been urging

[4] Young Storrow was no self-made man; his father, Thomas Wentworth Storrow, descendant of the Wentworths, colonial governors of New Hampshire, was a merchant in Boston from 1802 to 1815, and in Paris from 1815 to 1829. Charles Storrow went to school in France, then graduated from Harvard with the class of 1829, and entered the École des Ponts et Chaussées early in 1830. His father's friend, General Lafayette, secured his admission to this outstanding school.

Lawrence to endow a scientific school at Harvard like the École des Ponts et Chaussées in Paris. In 1847 Lawrence, having made his gift, asked Storrow to head the school. He refused because he had just finished the great dam on the Merrimack and had his hands full with the building of the mills and the planning of the "model" industrial city of Lawrence. In 1853 the newly incorporated city made him its first mayor.

Either the Boston and Lowell Railroad or the city of Lawrence would be monument enough for one man, but Storrow in 1862 made a report for Governor Andrew of Massachusetts which paved the way for the Hoosac Tunnel piercing the Berkshires. He was later the consulting engineer on its hydraulic work.

Charles Storrow is, thus, a leading representative of the generation of New Englanders who built that region's textile cities north and west of Boston, harnessed the water power of its rivers, and tied the mill towns to Boston by railroads radiating from its hub. They established Boston as capital of New England industry, transformed the productive capacity of a region, and reorganized its social structure, shifting its major concerns from subsistence agriculture and commerce to industry. Without the Lowells, the Lawrences, the Appletons, and the Storrows, the production men who made the whole industrial experiment effective, Boston would have declined as a regional capital, when the clipper-ship gave way to the steamship, and New York secured the bulk of the overseas trade formerly moving in and out of Boston.

The performance of Charles Storrow's generation is not—strictly speaking—a case of free enterprise as we are accustomed to think of it. Individual entrepreneurs were not the prime movers in this historical development; most of the outstanding leaders of this movement were closely connected by blood or marriage, members of one extended kinship group. Their family fortunes had been made in the Revolutionary War by ancestors active in privateering and war contracts. The next generation or two maintained and enlarged these fortunes by ship-building and overseas commerce, increasingly in the trade with China and India. More and more of the younger generation made Boston their headquarters, rather than the North Shore towns of Salem, Beverly, and Newburyport. Through what is known as the Essex Junto, they established themselves as the political rulers of the state of Massachusetts, operating from the State House under the sign of the codfish in Boston. Starting with the Waltham experiment, established by Francis Cabot Lowell, his brother-in-law Patrick Tracy Jackson, and their friend and fellow-merchant Nathan Appleton, Boston businessmen made their city the industrial capital of New England, north and west.

To validate their role as industrial pioneers, they were in a position to pass legislation through the Massachusetts state legislature, authorizing corporate franchises for banks, industries, and railroads. By this process, they chipped off the sovereignty of the state, and conferred sovereign power to operate in the open market on individual firms dominated by this close-knit group of "the Boston Associates." A whole series of social institutions, directed by this group of relatives and friends, tied together the political, social, and economic structure in the region of New England.

As further expansion of such activities continued in later years, they remained the principal beneficiaries; new men were coming forward—indeed, Abbott Lawrence, Nathan Appleton, and others who were self-made, moved up within the orbit of this central group. Rival groups formed and created their own banks and corporate organizations in industry and other lines of business, but did not oust "the Boston Associates" from their central role as the chief decision-makers for New England. Increasing productivity generated by technological change proved a big factor in maintaining the position of these dominant groups; characteristic of the institutions responsible for such technical advances were the Lowell Machine Shops at Lowell, Massachusetts, from which a stream of locomotives and factory machinery emerged over the years. No one would suggest, of course, that the efficiency and productivity of these machines was solely responsible for the transformation in productivity of the region. The organization of workers under the factory system, the transportation of goods to and from the textile cities by rail, and other similar advances which are not classified as improvements in factory machinery were equally responsible for New England expansion.

At the focal point of all this activity, then, we see a vigorous group of decision-makers who centralized power and control—economic, political, and social power and control—over the existing processes, and the power of deciding what, if any, changes in productivity to introduce. By keeping our eyes fixed on a model of the regional-metropolitan economy with Boston as the hub, and the men at its center, we shall see that we need to work out in detail the *structure* and *functions* of this model and to understand *the processes of change* as they unfolded within this structure and through these functions. The economist who is satisfied to discuss these developments in terms of fluctuations of the market or growth of the individual firm loses sight of many of the most important factors in the growth of a regional economy.

He also tends to overlook the fact that the expansion of a regional economy creates a metropolis, surrounded by a large number of key sub-regional cities and their satellite communities. This process of building communities is part of the total process of increasing productivity. A labor force is attracted to the area, and equipped with housing, public and private agencies for transportation and communication, distribution of goods, and other amenities of life. All this becomes a charge on the economy; someone must keep it going by taxes or purchases in the market.

The same groups who own and control the chief industries of the region usually control and own the most valuable of the early properties which equip the community with these amenities. While regional opportunities for further profitable investment diminish, the overhead costs of maintaining the community continue to rise as people demand a higher standard of living. Regional investors are induced to look outside the region for new investment opportunities.

New England reached the stage of increasing external investment before the Civil War. Already the best water-power sites had been developed, and the chief industrial communities had been founded. The day of high rates of return and quick profit seemed to be over for the region.

Among Charles Storrow's generation were outstanding merchants like John Murray Forbes, who made their money in the China-trade; they turned to investments within the New England region where they settled down on returning from abroad, but soon began to spread the influence of New England to the West as it developed. Forbes was the most outstanding among a number of these contemporaries and associates, active in railroad development of the West. Their investments became the cornerstone of two outstanding banking houses in Boston: Lee, Higginson and Company, and Kidder, Peabody and Company. The founders of both firms could trace their fortunes back to the days of North Shore commerce and to successful investments in the New England textile industry. They owed the continued growth of their fortunes, however, to their diversification of investments, including an increasing role in the development of western railroads, and other productive properties outside New England.

Builder of a Model Corporation:

Charles Storrow's son, James Jackson Storrow, is an important example of this post-Civil War generation who spread the influence of Boston fortunes beyond that region. He and his associate, Frederick P. Fish, later president of the American Telephone and Telegraph Corporation, were of counsel for Lee, Higginson for many years. The senior James Storrow is remembered in Boston particularly for his role as counsel for the Bell Telephone Company from 1878 until his death in 1897. In this capacity he was intimately acquainted with Alexander Graham Bell, the pioneer of the telephone industry, and with Bell's assistant in the invention of the telephone, Thomas A. Watson. Storrow, as patent attorney for the Bell Company, won that series of court cases which upheld the validity of its patents. In these contests, he relied heavily on Bell and on Watson, chief active engineer of the company, and on others who pioneered its inventions. He made himself technically qualified to argue before the U. S. Patent Office and the courts;[5] he had his own small laboratory where he conducted experiments, but for expert testimony he turned to Professor Charles R. Cross of the Massachusetts Institute of Technology, and others of his calibre.

James Storrow's career exemplifies the change which had come over American business and with it New England business in the period after the Civil War. When Charles Storer Storrow and his associates transformed New England industry from handicraft to factory operation, the technology of their day centered on the use of iron, coal, and the steam engine, together with the harnessing of water-power by mill wheels. With the coming of the electrical age, a new order of business had to develop to keep pace with technical change. During the previous generation when the rise of the railroads required a shift from the family as an economic unit holding business control, the corporate device brought together other people's money for the use of such a great public utility as the railroad. To protect these investments railroads and other utilities secured a public franchise, and for a generation this type of protection of property sufficed. In the days of the senior James J. Storrow, the patent began to be the foundation for industrial fortunes. To spread a network of communi-

[5] General John J. Carty, chief engineer of the American Telephone and Telegraph Corporation, under the Presidency of Theodore N. Vail, said of Storrow that he was "the greatest patent lawyer that our country has ever produced. His arguments and briefs in the telephone cases are classics, and his handling of these trials established the fact of his preeminence."

cations across the United States the investors in the Bell Telephone Company established control over future development in their industry by taking out and validating patents. In this operation, Storrow was the indispensable man. The public utility holding company known today as the American Telephone and Telegraph Corporation rests upon his work as its patent attorney.

When, after 1880, Bell's father-in-law yielded control of the Bell Telephone Company into the hands of a group of Bostonians,[6] this group was closely identified with the First National Bank of Boston and with the banking house of Lee, Higginson and Company. Thus, men at the center of Boston finance were exercising an influence far beyond the New England region.

In 1885, when James Jackson Storrow, Jr., graduated from Harvard College, he entered the Harvard Law School, and by 1889 was a member of a new firm including his father's associate Mr. Fish and Mr. Richardson. Young Storrow's practice was done from the top drawer of Boston business between 1889 and 1900.[7]

In 1900, the Boston banking house of Lee, Higginson and Company was looking for a new partner to fill the vacancy created by the death of James Jackson. It was appropriate that he should be replaced by *James Jackson* Storrow, Jr. Frederick Fish is said to have told Major Higginson, then head of the firm, that young Storrow, if he agreed to enter the firm, would succeed the Major upon his retirement and would in the end be recognized as "first citizen" of Boston.[8]

Builder of a Model Investment Banking Firm:

At thirty-six years old, when J. J. Storrow, Jr., became one of the senior partners of Lee, Higginson and Company, he turned immediately to the task of building up the sales force for the firm which, prior to that time, had done about 95 per cent of its business in rail-

[6] William H. Forbes (eldest son of John Murray Forbes) became president of the Bell Telephone Company in 1880, retaining that position until 1887, when he was succeeded by Howard Stockton of the First National Bank of Boston. After 1889, when Stockton resigned and John E. Hutchinson took his place, the company was controlled by a board of directors to which Storrow and Fish were counsel. And on the board were, in addition to Forbes, Alexander Cochrane, George L. Bradley, C. E. Perkins, and Henry L. Higginson, all of Boston.

[7] He was connected, for example, with the foundation of the United Shoe Machinery Corporation, and in this series of negotiations represented the Gordon McKay Company. It is interesting to note that his grandfather, Charles Storer Storrow, had persuaded Lawrence to give the money for the Lawrence Scientific School at Harvard, and that, fifty years or more later, Gordon McKay was the benefactor of Harvard engineering at a time when Storrow was one of his intimate advisors.

[8] Henry G. Pearson, *Son of New England,* p. 31.

road bonds. This was, of course, an outgrowth of the relations between that firm and J. M. Forbes and other American railroad builders.[9]

After 1880, Major Higginson's position on the board of the Telephone Company had led his firm into financing this new utility, and during the 1880's the firm moved into another new industry. Charles Coffin of Lynn took over financial direction of the Thomson-Houston Electric Company. Among his active supporters, besides Major Higginson, were T. Jefferson Coolidge and George P. Gardner. When the General Electric Company was founded in 1892 as a merger of the Thomson-Houston and the Edison Companies,[10] Higginson was one of its first directors, along with T. J. Coolidge, Coffin, and F. L. Ames, a former governor of Massachusetts.

Lee, Higginson at the time of the General Electric merger found it necessary to share its controlling position with the firm of Drexel, Morgan and Company, soon to become J. P. Morgan and Company. In other words, whereas Lee, Higginson and Company was in on the ground floor of two of the greatest American corporations, the A. T. & T. and the General Electric Company, it was necessary by 1892 for it to yield to the New York bankers in its position of top control of General Electric, and by 1907 in A. T. & T.

We can pause at the year 1900, when young James Storrow became a partner in Lee, Higginson and Company, to survey the New England scene. His father, the senior James Storrow, had died in 1897, but his grandfather, Charles Storer Storrow, was still hale and hearty, having celebrated his ninetieth birthday the year before. Indeed, he died only in 1904 at the age of 95, by which time the younger James Storrow was forty years old. Before 1900, the New England textile industry north of Boston had gone into something of a decline. The

[9] The securities of the Michigan Central and Chicago, Burlington and Quincy railroads, founded by Forbes, were among the chief blue chips for Lee, Higginson and Company before 1900.

[10] It is interesting to observe that the conversations leading up to this merger took place at the Boston residence of Hamilton McKay Twombley, one of those connected with the Thomson-Houston Company, and that the plans carried through at that meeting were drawn up by Frederick Fish, counsel for the Thomson-Houston Company. At the time of the merger, the new General Electric Board included a number of New York representatives; these, besides Thomas A. Edison, were Charles H. Coster of Drexel, Morgan and Company, and Mr. J. P. Morgan himself, together with the New York banker, D. O. Mills, and representative members of the boards of the previous Edison and Thomson-Houston companies. Almost a year had been required to work out the merger completed on April 15, 1892. Twombley was elected chairman of the board, and Fish was made general counsel. (See Arthur Pound, *Men and Volts.*)

full measure of this decline was perhaps not appreciated generally in Boston because many of these companies maintained good rates of profit, but they were definitely earning much lower returns than those enjoyed during and after the Civil War, before the panic of 1873. The largest Boston fortunes were undoubtedly increasingly dependent either upon real estate holdings and other fixed investments throughout New England, or upon returns from other regions of the United States. Also, there was an increasing interest in foreign investments, especially in Cuban and other West Indian sugar plantations, and recently in the banana industry in the republics of Central America. Within New England, patents for shoe machinery formed the cornerstone of the United Shoe Machinery Corporation, and this company was able by leasing rather than selling its machinery to prove highly profitable to its Boston associates, who were connected with Lee, Higginson and Company and with the First National Bank of Boston.

In fact, patents and franchises were pivotal for this new type of development, just as the tariff had been a necessary means of protection for earlier generations of New England capitalists. Local railroads of Charles Storrow's generation had turned into the transcontinental roads of James Storrow, Sr.'s generation, and during the days of the younger James Storrow these roads were being tied together in new ways by J. P. Morgan and Company, Kuhn, Loeb, and other New York banking houses. The kind of activity open to Boston prior to 1900 was beginning to disappear after 1900. A firm like Lee, Higginson and Company could no longer expect to be solely responsible for the flotation of securities of the largest corporations. The capital required was beyond the regional resources of New England, and the leadership had passed to New York.

Moreover, the emphasis was no longer primarily upon increasing productivity but upon control over future developments in a restricted set of hands. The structure and functions of the American economy were changing, and changing in the direction of centralization of decision-making in the city of New York. Regional capitals, like that of Boston, were being drawn into the New York orbit and expected to cooperate in the decisions made for them by the leading New York interests.

The firm of Lee, Higginson and Company underwent a thoroughgoing transformation during the fifteen years between 1892 and 1907. From the time when young James Storrow became a partner in the firm in 1900 until after the panic of 1907, changes in the work of the firm were largely due to his organizing efforts. He saw its role as that of the bellwether for New England. Until his death, we see him throwing all the weight the firm could mobilize in New England behind any undertaking they supported.

To enlarge the firm's effectiveness in the face of the changed investment market situation, he organized and staffed an office in Chicago in 1905, and in 1906 opened one in New York. In that year also, he established an affiliated firm in London, and for a while conducted a branch in Paris which eventually had to be given up. These offices were opened in order to spread the influence of Lee, Higginson and Company, to enable it to face the great New York wholesale bond houses on a wide front, so that they would turn first to Lee, Higginson in New England for the retailing of their bonds.

He was not pleased with the heavy emphasis on railroad bonds, believing that the smaller investors, whom he was eager to cultivate, should have diversified portfolios. He began, therefore, to persuade the firm to sell public utility securities and to push industrial bonds. By 1913 he had been so successful at this as to convert the firm's business over to a preponderance of industrial and public service bonds.

He had established the Chicago office in part to keep the firm fully informed about expanding businesses in the midwest where he saw the greatest opportunities for new investments. He did not overlook, however, the responsibilities of Lee, Higginson and Company for service to a number of the larger New England industrial corporations. Notable among these businesses were the United Fruit Company, developing in Central America and the Caribbean; the United States Smelting, Refining, and Mining Company, operating mining properties in the West; and the United Shoe Machinery Corporation, with which he had been connected as counsel at its merger with the McKay interests. These are still among the major industrial corporations having headquarters in Boston. Storrow, also, through his directorship in the First National Bank of Boston, and membership on its executive committee, linked the firm of Lee, Higginson and Company with the largest bank in New England. Through these widespread contacts, he was able to assist the firm to ride out successfully the panic of 1907. Indeed, months before it occurred in October, he had foreseen heavy financial weather.

The panic of 1907 brought to a head developments going on prior to that time throughout American finance; it insured once and for all that major economic decision-making would center in the city of New York. Indeed, it shook the New York money market itself, and only the presence of the elder J. P. Morgan enabled the leading banks and investment houses in New York to weather the storm. Immediately after the restoration of confidence, the bankers appeared to have decided that they would not repeat this experience without help from the federal government. The result was a move to found a federal reserve bank system. This soon became involved in politics, and in the end twelve reserve banks in as many sections of the country were established, largely through the influence of William Jennings Bryan. These reserve cities (including Boston) have subsequently become regional financial capitals, but the system has been so organized as to make these regions look toward New York and Washington.[11]

Storrow became the leader in New England of the movement for a federal reserve system, associating himself with Paul Warburg of Kuhn, Loeb and Company, and with his classmate Frederick A. Delano of Chicago, then President of the Wabash Railroad. Storrow was undoubtedly partly responsible for securing the appointment of Professor J. Laurence Laughlin, formerly a political economist at Harvard and at the time Professor of Economics at the University of Chicago, to be executive director of the "National Citizens League for the Promotion of Sound Currency." The League prepared the way for the Aldrich plan, forerunner of the Federal Reserve Act, known at the time as the Glass-Owen Bill.

Storrow, deciding not to assume an active part in the new Federal Reserve System, turned his back on the national and international roles he might have played in this period of transition for the United States.[12] Instead, Storrow saw New England as the field he must plow most strenuously. He became the consolidator of the position of the leading New England institutions, such as the firm of Lee, Higgin-

[11] During the early days of the system, the New York Federal Reserve Bank in Washington served as the pivot for the entire system, and the Board in Washington played a much less important role. Since the panic of 1929-30, the entire focus has shifted and today the New York Bank is probably less important than the Board in Washington. The depression of the 1930's and the Second World War, with their great aggrandizement of the Federal Government and its financial transactions, have contributed to this trend.

[12] Senator Aldrich of Rhode Island, himself a successful businessman and father-in-law of John D. Rockefeller, Jr., performed such a role for the region at this time. During and after the First World War, other New Englanders, such as Thomas Nelson Perkins and Roland Boyden, held important posts in the settlement of Allied war debts and German reparations problems.

son and Company and the First National Bank of Boston, strengthening them for their regional role in the national economy. He, himself, for a number of years was active on the national economic scene, as we shall see, but always as the representative of these leading New England interests.

Consolidation of a Regional Economy:

Storrow's efforts on behalf of New England as a region and of Boston as the economic, political, and social capital of that region are almost too numerous to catalogue. We shall not describe them in detail but try to organize them in some fashion which will indicate their scope. First as to the city of Boston: in 1901, Storrow introduced a bill in the Massachusetts Legislature which led to the creation of the Charles River Basin, transforming the character of Boston, Cambridge, and the towns lying along the banks of the Charles River. The new Boston embankment road bears his name as a small testimonial to this public service. In 1901, also, he joined up in the fight for a better Boston school committee, and in 1902, became its president.[13] During these same years, he joined with E. A. Filene and Bernard J. Rothwell in the formation of a Boston City Club, and shortly afterward gave leadership to the Merchant's Association in the formation of a Boston Chamber of Commerce, incorporated in 1909. In 1909, Storrow was the Good Government Association candidate for Mayor of Boston, under the new city charter, losing by 1,400 votes out of 95,000 to Mayor Fitzgerald, the machine candidate.[14]

On the New England scene he played an increasingly influential role, starting in 1913, when he became President of the new Boston Chamber of Commerce, and threw his weight behind the movement to

[13] His "Storrow Plan" extended the use of public school buildings for neighborhood purposes as educational centres, including centres for adult education and Americanization. With the help of Henry W. Holmes, later Dean of the Harvard Graduate School of Education, he developed a plan to remodel the school committee. The fight which emerged around this proposal led Storrow to run again and to be elected in 1906 as Chairman of the new five-man School Committee.

[14] The Legislature in 1909 brought forward two amendments to the old Boston City Charter, one of them providing for nominating each candidate for mayor by a petition containing 5,000 signatures; names on this ballot were to appear without party designation. Storrow supported the Good Government Association's efforts to educate the voters on this new plan and to beat the bosses by a 4,000-vote margin in the contest to establish the plan. Mayor John F. Fitzgerald decided that, if he could not beat the plan, he would become the Mayor under it. When the Good Government forces pushed Storrow forward as their candidate, he lost to Mayor Fitzgerald by the narrow margin of 1,400 votes out of 95,000.

reorganize the New Haven Railroad. In 1922, Storrow was made chairman of the Joint New England Railroad Committee to report to the governors of the New England states on the question of the consolidation of New England railroads.[15]

The Committee report concluded that both the major New England roads needed to be rehabilitated, and made proposals to that end. Mr. Storrow, as chairman, took the operating managements to task and the later performance of both roads seems to have justified his criticism. Once the report was issued, Storrow organized support for it throughout the New England states and rallied a formidable array of industrial organizations, civic organizations, and the leaders of individual businesses. It was his purpose to make the New England system a consolidated one: of New England, by New England, and for New England. As he said in the report:

> If New England's industries are ever forced into a position where they chiefly depend on standard trunk line rates, they are bound to suffer, but if New England can hold its own knife and fork and feed itself to a balanced ration of standard rates, differential rates and water rates, we see no reason why we should not maintain full bodily vigor and continue to meet changing conditions by new adjustments of our industries and enterprises.[16]

Despite his gargantuan efforts, the question of the New England railroads remained unsolved until after the beginning of the depression in 1929. A new committee, under the chairmanship of former governor Spaulding of New Hampshire, reported in May, 1931, conclusions which closely paralleled those of Storrow's committee regarding the trunk lines.

These were the chief contributions of Storrow to the city of Boston and the region of New England. Certain special undertakings, not previously mentioned, will round out the picture of his role as "the first citizen" of Boston during the years before his death in 1926.

[15] From August 14, 1922, until January, 1924, when this question was argued before the Interstate Commerce Commission in Washington, Storrow served as chairman of the group and gave wholeheartedly his own talents and energies. Under Storrow's direction, the 30-man committee appointed by the New England governors studied the entire New England transport situation. Their studies considered transportation by sea, rail, and truck, and combined operations, including the subject of differential routes and rates and interchange of traffic between New England and other states, and within the New England region. Their hearings built up a stenographic record of over 6,000 pages. There is reason to believe that Mr. Storrow himself, out of his private pocket, spent nearly a quarter of a million dollars for the committee's work, including the hiring of experts for the committee.

[16] Pearson, *op. cit.*, p. 263.

Reorganization of General Motors:

Through his directorship of the First National Bank of Boston, he became deeply involved in the reorganization of the General Motors Corporation.[17] The voting trustees named Storrow as their chairman, and from 1910 to 1915, the group he headed was in control of the General Motors Corporation for its stockholders.

These early days of the automobile industry must be recalled to explain the job he faced. Durant, a former carriage builder, had become president of the Buick Company, which was in 1908 the largest producer of cars in the United States, with over 8,000 output. From this base, Durant began a two-year run of consolidation and brought into the General Motors holding company subsidiaries including the Cadillac and Olds companies. By the fall of 1910, he was forced, by financial difficulties, to agree to a bankers' trusteeship with himself as one of the five trustees.

Nowhere in the career of James J. Storrow, Jr., do we see his entrepreneurial capacities coming more prominently into play than during these five years of reorganization of the General Motors Corporation. Storrow had repeatedly demonstrated the qualities of team play and leadership.[18] He never needed these qualities more, however, than when he became Boston's chief representative of the new automotive age as chairman of the trustees for the General Motors reorganization. He realized at once that his first need was for more money, partly to help carry the huge inventories piled up by the various subsidiary companies and partly to give them working capital. To insure the security of the loans he was able to get from the banks, he moved to find production men who could make good on this advance. He transferred the head offices of the company to Detroit in order to secure support from the new Detroit members added to the Board. This brought bank support in Detroit and Chicago and the

[17] The bank, in the summer of 1910, was a party to the difficulties of the Buick Motor Car Company of Flint, Michigan, one of the twenty-four companies put together in the General Motors Corporation formed by William C. Durant in 1908. Indeed, the Buick was the cornerstone of this structure. Lee, Higginson and Co. and the First National Bank of Boston were drawn into the efforts to pull the Buick Company through, which centered on a New York group, including the Central Trust Company of New York and the banking houses of Kuhn, Loeb, and Company, and J. and W. Seligman Company.

[18] Storrow's leadership started with his captaining of the Harvard crew, which, thanks to his changing the method of rowing from fixed seats to slides, beat Yale in his senior year by the phenomenal record of 25 lengths. Repeatedly thereafter, within the firm of Lee, Higginson & Co., in the fights on the Boston School Committee and for the Mayoralty, and in the reorganization plans for the New England railroads, he duplicated these feats of leadership.

companies began paying their bills. He next instituted a tight-knit accounting procedure for the various companies. This accomplished, he was able to reconstitute their engineering and research and push for the discovery of able factory managers. One of the first of them, Walter P. Chrysler, who at thirty-six was manager of the Pittsburgh plant of the American Locomotive Company, Storrow brought in as general manager of the Buick plant. Finally, he turned his attention to selling the increased output, and in this combined the system of centralization of control and decentralization of responsibilities by which he had transformed Lee, Higginson and Company after he entered its partnership.

In September, 1915,[19] when the bankers' control under the trusteeship was due to terminate, Durant organized a conference where what appeared to be a balanced board was formed, evenly representing the two groups, led by Storrow and Durant. Storrow became chairman of the Executive Committee, Charles E. Nash was made president of the company, and Irenée DuPont became chairman of the Board of Directors. Durant moved through incorporation of a new Chevrolet Company in Delaware to float a large issue of its capital stock which he proposed to exchange for General Motors stock at the ratio of five Chevrolet for one General Motors. By June, 1916, he had forced Nash out as President and himself in, and Storrow and his friends retired from the Board.[20]

This ended the efforts of the New England financial interests and their New York associates to control General Motors Corporation. It marked also the last of the attempts of the Boston group to play a major role on the national financial scene. It is interesting to recall that the groups centering on Lee, Higginson and Company and Kidder, Peabody and Company had at one time or another the majority control of three of the greatest American corporations, General Motors, General Electric, and The American Telephone and Telegraph Corporation. But in each instance the Bostonians had lost out to

[19] By 1915, the General Motors Company was able to declare a cash dividend of $50 on each share of its common stock. This was the first dividend paid on it since the company was formed in 1908. On the board of trustees, Durant had been one of five, but acted throughout as a minority of one. He organized the Chevrolet Company at this time, as an effective competitor of the Buick Company, and when he proved unable to drive Buick to the wall, moved to absorb it. He found financial support among the DuPont family.

[20] This defeat in General Motors did not end Storrow's connection with the automobile industry. During the summer of 1916, he and a number of his friends, including Emory W. Clark of Detroit and Robert S. Herrick of Boston, organized the Nash Motor Company; Storrow became chairman of the board.

major groups centering in New York, if we can include the DuPonts of Delaware in this category as New Yorkers.

Our account of Storrow's major public and private contributions ends with his patriotic efforts on behalf of New England, lasting through the close of the First World War.[21] It seems desirable, however, in an essay on the relation between three generations of this family and the region of which they were natives, to mention two other episodes in which Storrow played a part.

The first of these, involving him as arbitrator in the serious labor-management dispute between the Boston elevated railway and unions of motormen, conductors, and other employees, shows Storrow's concern for a healthy relationship between labor and management. This arbitration began in the summer of 1913. He was to be the third of three arbitrators, what we may call the "impartial arbitrator," on whom the chief burden was bound to fall.[22]

The union's lawyer was Joseph B. Eastman, later chairman of the U. S. Interstate Commerce Commission; Eastman was then starting his Boston practice. He persuaded Storrow of the rightness of his two major arguments,[23] and Storrow in his report accepted both of Eastman's arguments as the basis on which he made his recommendations. He did not recommend sizeable wage increases but attempted to establish rate scales and working conditions which the company could maintain. He placed the responsibility for good transportation

[21] Governor McCall of Massachusetts appointed him Chairman of a large committee on public safety in February, 1917, at the moment when diplomatic relations between the United States and Germany were broken off. Storrow saw New England's major difficulties during the hostilities as tied up with transportation of food and fuel; and first, as chairman of this committee and then as New England fuel administrator he devoted himself to keeping New England supplied with coal.

[22] This was the moment when his doctor discovered that Storrow must be operated on for what proved to be a malignant tumor in the neck. Despite his weakened condition, as soon as he could leave the hospital, he entered on the arbitration, held fifty-six days of hearings and accumulated a record of over 5,000 pages. At his own expense, he took a suite in the Copley Plaza Hotel and spent a month putting the arbitrator's report into shape. By January 15, 1914, he had hammered out a report of 94 pages.

[23] The first of Eastman's arguments insisted that the men had the right to organize and to strike, and that a strike tested the ability of the company to replace the men within a reasonable time. The men, in agreeing instead of striking to arbitrate, confronted the company with the question whether the wage scale they were paying would make it possible to replace all of them in a reasanable time. Eastman also argued that the financial condition of the company should not be the final basis for judgment whether it was obliged to pay adequate wages, because any receiver substituted for the company in case of its financial difficulties would have to pay adequate wages even though the company could not pay rentals and interest on its bonds. In short, Eastman argued that adequate wages were a problem for the community to meet.

services squarely on the public. He called on the men to enable the company to carry the additional burden but insisted that the company should accept the fact that it had, thereafter, to deal with its employees as an organized body. Coming as it did from Boston's leading investment banker, no doubt Storrow's report went far to transform the relations between labor and management in the metropolitan region, centering on Boston.

One other instance of his concern for the region was shown in the receivership for the Arnold Print Works at North Adams, Massachusetts, in the fall of 1907. Storrow and two other co-receivers persuaded the bankers to wait until they could reorganize the company, thus freed working capital to keep the North Adams plant going so that the community would not suffer unduly during the winter; by selling outside plants and inventories, the receivers were able to turn the company back to its owners in a relatively short time. This provides us one more instance of his determination to maintain and strengthen New England and its communities, a guiding principle throughout his career.

In the course of this essay we have placed great emphasis on the individual personalities of the three Storrows. This is done to provide a thread through the maze of New England development and not to pretend that they made their contributions to the life of the region or the United States single-handed; on the contrary, all of them in their careers proved to be team players, and of course this was especially true of James Storrow, Jr. The object of this essay is to use their careers as an illustration of the relation between personality, social structure, and productivity.

This essay seeks to call the reader's attention to the structure of decision-making in an industrial and financial system, and in the social structure of a region. As the Storrow story shows, increasing productivity depends upon the growth and the increasing interrelationship of an entire community or set of related communities. The major decisions which make such changes possible are in the hands of a relatively limited number of decision-makers.

We are concerned with the ways in which men arrive at these strategic points of decision-making. The careers of the three Storrows throw considerable light on this process. They show that in an older region like New England where the structure of society is already well established, the ladder to success has been built for at least the major decision-makers. Most of the men who are going to occupy the key positions in economic, social, and to some extent political, life will be drawn from those groups in society who are already able to exercize control over these points of decision-making. Institutions, like colleges and universities, and other organizations, mobilize talent, but they do so on a selective basis.

New leaders are not ordinarily drawn from the ranks of self-made men, although there are exceptions to the rule. Selection is not by self-appointment but by choices from within the upper brackets of an economic and social grading system. The political structure of the community stands somewhat apart from the economic and social structure but interlocks at various points and in various ways which we cannot explore in this essay, except to say that in New England the old Yankees have by no means lost control, although frequently they exercise it by indirection. We are here primarily concerned with the economic structure and its relation to the social structure.

The major economic decision-makers, those occupying the chief strategic points of decision-making, are chosen by the representatives of those groups who have tended to dominate the life of New England for well over a hundred years. This is, of course, to be expected in an area which has been as long established in its social structure as New England.

The recent report by the Committee on the New England Economy, submitted by the Council of Economic Advisers to President Truman in July, 1951, refers to this situation in its introductory summary on page xxii:

> New England made its change from the extractive industries, such as agriculture, forestry, and fishing, to manufacturing industries at an early date. As a consequence, there developed in New England a quality of industrial leadership which persisted for many generations. Important characteristics of that leadership were its ingenuity, its inventiveness and shrewdness. New England's industrial leaders of past generations often attained success only after considerable struggle with competitive forces. In later generations, the new industrial leaders often attained their positions 'by appointment'—a hand-me-down from father to son. Their wits and energies had not been sharpened by the trials and contests of the market-place. Moreover for reasons which are obscure, succeeding generations of management seem to have turned their attention away from industrial progress and have shown, too often, a greater interest in the preservation of the *status quo.* They have often sought safety by minimizing their risks or by exporting capital to other regions. One consequence was to develop an attitude of protection and security rather than a continuation of the earlier drive toward industrial progress.

We can say that in the generation of the elder James Storrow there was manifestly a tendency toward "protection and security," although he was associated with a group of men who were developing a new industry, that of telephone communication.[24]

Certainly this charge could not be made against the younger James Storrow as chairman of the trustees of the General Motors Corporation, where he was alert to the needs of improved technology and pushed the production management to secure the best help they could find and to give it a remarkably free hand.

Generally speaking, we can apply to James J. Storrow, Jr., the remarks made by the Committee on the New England Economy which follow the paragraph quoted above, when they say:

> Within the last two or three decades, however, partly in response to local conditions and the competition of other regions, there seems to have been a rebirth of alert leadership qualities, together with a development of social and political attitudes encouraging new types of industrial leadership. We are convinced that the growth of this newer type of industrial leadership will be progressively more and more successful in solving the problems of adaptation within old industries and in building up new industries.

Jim Storrow would also have subscribed to their statement that:

> The problem must be met by leaders in each state, or even in each city and town as a local problem calling for positive and cooperative action.

In closing their summary, the Committee on the New England Economy say of the problem of New England that:

> It is no longer one of shifting from the primary industries, such as agriculture, fisheries, and forestry, to manufacturing, but rather one of adapting its existing manufacturing industries to changing technologies and new products and diverting its resources into newer and expanding industries which involve a high ratio of value added to value shipped.

Problem: How to Recruit Leadership:

Our study of three generations of the Storrow family has shown that if the ideal stated by the Committee on the New England Econ-

[24] The most comprehensive study of the telephone industry, *AT&T: The Story of Industrial Conquest;* New York: The Vanguard Press, 1939, by N. R. Danielian, indicates that during the days when the Bostonians controlled the industry, its growth was less rapid than at a later period. Not only did these Bostonians slow down the spread of the telephone system, which had begun a few years before they secured control, but they relied upon outsiders for most of the advances in technological improvements. After they lost control, the management instituted a large scale development of technological change within their own laboratories.

omy is to be attained and if the region is to provide sufficient employment opportunities at good wages to assure its population adequate living standards, the pattern by which it has recruited its leadership must change. The younger James Storrow is the exception who proves the rule. He saw his region steadily and as nearly whole as one man can be expected to do. He extended his grasp of regional problems by employing the ablest men he could find to keep him informed, and he was able to afford this assistance because of his unusually strategic position as a decision-maker heading the most important investment banking house, while sitting on the boards of many of the region's leading industrial corporations and on the executive committee of its largest commercial bank. Despite his singular opportunities, he would probably have been the first to admit that he had not stemmed the drift towards centralization in New York City of decisions about the development of New England.

Since 1926, when James Storrow, Jr., died, this drift toward centralization of decision-making has shifted again; this time to Washington, which shares political and economic decision-making with the economic capital of the United States in New York City. There are no easy answers as to how the control of decision-making can be decentralized and, so far as possible, returned to the various regions and regional capital cities of the country and from there further decentralized toward the grass roots. Until we find such answers, however, it is predictable that the tendencies toward greater centralization of control over decision-making will continue and that these will become increasingly political and less and less economic and social. The development of a mobilized economy, an economy based upon defense production, reinforces these tendencies.

As James Storrow, Jr., recognized, however, the values on which his region was founded depended and continue to depend upon the extent to which the leadership within a community can become members of a team. By his career he showed that this team must come to include not only the economic leaders of the community, but representatives of the other groups having a stake in the development of the community. The average citizen, through his political representative, wants a say in these matters, and the employee in the individual firm feels likewise that he has a right to determine changes in productivity along with his employer.

During the generation of Charles Storer Storrow, these matters were not considered as deserving public participation, and in the days of his son, the senior James Storrow, the tendencies toward centralized control and toward public participation in this decision-making, either through the ranks of organized labor or through the political representatives of the general public, were minimized. After the beginning of the twentieth century, this situation changed, and the career of James Storrow, Jr., demonstrates clearly the recognition he gave to this change and the leadership he provided for other economic decision-makers looking toward a changed attitude to the community's problems.

The purpose of this essay is to urge the use of model building as a means for analyzing the interdependent relationships of personality, social structure, and productivity in community development. If New England, in the words of the Committee on the New England Economy, is "to look to the changing industrial structure of the economy and aggressively seek the development of new industries," its regional leadership, drawn from all walks of life, must construct a recognizable model of present-day New England, whose problems must be studied in much more detail than is provided by the report on "The New England Economy" prepared by that committee. Only by understanding, community by community, the condition of its existing industries, and by recommendations as to how they can employ new technologies to produce new products, can New England hope to hold its own in the national economy.

Generalizing from the New England Model:

In this final section of our essay on "productivity and social structure," we shall try to generalize from the model provided us by the story of the Storrow family in New England:

Regions grow partly by accident, but largely by design. In the United States, throughout the nineteenth and the first half of the twentieth centuries, the growth of regions has been channelled by certain strategically placed decision-makers. Until quite recently these strategic points of decision-making have tended to be controlled by a limited number of representatives of those families whose ancestors assumed the early leadership of the regional economy (the age of each region as part of the modern economy determines the number of generations of such old families with whom the economic historian must reckon).

Studies of this process of regional expansion within established channels show that the successful maintenance of control by these old families depends upon their capacity to create institutions for the self-perpetuation of the family as an economic unit. Until quite recently the most useful of these devices has been the investment banking house. More recently, some of the largest American fortunes have come to rest on control of one or more great industrial corporations.

The family as an economic unit is always threatened by the practice of sub-dividing the family fortune through inheritance. The development of the Massachusetts Trust has proved a valuable means among Boston's wealth families for preserving the family as an economic unit "in perpetuity." Even under the direction of an able trustee, however, this tends to be a passive device, lacking the vigor of active entrepreneurship.

For nearly a century, the investment banking house of Lee, Higginson and Company provided a large group of wealthy Boston families with an institution capable of participating in entrepreneurial decision-making. As we have seen, this firm, starting with regional textile mill and railroad and urban real estate developments, branched out after the Civil War into western railroad and urban real estate developments, and the exploitation of western resources in mines and forest products.

These interests outside the New England region did not divert the attention of the family group clustered around Lee, Higginson from maintaining its controlling position in the New England economy. They did, however, reduce its need for continuously ploughing back profits into the older industries of New England.

The "Boston Associates" continued to take an active interest in developing new businesses like the United Shoe Machinery Company, and in encouraging new companies like the Bell Telephone and General Electric to develop near Boston. They did not "rationalize" the older parts of the New England economy, notably the textile industry. Above all, they failed to hold most of those growing units of the newer industries—automobiles and parts manufacturing, telephone and electrical equipment—so as to make New England the headquarters for those new companies.

The main plants of these newer companies tended to move elsewhere, and the corporations' head offices tended to settle in New York City. By the panic of 1907 it was apparent that New England had lost the race to become a major factor in American industry and finance during the twentieth century.

We should not be surprised, therefore, to see the cotton textile or the boot and shoe industries move to other regions after the first world war. It was by no means only the wage differential between New England and the South, or the inducements offered southern mill builders by New England textile machine companies, which carried cotton textile manufacturing to the Southern Piedmont. Nor was it merely lower wage rates and leased machinery which shifted the center of the shoe manufacturing industry to St. Louis.

In both movements the New Englanders failed to meet competition growing up long before the outbreak of war in 1914. They did not see that the rising southern mill town or mid-west industrial city offered its local capitalists the same sort of geometric increase in profits afforded Boston before the Civil War. To meet such competition, the Bostonians needed to staff their textile and shoe companies with the ablest leaders they could find, inside or outside the family group. Instead, the job of mill treasurer tended to be handed on by nepotism. Too many of these men kept their mills going by successful speculation in raw cotton and grey goods, rather than by reducing manufacturing costs by installing the latest machines. These jobs, moreover, were reserved for the less able members of these families. The best places were those in the banks and investment banking houses interested in investing New England capital outside the region.

Young men like Jim Storrow were devoted to New England's interest and especially to the interests of the closely integrated group of outstanding families whom they represented. This meant, however, an allegiance divided between the region and the wealthy families who maintained their residence in the region, but increasingly made their new investments outside New England.

This has produced a pattern whereby Boston remains a great financial capital for fortunes invested throughout the United States and abroad. This wealth, however, is by no means wholly dependent upon the productivity of New England industry for its income. On the contrary, the present level of New England community life and the regional standard of living depend on the flow of incomes from elsewhere.

The insurance companies and other investment groups, individual or corporate, located in New England, usually work hard for their money. Their incomes are largely based, however, on enterprises operating outside this region. If, as, and when these other regions level off as New England has done, these investment groups—and with them New England itself—will lose further headway.

Our discussion of the Storrows has not included a detailed examination of New England as a region; we have presented a very skeletonized regional model. We have not considered the smaller—and some large but new—businesses which have grown up in the shadow of the "Boston Associates." Also, we have not discussed the invasion of the New England regional economy by branches of national corporations in industry and retail and wholesale business. All parts of the United States have been profoundly affected by these developments in the last fifty years, and New England has been affected at least in proportion to its area and population.

We can say, by way of summary, that any model of a regional economy stressing social structure shows that the final decision-makers who must be consulted in the region (in our case, New England) are still representative of those oldest family groups. When, as, and if, changes in productivity come within the region, nationwide corporations and national political leaders will find that representatives of these regional decision-making groups must be reckoned with. If the present generation of decision-makers in New England is to keep its region abreast of national development, it must raise up model-builders like the Storrows.

MANAGEMENT TECHNIQUES FOR STIMULATING PRODUCTIVITY

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Summary

Within a single century, the form of industry has evolved from primitive handicrafts to a very complex technology. Techniques for stimulating productivity have changed drastically in order to keep pace with the changing form of industry. Necessarily, the application of the new techniques lags behind the potentialities. Many managers are unwittingly applying, to today's problems, techniques designed to solve the problems of yesterday.

Management techniques for productivity have to date emphasized productivity of the individual production worker. To solve the problems of tomorrow, management must not only extent these techniques to include the non-production worker; it must give far more consideration to the productivity of the enterprise as a whole.

This new emphasis will find expression in improved coordination between departments, in extension of the concept of management controls, and in a planned selection and training of managers.

Characteristics of Simple Enterprises

The more primitive forms of industry were (and still are) characterized by:

(a) A simple product devoid of precise quality characteristics

(b) A simple process involving use of elementary tools to fabricate elementary materials

(c) Use of unskilled human labor for the fabrication and materials-handling operations

(d) A small shop in which the owner-manager directly supervised all workmen as well as carrying on the commercial function of the enterprise.

Under these conditions, the costs of materials and of overhead were relatively small. The chief costs were the wages of the workmen. It is entirely understandable, therefore, that the emphasis of the managers of such enterprises, was (and still is) devoted to increasing the productivity of the workmen.

Manifestly, it is unit cost of production which is vital in the enterprise. Where labor was the dominant cost, the "solution" for the owner-manager was "obviously" to make the wages as low as possible, the while securing from the workman as great a day's work as possible.[1]

Early Management Techniques

Following this primitive reasoning, the early managers did in fact keep wages low the while exhorting workmen to high production. The stimuli used by the managers varied with the form of civilization in vogue, but the effectiveness of the stimuli was always based on the compelling needs of the workman. The workman had no recourse under the then existing forms of society.

Wages were placed at that minimum required to sustain the lives of the slaves, serfs, or by whatever other title the workmen were called. The day's task was evidently based on past performance. The toil and the weariness associated with completion of the day's task were preferable only to the consequences of failure. Tasks were subject to arbitrary increase, again with no recourse on the part of the workman.[2]

The early days of the Society of Contract brought forth very little change in the conditions which had prevailed in the Society of Status. The early Lancashire mills operated under standards of a day's work and of wages which we now regard as appalling. Curiously and tragically, the same workman who had fought his way out of political bondage became forced by circumstance to contract himself, "voluntarily," into economic bondage.

It is important to note incidentally that the application of these blind stimuli *placed on the workman the burden of solving many problems in productivity*. The concepts of finding the best way, and of selection and training, were a long time in developing. Until they had developed, the workman was, in the main, left to solve his problem unaided.

[1] These two, the day's work and the day's wage, are often coupled in slogans. But it is well to avoid confusion here. Actually, two different dimensions are involved. Determination of a "fair day's work" is a problem in measurement through engineering and biometrics. Were we able to define and apply a unit of human work with precision, the problem of how much is a day's work could be laid to rest just as effectively as the problem of how much is a bushel of wheat has been laid to rest. On the other hand, the fair day's pay is a problem in economics just as is the price of a bushel of wheat.

[2] Exodus 5 (Bricks without straw).

Taylor's Principles of Productivity

A number of managers of the 19th century experimented with means for improving the productivity of the individual workman. It remained for Frederick W. Taylor to give clear expression to four management principles for securing productivity. Use of these principles has become widespread indeed. Taylor's principles may be re-stated as follows

1. The *method* for performing each job is to be determined by scientific study, not by rule of thumb.

2. For each job there is to be established, through scientific study, *a standard of a day's work.*

3. For each job, the workman is to be *selected* on a basis of general fitness, and then is to be *trained* in the best method.

4. An *incentive* is to be established to urge the selected and trained workman to use the best method and to meet the standard of a fair day's work.

Much improvement in productivity has been achieved through use of these principles. However, much mischief has also been done. In part this is due to misapplication of these principles by men unqualified, over-zealous, or unscrupulous. But in part the principles themselves were limited in their validity.

Taylor's principles will now be considered individually.

The Best Method

The concept of replacing human effort by mechanical effort had already been well developed when Taylor arrived on the scene. But Taylor dramatized the principle that the use of *the human body as a machine for work* likewise warranted study. In his studies of materials handling (shoveling, carrying pig iron) he came up with scientific determination of size of shovels, percent of resting time required, and related measures.[3]

It remained for Frank and Lillian Gilbreth to devise the techniques for putting the principle of the best method into practice. This they did through development of what is generally known as Motion Study. Their methods included the techniques of motion picture study, the definition of elemental motions (therbligs), a system of

[3] Frederick W. Taylor, *Scientific Management* (New York: Harper & Bros., 1947).

codes and symbols, flow charts, and numerous others. The techniques of the Gilbreths have been widely applied in industry.[4]

Within the last decade, the question "Who shall determine the method to be used?" has received much discussion in industry. It was Taylor's view that the method must be left for scientific determination by experts. The workman was to be given detailed instructions on what to do and how to do it.

Experience since Taylor has raised several objections to so rigorous a view, on the following counts

(1) It is simply uneconomic for an expert to establish all methods, since many operations involve relatively little production time.

(2) The foreman and the workman resent adapting themselves to changes originated by someone else.

(3) It is desirable to enlist the *mind* of the workman, not merely for his specific contribution of ideas, but for the vital sense of participation created thereby.

Out of this experience, the following appears to be evolving:

(a) On major questions of method, i.e., plant layout, purchase of machinery, etc., the basic study is made by the engineer.

(b) On minor questions of method, i.e., layout of the individual work-place, the foremen and workmen are trained in the psychology and the techniques of methods improvement, and are stimulated to find new ways in old surroundings.

(c) In any event, the foremen and workmen have a voice before a change is made effective.

The Standard of a Fair Day's Work

Taylor not only stated this principle; he developed the use of stop watch time study as a technique for establishing the standard. Thereby he generated a storm which has at this writing not yet subsided.

It is easy enough for engineers and Union stewards to agree on how long a workman in fact *did take* to perform a given job. The difficulty is in converting this record of actual performance into an esttimate of how long it *should take* a trained workman to perform the job. Implicit in this conversion are two principal sources of error:

[4] See Ralph M. Barnes, *Motion and Time Study,* Third Edition (New York: John Wiley & Sons, Inc., 1949).

(1) The "rating" or estimate of the effectiveness of the workman under observation. This rating is made to a subjective standard carried in the mind of the observer.

(2) The fatigue factor added in the (usual) case that the study was conducted over a short period of time rather than a full working day.

Taylor [5] and those who came after him have generally overstated the precision attainable in measuring the fair day's work. Until the last few years, industrial engineers have avoided publication of results of independent studies by engineers on identical jobs. This reluctance has undoubtedly slowed down the development of a solution.

A recent research study [6] has generated much new data on the precision of measuring a fair day's work, as well as making available motion picture films of various common operations to serve as objective standards.

Another development has been publication of time values [7] for "elemental" operations on the theory that a job can be analyzed to discover which of these "elements" it contains. These elements can then be summed up to yield a time value for the total job. In the absence of comparative data on results arrived at independently by practitioners, the precision of the method cannot as yet be appraised objectively.

The precision of any device for establishing standards of a day's work is measured by the uniformity of the results obtained when the device is used independently by a number of engineers (or Union stewards). Such data as have been seen by the present author would indicate that the best of the existing means, if tested independently by a group of engineers, would find at least a third of them differing by more than ten per cent from the average of the group.

On the face of it, such a result, if attained universally, would not be too bad. Certainly it is far more precise a measure than that derived by perpetuating past history. Considering the errors inherent in many engineering computations, the present attainable precision of measuring the fair day's work is not unreasonable. (In designing a bridge, or a vehicle, the fine precision of theory of stress and strain is grossly

[5] Frank B. Copley, *Frederick W. Taylor, Father of Scientific Management* (New York: Harper & Bros., 1923), Volume 2, Chapter VI.

[6] Conducted by the Society for the Advancement of Management.

[7] See for example, Harold B. Maynard, Stegemerten and Schwab; *Methods-Time Measurement* (New York: McGraw-Hill Book Co. Inc., 1948).

diluted by an arbitrary factor of safety which may run to several hundred percent.)

Nevertheless, the industrial engineers are not happy over present precision of measuring a fair day's work. In part this is due to the fact that the results touch a sensitive nerve of the workman. In part it is due to the fact that so long as any subjectivity remains in the measure, so long will there continue to be accusations to the effect that the slack is all taken up in favor of management.

Moreover, it is surprising to industrial engineers that the unions have not made more of an issue of the matter. Evidently union engineers are fully aware of the limitations.[8] Yet the fair day's work problem is but one of a whole series in the entire complex of union-management relationships. To date, at least, the unions have generally been more concerned with other problems in the collective bargaining group.

Selection and Training of the Workman

The selection principle has run squarely into a series of limitations of union origin. From the viewpoint of the manager, three of these limitations are particularly unsavory:

(a) Hiring. In some instances, employee nepotism, former length of service, or other form of employee determination becomes part of the basis for choosing new employees.

(b) Upgrading. It is now a widespread requirement that notice of higher grade jobs be published so that employees may bid for such jobs. The point is that the management is precluded from appointing that employee which it thinks most qualified. It must appoint, at least on a trial basis, that employee of longest service who wants a trial.

(c) Layoff. The seniority rule has come to compete quite successfully with the rule of merit in sequence of layoff.

Running through these and other elements of the selection problem is the clear evidence of development of "rights in the job." These rights are rapidly becoming a new form of property, and are prevailing against the historical management "prerogatives."

The principle of training of the workman was dramatically demonstrated in World War II as a result of the Training Within Industry [9]

[8] William Gomberg, *A Trade Union Analysis of Time Study* (Chicago: Science Research Associates, 1948).

[9] *Training Within Industry Report,* 1940-45 (U. S. Government Printing Office, 1945). U. S. War Manpower Commission, Bureau of Training.

program. There can be no doubt of the important role played by this training in the productivity of the United States.

The comparatively wholesome acceptance of the training principle suggests extension of its use to offset the limitations imposed on the selection principle. Management has far to go to apply even existing knowledge on usefulness and techniques of training.

Taylor's Principle of Incentives

Taylor's principles of the best method, the fair day's work, selection and training have proven sound, though lacking complete mechanisms for applications. However, Taylor's version of the principle of incentives has been demonstrated to require fundamental modification.

Underlying Taylor's system of incentives were the concepts:

(1) The prime concern of the workman is money.

(2) The lure of added money is a sufficient incentive to induce the workman to increase production.

These considerations may well have been vital in Taylor's time. When one it at or below the subsistence level, money becomes the basis of liberation from a budgetary prison. The dominant concern is indeed to secure liberation from this perpetual poverty.

But it is another thing to conclude that preoccupation with money continues even though the workman has risen above the subsistence level. On the contrary, the gathering evidence indicates that the higher the workman's standard of living rises above the subsistence level, the less is the relative importance of any money increment, and the higher becomes the relative importance of other incentives. Moreover, there are widespread instances in which the workman has restricted his production notwithstanding his clear need for higher income. His reasons? Simply that there are things in life more important than increments of money.[10]

The lesson of these recent researches is that money, as an incentive for productivity, is no longer the paramount incentive, even granting that it might have been so in other years, or that it may be so today in other countries.

[10] For examples see:

F. J. Roethlisberger and W. J. Dickson, *Management and the Worker* (Cambridge: Harvard University Press, 1939).

William F. Whyte, *Pattern for Industrial Peace* (New York: Harper Bros., 1951).

Currently much is being done to establish an up to date principle (if not an enduring principle) of incentives to worker productivity. The final result is by no means clear, though rough outlines have begun to emerge.

Certainly the concept of *participation,* the idea of being on the team, is bound to play an important role.[11] This is not restricted to financial participation in a form such as profit sharing; it is essential that the workman have a voice in the shaping of events as well.[12]

The Shift from Emphasis on Production Worker Productivity

The foregoing has dealt with principles of *production worker* productivity. In the handicraft industries, this production worker productivity is the main variable; no vital gains in productivity can be made unless production worker productivity is improved. However, other aspects of productivity, of minor importance in the handicraft industries, become of substantial or even leading importance in the larger, more complex enterprises.

In particular, management emphasis has been revolutionized by the advent of mass production of precision goods. The very nature of such mass production suggests the direction of the new emphasis. Mass production of precision goods is characterized by:

(1) A product design adapted to interchangeable manufacture. This requires engineering effort, not merely for the basic functional design, but to an even greater extent for the specification of the standardized, interchangeable components essential to mass production.

(2) A manufacturing process of sufficient precision and digestive capacity to meet the needs of quality and quantity. This requires engineering effort to specify machines and processes, to design tools, fixtures and gauges, to lay out the plant for economic flow of materials and to specify the necessary operations and division of work for production operators.

(3) A swift, sure flow of large quantities of materials. This requires increased effort in purchasing, expediting, storing, materials-handling, packaging and shipping.

(4) Timely maintenance of the physical buildings, machines, tools, etc. This requires a new force of skilled workmen, which in some

[11] See James F. Lincoln, *Lincoln's Incentive System* (New York: McGraw-Hill Book, 1946).

[12] See Sir Charles Renold, *Joint Consultation Over Thirty Years* (London: Allen Unwin, 1950).

enterprises (certain chemical process plants) exceeds, in number, the production force.

The foregoing, plus still other services (such as employment of workmen, inspection of the product, etc.) were once performed, if at all, by the foreman. In the large enterprise of today such functions must be performed by special auxiliary departments. These auxiliary departments are vital organs in the enterprise. Not only must each perform its function; in many instances the size of these auxiliary departments is such that *their* productivity is likewise important to the enterprise. For example, a large office force for customer billing (certain public utilities) not only must perform this vital function correctly; it must perform it efficiently as well. Thus it can lower the productivity of the enterprise in two ways, either through failure to carry out the billing function, or through carrying out this function at a waste of manpower.

Nor is this all. The functions of finance and sales, usually performed by the proprietor of the small enterprise, likewise grow in size and complexity as the enterprise grows. The sales function, especially, has grown broadly to include sales promotion, advertising, sales service and still other complications. The efficient functioning of these departments is secondary only to their basic performance.

Finally, the growth of the enterprise gives rise to the need for a whole series of management controls. These are of the utmost importance. It is no exaggeration to state that *in the larger enterprises, the limiting factor in productivity lies in the management controls.*

A rudimentary example may be in order here. Consider the simplicity of regulation of pedestrian traffic in the village market place or on a country lane. However, as the traffic multiplies, is mechanized, bears great loads, and moves at high speeds, controls become essential as to right of way, speeds, loads, and many other characteristics. The limiting factor in the successful movement of this complex traffic lies not in the skill of the drivers or in the excellence of the vehicles; it lies in the traffic *controls.*

It follows that early management emphasis on production worker productivity is out of date in the large complex enterprises. It does not follow that managers have fully grasped the implications or even the presence of these changes. On the contrary, there are many enterprises in which management attention is focused on trivia of worker productivity (talking on the job, personal time-out, etc.) when there is no clear definition of organization, no table of delegation, no clear channels of communication, no system of reports for executive control.

Such situations are not surmises. Not only do they exist; they abound.[13]

Manifestly, the productivity of the individual production worker is now of no less numerical importance than it has been. However, the importance relative to total productivity is decidedly less. Sole preoccupation with production worker productivity is in many enterprises the application of yesterday's management solutions to the vastly different problems of today.

Consequences of the Shift in Emphasis

Manifestly, Taylor's principles—the best way, the fair day's work, selection and training, and the incentive—apply with equal force to all employees, whether production worker, office worker, supervisor, engineer, or any other. But economic application of these studies to improve productivity presupposes that the thing to be controlled is large relative to the cost of exercising the control. The large gangs of unskilled labor of Taylor's time have disappeared to be replaced by the more variegated production and auxiliary tasks of modern enterprise. Thereby the economics of extensive time study and motion study has shifted.

In a measure, these new problems have suggested their own solutions. Study of methods of doing work is no longer asserted to be the sole province of the industrial engineer; the foreman and the workman are trained to aid in such determinations. Individual time studies are giving way to tables of standard times based on prior studies. Individually designed piece rates are giving way to group incentives.

But these adjustments relate only to the economics of controlling worker productivity. The new and often greater problem of management controls is of a different character. It requires not merely an adaptation of former solutions; it requires new solutions in place of or in addition to, the old solutions.

In part, the new solutions involve fundamental changes in managerial attitude. Foremost of these is the change in the manager's basic loyalty. This loyalty, originally devoted primarily to the interests of the owner, must now be devoted primarily to the interests of the enterprise. This change has become simplified as a result of the separation of ownership from management.

[13] A wag has labeled such situations as "Polishing brass while the ship is sinking."

A second change in managerial attitude is that with respect to employee relations. At the dawn of the Industrial Revolution, the basis of employee relations was the Anglo-Saxon law of contract, a sale of the services of a human being for money. But as more and more human beings have become involved, it has become increasingly evident that this relationship includes a private regulation of the daily lives of a sizeable segment of the population. Wherever human beings live, whether on the farm or in the factory, there human rights spring up.

As these new human rights develop form and substance, there arises the need for enforcement of the new rights. On the industrial scene, the managers failed generally to recognize the existence of these new rights, let alone attending to their enforcement. In consequence a new agency, the labor union, arose to represent the industrial citizenry in redress of grievances and in codifying of the industrial law.

A further shift in emphasis arises from the growth of organization to a point that communication and coordination become serious limitions on productivity. Such problems exist only in rudimentary form, if at all, in the small enterprise. In the large enterprise, much management effort is required to develop lines of communication and methods of coordination.

A corollary to growth of organization is the need for a supply of intermediate supervisors and of technical personnel. The selection and training of men to fill these posts is again a serious new problem for management.

Summarizing, it is seen that for the modern enterprise, the former emphasis on production worker productivity must now be extended to include all workers. Moreover, the basic attitudes of management must be re-examined, both as to management loyalty and as to industrial relations. Finally, the new problem created by size must also be solved. These new problems include establishment of means for communication and coordination within the enterprise and for the selection and training of the management hierarchy.

Productivity of Non-Production Workers

The early handicraft industries featured a high concentration of manpower in the direct productive operations—not only the skill, but the energy was supplied by human beings. Because the human being is such a feeble source of energy, it required many human beings to generate any respectable amount of energy.

With the advent of mechanical sources of energy, the productivity of the production shops rose sharply. The collateral advent of mass production processes still further increased the productivity of the shops.

As the production of the shops rose, both through greater productivity and through expansion, the numbers of service personnel rose sharply. The flood of goods needed to be inspected, counted, packed, stored, sold, shipped, invoiced, etc. Furthermore, in the service industries (merchandising, insurance, government, banking, etc.) the numbers of employees also rose sharply. Much mechanization [14] has taken place in these industries, with the collateral need for machine operation and machine maintenance.

Taylor's principles for doing work are admittedly applicable to non-production operations, even though the applications are special. But the pace of application lags decidedly behind that in vogue in the production shops. In the United States, serious charges of inefficiency continue to be leveled at the government agencies, the railroads, the building industry and many others. In contrast, great strides are being made in merchandising, and in farming.

The modifications necessary to apply Taylor's principles to non-production jobs are beyond the scope of this chapter. The main point is rather, that progressive management cannot afford continued preoccupation with production worker efficiency. This is placing continued emphasis on a problem of diminishing size, the while neglecting the greater and growing problems of non-production worker productivity.

[14] *Note on Productivity Through Mechanization*

There is much debate over whether mechanization is a problem in engineering or in management. This may be a good place for some clarification.

Engineering is generally understood to consist of utilization of the forces of nature (as discovered by the scientist) for the benefit of man.

The distinction between engineering and management lies in the fact that the latter coordinates the forces of *people,* also for the benefit of man.

Of course, the engineers who design machines, the craftsmen who build them and the workmen who operate and service the machines are all people. In this way, management, through directing the activities of these people, makes vital decisions regarding mechanization. But the distinction made between engineering and management is of great importance.

Management, in its prime loyalty to the enterprise, must strive for higher productivity through all means available. One of these means is through mechanization. Management's role is to sense those situations which might economically be mechanized, to have studies conducted by the experts, to consider the findings of the experts in the light of the surrounding circumstances, to find ways of financing the mechanization, and finally, to put the mechanization into practice in a way which avoids any serious disruption of the lives of the human beings affected.

Departmental Productivity

As the enterprise grows, there arises the necessity to create departments for the more effective performance of the work. This development parallels the development of organs in the biological organism. Thereby a new unit of industrial life, the department, comes into being and requires management techniques for productivity.

The principles of the best method, and of measure of a fair day's work, apply to the department as well as to the individual workman. "Method" is applied to the department more usually is designated as "procedure" or "routine." The standard of a fair day's work for the department is often called the "production capacity."

"Selection of the workman" takes on a new connotation, for it implies selection of mutually compatible associates for the department. Training in working together as a group is no less important. Often the training time in group collaboration exceeds in length the time required for training the individuals to carry out their individual tasks.

The incentive for the group is often more forceful than the incentive for the individual. The individual wants to be part of a team, and his desire "to belong" generates a corresponding desire to perform in a way which does not let the team down. Industry has far to go to exploit this team-work form of incentive.

The system of management controls requires measures of departmental productivity both as a measure of the effectiveness of the departmental performance and of the departmental supervisor's performance. However, carried to extremes, high departmental productivity comes at a prohibitive price. A perfect record by the credit department normally means that too many sales have been lost. A demand, by the inspection department, for flawless appearance of the product, usually raises the cost of production needlessly.

The emphasis on departmental performance is far more complex than mere productivity. The urge to develop the department into an independent, self-sufficient industrial community is ever present. Rivalry and even hostility can develop respecting other departments. "Iron curtains" are not unheard of between departments.

Such over-emphasis on departmental importance can become a serious drag on the productivity of the enterprise. The necessary means for communication, coordination and control must be developed. At times these rise spontaneously from below. In the absence of such spontaneous leadership, top management itself must step in to fill up the gap.

Coordination to Aid Enterprise Productivity

The concept that top management can effect all necessary coordination is simply naive. The enterprise has need for numerous reflexes over and above the conventional coordination through the central nervous system, i.e., the top management hierarchy.

Coordination is the antidote to many of the ills of departmentalization. An example, one of many, can be cited from a company fabricating metal parts. The productive organs consisted essentially of a large foundry and a large machine shop. Each of these departments was well equipped with modern machinery. Each was manned with sincere, able people. Yet the organization was suffering serious losses due to numerous parts being defective beyond repair.

Closer scrutiny disclosed that while each department was devoting much effort to improving its own operation, the basic scrap problem was interdepartmental. The bulk of the scrap, turned up at machining, was of foundry origin. Under the circumstances, no solution was possible unless, through coordination, the fabrication conditions at the foundry could be correlated with the troubles discovered during machining. In this instance, coordination was through a staff department which could, by investigation, discover relationships between cause and effect.

Such situations abound in industry. Production lags because the equipment maintained by another department fails repeatedly. Yet the repeated failure might be designed out of existence were the facts known. Again, seriously unbalanced inventories may result from failure of communication between sales and production.

In contrast to the bits and pieces improvement derived through greater worker productivity, instances such as the foregoing can mean much at one stroke. The recognition of the presence of these situations, and their solution through staff department or higher management intervention, constitute a fruitful field for improving productivity.

The devices for securing coordination include, over and above the appeal to the common boss:

Conferences—a spontaneous form of meeting for discussion of problems.

Committees (for discussion)—a more formal group, with legitimacy as to the agenda and as to the right to publish minutes.

Committees (for decision)—a relatively new management development, differing from the conventional committee through having a delegation of power to make binding decisions. Sometimes called Junior Boards.[15]

Committees (for consultation)—a discussion group which is adjunct to the presiding executive. It appears to retain the usefulness of group deliberation while retaining also the unbroken chain of command.[16]

Staff departments—a device of great flexibility, used to collect facts, to make analyses of facts, to draft recommendations, and to secure approval for joint action.

As the enterprise grows in size and in complexity, the need for devices for coordination rises in geometric proportion. This trend is equally evident in the biological organisms. But management has far to go to develop means for coordination which approach, in effectiveness, the nervous system of the biological organism.

Management Controls

The amazing parallel which exists between the enterprise and the biological organism suggests the need for far greater development of the concept of "management controls." The biological organism achieves control by:

(a) Sensing what is going on, through a marvelous number and variety of sensory organs,

(b) Analyzing the resulting data through the integrating mechanism of the nervous system,

(c) Issuing orders to effector organs to take action based on the results of analysis,

(d) Sensing the results of the action, which starts the cycle of events over again.

The development of the servo-mechanism has gone far to adapt these biological principles to solution of engineering problems. Many production processes are now equipped with instruments which measure a phenomenon, and compare the results of measurement with a standard. In the event of disparity, the servo-mechanism sets into motion the means for regulating the process to meet the standard.

A related problem faces the manager. Expressed in more appropriate terms, the need in management controls is to:

(1) Decide on what are the essential facts required to regulate the enterprise,

[15] See Charles P. McCormick, *Multiple Management* (Clinton, S. C., Jacobs Press, 1938).

[16] See Sir Charles Renold, *op. cit.*

(2) Define units of measure for these facts,

(3) Design management instruments to measure the facts in terms of those units of measure,

(4) Connect the instruments to the source of the facts,

(5) Summarize and present the facts in relation to standards of performance,

(6) Focus managerial attention on those situations in which performance fails to meet standard.

The resulting collection of facts is sometimes called the "Executive Instrument Panel."

The idea of steering an enterprise by instruments is in its early stage of acceptance by managers. For the small enterprise, most essential facts are within the direct observation of the manager, and the need for an instrument panel is small. The larger the enterprise, the more acute becomes the need for the instrument panel.

The instrument panel is but a technique for aiding management control. Management control includes not only the sequence of events discussed above; it includes also the definition of the objectives of the enterprise. It includes defensive policy in discovery of what are the perils of the enterprise, and planning to avoid these perils. It includes aggressive policy planning for the growth of the enterprise.

Much remains to be done in clarifying the concept of management controls and in perfecting techniques for accomplishing the controls. The parallel between the problem of engineering control with that of biological control has given rise to a new word[17] to identify the generic character of these controls.

The Supply of Managers

The know-how of productivity is only of academic value unless the managers on the job possess this know-how and have the determination to put it into practice. The supply of such managers constitutes one of the limitations in achieving productivity.

The problem is not merely one of quantity of managers; the quality is equally a problem. There is increasing awareness that neither general knowledge of life, nor special knowledge of technical processes, suffice to make a man a manager. The need is for skill and experience *in the managerial process*, which is quite a different thing.

Training of managers poses new problems in education. For such training, the laboratory is not to be found in the schools; the labora-

[17] See Norbert Wiener, *Cybernetics* (New York: John Wiley & Sons, 1948).

tory is industry itself. Thus far, management training has been restricted to the locale of the laboratory, i.e., on the job. Men have learned to be managers through being apprenticed to practicing managers. The advantage has been that in practice one deals with real situations as they arise. The limitation has been in the extent of empiricism which prevails among practicing managers.

Within the last decade a relatively new form of management training has arisen—the seminar.[18] This is essentially a meeting of not more than (about) 20 practicing managers, under skilled leadership. Through multi-lateral discussion these practitioners not only learn techniques from one another; what is far more important, they develop a keen awareness of the existence of universal principles of management.

In the large enterprises there has been development of long range planning to insure adequate supply of managers. Inventories are taken of the number and kind of managerial vacancies which are coming upon the horizon. Paralleling this, inventories are taken of the available candidates for these openings and of the extent of further training and experience needed by these men. Thereupon a long range program of rotation and training is established to close the gap.

A final problem in supply of managers is the question of professionalism for managers. The responsibilities of the manager, both as to the life of the enterprise and as to the many people whose well-being depends on the life of the enterprise, have grown greatly. In this way, while the decisions of the manager appear on the face of it to be private in character, these decisions strongly influence the lives of many people and can properly be regarded as tinged with a public interest.

Those who as a class make important decisions affecting the public interest must solve the problem of competence, ethics, etc., if they are to avoid regulation by the public. The doctors and lawyers solved this problem through creation of professions. At the other extreme the railroads failed to solve the problem and found themselves heavily regulated by public laws.

The attributes of a profession are well known. They include the rendering of an essential public service, a codified body of special knowledge, selection of the candidates on the basis of fitness, cultural

[18] Seminars offered by American Management Association currently exhibit the broadest variety of subject matter.

and special training, examinations as to proficiency, subscription to a code of ethics, and finally, licensing by the public.

Analysis discloses that as yet, management has moved only partly in the direction of professionalism. But if interchangeability of managers is to expand, there will have to be a change in the manner of appointment of managers. The present system of apprenticeship must give way to professionalism.

ORGANIZATION AND MOTIVATION OF MANAGEMENT

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WHEN WE THINK of productivity in the plant, we are inclined to think of the organization of machines, processes and of workers, since that is where attention on the problem has been focused. We are inclined to forget that management people must also be organized and motivated for maximum productivity. In fact, if the managerial organization is unsound and the managerial people are ineffectively motivated, we can hardly expect good results on the production line.

We are inclined to assume that the management man is just naturally striving for high production. This assumption requires certain important qualifications.

Prices and Productivity

Management's approach to productivity cannot be separated from management's price policy. The firm can operate with relatively low prices and count on high volume production and sales to make its profits, or it can seek to keep prices high to make a high unit profit on a smaller volume of sales. Of course, it is only the first approach which is compatible with maximum efforts toward productivity, and it is that first approach that has in large measure in times past characterized the American economy, and distinguished it from economic organization in certain other countries. Certain students have held that American industry is becoming less competitive in price and is more committed to maintaining a given price and limiting production to the dictates of that price policy. Thorstein Veblen argued eloquently for this position. It is not the function of the present paper to weigh this argument, but simply to point out that efforts to get maximum production from the workers will depend in some measure upon top management's decision as to how far productivity shall be stressed.

Individual Competition and Productivity

If we examine the motivation of the individual in management, we see another phase of this problem. Management is often looked upon as an aggregation of individuals with each one competing with his fellows to reach the higher positions in the organization. The rewards of promotion and higher pay are felt to go to the individuals who are more efficient and more productive. We may well ask whether this career competition necessarily leads to higher productivity.

We sometimes see two factions competing for control of a corporation, where the outcome of the struggle may have rich financial rewards for the winners but have little if any effect upon productivity within the corporation. Even if we move down from the top level of financial struggles, the correlation between career success and productivity is not at all clear. We see some organizations where the primary requisite for success is personal loyalty quite apart from the technical performance of the job. Of course, a certain minimum performance is necessary but, beyond this relatively low threshold of ability, the individual's success seems to be determined by his skill in picking his way through a network of political intrigue.

By contrast, we see other organizations in which we have the impression that effective performance on the job is the primary, though never the only, criterion for personal advancement.

We are thus moved to ask whether the sharply contrasting characteristics occur simply at random or are due to the particular personality dominating the organization. Or can we lay out certain objectively observable factors in organizations that account for these differences?

This is a field in which rather little is yet known, but recent research suggests that we should look at the structure of the company organization for some of our tentative answers.

In the first years of this century, the field of organizational theory was dominated by Frederick Taylor and his disciples, operating under the banner of scientific management. In the past fifteen to twenty years, the tenets of scientific management have come increasingly into question, and a new, more experimental approach to managerial organization has been coming to the fore. Any discussion of the motivation of managers might begin by describing and analyzing the points at issue between the two approaches to organization theory.

Tenets of Scientific Management

For our purposes, three of the tenets of scientific management are of most significance.

1. *Standardization and Specialization.* The theory holds that the plant is most productive if the machine processes are highly stand-

ardized. The one best way of doing a job should be determined through time and motion study and the operator should then be trained to do the job in that one best way. Furthermore, the theory calls for maximum specialization of function. The jobs are to be subdivided into their simplest components, so that the worker will be doing a very simple routine operation.

2. *Span of Control.* This refers to the number of people who can be effectively supervised by a single individual. Authorities vary as to just how large this number is, and agree that it varies with the level of the hierarchy at which the people are functioning, and with the complexity and interrelations of their tasks. However, the emphasis is all in the direction of limiting the supervisor to a relatively small number of supervisees. This means that if there are large numbers of people in the organization, we will have a long line of authority.

3. *Economic Incentives.* The theory holds that economic rewards are the primary if not the only incentive that the employee seeks. To capitalize upon this drive, management should seek to measure the work of its employees and base their pay upon amounts produced. This leads to piece rate and bonus systems of various sorts.

Let us now examine these points in detail.

Standardization and Specialization

Critics of scientific management do not reject this principle in its entirety. They agree that efficient mass production depends upon considerable standardization and specialization. They argue, however, that efforts to standardize and specialize can be self-defeating if carried to extremes. They have no quarrel on the whole with the standardization and specialization of machines, but object when this mechanical approach is applied to human beings. This may be illustrated by an example discussed by Gardner and Moore.[1] They observed a plant engaged in the manufacture of plastic raincoats. The girls in one department were engaged in assembling various parts of the raincoats. The work was highly specialized so that, for example, one girl would cement the two pieces for the back, another would put on the sleeves, and still another would attach the collar, and so on.

Management decided to experiment by changing the organization of work to have each girl assemble a complete raincoat from the mate-

[1] Burleigh Gardner and David Moore, *Human Relations in Industry,* (Chicago: Richard Irwin & Co., 1950).

rials that were delivered to her bench. The results were gratifying both in productivity and morale, since the girls not only produced more but said that they found the work more enjoyable.

There was also a gain in the flexibility of the operation. In the days of extreme specialization when some of the girls who were engaged in afixing the sleeves to the raincoats happened to be absent, management would find itself piling up sleeveless raincoats and would have to make an effort to reorganize its activities to strike a balance. This required more controls and general managerial activity than was the case when all the girls were making the complete raincoat. In that case, an unexpectedly large number of absences would diminish total production, but would not create any imbalance in the productive activity.

The question of the one best way to do the job also requires scrutiny. In assembling the raincoat, the girls were at one time averaging approximately thirty-five coats a day, but there were two girls who far outstripped the others and turned out regularly over fifty a day. An industrial engineer who had been studying their work threw up his hands in despair as he pointed out that the two girls had organized their work in quite different sequences of activity. They seemed to have only one thing in common. There was rhythm in their movements so that one activity flowed naturally into the next. We might assume that the outstanding performer had naturally evolved the one best way to do the job, but how could the engineer impose a one best way in this case when the two outstanding performers did the job so differently?

Now this does not mean that time and motion study is of no value. Certainly there are a number of wrong ways to do a job—waste motions and undue efforts which mean inefficiency no matter who is on the job—but it is highly questionable whether there is such a thing as a one best way for every individual on the job, at least for most jobs. That being the case, efforts to achieve extreme standardization in job methods will have unfavorable effects on productivity and will also build up personal resentment against managerial controls.

Some standardization and specialization there must be, to be sure. But management will do well to balance the anticipated advantages in this direction with the possible losses in morale among employees who find that they are doing a monotonous and apparently meaningless job.

Furthermore, this scientific management approach tends to divide the plant into two classes of people: the experts who plan, organize, and lay out the work, and the human automatons who follow orders and do the work. A good deal of research shows that productivity and morale are both higher when employees have an opportunity to influence the way in which the work gets done.

This standardization and specialization approach tends to put management in the position of making and enforcing the rules. It makes impossible the sort of collaborative activity which seems to build good morale and good production in the work force.

Span of Control

Span of control theorists argue that only a small number of individuals can be closely supervised by a single individual. They allow for some variation in numbers according to the level in the hierarchy at which the people function and according to the complexity of their jobs, but they insist that the number directly supervised must be relatively small.

Their arguments are irrefutable if we accept the assumption on which they are based. That assumption is, of course, that people require close supervision. Critics of this point of view (notably Gardner, Moore,[2] and Worthy [3]) would argue for giving the supervisor so many people to supervise that he is totally unable to give them close supervision. They recognize that such a statement puts the issue in extreme form, but it does serve to bring out the contrast in point of view.

The contrast is between organizations having a long hierarchy (in accord with the principle of span of control), and organizations with flat structures and few levels of authority between top and bottom.

These two types of organizational structures lead to very substantial differences in human relations. In the long narrow hierarchy, where a man has only a few subordinates to supervise, he naturally tends to give them close and detailed supervision. If he only has a few people immediately under him, he will have plenty of time for this sort of supervision and little to take his attention away from it. This sort of supervision places a premium for subordinates upon the ability

[2] *Ibid.*
[3] James C. Worthy, "Organizational Structure and Employee Morale," *American Sociological Review,* XV, No. 2 (April, 1950), pp. 169-179.

to follow instructions. It provides relatively little opportunity for the exercise of initiative and for the growth and competence that comes with the assumption of independent responsibility. Under this close type of supervision, a decision of any importance will necessarily be referred to the boss, at least for his approval, and the individual subordinate has little opportunity to lay his judgment on the line and test it against future events.

The flat structure organization necessarily operates in a very different manner. Being unable to provide close supervision for a large number of subordinates, the supervisor must necessarily delegate considerable responsibility down the line. The supervisor must then get results through selecting able subordinates and providing the general direction in which they can test their own capacity and learn through the assumption of responsibility. He cannot prevent them from making mistakes, but responsibility is clearly located so that they recognize the mistakes as their own and have an opportunity to learn from that experience.

The Case of Sears, Roebuck and Company

This point of view is the organization theory of Sears, Roebuck & Co. Particularly in the retail branch, the Sears organization conforms to the idea of the flat structure to a remarkable degree.

It may be argued that the remarkable growth and outstanding economic success of Sears, Roebuck & Co. is due in important measure to the type of organization structure that has been evolved. On the other hand, we must be cautious in making this assumption, for we can certainly point to other companies that have achieved comparable growth and economic success with quite a different organizational structure.

If we look within Sears itself, we find a more impressive test of the flat organizational theory. Recent studies of a group of intermediate size stores are pertinent here. Each of the stores in this group had approximately thirty-five departments. Without any management planning in this particular respect, the stores have grown up with two different types of management structure. In the one that we may call type X, there is a store manager, an assistant manager, and approximately thirty-five department heads. The assistant manager helps the manager in various duties, but the department heads report directly to the manager. In the other type of structure (type Y), we have a manager, and then division managers each having four to six department heads reporting to him. In other words, type X has two levels of authority above the salesmen, while type Y has three.

Sears organization surveys show that morale in the type X stores is markedly higher than in type Y. Furthermore, the statistics on costs and profits show that type X is also more effective from an economic point of view, and finally the Sears personnel department finds that type X produces much more than its proportionate share of people promotable to higher managerial positions, whereas type Y produces less than its proportionate share. (A note of caution should be struck here, for the Sears organization at higher levels places the same emphasis upon ability to function with a minimum of direction, so that the experience gained in store type X would more rapidly qualify the individual for promotion. In other words, we are not dealing simply with ability in a general sense—and we will need to examine the concept of ability later anyway—but with ability to function effectively in a certain type of organization structure.)

We might ask parenthetically why, since Sears has found that type X is the superior model, the structure of all stores of this size and type are not at once recast in the X model. The problem here is more complex than it seems on the surface. Men who are reasonably effective as managers in type Y stores where they give relatively detailed supervision, cannot readily change over to the much more free and unstructured situation found in type X. In other words, the two different types of structure tend in part to select different types of personality and also to train people in different ways.

Even if we should grant the superior effectiveness of the flat type of structure for department stores, we may ask whether this type of structure is really feasible in other lines of economic activity. Are there special characteristics of department stores which render them more adaptable to a flat organization, compared, for example, with factories?

We may suspect that this is the case at least to some extent. The various departments of the department store can function relatively independently of each other, whereas in some complex factories there are tremendous problems of coordination among various departments along the line of the flow of work.

The Case of the IBM Plant

On the other hand, let us not assume that the large factory must necessarily have a long heirarchy of authority. The Richardson and

Walker [4] study of an International Business Machines factory in Endicott, New York, is very suggestive on this point. The researchers here studied a plant which in the course of the years 1940-1947 expanded from 3500 to 7000 employees, and at the same time reduced the number of levels of authority. This remarkable shortening of the line of authority in the face of organizational expansion provides too complicated a story for retelling here, but one point may be pulled out for special emphasis. This plant did indeed have very complicated problems of coordination and cooperation between production, maintenance, and assembly departments, and between line and staff officers, but it was deliberately decided not to rely wholly upon the authority system to resolve the problems of coordination and cooperation. The company instead developed a staff of people who would work with workers and foremen in helping them to speed up and smooth out the flow of work from one department to another. These men functioned without formal authority but seemed to have been invaluable aids in keeping track of a complicated process and in working with the people to avoid crises that come up when coordination between departments break down.

This observation suggests a more general point. Perhaps in our traditional thinking about organization we are inclined to think too much in terms of the line of authority. If difficult problems arise, we think of solving them in terms of the authority system. This sort of thinking leads to a condition where many problems cropping up at low levels of the organization are referred up to higher and higher levels for decision. Such an approach makes it exceedingly difficult to meet problems where they actually first show up. Perhaps in order to build more effective and productive organizations, we need to think somewhat less in terms of systems of authority, and somewhat more in terms of stimulating cooperation among line officers and in terms of developing staffs of people who can work with the line in smoothing out the flow of production. Such individuals would not function with the force of authority, but could win acceptance insofar as they were able to act effectively upon problems faced by the line organization.

Economic Incentives

The economic man theory has been so thoroughly discredited through research that it would be tedious to go over that ground

[4] F. L. W. Richardson, Jr., and Charles R. Walker, *Human Relations in an Expanding Company* (New Haven: Yale University, Labor and Management Center, 1948).

again.[5] However, we must not jump to the conclusion that economic incentives are totally ineffective.

We must assume instead that economic incentives will be effective or ineffective, in part, according to the pattern of human relations in which they are applied. Various studies have shown that worker response to the same economic incentive will vary with changes in worker-management and union-management relations.[6] This then is a problem of organization and administration, a problem involving the relations of people to each other as well as being a problem of systems and technical information.

The sort of problems of administering an incentive system described by Melville Dalton in this volume are all too commonly seen in American industry. If the organization structure is planned at all in such situations, it seems to be planned in terms of the theory of competing and conflicting groups. The incentive engineering organization commonly makes its studies or re-studies without regard to the interests of the line organization. Rate setting is apparently thought of as a specialized technical job in which the line officers have no competence and no proper concern. Thus we often have a situation where there is conflict not only between the incentive engineers and the workers and the union, but also between incentive engineers and line management officers. Here the foreman sometimes feels that he is just about to get his problems in the department smoothed out when the rate setters come in with a new rate that seems grossly unfair to the men, and perhaps even to the foreman himself. In such a situation, the foreman can defend the position of the rate setter before his men, or he can disavow all responsibility for the rates and stimulate conflict between the two branches of management. Whatever the foreman does in such situations, the economic incentive loses a large part of its effectiveness.

The problems of economic incentives must properly be seen in terms of conflict and cooperation within the factory as a whole. Where there is serious distrust and hostility between workers and management, and union and management, it is impossible to make an economic incentive work with anything approximating its full potentiality. It is sometimes forgotten that this point was stated by the early exponents of scientific management. They started with the assumption of coopera-

[5] F. J. Roethlisberger and W. J. Dickson, *Management and the Worker*, (Cambridge: Harvard University Press, 1939); and Elton Mayo, The Human Problems of an Industrial Civilization, (New York: MacMillan & Co., 1935).

[6] See, for example, the author's *Pattern for Industrial Peace*, (New York: Harper & Bros., 1951).

tive relations between workers and management, and granted that the incentives would not work without such cooperation. For example, consider this statement made in 1913 by Frank Gilbreth: [7]

> . . . it should be stated here emphatically that there is nothing that can permanently bring about results from scientific management, and the economies that it is possible to effect by it, unless the organization is supported by the hearty cooperation of the men. Without this there is no scientific management.

In industrial relations today, we certainly cannot assume this harmony, but must seek to discover how reasonably cooperative relations may be established. If we put the problem in that way, we will think of incentive engineering not simply as a set of specialized techniques and as a special department of industrial engineers. Instead we will think of the over-all context of worker-management and union-management relations, and then we will ask ourselves what position the incentive engineers should hold in the management structure, and what relations they should seek to develop with the line organization and with the workers and union officers.

Incentives and Organizational Structure

This approach can be illustrated in the author's recent study of an Inland Steel Container Company plant.[8] There, over the years of union-management struggle, incentive rates had been one of the chief issues in the conflict. During the period of conflict, the industrial engineers had been free to move about the production departments at will to make any study and observation they happened to be interested in. Rates on new jobs were set without the approval of the departmental foreman and were put into effect without any consultation with the union. A revision of a rate was undertaken when, in the opinion of the industrial engineer, the content of the job had changed sufficiently to warrant a rate change. Under this procedure there were many and bitter arguments between union and management concerning this rate setting activity. Every time an incentive engineer came into a production department, the workers would seem to be on edge, expecting that some arbitrary change would be imposed.

In the course of some months, relations between workers and management, and union and management, were markedly improved in this situation. The story of these over-all changes is beyond the scope of this paper, but the changes made in rate-setting activity are pertinent

[7] Frank Gilbreth, "Units, Methods, and Devices of Measurement under Scientific Management," *Journal of Political Economy*, XXI (July, 1913) p. 623.
[8] *Op. cit.*

here. Under the new procedures, the incentive engineer cannot enter a production department for the purpose of making any studies or observations without the written permission of the general production supervisor (in effect, the factory manager). Upon entering the production department, and before making any observation or study, he must show this authorization to the foreman and to the union steward, as he explains to them the purpose of his visit. When he has finished his study and is ready to propose a new rate or a rate change, this decision does not immediately go into effect. Before the rate becomes official, it must have the approval of the foreman and the general production supervisor; the approval of the union is not required but the new rate is discussed informally with the union steward before it is put into effect. If the steward feels the rate is not fair, the union and management officers then have the opportunity to discuss the problem informally before management makes its decision regarding the rate.

Management retains the right to set the rate without the union's approval, but the management officers recognize that they have much less trouble with the rate when there is an opportunity for prior informal discussion than is the case when the union can only be heard concerning a rate by filing a grievance. A grievance can be filed, of course, only after a management decision has been made. In such a case, even if a responsible management officer should decide that the rate in question is a mistake, it creates a rather awkward situation for a manager to have to reverse his own industrial engineer. Management people and union people alike feel that the new procedures on rate setting and rate revision are a great improvement over the former arrangement. The rate issues that were before constantly being argued have now dropped almost entirely from the scene.

What lesson can we draw from this change? It would be a mistake to assume that the procedures outlined could be applied effectively in every union-management situation. The changed procedures in this case were effective only because they were part of other related changes that brought about more harmonious worker-management and union-management relations. Nevertheless, incentive engineering activity is often a focal point of labor-management conflict. Managers who are striving to build a more productive organization would do well to examine critically the relationship of the incentive engineers to line management, workers and the union.

Ability and Social Compatibility

We often talk about ability as if it were rather easy to recognize—except in cases where we are biased by our own personal interests. Actually, of course, the concept of ability presents a very complex problem, particularly when we are talking about managerial activity. We will all agree that the continuing effectiveness of an organization will depend upon the extent to which promotions are based upon ability, and yet when we come to ask what ability is, we are at a loss for any simple answer. It is hard enough to get an adequate measure of a shop worker's ability if we are conscientious enough to ask to what extent his production records reflect a negative attitude toward management which leads him to withhold what he could readily produce. But in that case, we do at least have figures on what he produces on the machine. At managerial levels, no such simple measures are possible. The manager works with people and only indirectly with machines. His technical knowledge is important and that can be tested to some extent through an examination. But we all recognize that there are men who are technical experts who fall down as managers, as there are managers who perform very effectively with only a general and superficial technical knowledge because of their ability to get other men to work with them.

This means that the manager cannot get by on technical ability alone. He must be socially compatible with the people with whom he works. The work of industry involves, of course, much more than the giving and following of orders, much more than the taking of action, and the submitting of reports. For people to work effectively together, these formal aspects of the job must be imbedded in a good deal of informal discussion, some of which may have nothing obvious to do with the job at hand at all. For men to work effectively together, they must have confidence in each other. This confidence does not arise out of technical ability alone, although technical ability may contribute to it. Men need to feel that they know what to expect from their associates at work, and this feeling arises only out of a fairly close personal acquaintance. This does not mean that people in management must be good friends in frequent contact with each other outside of work. It does mean that they should be able to feel at ease with each other in the day-to-day situations they encounter on the job.

This means that some men of unquestioned technical ability simply will not be and should not be promoted to positions of higher responsibility. A man must fit into his position socially as well as technically. On the other hand, this social requirement always presents dangers in the organization. There is perhaps a constant tendency to select "our kind of people" for higher positions, which may make for a very easy and happy group life, yet this tendency, if unchecked, may easily lead to the stagnation of uniformity of ideas and the stifling of new ideas that would come up with people of different background and experience.

The problem of social compatibility tends to be particularly acute at the dividing line between the work force and lower supervision. The foremen are selected, of course, by higher management. They must be able to adjust to higher management, and this is always considered in the selection process, but they need to be able to adjust to the workers also and the problems involved here are often overlooked.

The College Trained Supervisor

For example, in one factory [9] management decided to bring in college graduates to be trained as foremen. The individuals were selected on an estimate of their "supervisory ability." So far as we could determine, this meant that preference was given to men who in college had been active in extra-curricular activities. That is, they had led an active social life and were not lone wolf students. This social acceptability on the campus, however, proved no guarantee for acceptance with the work force. The foreman trainees began with no detailed knowledge of the machines and processes, and so had to learn from the workers as they prepared to supervise them. The workers resented the imposition of these men who lacked the know-how of job experience. The differences in education, social status, and experience set up barriers which proved to be unsurmountable in these cases. We observed a whole series of such college-trained foremen failing on their jobs because of their complete inability to win cooperation from the workers.

Compared to many other countries, the roads to advancement in industry are still quite open in the United States, but we must recognize that the man who can enter the bottom of a large organization without having had a college education and is then able to move up to high managerial positions is becoming increasingly rare. More and more, we depend upon our educational system for the social mobility

[9] Unpublished study by Donald Roy.

that has characterized our society. Thus the son of the shop worker may be able to get to college and move on up into the ranks of management, but the worker himself is likely to be blocked by his lack of advanced education.

In some companies today, it is practically impossible for the non-college man to move up even as far as foreman. In other companies, the positions of foreman and even perhaps general foreman are usually filled from the work ranks, but admission to higher levels depends upon the college degree.

While research on this point is still fragmentary, we may guess that wherever it is possible to draw a horizontal line through an organizational hierarchy and divide college graduates from non-college men by means of this line, there we will find serious problems of developing an effective and reasonably harmonious organization. Such a line can be drawn more often than we think, especially if we look at current practice and recent history in the organization. That is, in some organizations we will find in high positions men in their fifties and sixties who have not had college education and yet we may find that non-college men are no longer promoted except in very exceptional circumstances.

We should not minimize the importance of advanced education for modern management. We must recognize that for many of the managerial functions, the immediate experience of operating machines does not qualify the individual, and in fact long years of experience of machine operation may actually be a disqualification. On the other hand, let us not minimize the importance of familiarity with and understanding of the machines and processes and the men who operate them in the factory.

American management today needs to develop a combination from the experience of university training and from shop experience. Some companies have sought to meet this need by teaming up in management the college and non-college men. For example, one company in the petroleum industry has made it a practice of having in one installation a college-trained engineer as superintendent, and, as his assistant, a man who came up through the ranks. In another installation, the non-college man would be superintendent and would be assisted by a college-trained man. This has seemed to develop a more closely integrated organization, and a more effectively functioning line.

Other companies have sought to avoid a sharp line between college and non-college men through developing special courses to enable the man on the machine to broaden his knowledge and acquire some of the skills and understanding necessary at higher levels.

If we are to maintain the dynamic characteristics of our economic organizations, the growth of a social cleavage based upon differences in education presents a most serious problem. More education and training will always be necessary at higher levels, but the sharp dividing line prevents men of first-class ability from making their contribution and tends to divide the organization into two camps which have great difficulties in getting along together.

Conclusions

It would be presumptuous to imply that the general conclusions to be summarized here carry the weight of substantial research. They are simply tentative conclusions which are based in part upon solid research and in part upon speculation.

1. *Controls and Cooperation.* There seems to be a tendency in some organizations to seek to get results through the establishment of an elaborate set of controls. Men in the organizational hierarchy devise detailed directives and reporting systems while specialized functionaries are provided to check upon performance and enforce the rules. This emphasis upon controls and rules leads people in subordinate positions to spend a large part of their time in giving the appearance of conforming to rules and directives, and avoiding censure of their superiors. It takes attention away from the production problems the manager faces in his immediate working environment. The executive who can shift the emphasis off of controls toward the means of developing cooperative relations will thereby enable people down the line to do a more effective production job.

2. *Conflict and Organizational Design.* We see in industry today many groups competing and conflicting with each other. It seems highly questionable whether this process keeps people on their toes, doing a good job in productivity, as is sometimes claimed. We have seen many cases in which the best energies and intelligence of people seem to be devoted to outjockeying some other group within management for prestige or control. These efforts often have nothing to do with promoting productivity and may actually exercise a very serious hampering effect. It may be well for management to give more attention to the possibilities of developing better integrated organizations, so that people can work cooperatively toward productivity.

3. *The Evaluation of Managerial Success.* Everyone will agree that men should be promoted in recognition of the results they have achieved. But this simple proposition becomes very complicated to put into practice. For a policy of promoting on the basis of results to have any meaning as an incentive to the members of the organization, the results must be observable. The individual must be able to demonstrate what he has achieved so that his elevation is clearly based upon something more substantial than the sixth sense of his superior. In the organization having a long hierarchy, where detailed directives are issued and controls are highly centralized, it is difficult if not impossible to show what the individual has achieved. The tendency then is to reward people on the basis of their faithfulness in following directives and on the basis of their loyalty to their superior officers. Since the individual is allowed little initiative, there is little opportunity for him to show what he can do if given more responsibility.

By contrast, in the organization which functions in a relatively decentralized manner, the individual has much more chance to make his own decisions and to experience his own successes and failures. Thus his superiors have much more to go on as they assess his ability. We may therefore ask, is the organization's structure so designed that individuals really do have an opportunity to demonstrate their ability? This raises the whole question of broad, flat organization structure vs. long, narrow hierarchy, which has been discussed earlier.

4. *Ability, Compatibility, and Mobility.* When we speak of managerial ability, we cannot be concerned with technical ability alone, but must deal also with the individual's capacity to adjust himself to the associates with whom he works. When we are dealing with a hierarchial organization, this problem of social compatibility becomes difficult for we may readily have a situation in which the managerial people fit together very congenially, but where there is a marked cleavage between them and the work force so that communication and cooperation breaks down. Or we may have more than one dividing line so that, for example, there is a cleavage between higher and lower supervision, as well as between supervision and the work force. Clearly such a condition diminishes the productivity of the organization. The management that takes positive steps to promote mobility up from the work ranks may thus eliminate the sharp dividing lines which lead to social cleavage. This will, in turn, increase the ability of people at all levels to work together effectively.

TRADE-UNION ATTITUDES AND THEIR EFFECT UPON PRODUCTIVITY

SOLOMON BARKIN
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MANY CURRENT ATTITUDES in the American trade-union movement differ from those prevailing in earlier years. The present tolerance and acceptance of technical change strikingly contrasts with more general opposition in the past.

Not the least important factor producing this change has been the predominant characteristics of the new trade-unions themselves and their members' needs. Unionism, in the mass production industries, has shifted its emphasis from trying to meet the requirements of craftsmen and to strengthen their bargaining tools to those of the millions of semi-skilled workers employed in the newer industries with constantly changing technologies and methods of production.

Unlike the craftsmen, they are less able to control the specific job. The right to a job and the realization of rising income levels and greater economic benefits overshadow in importance the control over the specific job. Moreover, many difficulties exist in trying to devise controls over jobs in the mass production industries comparable to those exercised by the craft worker in the older industries.

The fact that these newer unions grew and became stable in an era of economic expansion and prosperity also favored this new attitude. Widespread employment opportunities dimmed the fears of unemployment and eased the problems of personal adjustment. The financial well-being of industry made for more liberal wage and personnel policies. Workers themselves have not given up their basic personal resistance to innovation. But in such an era, trade-unions have not lent themselves to open and deliberate opposition to technical progress; they became preoccupied more with the responsibility of securing economic gains rather than fastening their controls on a specific job.

Craft Unionism

The contrasting outlooks of the craftsmen and the mass-production workers have been critical factors in determining trade-union policies toward technical change. In the earlier craft-union era, the dominant policy was to control the supply of craftsmen in order to enhance the bargaining power of those in the trade and to assure adequate employment and income for them. Unions sought to limit the supply of apprentices and set careful ratios of helpers to craftsmen. To forestall the dilution of the craft itself, job boundaries were rigidly defined.

Unions won closed shops to limit the recruitment of labor to prevent an excess supply of workers and to protect their rights to place their members.

The drive to preserve the demand for the craft is reflected in the many jurisdictional disputes arising among the craft unions, each challenging the older boundaries laid out by other unions or claiming newer types of work. To maintain the demand for craftsmen, workers and unions arranged to limit output and speed of work; control the quality of work; demand time consuming methods; require unnecessary work; regulate the size of men complements for given jobs; and prohibit employers or foremen from doing work of the trade. Even more significant was union resistance to new technologies.

Craft unions also sought collective bargaining agreements which would aid them in controlling the job. Detailed job rules are very common in such contracts. Schedules differentiate with great care the rate for various types of machines, classes of work on the same type of machine, and even types of establishments, as in the case of the printing pressmen and teamsters.

A true measure of the degree of control developed over job operations is to be found in the elaborate piece-rate systems negotiated by such unions. Their emphasis is on industry-wide uniform piece-rate lists, rather than uniform worker earnings. They assume a stable and simple technology and usually specify standard systems for adjusting piece-rates for existing variations in the methods of production. The job area is defined and each worker is expected to enforce the rules and rigid rate differentials. A standard job task, rate and output are the result.

The above type of unionism was severely jarred by the increased flow of new technology and the procedures of "scientific management." They were threats to established skills. They rendered many of them obsolete or unnecessary, or restricted the demand for the craft by diluting the job. The craftsman's bargaining power was severely curtailed. As a result, unions openly blasted the techniques of "scientific" management and sought to prohibit or restrict their use. Some unions have successfully resisted innovations but most of them have not. Some were destroyed as a result of their opposition, while some were reduced to insignificance. Others yielded and still others made their peace with these changes, particularly where they could extend their jurisdiction to include the new procedures and machinery. But they all took reluctantly to changes.[1]

Industrial Unionism

In contrast, the resurgent trade-union movement of the mid-thirties was rooted in the newer technologies. While craft unions continued to grow and increase their influence in their own areas, unionism expanded particularly in the mass-production industries and services. In these areas, technology and methods of production had been rapidly changing. The practices and philosophy of "scientific management" were widely accepted and used by employers.

The worker, himself, in these industries, was steadily pounded by innovations. He was moved from one job to another. In forming and joining unions, his outcry was against discrimination; the ruthlessness of the process of making shifts; his inability to voice his discontent; the failure to enjoy the benefits of the improvement; and the insecurity bred by the rapid rate of change. He also protested the failure of the industrial system to provide employment and satisfactory living conditions.

He was not organizing to stop these changes. They were frequently the means for maintaining the market for the product and the volume of employment. He looked to the union to set up a system of industrial government to protect him against discrimination, establish formal rights to employment, provide him with the opportunity to enjoy the benefits of rising productivity and give him a voice in the determination of his conditions of employment.

The new industrial unionism has not had to maintain a specific technology and job. Its jurisdiction ranges over the entire gamut of jobs within a plant. It seeks to protect all workers. Its effectiveness is not dependent upon control over a particular skill or work experience or the ability to command a specific labor market. The closed union and closed shop are immaterial to its force and growth. Its leverage flows from the determined will of the mass of workers.

[1] S. Barkin, "The Technical Engineering Service of an American Trade-Union," *International Labor Review,* Vol. LXI, No. 6, (June, 1950) pp. 610-613.
H. Ober, *Trade-Union Policy and Technological Change,* Report No. L-8 (Philadelphia: WPA National Research Project, 1940), pp. 201-279.
S. Slichter, *Union Policies and Industrial Management,* (Washington: Brookings Institution, 1941).

They could be replaced but their numbers and determination breed solidarity among themselves and respect for their cause among the entire working population. New or changed jobs remained within the bargaining unit.

In an industrial union, craft or job groups will not easily secure support from the mass of workers for specific job rules or controls unless they are generalized into a broad demand for workers on most jobs. Even key groups of workers, either from the point of view of production or the political leadership or structure of the union, cannot automatically exploit their position to force a showdown on their own concrete job problems.

Strikes and stoppages by single occupational groups have occurred in the past, but they have tended to become less frequent as the reduced power of the separate individual groups has become apparent. Moreover, the leaders of such unions have learned the disadvantages of concentrating primarily on improving controls of specific jobs. The interests of the greater number may be overlooked and the union itself may be destroyed by focusing on single jobs.

As collective bargaining stabilizes, there is less resort to the promotion of such specific job interests. Moreover, craft workers in mass-production industries have become less insistent on craft units and found adequate satisfaction of their current demands within the industrial union without the restrictive emphasis of the craft union.

Job Controls Difficult to Evolve in Mass Production Industries

The industrial setting of the mass production industries also provides less opportunity for the development of job controls and rules. The latter requires, first, the regulation of the supply of labor. But unions in the mass production industries have not adopted this goal. The limited training and skills or experience demanded of workers make this procedure largely impractical. Employers continue to hire employees as their needs develop. Even the seniority principle for hiring and lay-offs is not designed to close the labor market. It is basically a means of assuring present workers a prior claim to jobs. It is less an economic tool for wage bargaining than an emphasis on a basic human principle.

Secondly, control contemplates the regulation of the rate of pay. Job rates have become the common practice. But there is no prohibition against the job disappearing or a reduction of the number of persons employed on it. The job definition is not a barrier to the shifting of workers; it is a clue to the rate of pay.

Also suggested is control of the output or task. But such controls and understandings are difficult to establish. Technology and products are constantly being altered so that the norms of today no longer serve for the next day. The high rate of innovation is controlling since it takes time for workers to evolve their own personal measure of the proper level of output on a new item. Recognition is not enough. It must be communicated to the group and gain acceptance by them. Changing methods, products and jobs make controls difficult, if not impossible, to impose.

There also must be an easy measure of output or application which relates both automatically and convincingly to the job. These are not easily obtained for a combination of jobs, each of which varies significantly from another. Measures can be formulated on some jobs in mass production industries, such as for a single-speed assembly line or semi-automatic machine operations in textiles, through agreements on speed, in the first instance, or bench marks of a proper task in the second. They may serve for a single plant for a single occasion but many hurdles are likely to be met in evolving generalized industry-wide formulae.

In the textile industry, employers have resisted them. Workers have not had enough experience with them to have confidence in the technique. Moreover, they are primarily interested in protecting existing machine assignments. Generalized formulae will not always accomplish this goal. Workers are, therefore, reluctant to try them. The worker hopes to gain special advantage from his bargaining power in specific job negotiations. Employers continue to insist on determining each job standard on the basis of management judgment derived either from time study or experience. Both parties, therefore, shy away from such formulae.

Industrial unions have also found the development of techniques of control a formidable and unrealizable goal. The intimate knowledge required of specific tasks cannot be easily acquired by the union leadership except in such cases as are suggested above. The burden of evolving the control, therefore, would tend to fall back upon the workers and upon job leadership. Where there are men with experience with control or the ingenuity for evolving them, some understandings may be developed on a job basis; but they are not common.

The industrial union also tends to diminish the importance of the informal group as it substitutes the grievance unit headed by the shop steward. Grievances against job conditions under collective bargaining are more likely to be directed against the source of the trouble than to be vented through warped expressions, such as production controls, of a frustrated worker unable to voice his protest. The worker will file real complaints rather than seek control. Moreover, the grievance unit used by the union is also less adapted to handle such specific production controls since it also is likely to be composed of a number of workers on a variety of jobs and tasks.

Industrial Unions Have Accepted Industrial Change

Industrial trade-unions have accepted the principle of the inevitability of industrial change. They came into being with a distinct sympathy for change. Even during the thirties, in the midst of widespread unemployment, leaders voiced their conviction that industrial progress is inevitable and could bring general benefits if workers are protected from having to carry the brunt of the costs of change and could share in the benefits.[2]

The high rate of economic activity during the forties offered workers many opportunities for improving their income and benefits. The rising prices and increases in business profits produced a shift in interest toward higher wages. One round of increases followed another. The so-called fringe benefits expanded in kind and became more liberal in amount. New protective provisions in the form of health, sickness and welfare programs and pension plans were won. These advances focused workers' interests on economic gains. The over-riding fear of a scarcity of job opportunities receded in the minds of workers and trade-union leaders. Restrictive labor policies became less significant to workers.[3]

Even more significant than the declaration of views and favorable attitudes has been the growing acknowledgement in collective bargaining contracts of management's right to make changes. Contracts either affirm this right or restrict the union's right to interfere, restrain or object to their introduction. Unions have had their rights limited to the protection of the terms of employment rather than extended to a review of the innovation itself. This movement has been most dra-

[2] U. S. 66th Congress, 3rd Session, Temporary National Economic Committee, Investigation of Concentration of Economic Power, Hearings on Public Resolution No. 113, Part 30, *Technology and Concentration of Economic Power*, pp. 16456, 16831, 1733, 16727.

[3] S. Barkin, "Human and Social Impact of Technical Changes," Proceedings of the Third Annual Meeting of Industrial Relations Research Association, 1950, pp. 112-127.

matically epitomized by the broad concessions granted to the General Motors Corporation in its contracts with the United Automobile Workers of America. They provide that "products to be manufactured, the location of plants, the schedules of production, the methods, processes and means of manufacturing are solely and exclusively the responsibilities of the corporation." [4] The contracts in the textile industry provide that the "employer shall have the right to change or introduce machines, processes and methods of manufacture for the purpose of insuring the efficient operation of the mill and utilizing the employees' working time most productively." [5]

Procedure, Rules and Benefits Sought By Industrial Unions

While granting these broad rights to management and recognizing that the vast area of industrial change effected through the establishment of new plants and industries are beyond the trade-union's rule, they have pressed vigorously for procedures and regulations governing their introduction to protect and benefit the incumbent and other workers and smooth the processes of change.

The first basic union demand has been to be notified and given adequate information about impending changes. The usual proposal is that the union receive the data concerning specific, proposed innovations. The contracts in the textile industry usually require information on the approximate date of the installation, its nature, the proposed duties and job assignment and expected earnings and the provision made for the affected employees. Other contracts are less specific and provide for informing "the local union of the change in detail."

More recently, the textile union has management provide it with an annual and quarterly budget of job changes. The budget provides in one contract for "descriptions and general explanation of contemplated technological changes, contemplated changes in method of wage payment or work assignment, job duties or work assignment, and where tentative job specifications are available that they be included. . . . The contemplated effect on wage rates, earnings, number of employees required in each occupation and disposition of those likely to be displaced. The approximate date of each step of the application of the projection plan, including for example, start of studies, mechanical changes, submission of proposal, start of trial, etc."

[4] General Motors Corporation and the UAW-CIO, Section 8.

[5] Fall River Textile Manufacturers Association and New Bedford Cotton Manufacturers Association and Textile Workers Union of America, CIO, January, 1948, Article IV.

The second demand is for a provision regulating management's right to install the innovation as it affects the workers. Cotton-rayon textile contracts typically provide that employers can make assignments following on routine changes, defined as resulting from "alterations in constructions of existing jobs and requiring no change in methods, machinery or equipment." . . . and technological changes which are defined as resulting from "changes in equipment or machines used on the job." But all other changes in assignments can be made only with the union's consent or by a determination of an arbitrator.

The effect is to limit management's rights in changing the level of work effort, work duty patterns, methods of element performance or methods of doing a job, methods of pay or altering work assignments because of changes in raw materials prior to processing, types of supply packages, methods of removing material or product, overhauling and repairing of machinery or production needs.[6]

The above position seeks to accommodate the regular trade-union approach which insists upon agreement upon all changes prior to their introduction and the management's position of the right to apply the new working standards without prior union review. The latter is exemplified by the provisions of the General Motors contract which allows work standards to be set by management with the union retaining the right to submit complaints to the foreman. The union is limited in its submissions to the umpire to questions "relative to procedures on production standards" and not the "production standards themselves." The workers have retained the right to strike, in case of dissatisfaction, if all steps in the grievance procedure have been completed and such strike is sanctioned by the international union. But this right has been used in rare cases.[7]

In determining actual work assignments, production standards and incentive rates, union and employer views diverge sharply. Employers, on the whole, favor uniform procedures and rules though they would rather avoid having them spelled out in the contract, preferring to retain full control over them and to avoid granting bargaining rights to the union. Time studies, or standard data, or predetermined time techniques are being used increasingly for the setting of stand-

[6] S. Barkin, "Handling Work Assignment Changes," *Harvard Business Review*, Vol. 25, Summer, 1947, pp. 473-482.

[7] Frederick H. Harbison, "The General Motors and United Auto Workers Agreement of 1950," *The Journal of Political Economy*, Vol. LVIII, No. 5, (October, 1950), pp. 397-411.

ards, assignments and rates. They are preferred as they allegedly provide consistent results for all jobs, a characteristic which is prized and considered more essential than validity. In collective bargaining, they supply a defense for standards for which no real alternative systems have been evolved.

The industrial trade-union, on the other hand, has preferred a more opportunistic course in the newer mass production industries. Unlike the craft unions, they have not favored carefully defined rules and guides for job rate setting. Not being able to get specific job control and confounded by the complexity of the task of reaching such a goal, they have emphasized the need to bargain out individually each production standard assignment and rate hoping thereby to capitalize on the local bargaining strength and specific job needs. They have feared pre-determined rules as limiting the ability of specific groups of workers to bargain for their own job conditions.

Workers and unions have also a deep-seated suspicion and disbelief in the proposition that the severity of work or application on various jobs can be equated to a common denominator. Each job presents many different combinations of demands and strains upon the worker. There is no available technique for analyzing jobs to identify all of them. Nor is there any meaningful procedure for combining these demands into a simple index. Current time-study procedure offers judgment and elusive definitions in place of careful analysis and measurement. It is, at best, an orderly procedure for making crude guesses in terms of ill-defined criteria. In the present state of the art, valid, reliable and tested approaches have not been evolved. One careful finding may be as serviceable as another.[8]

Managements which have learned the practical arts of collective bargaining and the needs at the job level have accommodated themselves to the above approach. A recent survey of methods of handling job modifications concludes that their solution "may require management to temper confidence in time-study and job-evaluation techniques with an understanding of worker psychology." [9]

[8] S. Barkin, "Organized Labor's Stake in Industrial Engineering," *Modern Management,* Vol. VI, (July, 1946), pp. 50-54; 57-59.
W. Gomberg, *A Trade-Union Analysis of Time Study,* (Chicago: Science Research Associates, 1948).

[9] R. A. Lester and R. L. Aronson, *Job Modifications Under Collective Bargaining* (Industrial Relations Section Department of Economics and Social Institutions, Princeton University: Research Report No. 80, Princeton, N. J., 1950), p. 77.

The fourth area of negotiations upon which increasing stress is being placed comprises the terms of the changes themselves. It provides the most fruitful area for negotiations. It is the one in which the greatest amount of understanding has been reached with management. The first issue relates to the workers' claims to the jobs remaining after the change. Unions, invariably, have insisted upon the priority rights of the senior employees on the affected jobs. Provision is frequently made for giving training and otherwise helping them in the adjustment and maintaining earnings.

The second issue often is the rate of pay for the new job. Unions usually insist that earnings shall be no less than those that had prevailed on the job, even where the job has been simplified and where existing systems of rate determination may justify a lower rate.

Unions also tend to demand for employees some share of the benefits of higher productivity. Various formulae have been prescribed. The TWUA contract with the American Woolen Company provides that the parties may negotiate the expected earnings on the new job and an arbitrator in considering a dispute may "give consideration to all relevent factors including, without excluding other factors, increased application and increased productivity." Another agreement provides that "should the installation of new machines or improved methods of production result in an increased burden to the employee or employees involved, added compensation commensurate therewith shall be granted by the employer." [10] There are agreements on specific formulae for sharing these benefits such as the following: "in those cases where machines have been redesigned so as to secure higher rates of output, (the company is) to assign to the operators of such machines an increased rate of pay which has amounted to one-third of the total saving made in the cost of labor as a result of such redesign."

Even where there is no such formula, employers have learned that "successful adjustment of job modification disputes (may be effected) if the parties are willing to negotiate practical solutions and treat principles (of wage determination) as useful guides rather than as absolute criteria." [11] Finally, the annual wage improvement factor in the contracts with the General Motors Corporation and other com-

[10] U. S. Bureau of Labor Statistics, *Collective Bargaining Provisions, Union-Management Cooperation, Plant, Efficiency and Technological Change,* (Bulletin No. 908-10, Washington, 1950), p. 47.
[11] R. A. Lester, *op. cit.*, p. 77.

panies represents another procedure for sharing the benefits through general rather than specific job wage adjustments.

A third area relates to provision for surplus employees. The primary union demand is for their retention irrespective of whether they are assigned to other work or not. On new jobs, unions seek to assure these workers their previous level of earnings. More and more companies have accepted these principles and regulate their new hirings to assure the absorption of these employees on productive jobs. Where they have not been assigned immediately, contracts have provided for their preferential rehiring on a plant rather than on a job basis. Displaced employees have been granted dismissal bonuses frequently equal to at least one week's pay for each year of service. Moreover, unions are demanding the liberalization of pension programs for technologically displaced employees by securing reductions in the age and service requirements for such pensions as well as more liberal benefits.

Effect of Union Activity on Productivity Trends

The growing predominance of policies of industrial union has rendered obsolete much academic discussion on the influence of unions on the rate of discovery and their effective application.[12] Having drawn their conclusion and observations from the practices of a limited number of craft unions the writers did not fully evaluate the actual influence of unions as a whole. While craft unions prefer stable technologies and jobs, they have not been the actual determinants of the final rate of industrial discovery or application. Where their policies and acts have been characterized as most significant as in the case of the building industry, the employers themselves preferred to maintain the prevailing organization and technology. Employers determined to make changes or surmount resistance have usually sought to win unions over to their position, and by and large, have succeeded. Or they have battered the resisting unions, frequently to the end of eliminating them. The newer metal and other mass production industries fought and destroyed unions and prevented their rise in this country well into the middle-thirties when the newer industrial unions appeared.[13] The new industrial unionism has presented few real deterrents to change.

[12] For a most recent exposition of such an analysis see G. F. Bloom and H. R. Northrup, *Economics of Labor and Industrial Relations*, (Philadelphia: The Blakiston Company, 1950), pp. 349-505.

[13] S. Perlman and P. Taft, *History of Labor in the United States*, 1896-1932, (New York: MacMillan Company, 1935), pp. 92-149.

Within the individual plant, the union affects actual productivity both by conditioning the general morale of the work-force and by influencing the rate at which innovations are sought and applied. As for the former, conclusions can be drawn with considerable confidence. Workers prior to their organization into unions tend to establish job control and output restrictions through informal job groupings. These express their protest and constitute the workers' only defense during the process of job change. These workers use crude methods of job control as they have no direct channel for presenting complaints. When union organizations supersede informal groups they allow for complaints and grievances to be directed against the direct causes of discontent. The result is less attention to the restrictive attitudes, unless the grievance mechanism is unavailing.

A positive job relationship may flow from constructive collective bargaining. And in periods of general economic growth and individual plant prosperity, when workers are enjoying progressively rising benefits, such a position can be more easily attained. It creates as a minimum a definite worker interest in performing the jobs without the restraints and stinting spirit characteristic of the disgruntled. It may in many places engender a positive willingness to aid the production process to insure fulfillment of schedules, conformance with standards of quality and tolerances, compliance with all instructions and more adequate coordination of production, workers, materials, handlers, inspectors and other specialists in the production process. Good plant-wide morale can aid in the more effective realization of the many financial and non-financial inducements favoring higher individual application. Final attitudes, it must be noted, are also considerably influenced by the prevailing tensions and industrial and social conflicts outside of the plant within the community or the nation. The bargaining relationship within the plant becomes one of a number of forces affecting plant morale.

The second union effect is exercised through workers' behavior in connection with specific changes. The better the morale and the more constructive the collective bargaining relations and the more fully the above union programs are met, the easier it is to gain acceptance for specific technical and job changes. An understanding union leadership will feel more secure and be more disposed to recommend the acceptance of changes. Workers protected from the risks and assured of benefits from change are likely to be less resisting.

The union grievance procedures have also served as inexhaustible sources of constructive ideas and information on difficulties and problems on the production floor and sorespots within the organization for those managements which have learned to utilize them. Where conditions unfavorably affect earnings or working conditions, unions will insist upon corrections with consequent improvement in productivity. As for other observations made during grievance discussions, the degree to which they serve management as an effective check on plant and department operations depends upon its alertness and skill in securing such data during meetings and converting them into direct insights into the character of performance.

Trade-union economic demands have also had a stimulating effect both within individual organized plants and in the economy as a whole upon the rate of discovery and their application. In some cases, specific increases in wages or improvements in conditions of employment have acted as catalysts for employers to introduce individual technical changes, to institute more efficient methods in the utilization of labor, improve the training and methods of assignments and work measurement and to better supervision for greater labor productivity. The very wide disparity in the relative efficiency of competitors and the impressive differences in their degree of utilization of available knowledge and techniques and machinery allow for significant advances in most every plant when the management has been pressed by increases in labor cost. The sluggishness of management, which neither competition nor profit seeking seem fully to overcome, is frequently partially corrected by the pressure from the recurrent demands for improvements in labor benefits. At times, these advances come when, in addition to other factors, the balance of costs is so close that the additional increase in labor costs is sufficient to favor the introduction of a new machine, process, or product, or the investment in a new location or plant. Dramatic instances of such innovations abound in American industries. This experience is basic to the optimism underlying the wage policies of American industrial unionism.

Individual unions, in particular, have not been restrained in their demands for economic gains by the possibility that they may result in a higher rate of innovation. They have generally proceeded from the conclusion that vast numbers of changes are not tied down to specific improvements in labor standards. They originate from earlier decisions. While additional increases in labor rates may hasten a specific innovation and instigate a series of labor-saving programs, the principal effect will be in the matter of timing. The assurance to workers of enjoying the benefits of higher productivity with the protections provided by a union contract, more than offset the hesitance to seek such gains suggested by the probable advance in the introduction of specific innovations. Moreover, expansion in employment, it is hoped, may compensate for the possible displacement of workers by individual changes.

A somewhat more cautious attitude will be shown in those instances where increased labor rates and improved conditions may result in the migration of plants or an industry. But even with respect to these instances, the national industrial union is likely to place considerable weight and reliance upon its ability to organize these new plants and areas. Its orientation is not local in character. It will recognize the inevitability of turnover in business establishments and industrial areas. It will be restrained but not paralyzed by the threats of migration or the development of new industrial areas within its jurisdictions. The economic rationale of the leaders of industrial unions is vastly different from the models of economic logic used by economists in their reflections on the effects of unions on industrial change.

But more consequential than even the effect on individual innovation is the general influence of the trade-union philosophy upon the economy. Expressing the deep-seated yearning of Americans for a continuously rising standard of living, trade-unions are dedicated to work toward this goal. Their periodic demands for wage increases and improvements in conditions of employment have introduced a fixed factor in the industrialist's calculation. While there have been many forces other than unions in our American economy which have favored high labor rates, the increased trade-union coverage has reenforced their influence and weakened the hope of the individual employer that he could find refuge in lower wages when the competitive pressure or economic conditions suggest this course of action to him. He must now more realistically conclude that labor rates will be high and will tend to go higher. Reductions in labor rates are not likely to occur during periods of recession. Labor-saving devices and products with lower labor content will improve his competitive position. Substitutes will prove profitable. Migration may be advantageous.

A positive managerial interest in innovation has also been stimulated by other trade-union policies besides the general drive for higher earnings. Foremost among these is the move toward greater uniformity in wage movements and levels. Unlike the craft unions, industrial unions stress uniform worker earnings and leave management free to achieve this goal through its technical ingenuity.[14] Unions seek uniform plant minima, occupational rates and, at times, uniform plant average hourly earnings. They fight against differentials in rates on the basis of sex, color, locality or industrial sectors. They also have emphasized higher plant minima and strengthened the forces which have reduced the spread between the lower and higher paid jobs. Individual employers must, therefore, apply themselves to acquire at least the prevailing technology to keep abreast of rising costs.

Even concerns which establish themselves in low labor markets, such as small towns or the South, are increasingly aware that the advantages are temporary. Unions will, in time, reach them. Moreover, the vast forces in this country pressing for the equalization of rates among the different regions of the country, among which the trade-union movement must be considered as one of the strongest, will operate in these areas. The most outstanding illustration of this trend is in the Southern textile industry where wage rates have risen strikingly and the differentials narrowed.[15] These managements also must seek to establish high performance levels for the day when wages will be high and differentials in labor rates will be narrow or non-existent.

Other trade-union policies have had a similar effect in minimizing the ability of employers to offset their own marginal performance or low firm efficiency. The practice of seniority and the restraints on the employers' ability to discharge employees at will have prevented the deliberate selection of workers of highest productivity. Other shop rules concerning the sharing of work, the penalties on overtime work, the regulations concerning transfers and temporary assignments of workers all strengthen the importance of supervision and management in getting effective results. Good planning, precise scheduling, careful lay-outs, accurate coordination and well-designed job patterns and subdivisions will contribute to excellent production results and counteract the lower output resulting from less discriminate selection of workers. These programs have been strengthened by "advanced managements" with the advent of unionism.

[14] S. Barkin, "Industrial Union Wage Policies," *Plan Age*, Vol. 6, 1940, pp. 1-14.

[15] U. S. Senate 81st Congress, 2nd Session, Committee on Labor & Public Welfare, Subcommittee on Labor-Management Relations, Hearings on S. Res. 140, *Labor-Management Relations in the Southern Textile Industry*, Part 2, pp. 3970.

The influence of trade-union policies and goals upon productivity in the country as a whole has been made effective by the prevailing American industrial culture. The latter has emphasized the importance of technology, management techniques and careful calculations of the advantages of new machinery and materials and the effect of new products. It has inculcated in management the belief in the profitableness of change. Industrial advance has also been nurtured by the expansion in markets and practical business attitudes, vast underdeveloped areas, rich natural resources, wide-spread technical education, a democratic spirit, a speculative urge, a brash attitude and a drive for private gain. During the last few years, these forces have been reenforced by our tax laws and financial incentives provided by the government. The huge profits of our business enterprises have also encouraged more industrial research and greater venture in newer industries. The use of consultants and specialists with the available "know-how" for immediate application of current labor-saving practices has been promoted by the positive upward trend in labor rates and benefits. The increasing sway of large semi-monopolistic enterprises dominated by professionals has prompted a wider interest in labor-saving devices. Backward managements have, on the whole, lost out in this era of technical change, industrial expansion, rising labor rates and improving labor standards.

In a dynamic industrial society, such as we have in the United States, wage increases and high labor rates have served as an additional important stimulus to higher productivity. The prevalance of interproduct competition and the actual conflict over markets have meant that wage increases have quickened efforts to develop lower labor content substitutes and methods of production. The very determination by unions to seek higher wages has also been encouraged by the experience that such increases have been compensated by managerial improvements. The success of one wage movement and managerial achievements in offsetting its impact on costs through labor-saving innovations have fed additional efforts in the same direction. In combination with other economic influences they have fostered more highly capitalized production methods and advanced products and services with lower labor content.

Positive Participation By Unions In Production Drives

Writers have periodically called for the type of collective bargaining relations in American industry wherein management and unions would be jointly applying their resources to advance plant productivity. Singular illustrations of such cooperation have been pointed up to emphasize the benefits which would flow from such projects. These are not instances of mere consultation or conveyance of information. They are cases wherein the union undertakes to aid the enterprise by having its members and staff examine production techniques, operating methods and working conditions and possibly even the product itself to devise more efficient, less costly, less arduous and lower labor content proposals. Most plants with such programs have had uncertain futures or were faced by financial difficulties and were unable to grant union demands. Union assistance was accepted for what it could offer and as an opportunity to present the company's difficulties to the work force.

Unions have, in other instances, taken the initiative in urging individual managements to adopt more advanced operating techniques or to follow the merchandising and organization techniques of more progressive companies. They have stressed the need for the wholesale modernization of equipment and methods involving considerable displacement of workers to maintain the unit in operation. Again, these efforts have been made primarily in cases where entire industries or branches of industry have suffered competitively.

Unenterprising and unprogressive managements are likely to be pressed by unions to overcome their inertia in the hope that the concerns might be made more flourishing, jobs might be made more secure and employment standards improved. In an expanding era in our economy, when the long term effects of competitive forces are not obvious and clear, and alternative jobs are available locally, even in decidedly weak situations, there is usually less vigorous union advocacy for such programs.

In our country, responsibility for enterprise rests primarily on management. Most executives of expanding and prosperous companies are reluctant to share these rights to consider innovations or determine their application. Moreover, unions usually find that companies with aggressive programs present them with enough problems and changes and disturb the existing job relationships and patterns so frequently that there is little reason for them to accelerate the process.

In other countries such as Great Britain, there are a number of factors combining to support more direct union participation and interest in the movement for the promotion of productivity. The British T.U.C. does not control the wage policies of its affiliated organizations but, nevertheless, realizing its responsibilities, has declared its views as guidance. Foremost is the acceptance by the leaders and substantial segments of the trade-union movement of a wage policy which would avoid inflationary pressures. They knew this could be avoided if rising wages were provided by increasing industrial productivity. They had to secure such improvements directly since they were willing to relate their increases in earnings where practicable to the rise in productivity. Such a wage policy was followed until the outbreak of the Korean war because the Labor government's tax and economic policies had already insured a great measure of equality of sacrifice and a high level of equality in the enjoyment of the benefits of the economy among the people. The government's policies and practices gave the trade-unions the confidence to proceed voluntarily upon the restrained wage program.

Recognizing, therefore, that the rise in wages must be preceded or accompanied by a specific local and national rise in productivity, the trade-union movement together with the Labor Party dedicated itself to helping realize this goal. Programs were advocated to this end. Trade-unions worked assiduously on "working parties" studying the problems of various industries. They joined in the free examination of trade-union and worker practices which interfered with higher output. They supported and originated many recommendations aimed at correcting them. Industrial developmental councils with labor representation were pushed for the implementation of these programs. Trade-unions supported nationalization programs with the hope of making industries more efficient and overcoming the inertia of monopolies. Recently the Miners Federation appointed a committee to examine the workings of the National Coal Board. They have been in the forefront in the fight against monopolies which they claim have stood in the way of modernization. They have been active on governmental scientific and industrial boards devoted to managerial and production problems.

No more outstanding illustration of trade-union determination to contribute to the program can be found than in the cotton-textile industry. In it, major craft unions agreed to the substitution of modern incentive wage systems for older piece rate systems and to larger machine assignments. Its leaders personally pressed for their adoption at individual plants. Trade-union representatives on the Cotton Board have been most vigorous in promoting further modernization of plants and equipment.

At the shop level, the leaders of the trade union movement have urged the wider use of formal joint consultation councils to overcome the gap between the current union organizations and the practical production issues. At these council meetings, they hope to be able to contribute directly to the advancement of productivity.

The Trade Union Congress has assumed the leadership since its special conference in November 1948 in popularizing a positive attitude toward raising productivity. It has placed trade-unionists on productivity teams visiting the United States under the auspices of the Anglo-American Productivity Council to study American procedures and practices. It sent a group of trade-union officials to study the role of American unions in the program for increasing productivity. The teams' reports have been widely disseminated in trade-union ranks. The Congress has sponsored a full week's course to initiate a program for training union officials in production problems. Individual unions have, thereafter, sent their members to technical colleges or organized similar programs. A large number of national unions have followed the TUC in joining the British Institute of Management to increase their own technical resources and accent the Institute's work in advancing managerial competence. Job study and wage incentive programs are now more freely adopted in unionized industries.

The positive attitude is expressed in a recent report by the TUC which declares "trade unionists can take a proud share of the credit for the increased productivity attained last year." [16]

Conclusion

The advent of industrial unionism in the United States has meant greater tolerance by the industrial worker for technical and job changes. The older insistence on job controls has been replaced by a broad program demanding clear procedures regulating the process of making changes and specific benefits to protect the worker and assure him some of the gains of productivity. The wage and industrial relations policies of the industrial union favor the good industrial morale necessary for high productivity. Their adoption has promoted greater acceptance by workers of management's objectives in advancing efficiency. They have, at times, served to hasten the introduction of changes and generally strengthened managerial interest in greater

[16] Trades Union Congress, *What the TUC is Doing.* An informal account of the activities of the General Council of the TUC since Congress met in September, 1950, (London, 1951), p. 14.

effectiveness and more labor saving procedures, machines and products.

In the dynamic American economy, unions have not been called upon to play a positive role alongside management in promoting productivity except where management has been faced with adversity or in times of national emergency. Many of the requirements for such an all-out cooperative program are lacking in this country. Management has not been interested in such assistance. Trade-unions have characterized the present rate of innovation in progressive companies as very high. They have played a significant role in helping to accommodate workers to technological change and in insuring a more satisfactory distribution of the benefits of change to workers in higher wages. These gains have in turn facilitated and stimulated further technological improvements.

ECONOMIC INCENTIVES AND HUMAN RELATIONS

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THE USE OF WAGE incentives in industry is now widespread in the United States.[1] Such incentives presumably stimulate the worker to greater effort by seeking to correlate pay with production. However, there is dispute as to the merit of wage incentives.

The aim here is to note some of the problems of applying wage incentives and to offer suggestions for making incentives more workable. Though there are many varieties of economic incentives,[2] in a short paper it seems more feasible to discuss problems that arise under one of the more troublesome (but probably most effective) types of incentive, that giving immediate and individual reward. When such a system is used in industries (1) that are unionized, (2) that operate by shifts, (3) that have tasks that may begin and end any time and/or overlap shifts, difficulties reach a maximum. Our purpose then will be to consider such problems and to make general recommendations for their reduction. The discussion will be presented under the heads of (1) disturbances attending introduction of an incentive system, (2) problems of application, and (3) recommendations.

Initial Adjustments

To understand the complex relationships of workmen under incentive it is well first to note the initial effects of introducing a bonus plan. Usually the plan grows out of a period of experimental time-studying. After considerable wrangling between union and management and much anticipatory gossip among workmen, it is inaugurated on the floor.

Here a general tension and a feeling of caution develop. Because of differences in ages and experience on the current job (as well as in other earlier positions where transferable skills may have been built up) it is unlikely that the group of workmen will have uniform skill levels. Usually, however, attempts are made to graduate incentive pay to fit these skill differences. But because the base pay classification of

[1] "Incentive-Wage Plans and Collective Bargaining," Bulletin No. 717, U. S. Dept. of Labor, U. S. Government Printing Office, Washington, D. C., 1942.
[2] Lytle, C. W., *Wage Incentive Methods,* (New York: The Ronald Press, 1942).

workers is often arrived at from consideration of factors in addition to actual skill (seniority, attitudes, etc.), the official skill category into which a workman falls does not necessarily reflect his real skill. In short, when the system is introduced, consciousness of skill differences enters the picture and influences behavior. Some workmen fear they will suffer in comparison with others and will fall in group opinion. Some of course fear that management will react unfavorably to relatively low performances.

Much observation and discussion go on initially among workmen as to "where we ought to stop." Usually after days of trying the system and repeated discussions on the job, in the wash rooms, and outside the plant, an unofficial limit for a "day's work" will be agreed on by most of the workers. There will always be a minority that will be disinterested in the system and another minority which shows that it does not intend to observe the informal limit set up by the majority. Thus the total work group in terms of response to the incentive is usually broken up into three sub-groups: (1) the few who refuse to be restrained by the group ("rate-busters"); (2) the majority of the group who respond in varying degrees to the incentive; and (3) the small group who either are indifferent toward the incentive or withdraw from dislike of conflict, lack of skill, etc.

Formation of these functional sub-groups naturally initiates new friendly and hostile alignments among workmen, between workmen and production supervision, between workmen and inspectors, and between workmen and members of the engineering group which develops and applies the incentive plan. And, of course, relations in and among the inspecting, supervising, and engineering groups are inescapably affected in various ways.

Problems

Problems under an incentive will naturally vary somewhat with the type of plan and the technological process. But when an individual incentive is used under the conditions given above, problems may be considered under the topics of (a) relations among workers, (b) relations between workmen and incentive appliers, (c) relations between workmen and inspectors, (d) relations between workmen and supervision, and (e) the position of the incentive engineer.

Relations among workmen. Rising from irregularities that exist in many incentive plans (see below), there is frequently conflict in the shop over possession of the better-paying jobs. This involves most workmen. They have fears of not getting good jobs, and, though approving the principle of group control of the individual, they often resent group efforts to hold them to the informal limit on output when getting such jobs. Members of the group watch each other's performance and report production above the limit (which may be high relative to the abilities of most of the group) to the shop steward or grievance committeeman. Frustrations and enmities grow naturally out of such situations and lead to re-alignment of friendships.

Unequal skills can cause friction when a job on bonus overlaps shifts and requires proration among two or more workmen. Frequently different stages of some jobs will require different levels of skill. A workman of a given dexterity may find himself at a stage so trying to his skill that he slows down to hide his lack of facility and/or to keep from ruining the job. If the workman on the next shift has the requisite skill he will resent sharing the bonus with a man he "had to carry," who "couldn't hold up his end of the job." If the situation is reversed, the more skilled workman may be tempted to complete the entire job "too soon," rather than lose bonus by sharing it with his inept relief.

Engineering irregularities in the appraisal of jobs may also cause conflict among workmen of *equal* skill in some cases. For example, though in the same work rate, one job may have a series of atypical operations (requiring more time to do) which have been averaged in with the values assigned to common operations and thus make the total job poorer in terms of bonus than a job with operations that are all typical. In such cases, a workman on a job in the latter category who might be able to complete the good job early in his turn will "ride it out" to avoid starting a job he knows is poor in bonus. In doing this he will anger both men on the other two shifts.

Conflict frequently arises because one man, though skilled, will not work as persistently as another. If the second man wishes to make high bonus, he will probably seek to avoid sharing jobs with the first. In such cases a different philosophy of work may account for the divergent responses. Limited research indicates that social background, political orientation, recreational interests, and other factors may be important in differences of behavior toward the incentive.

Relations between workmen and incentive appliers. Even in plants where wage incentives and specific procedures for their application are officially accepted by the union, a certain evasive informal bargaining is likely to develop between workmen and management's incentive appliers. The incentive applier does not make time studies or set rates. He merely applies what is given him by the engineers. Usually he works in relative isolation from his department. In the shop he is perforce in frequent contact with lower line supervision and with production workmen. But viewing him as representative of what is regarded to some extent as a manipulative group, workmen, and often first-line foremen, treat him with a degree of hostility. He is dependent on them for carrying out his function. He must have information from the workman concerning details of the job in order to apply the incentive standards. But when workmen become hostile for any of the many reasons rising spontaneously from changing situations that influence their pay, the incentive applier must turn to the foreman for information on the work to be done.

The direction which behavior between workmen and incentive appliers will take varies and frequently is determined by expediencies of the moment. Here the incentive applier is often forced to depart from the rules laid down by his superiors to guide him. He makes accommodations in the direction of relieving pressures on himself and making his situation bearable. He will usually try to follow his instructions as closely as possible. If his attitudes are such that he is able to be relatively indifferent to the hostility of workmen, he will orient his behavior toward the engineers. In doing this overtly he may arouse antipathy to the system and defeat its purpose. On the other hand, if he is "soft" to the pressures of workmen and union officers he is likely to set precedents that will lead to union-management friction, as well as staff and line tensions inside management, and thus also defeat the purpose of the incentive.

The character of accommodations that develop will depend on such factors as the personnel involved, the type of incentive scheme, and the technology of the plant concerned. Usually, however, the complex relations between workmen and incentive appliers acquire a shifting and provisional character sensitive also to the actions of two other groups in the incentive situation, the foremen and inspectors.

Incentive work and inspectors. The desire to make bonus stimulates the worker under incentive to turn out the product in the roughest condition that will pass inspection. When specifications set up by the customer (or by the local plant if the production is for maintenance use) require a total tolerance of two or three thousandths of an inch, rigid inspection is necessary. High-performing incentive workers usually are antipathetic toward inspectors. On their part inspectors are proud of their jobs and stress the skill and knowledge required for their function. However, like the incentive appliers, they receive no bonus. Probably neither of them are entirely free of envy when workmen make high bonus. This may encourage "tightness" (of which workmen complain) in both inspection and the application of standards. However this may be, the chief of inspection is sometimes called in to settle disputes over whether or not certain production should be rejected (and reworked) because of not meeting specifications. And in some cases workmen and inspectors come to blows. Reprocessing of rejected pieces multiplies paper work and complicates the application of incentives for all persons involved.

Sometimes workmen collaborate to hide material that is spoiled. But in some cases workmen collude with the inspector to cover up unacceptable work and keep it off the employee's record.

Incentive workmen and supervision. Since the foreman has the power to distribute work, he is likely to allocate the higher-paying jobs to individuals on whom he feels he can count because of skill, willingness to do the task quickly if it is marked "rush," etc. Also he may wish to reward certain workmen for what he regards as past favors, such as not causing him trouble and/or for cooperating with him when he was caught in situations that forced him into expedient and often rule-evasive behavior to protect himself against his superiors or the union. Much oftener than would be admitted, foremen and grievance committeemen reach agreements resulting in an exchange of favors that gives a majority of the work group advantages under the incentive,[3] while penalizing a minority. Fear of unofficial action from the foreman-union clique will prevent the minority from filing grievances, but their resentment may show up in covert behavior against the incentive.

On the other hand, in some cases top performers have felt that their immediate superiors (first-line foremen) envied them their high bonus, especially when their annual income (usually known to superiors) approximated or exceeded the supervisor's salary. If such workmen then receive a flow of "nasty" jobs, they may be disposed to stir up discontent and recriminations among other workmen. Usually, however, friction between top performers and supervisors over high bonus is minimized by accommodations in the work group and by the

[3] Such exchanges are not restricted to incentive job manipulation but may cover other things.

more or less correct appraisals that workmen and supervisors make of each other.

Under nearly every incentive plan based on individual effort and reward a problem arises from the presence of workmen in high skill and pay categories whose production is relatively low. Because of seniority, genuine ability, etc., many workmen are in such categories at the time an incentive plan is introduced. The problem results from the action of workers in lower pay categories who develop skill and push to enter the higher pay and skill levels. Usually management formally agrees to promote lower level workmen who show a given sustained performance over an agreed period of time. But in practice when there are many such workmen, responding to the incentive appeal both for immediate gains and the hope of promotion with higher base pay, management may hedge somewhat.

Sometimes, encouraged by the incentive engineers, impatient workmen gain access to the production records of class-A workmen who are low performers and demand to know why they, placed in C and D skill and pay groups, and producing more than A-rated workmen, are not promoted at once. General foremen and superintendents then prod low-producing A-rated workmen to justify their skill classification and to establish an appreciable gap in performance between themselves and lower-rated workmen. Conflict and frustration in such cases often become acute for all groups involved. Some managers feel the impulse to demote low-output workmen and promote high performers into their places, but are blocked by the union which opposes demotions. When, as does happen, the union favors pay and skill distinctions, it shares management's problems of explaining the obstacles to having all workmen in category A. Some officers of both union and management are often forced by pressures of the work group into expedient evasions of seniority and promotion rules. The resulting complex of mutual commitments and obligations—which must naturally be kept off the record—frequently leads both the union and the line branch of management to see their problems as "caused" by the engineers and their incentive plan. On their side the engineers contend that "fair testing and promotion practices" and "not so much politics" (unofficial union-management bargaining) would solve problems arising from the incentive.

Restriction of output. The phrase "restriction of output" usually refers to limitation of production by workers as a resentful response to management. Since other causes are at work and lead to similar results, the writer believes that the term should be used more broadly. If restriction is defined as conscious checking of productive effort to some point which the workman regards as below his usual rate or less than what he feels is "proper," then in addition to restriction from sentiments antipathetic to management there is restriction arising from personal ambitions and fears among members of the work group.

For example, as mentioned above, there was restriction to hide lack of skill from a fellow-workman on the relief turn and/or to avoid reaching that point in the job where all work would have to stop or risk damaging the piece beyond repair or to a point that the time for re-working would consume the bonus.

Inequalities in the skill-pay ratio may also cause the workman to spend more time in completing a job than he usually would. For example he will receive a job that he and his fellow worker usually complete in 12 or 13 hours. Now, however, as he relieves his "buddy," he finds 8 hours charged to the job and learns that the following task is a poor one in terms of possible bonus. So, since the present job can bear it and still pay a fair bonus, he puts in the full 8 hours on it which allows him to avoid starting the poor job and to get a "bigger cut" out of the present one.

A form of restriction occurs in certain incentive plans where there are a number of small jobs to be done in each turn and all completed jobs are averaged. For example, a workman under such a plan has completed a series of such jobs after, say, six hours and his bonus average is negligible. Then he receives a "good" job that he could complete in the remaining two hours but that would still return fair bonus even though four hours were spent on it. Rather than finish the job and risk losing all his bonus by averaging it with the earlier assignments on which he had performed poorly, he will charge the two hours to the job, work leisurely, and let it be completed on the following turn. His time on the job will then be prorated and be unaffected by the earlier jobs.

Many workers under incentive wish to hold their average performance near a certain level. Usually they have two reasons for this. They wish (1) to be consistent in case management is sensitive about wide variations in performance, and (2) to have the average at a point allowing them to work easily without fear on days their energy is low. Hence there are varying amounts of restriction among workmen who have a personal production average they wish to hold fairly constant.

Where there are both irregularities in the incentive plan and collaboration between incentive appliers and workmen, "blood banks" are sometimes maintained. This is a device that grows out of restriction. The "bank" is a reserve of jobs that are completed but only partially reported. The reserve is accumulated from jobs on which the rate is so "loose" that moderate effort will return a volume of bonus the workman feels is too great to report. On jobs that are regarded as too "tight," sufficient reserve is drawn to make "a fair day's bonus" and possibly to allow some leisure. Also common in such situations is the skillful manipulation of time cards, shop order numbers, etc., which enables the workman to establish a reputation with his fellow employees, and especially with management, for being able to "make out on any job." This repute, with production statistics to support it, is also very helpful in restraining the filing of grievances by irate fellow workers who are prone to charge that this person does well on all his jobs because he is given only the better work by the foreman. The foreman then points to production statistics which show that the individual did well on jobs that other workmen "fall down on." And in some cases where actual favoritism [4] allows a workman to build a "blood bank," grievance committeemen may deal privately with the foreman to check filing of grievances in exchange for approved use of certain bonus-increasing factors to aid other workmen in the particular incentive group.

Thus in addition to limitation growing from resentment over low bonus and hostility toward a supervisor or management as a group there is restriction (1) to hide lack of skill, (2) to (paradoxically) increase bonus, (3) to protect bonus already made, (4) to build opportunity for periods of relaxation on the job, and (5) to protect a "loose" rate and win status as one who can "make out" on any job. Restriction (as well as increased production) can also result from the complex play of personal rivalries. Restriction is of course not necessarily associated with wage incentives but may also occur under hourly pay. However the variations in effort are usually not so pronounced or quantifiable.

Position of the incentive engineer. Students of worker behavior under wage incentives can better appreciate the intricate conflicts, frustrations, and accommodations that develop by study of the incentive engineer's function. Like most staff officers he is involved in

[4] M. Dalton, "Unofficial Union-Management Relations," *American Sociological Review*, XV, (1950), p. 615.

a measure of conflict with the line organization as he fills his research and advisory role. In a profit-conscious organization he must justify his existence. He meets this requirement by improving production methods and seeking to stimulate personnel to greater productive effort. Sharing the material and financial values dominant in our society, he naturally resorts to wage incentive as the stimulus to production. Trained in mathematics and the logical approach of Taylor he also naturally sets up a precise scheme to encompass what he regards as the simple motivation of workmen. In the minority of cases where he regards human motivation as more complex, he justifies his unilateral approach as one that is exact for dealing with the particular facet of motivation for which he is responsible, as against other areas of motivation on which there is dispute and which he regards as probably irrelevant as long as they cannot be isolated or measured.

He lectures his less highly-trained subordinates in this philosophy. But, when they go on the floor to apply the incentive, they find other factors at work. As noted above, the incentive appliers are likely to make dissimilar accommodations to the shop situation. Usually very young and eager to advance themselves, they present as favorable a report as possible of their daily activities in the shop. Meanwhile the engineer is concerned to impress his superiors in the line organization with the success of the incentive plan. He studies the performance and production records of all the individuals in the work group as the data reach him through reports. He notes irregularities in response. He is concerned about workmen who make low or negative responses and seeks information on their attitudes. He is pleased with above average performances, but extremely high performance gives him concern, for he knows that "excessive" bonus will likely be viewed by cost-conscious line superiors as incompetence on his part. Doubtless the engineer's sensitivity on this point is a factor in "tight" rates.

The engineer may also learn from his colleagues in the line that grievances have increased since the incentive was introduced, and, it is implied, probably because of the plan. Having to assume that his standards are correct and invariable, and being powerless to effectively criticize the line for difficulties with the incentive, he suspects his subordinates of misapplication and lectures them again on their conduct in the shop. Then he learns of the conflict and irregularities discussed above, and seeks a way to control more closely the behavior, and to check the turnover, of his incentive appliers.

Taking the problem up with his engineering colleagues he finds dispute over the concept of a "day's work." One group holds that the standards are so devised as to reflect a constant amount of work under all circumstances, and that, therefore, a certain amount of standard produced (bonus earned) will constitute a just day's work whether there was little or great physical effort on the part of the worker.

A second group contends that there should be a fairly high correlation between amount of production and expenditure of physical energy. They say, "The man who lays down shouldn't get much and the man who puts out should get the high bonus." This group holds that there are defects in the standards and that they should be constantly studied and improved, "because there are too many people in the shop working like hell and getting sore when they don't make much, while other people get a lot of bonus and do nothing."

A third group of the incentive engineers admit that "some errors are bound to enter where you have so many variables, but they are plus and minus errors and cancel each other out in any pay period, so that the end result is just about right."

Thus faced with (1) complaints from the line over "trouble" the plan causes; (2) irritating irregularities of response among workmen; (3) turnover of lower staff personnel who do not adjust to conflicts at the work level;[5] and (4) finding disagreement among his immediate colleagues, the top engineer is often hard put to find a way out.

He feels it unwise to tell top management that the standards have defects, and he dare not make such admissions to the union if the incentive plan and its personnel are to continue to function in the plant.

In such cases the chief of incentive engineering is usually unable to make more than trifling changes in the situation. The accommodations of intra-departmental and cross-organizational relationships preclude major changes. And since careers and statuses are involved at every point, only expedient adjustments are made where pressures are greatest.

[5] Under some systems the pressures on an incentive applier are almost irreconcilable. For example he has (a) workmen trying to persuade him to "be reasonable" in applying the standards, to allow manipulation of time on standard, to grant excessive "delay" and "non-standard" time (to increase bonus); (b) foremen demanding that no delay time be granted (because higher management wants no delay, only production); (c) cranemen and hookers refusing to have delay charged against them because it "hurts our bonus," and (d) the engineers demanding that all delay and non-standard time be justified by job number, description, time, location, and workmen involved, and signed by the line foreman concerned whose interests are different but with whom the incentive applier must remain on good terms.

Recommendations

The above discussion may give the impression that the gain of economic incentives is buried under attendant problems. Readers intimate with industrial life will know that similar problems sometimes arise in the absence of wage incentives. They also will be the first to point out that the treatment here of problems only, has distorted the picture of incentives in practice. My own opinion is that, in terms of greater income for the workman, increased production, and cost to the organization, wage incentives in most cases in our society are valuable absolutely and relative to other incentives. Their chief drawback is stimulation of conflict. Hence the aim in what follows will be to offer suggestions that will aid in reducing conflict and in striking a better balance between social and productive demands among the various groups in the incentive situation.

Since the workman under incentive almost inevitably feels an urge to find a short-cut, improved production techniques are often germinated at this point. Here is an opportunity for management to allow the workman's creative impulse the expression it so seldom finds today in industry and at the same time to offer wage incentive in a way less potent for conflict. Instead of the usual small payment that is made for a workable idea, and mention in the company or community paper, the workman who makes a significant contribution should receive a much higher reward. In several cases known to the writer, workmen have complained that they were "robbed" after being initially pleased with momentary publicity and a token payment, and then seeing their idea pretty obviously save the organization thousands of dollars through increased production. Claims made with respect to the importance of contributions are of course sometimes exaggerated, but the work group under wage incentive can be as fertile in improving production techniques as the laboratory researcher in his area. But usually the workman who finds a short-cut alarms the engineers. They feel that the rate should be adapted to the method, and both they and production supervision may oppose the new method as being "poor shop practice." This opposition is probably due more to fear of social changes and rule complications than devotion to fixed procedures.

If the workman persists in using his new method, it is studied and the rate is lowered. The workman would often like to have the old rate continue unchanged so that he could either triple his bonus or "take it easy" on the job. Since management opposes this procedure, the new technique is time-studied and the workman draws the same bonus as before, but he is hostile toward line supervisors and the engineers.

Knowing that his short-cut is likely to bring him nothing but antipathy of the engineers, the workman is likely to use the technique covertly and thus actually be forced to reduce his output to a level much less than he might do with relative ease using his new method. In theory this situation might bring the workman at least a little leisure, but can he relax if he must constantly be fearful of detection? And what is the mental state of the engineering group whose members are apprehensive that they will appear ridiculous in the eyes of top management? The game of evasion and counter-deception easily leads to intensified hostility. Sometimes enmities are built up to the point that rotation of personnel about the plant is the only measure that will bring participants back to a consciousness of their official functions.

If instead the workman had received payment related to the worth of his idea as soon as it had been demonstrated as an improvement, and if then the rate had been adjusted to function near or above his usual production, relations among all parties concerned would have been better and certainly the individual himself would have felt less resentment. This is an opportunity for the workman to practice private enterprise in a constructive way. To stifle it it seems contradictory when industrial organizations set up "suggestion boxes" and spend millions in research to improve production techniques. The question arises as to how a system of private enterprise can persist when only the official entrepreneurs may practice it.

Relations among workmen under those incentive systems using performance as a measure of fitness for promotion can be improved greatly if the element of "politics" is ruled out in the giving of tests and if valid tests replace the careless arrangements often set up as a gauge of skill. Where tests are not standardized there is latitude to give "tough" tests or only nominal tests, which allows the individual workman to be rewarded or punished as seems advantageous in the voluminous unofficial trading of favors between union and management, as the officers involved seek to escape pressures of the moment. When workmen reach the category of class-A by other than demonstrated skill or recorded productive behavior,[6] neither management nor union are in a position to answer complaining workmen who admittedly merit promotion. Careful testing and promotion will not,

[6] The principle of seniority naturally spreads the complication.

of course, aid an incentive plan with respect to the minority group of workmen who have the skill but are indifferent toward the incentive. Their motivation is outside this paper.

Since employees compare themselves with each other on the level of skill, as well as on the level of bonus made, antipathies can be reduced by bringing workers of similar skill levels together.

In many plants management has assumed some responsibility for training workmen who are to go on incentive pay. Failure to give such training limits the success of the plan. But care should be used in selection of teachers. Preferably the teacher should be an older and seasoned individual who is respected by the work group, and he might very well be a member of the work group. In any case he must be as skilled as the informal leaders of the work group (who will learn of the teacher's "dope" and evaluate it for trainees) and must have practical "know-how." Industrial teachers are usually regarded critically with respect to their competence and whether they themselves could do an outstanding job. If workmen with prestige hold the teacher in contempt, he is not likely to have good attendance in his class. The writer saw a young, skilled, college-bred shop teacher rejected by the work group largely because of his flippant, impatient, and superior manner. He was replaced by an aging, genial, and well-liked foreman who in two hours a week over a period of three months was presumeably very effectual, for most members of the class increased their bonus. Probably equally important was the change in attitudes among members of the group who wished to make bonus but in most cases did not know the "tricks." Apparently their lack of skill contributed to their earlier discomfort and frustrating relations in the shop.

The problem of bringing pay into more nearly equal balance with effort and skill is a great obstacle to making an incentive system work. While the engineers are not likely to admit that their standards are based on too few studies and limited experimentation, the fact remains that they often operate inside severe cost and time limits. Too often in setting up a rate to cover a single machine or operation their curve is based on only a few studies. Calculation of values based on such limited evidence is further suspect when joined with the use of the widely criticized concept of the "average man." To escape their limitations engineers are prone to consult manufacturers' descriptions of the potential capacity of machinery and equipment used by workmen under the incentive. Obviously, serious errors can result from this practice. Equipment in many, if not most, industrial plants is from 10 to 30 years old and often older. The engineers assume that equipment is kept in excellent repair when often it is not. When complaints of workmen are long and loud that the machines are below their assumed potential, repairs are sometimes made, but this is a touchy matter. The engineer has only his eloquence to persuade the line organization that certain equipment is defective, or should be replaced, and such suggestions may only build resentment against the engineers. All replacement and repair work is expensive and interferes with short-run production. Then, too, if special standards are set up for each machine or allegedly defective part, both standards and staff personnel will be multiplied. Hence a definite aid toward equating pay and effort is increased latitude for more studies by incentive engineers and real effort by management to keep equipment in top condition.

Differences in job behavior between the engineers and workmen are often offensive to the latter. Usually very young, well-dressed and unhurried, the incentive engineers and time-study men arouse antipathies in workmen. Workmen believe, as often do managerial line officers, that the engineers "spend too much time loafing." Such a belief makes for resistance to the engineers' expectation that workmen produce more. It is commonly believed in many plants that members of staff groups do "relax" and "visit" more than other groups. In the writer's experience much of this antipathy can be removed if the engineers employ themselves more in (1) visiting the shop frequently in shop clothes and mingling with workmen, (2) in listening to complaints even though little can be done, and (3) in conscientiously seeking to meet every provision agreed to by union and management concerning the incentive plan and to have those provisions modified that repeatedly are seen to be inadequate.

Though this is a controversial point, it seems likely that relations between the engineers and the union may be improved by the union's having an incentive engineer in its employ. His function will be to go over the standards with the engineers as they are set up and approve or reject them on the basis of their correctness. This plan is usually rejected by management but in some cases management engineers have requested it and in some few cases it has been adopted with reportedly good results.

A union engineer will naturally be subject to pressures from the union to push for loosening of rates, but he can talk on equal terms with management engineers and once he tells the rank and file that a rate is "OK" his word has weight. The usual haggling between union and engineers over acceptance or revision of rates can also be made both shorter and more pleasant by the union's having an expert on such matters.

The introduction of an incentive system in the form initially of a single rate to be followed by others as they are developed can lead to endless friction if the succeeding rates are not uniform. Such a condition frequently occurs when hostility to the incentive is expected. The engineers frequently feel that the way to "sell" the system is to make the first rate "loose." Workmen are pleased with the relatively easy bonus and the fact that the rate is guaranteed by the union. However, especially if the initial rate covers a sizeable part of the production areas that will come under incentive, the engineers may then "tighten" the succeeding rates so that even the more competent workmen have difficulty making bonus in most cases. Workmen soon compare their performances with those under the first rate. Then they compete for the few jobs on the later rates that pay bonus, and show their resentment to the others by working perfunctorily. When complaints arise, the engineers argue that all the rates were agreed to by the union and that equal effort under any of the rates will return equivalent bonus. On its side, the union will push for revision of the rates.

In cases like this, the value of increased total production resulting from the loose rate may be questioned when compared with the ill-will that is generated and that may spread to areas outside the incentive.

Recurring complaints against long and involved calculation of bonus is common in incentive shops. Unless workmen are quite sure at once just what the bonus will amount to on pay day, some of the incentive is lost. One often sees an eager workman who is aware that his bonus is going to be "good" but doesn't know just how good. If, as often happens, his job has a semi-automatic character, he is likely to want to plan, as he works, what he will do with the bonus. If a simple calculation cannot be made, in the fever of the moment he is likely to shut his machine down or leave his bench in search of the incentive applier to get a calculation. And if the latter is also unable to find his way through the formula, the workman's frustration checks his performance and may spread over the shop to others. Hence the engineer who is forced to use a complex formula should develop a simplified equivalent for use in the shop.

The possibility of introducing changes of the kind noted above depends on an over-all harmony among managerial units, such as staff and line and their constituent strata. Professor Whyte's discussion on management elsewhere in this volume is pertinent here.

We may say in summary: (1) Instead of penalizing, reward workman for short-cut methods. (2) When performance under incentive is used as a criterion for promotion, make tests uniform and valid, and administer them without variation. (3) Seek to bring workmen up to near the same skill levels by means of a training program. (4) Narrow the gap between effort and pay by constant study and revision of standards. (5) Minimize the social and job differences between engineers and workmen. (6) Let the union have its own incentives expert. (7) Don't use a "selling rate" to introduce a multiple-rate incentive system. Rather, seek to make all rates uniform. (8) Give workmen a simple formula for calculation of bonus.

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HUMAN ORGANIZATION AND WORKER MOTIVATION

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Historical Orientation

THE PROBLEM of motivating workers to achieve a high level of productivity and to accept the goals of the industrial organization has a long and instructive history. From the beginning of the industrial revolution to the emergence of powerful labor unions, the dominant philosophy was one of negative sanctions, of fear and punishment. Workers were expendable. They could be worked long hours; they could be sweated, and their compliance was secured through lay-offs, summary dismissals, penalties and threats. Moreover, these sanctions could be effectively invoked by the immediate over-seer or foreman, who had the power to discipline his men. With the growth of unions, with the tightening of the labor market, and with the general infiltration of democratic doctrines in all areas of American life, the system of driving people through orders and threats began to weaken. During the past twenty years we have increasingly become interested in the use of rewards. The shorter working day and week, more pleasant conditions of work, sick and death benefits, retirement plans, and recreational facilities have been some of the inducements to keep workers in the company, to encourage good performance, and to make them more receptive to company values.

In general, however, this period with its philosophy of rewards has never attempted any systematic exploration of the relation between the rewards and the type of activity to be affected. For the most part the rewards and inducements have had little intrinsic relation to the work process itself. The rewards have been removed in space, time, and nature from the day to day efforts of the employees on the production line. They are often long-run benefits, as in the case of retirement plans or health insurance. They are not administered by the person responsible for the productivity of the immediate work group, the immediate supervisor or the foreman. They are matters of company policy and are administered by the personnel department or some

The Human Relations Program of the Survey Research Center, on which the authors have drawn most heavily, is in the most complete sense a group undertaking. The authors are indebted especially to Eugene H. Jacobson, Floyd C. Mann, Nancy C. Morse, and Everett Reimer.

central agency representing the company as a whole. Moreover, they are not related directly or even indirectly to productive effort. The man who turns out quality work or a greater quantity of work does not attain more days of vacation, more retirement benefits, more pay, or more opportunities to see the plant baseball team in operation. Finally, there is no intrinsic relation between the rewards and the task to be performed. It is as if the jobs to be done were basically unappealing in themselves, and therefore people should be kept happy and induced to do their work by extra-curricular privileges. So vacations are increased, the age of retirement and the size of retirement benefits made more favorable, and new and varied social and recreational opportunities made available to employees.

The essential point is that the reward system has been geared unconsciously to only one aspect of worker motivation, namely, making the given plant so attractive that the individual will not want to leave it. This objective is not to be disparaged, since turnover is a costly matter and one aspect of productivity is to keep the workers in the plant. The other objective, however, of making people productive on the job does not necessarily follow from this type of reward system. It may make for differences in productive effort between plants, one of which goes in for benefits and one of which does not, but even this remains to be demonstrated. Within a single company, however, there is evidence to indicate that these external rewards bear little relation to productive effort.

We are now beginning a third period with respect to our philosophy of worker motivation. We are beginning to see that something more is necessary than the grafting on of external rewards to an industrial organization that was built without respect to motivational considerations. Our present attempts still represent a period of confusion. The recognition that more is necessary than external sanctions, whether positive or negative, has led to a grasping for any organizational reform or gadget which seems promising. We are in a period of groping in which we are beginning to get more thorough studies of the problem and more penetrating analyses of its major dimensions. In this period the importance of sociological and social-psychological research dealing with workers, supervisors, company officers, and organization gains acceptance. The present era is still dominated, however, by minor reforms and seldom are we oriented to the basic problem of achieving maximum satisfaction and motivation within large scale organizations.

The Central Dilemma

The central dilemma which must be faced in attempting to maximize productivity and human satisfaction is the antithesis between a regimented totalitarian organization, even of a benevolent character, and democratic individualism. As our shift from a punishment to a reward philosophy shows, we have been misled into thinking that the main dimension of the problem was whether we used a club or a piece of candy. There is a striking similarity here in our ideas about military organization. We are making some attempt to shift the role of the sergeant from the hard-bitten driving type of Prussian drill master to a more benevolent character who even praises his men. Despite the importance of this development, it still does not cope with the key variable in the situation. How do we gear into the spontaneous motivations of free men of a democratic society under conditions of machine-like organization? The key issue is the greater efficiency of the coordinated efforts of thousands and thousands of individuals performing tiny parts of a total task according to prearranged plan, compared to the individual efforts of citizens who are all captains of their own fate and masters of their own destiny. Is it possible to maintain the colossal gains in productive outcome which large scale organization has made possible and yet offer the individual rewards and satisfactions which are a direct function of his particular limited job?

To seek answers to this question means a careful inquiry into the particular way we have set up our large organization as it affects worker satisfaction, motivation, and productivity. We need to examine the organizational principles we have been following and see to what extent they are necessary in achieving efficiency and to what extent they can be modified without sacrificing essential productivity. It might appear at first glance that any principles which hindered individual motivation or any modification which strengthened individual motivation would account for major differences in productivity. Thus the problem would be simplified and there would be no real dilemma, since increased motivation would mean increased productivity. But it is easily possible to obtain increased productivity with a decrease in motivation through more efficient work methods, improved technical organization, and the like. For example, it would be possible to build automobiles with a high level of motivation by getting away from assembly line methods and utilizing highly skilled craftsmen. The craftsman might well be more highly motivated than the assembly line worker because of the more varied, more skilled, and more interesting nature of his work, and because the product turned out would be in good part the result of his artisanship. By depriving his job of meaning, fractionating it, and standardizing its component parts, we have taken away much of its intrinsic satisfaction, but we have added to productivity. Moreover, there are other reasons why the motivation of workers contributes only part of the differences in output. In a large factory there is a certain level of effort beyond which it is not necessary to motivate people. No matter how well energized, the individual worker can not move faster than the assembly line. The speed at which the whole line moves is determined not only by the motivation of workers at all points, but by the particular operations to be performed at various points, conditions of supply, and similar factors.

Before examining the principles of organizational structure and function as they relate to motivation, it is desirable to inquire into the nature and sources of human motivation.

Nature and Sources of Motivation

Motivation to perform effectively in given tasks over time can be regarded as essentially of two sorts. (1) The given task can be a path to some goal not directly related to the task. The worker must support himself and his family and so he appears regularly to take his place at the lathe or drop hammer or assembly line. Any other job which paid as well and promised as much security of employment with equally favorable surroundings might do as well. Or, given an inheritance, the worker would drop his tools the next moment. Where the motivation is to achieve some goal other than the work activity itself, it can still be increased if the amounts of effort spent on work activity or the path to the goal help proportionately to reach that goal. If the worker who produces more and produces better quality is paid accordingly, he can be highly motivated even though the work itself does not motivate him. Where, however, there is no direct increment of reward toward reaching his goal of support or security for himself and his family by increased effort, he is only motivated to do the minimum required to keep his job. In other words, an incentive pay system which rewards the person in an appreciable manner for increased effort is still an effective method of energizing people. The difficulties are with its practical administration, as will presently be discussed.

(2) The given task can in itself be rewarding. The individual attains real and important satisfactions out of his job. He will refuse other jobs which pay more but give less intrinsic satisfaction. Or the man who was compulsorily retired at the age of 65 with an adequate income still insists upon taking a similar job in another set-up.

These direct intrinsic rewards have been recognized by a variety of terms, such as craftsmanship, pride in accomplishment, ego-involvement, ego-enhancement, feeling of closure or completion, self-expression, self-determination, feeling of importance and of personal worth, desire for new experience, identification with the group product, and internalized motives. There is an equally long list of terms expressive of the blocking or lack of satisfaction from these intrinsic rewards, such as frustration, personal insecurity, inferiority feelings, fixated responses, hostility. There is no agreement on how these various forms of ego motivation should be classified, but there is growing recognition of their importance in situations in which the biological drives of hunger, shelter, and sex are adequately satisfied. In fact, the psychiatric world has shifted from its emphasis upon sex conflicts as basic to maladjustment to an emphasis upon conflicts in the sphere of the ego. Without attempting a rigorous classification of these ego motives we can for practical purposes distinguish between (a) self-expression, which gives the individual a chance to develop and demonstrate his own strongest abilities and talents, (b) desire for new experience, which gives his many interests and abilities a chance to be stimulated through varied tasks, (c) self-determination, or the feeling of freedom which comes from some choice in making his own decisions, (d) closure or completion, the satisfaction when tensions are successfully resolved, (e) ego-enhancement, the increase in self-esteem either through pride in accomplishment, identification with one's own product or the product of one's group, or the appreciation of the self by others.

The many manifestations of ego-enhancement or feelings of self-esteem extend beyond pride in the work to the appreciation which one's fellows show of one's job accomplishments or job status. The prestige that attaches to certain jobs either because of their status or the danger or difficulty of the work should be included here. For example, the overhead linemen in a public utility who have the difficult and sometimes dangerous task of replacing the lines in storms and freezing weather regard themselves and are regarded by other workers as the real guts of the operation.

Confluence and Conflict of Motives

In practice many of the direct and indirect forms of motivation have an opportunity to become fused on a job. The extreme case is where the fundamental ego drives of the individual can be expressed on a well-paying job which has high social prestige, as in the case of the exhibitionist who becomes a movie star and is paid for his exhibitionism. The principle of motivation that is important here has to do with the confluence and conflict of motives. Where a person finds he must take a job to support a family at a task distasteful to him, we may have a case of a conflict of motives which impairs the efficiency of the person. It is not only that his motivation is unrelated to the content of his work, but that it is in conflict with other motive patterns. Hence the conflicted person may not only be relatively unproductive, but he may be a constant source of difficulty to others in the organization, since his conflict may find expression in the release of hostility. At the other end of the scale is the confluence of motives as in the example of the exhibitionist, where the motive patterns reinforce one another with a terrific energizing of the individual. This is all the more reason for attempting to move toward some degree of confluence of motivation in industry.

Principles of Organization Structure

Granted that large scale organization is necessary and that it inevitably implies certain types of restriction and even of regimentation, the problem remains of attaining the required efficiencies with the maximum amount of human satisfaction, not only from its end product, but also from its very operation. The problem is generally not approached in this way, because we accept organizational structure as a *given* and try to operate within its framework in some ameliorative fashion. But the basic philosophy of organizational structure itself must be examined and the fundamental principles of organizational functioning discovered, if we are to make any meaningful attempts at change.

In our culture the fundamental philosophy of large scale organization, whether expressed as the doctrine of scientific management or as principles of public administration, is the machine theory of organizational structure. This theory has been well formulated by James Worthy as a result of his years of research and observation of employee morale and corporate structure. The organization is regarded as a machine to accomplish a collective purpose or turn out a collective product; hence the parts of the organizational structure must meet the same standard specifications as the parts of a machine and must bear the same interdependent relationships. The major criterion of organizational functioning is the efficiency of its operation. Efficiency is assumed to be the same as productivity regardless of the type of product the organization is supposed to turn out. A well-trained army represents the model of machine theory. In fact, General Bradley, commenting on his armies in western Europe, pointed out that the important differential between them was in the abilities of their commanders. Everything else had been reduced to standard parts and standard procedures. This machine theory of organization implies a number of principles, some of which have been explicitly formulated; others are more or less implicit. They include these generalizations:

1. Unity of command. There must be one central source of authority and decision making.
   This principle implies centralization of decision-making at the top hierarchical levels and the institution of controls to see that these decisions are followed. This means a minimum of autonomy at local levels as usually interpreted.
2. Chain of command. There must be a clear-cut hierarchy of subordination. The line of command must not be interfered with by a confusion of responsibilities. The ideal is to have individuals report only to one boss.
3. Standardization of operations and functions. There must be a standardized or routinized official procedure for all activities within the organization. Otherwise the parts of the organization can not be properly synchronized and attuned to efficient operation. This standardization means, moreover, uniformity of operation in every activity, no matter who the individual carrying on the operation. When the army moves forward in a coordinated attack, every person must perform his standard task according to rule so that the reciprocal supporting behavior of all units is maintained. Standardization or uniformity also makes predictable the actions of all members in the organization so that planning is possible. This prevents individual deviation and makes possible the exercise of control by the top leaders.
4. Specialization of function. Not only should tasks be standardized but they should be broken down into their sub-parts and each individual component part standardized. Minimum training can make each man in the organization prepared for his job because it is minute. Moreover, time can be saved by specializing people for a fairly limited task. The assembly line in the automobile factory exemplifies this principle.

5. No duplication of functions. Specialization of function, if carried to an extreme, leads to the principle of no duplication of functions. Since there is some overhead, some duplication of equipment in the maintenance of separate units, and since they may compete with one another, it seems more efficient to streamline by having one large unit carry out a given activity. Thus the Hoover report on the reorganization of governmental structure hit at the apparent wastefulness of agencies with overlapping functions.
6. Clarity of job specifications and responsibility. To make standardization effective, it is necessary to set up explicit job specifications for each task and position in the organization with a clear account of duties and responsibilities.
7. Line and staff functions. To allow for flexibility in meeting new situations and to give maximum intelligence to top operators about the way the organization is working, staff positions are created at the top level and at succeeding levels. The staff man surveys the situations and recommends to his supervisor the type of change which is necessary. If his recommendation is accepted, new standardized procedures will be adopted. But the staff man himself never gets into the line of operation to aid it or interfere with it.

Relation to Machine Theory of Principles of Motivation

This machine theory of organization is essentially non-psychological and pays scant attention to the nature of human beings, to their feelings, needs, differential abilities, satisfactions, aspirations, values, or motivations. The assumptions inherent in it disparage the potentialities of human behavior. The system is so set up as to guard against the mistakes, the foibles, the initiative of human beings, Error is prevented by recourse to protocol and procedures. Standard operating procedures encourage the assumption that the best method is the following of the rules and regulations. Allied with this is the assumption that most people are essentially alike and that a uniform method will suit all people equally well. To the extent that individual differences in ability are recognized, selection tests and criteria are provided on the assumption that the different cogs in the machine, the different job specifications for different tasks, somehow correspond with measurable differences in the aptitudes or training of the applicant. Hence the civil service standard of a given number of years of graduate training to correspond to a given classification rank.

The machine theory, moreover, is not concerned with human motivation and does not inquire into the relationships between its own principles and procedures and the corresponding motivation and effectiveness of human beings caught up in the system. In fact, it makes the blatantly erroneous assumption that motivation is unrelated to job content, to methods and procedures. It emphasizes standardization, uniformity, and highly limited responsibility.

A meaningful way to achieve motivation within the machine system would be to offer a differential return based upon the contribution of the individual to the total product of the machine; in other words, to establish a piece rate or incentive plan geared accurately to actual contributions to the work of the total organization. In practice this has not proved feasible in many plants for a variety of reasons. Neither the top level people in the organization nor the rank and file workers were willing to accept such a differential pay-off because they do not operate in practice like efficiency engineers, but like people. Thus top management would cut back a differential piece rate when earnings increased according to effort, and workers would develop their own group standards in defiance of the differential pay scale. In addition the very uniformity and standardization required by the machine theory makes it difficult to utilize a differential return according to effort and excellence of performance. Thus, on an assembly line all men must move at the same pace. To have a group piece rate for 800 men is not to reward differential effort, but to sub-contract to the union or to the workers. Moreover, in a complex organization there is no ready way of comparing the differential contribution of workers performing qualitatively different jobs.

Thus, the motivational sources open to the machine theory are external to the actual operations of the organization with one major exception. Where the machine theory is carried through in practice there should be clarity of job responsibility. Everyone knows what is expected of him and this well-structured stability can afford some degree of motivation.

Some Research Findings Regarding Industrial Productivity

The preceding sections of this paper summarize the historical development of contemporary thinking and practice in the administration of large-scale organizations. It is clear that the monumental gains in effectiveness offered by such organizations (industrial, military, and civic) have in large part made possible the present material achievement of our civilization. It is also becoming clear that most of these organizations rest upon an inadequate motivational base, and that our present industrial organization, for all its unequalled productivity, leaves untapped some of the major motivational sources which lead men to produce. Even more serious, perhaps, is the implication that the productivity which we have achieved has been bought and is repurchased each day at a great cost in those human satisfactions associated so prominently with the independent artisan of an earlier day.

In recent years there has been an increasing volume of social research which has begun the long task of replacing assumptions with scientific data. The findings from such research already reveal the short-comings of many present industrial practices, and point in a dim but challenging fashion toward some possible solutions to problems of industrial motivation. One of the major conclusions to be drawn from studies of worker productivity and morale is the importance of social psychological factors which are given scant attention by the machine theory of organization. In some of the earlier explorations this importance was reflected in the spontaneous responses employees gave for liking or disliking their jobs, or in employee ratings of the factors most important to them in the job situation. Hoppock and Spiegler,[1] Houser,[2] and Fosdick[3] reported findings which emphasized the importance of interpersonal relationships between employee and supervisor, and among employees in the same work group.

A number of war-time studies provided additional documentation of the importance of social psychological factors by relating the human relations practices of first-level supervisors and other management echelons to the criterion of absence from the job. The work of Fox and Scott,[4] and some of the findings from the shipyard studies of Katz and Hyman[5] are relevant here. Earlier work with the absence criterion had also stressed the importance of social psychological factors as independent variables. The work of Mayo and Lombard[6] in the aircraft industry, for example, involved a comparison of work groups with varying attendance records. Their major explanation is

[1] Hoppock, R., and Spiegler, S. "Job Satisfaction," *Research of 1935-37 Occupations,* No. 16, 1938, pp. 636-639.

[2] Houser, J. D. *What People Want from Business,* McGraw-Hill, New York, 1938.

[3] Uhrbrock, R. "Attitudes of 4430 Employees," *Journal of Social Psychology,* No. 5, 1934, pp. 365-377.

[4] Fox, J. B., and Scott, J. F. *Absenteeism: Management's Problem,* Harvard Business School, Business Research Series, No. 29, 1943.

[5] Katz, D., and Hyman, H. "Industrial Morale and Public Opinion Methods," *International Journal of Public Opinion Research,* Vol. I, No. 3, September, 1947, pp. 14-30.

[6] Mayo, E., and Lombard, G. *Teamwork and Labor Turnover,* Harvard Business School, Business Research Series, No. 32, 1944.

in terms of interpersonal factors, although the relationships within the work group rather than the supervisor-subordinate relationships are emphasized. This research, with its emphasis on the informal group structure, is very much in the tradition of the Western Electric studies of Mayo and Roethlisberger.[7]

The supervisor-subordinate or leader-group relationship has been the focal point for a considerable number of researches. Likert's [8] study of morale and performance in insurance agencies treated morale as an intervening variable which was determined in large measure by the character of supervision. The successful managers were those who, by giving recognition for accomplishment and in other similar ways, offered an ego-enhancing relationship to the agents under their supervision. The roles of the leader and group members, and their relationship to performance have also been explored in a series of studies by Lewin [9] and his colleagues and students. Their studies have concentrated particularly on the decision-making process.

Among the current researches dealing with the criterion of productivity is a series of studies conducted by the Survey Research Center of the University of Michigan. This program of research has the general aim of discovering the factors which govern group performance and motivation, with specific reference to organizational characteristics and leadership practices. Most of the studies have been conducted in industrial situations, with organizational effectiveness being measured primarily in terms of productivity and morale or employee satisfaction. The major findings from this research are summarized in the following pages.

(1) *Differentiation of Supervisory Role*

The supervisor with the better productive record plays a more differentiated role than the supervisor with the poor productive record; that is, he does not perform the same functions as the rank and file worker, but assumes more of the functions traditionally associated with leadership. Foremen of railroad section gangs, for example, were found to differ with respect to the amount of time they spent in planning the work and performing special skilled tasks. In general, the

[7] Roethlisberger, F. J., and Dickson, W. J. *Management and the Worker,* Harvard University Press, 1940.
[8] Likert, R., and Willits, J. M. *Morale and Agency Management,* Life Insurance Sales Research Bureau, 1940.
[9] Lewin, K. "Group Decision and Social Change," *Readings in Social Psychology,* Newcomb, T. M., and Hartley, E. L., editors, New York, 1947.

foremen with the better production records devoted more time to these aspects of their work, according to their own report, and they were perceived by their men as possessing superior planning ability. Similarly, in a company manufacturing heavy agricultural and road-building equipment, both the foremen and the men of high producing sections evaluated the quality of planning as superior to that of most other groups.

Another indication of the ability of the high-producing supervisor to differentiate his own function from that of the men is the amount of time which he gives to the work of actual supervision, as contrasted to the time allocated to activities which are not uniquely those of the supervisor. In the studies of clerical workers, railroad workers, and workers in heavy industry, the supervisors with the better production records gave a larger proportion of their time to supervisory functions, especially to the inter-personal aspects of their job. The supervisors of the lower producing sections were more likely to spend their time in tasks which the men themselves were performing, or in the paper-work aspects of their jobs.

The reverse side of this picture was also revealed in the railroad study, in which statements made by the section hands in low-producing sections indicated a tendency for an informal leader to arise in these sections. For example, in the low sections there was more frequently some one member of the group who "spoke up for the men when they wanted something." Apparently the informal organization in the low groups compensated in some respect for the abdication or mis-directed leadership of the foremen, but not without some losses in total effectiveness.

(2) *Closeness of Supervision*

A second major dimension which appears to discriminate between high and low-producing supervisors is the closeness with which they supervise, or the degree to which they delegate authority. Although the high supervisors spend more time performing the supervisory functions, they do not supervise as closely as their low producing colleagues. This general characteristic is reflected in a number of specific research findings. In the insurance study, low-producing supervisors were found to check up on their employees more frequently, to give them more detailed and more frequent work instructions, and in general to limit their freedom to do the work in their own way. In the company manufacturing earth-moving equipment, the high-producing workers reported more often that they set their own pace on the job.

There is a great deal of evidence that this factor of closeness of supervision, which is very important, is by no means determined at the first level of supervision. Rather, the first-level supervisor tends to offer to his men the style of supervision which he experiences with his own supervisor. Or to put it another way, the style of supervision which is characteristic of first-level supervisors reflects in considerable degree the organizational climate which exists at higher levels in the management hierarchy. Among the many findings which bear out this interpretation are the following: In the insurance study the low-producing supervisors reported that they were under closer supervision from above than did the high-producing supervisors. In the agricultural equipment factory, foremen of high-producing sections indicated relatively more freedom or scope of authority. They stated that they were able to plan their own work as much and as far ahead as they wanted to. In the railroad study there was a tendency for the foremen of high-producing gangs to report relatively less pressure from above and to be more satisfied with the amount of authority which they had on their job, although these findings were not statistically significant.

There are two additional analyses which bear heavily on the hypothesis that supervisory behavior at the first level is conditioned in great degree by practices of higher management, although neither of these analyses deals specifically with the productivity variable. In one case an experimental evaluation of a supervisory training program was carried out in a large utility.[10] Four divisions, consisting of approximately fifty first-line supervisors and four hundred employees were divided into a matched experimental and control group, each consisting of two divisions. First-line foremen in the experimental group received an intensive training course in human relations principles and techniques over a nine-month period, while their counterparts in the control group did not. The basic criterion measure of change in the foreman's attitude and behavior toward his employees was a change in the employees' perceptions of the foreman. In brief, the findings, based on measurements three months after the completion of training, revealed no significant change in the control divisions.

[10] Hariton, T. *Conditions Influencing the Effects of Training Foremen in New Human Relations Principles,* Ann Arbor: University of Michigan, Ph.D. Dissertation, 1951.

Of the experimental divisions, one showed a significant increase in satisfaction and the other a significant decrease. The factors which explain these differences are in large part reflections of upper management practices. Thus, the foremen whose men reported increases in satisfaction tended to be those who perceived greater opportunity for change, whose superiors acted in a way which was consistent with the principles of the training course, who were satisfied with their own job situation, and who anticipated that their own needs would be satisfied if they used the principles presented in the course.

The second analysis which emphasizes the importance of higher levels of supervision or organizational climate is somewhat different in approach.[11] The general hypothesis was that the relationships between the behavior of first-level supervisors and the attitudes of their employees are importantly conditioned by the organizational milieu in which the first-level supervisors are functioning, and particularly by the amount of their power or influence in the department—"their potential degree of control over the social environment in which their employees are functioning." In other words, the foreman who is given so little freedom or authority by his supervisors that he is unable to exert a meaningful influence on the environment in which he and his employees function will be ineffective in dealing with employees, regardless of his human relations skills. His intended supportive actions may even have a negative effect on employee attitudes, in so far as they encourage expectations which cannot be met by him. The data from this analysis in general support the hypothesis. Under high-influence supervisors, nineteen of twenty-eight correlations between supervisory practices and employee attitudes are positive, though small. Under low influence supervisors, twenty out of twenty-eight are zero or negative.

(3) *Employee-orientation*

A third dimension of supervision which has been demonstrated to be consistently related to productivity is a syndrome of characteristics which can be called "employee-orientation." The employee-oriented supervisor, in contrast to the production-oriented, or institution-oriented supervisor gives major attention to creating employee motivation. The specific ways in which he does this may vary from situation to situation, but they contribute to a supportive personal relationship

[11] Pelz, D. C. *Power and Leadership in the First-Line Supervisor,* Part I (mimeographed), Survey Research Center, University of Michigan, 1951.

between himself and his work group members. Thus in the railroad study, the workers in high-producing groups more frequently characterized their foremen as taking a personal interest in them and their off-the-job problems. This finding was repeated in a study in heavy industry, in which the high-producing employees reported that their foreman took a personal interest in them. A related finding came from the report of the foremen indicating that the high-producing foremen were more likely to say that the men wanted them to take a personal interest in them, whereas the low-producing foremen were more likely to have the perception that the men resented such a demonstration of interest. It is quite possible that this difference in perception is in part cause and in part effect. The low-producing foreman has a less satisfactory relationship with his employees and he may well be right in thinking that they want no more of the kind of relationship which he offers. At the same time, his conviction that they wish to minimize the relationship undoubtedly contributes to the psychological distance between him and the work group.

Even more consistent relationships were found in those behavior areas which not only reflect smooth interpersonal dealings, but also offer tangible evidence of the supportive intentions of the supervisor. Thus, in the railroad study the high-producing foremen were said by their men to be more understanding and less punitive when mistakes were made. They were also more likely to groom employees for promotion by teaching them new things. In the insurance study, the high-producing supervisors were more employee-oriented and less production-oriented than their low-producing colleagues. The low supervisors emphasized production and technical aspects of the job and tended to think of their employees as "people to get the work done," in contrast to emphasizing training people, taking an interest in employees and considering them primarily as individual human beings. In the same study the supervisors were asked this question: "Some people feel the job of supervisor is tough because they stand between the workers and management. Do you feel that this is a problem?" The high-producing supervisors were predominantly employee-identified, according to their own report. The low-producing supervisors were, for the most part, management-identified. This general statement was borne out by the supervisors' reactions to two aspects of company policy which at the time of the study constituted problems in morale or employee motivation. In both of these areas, the placement policy and the dining room set-up, the high-producing supervisors were more critical and more aware of the situations as sources of employee disaffection than were the low-producing supervisors.

In the study of industrial workers there was a whole cluster of findings which seems to fit this framework. The employees with highest production records were more likely to report a good overall relationship with their foreman, in terms of the quality of his supervision, the way they got along with him, and the interest he took in them. In addition, they reported good communications with him; they said that the foreman let them know how they were doing, that he was easy to talk to, that it usually helped to talk over a problem with him, and that he took care of things right away. (This indicates both a supportive relationship and an effective role in the larger structure.) It is perhaps a reflection of the importance of the supervisor's ability to understand and identify with the employees that in this study the foremen who had previously belonged to a labor organization had better production records than those who had not.

In this study also, the employee-identification of the higher-producing supervisors was associated with a greater criticism of certain company policies, although at the same time high-producing supervisors were better satisfied with many aspects of their own jobs, and felt that their own superiors were well pleased with their work. But it was the high-producing foreman who in greater numbers felt that their own supervisors were doing less than a very good job, and were no more than fairly good at handling people.

(4) *Group Relationships*

The fourth factor which seems to be emerging as a major determinant of productivity in industrial situations might be termed group cohesiveness, or pride in work group. This variable was tentatively identified in the insurance study. Employees in the higher-producing groups tended to express greater pride in their section (work group) and in their division. This was based on over-all coded ratings of the interview content and also on specific responses to the question "How do you think your section compares with other sections in the company in getting a job done?" Several interpretations of this finding are possible. On the one hand it is conceivable that the employees in high-producing groups were simply reporting what they know to be the objective fact—that their groups had superior work records. However, it is also possible that pride in work group was the cause and high productivity the effect. Finally, and perhaps most probably, there is the possibility that pride in work group and productivity are inter-acting variables, and that an increase in either one tends to bring about an increase in the other.

In the railroad study, both the men and the foremen in high-producing groups evaluated their group performance as better than most, even though they had no formal channels of communication through which to learn of the productivity of other groups.

In the factory manufacturing earth-moving equipment, this area was further explored. It was found that high-producing employees more often said that their groups were better than most others at putting out work. They also reported that they felt they were "really a part of their group," in contrast to the lower producers who were more likely to say that they were "included in some ways but not in ohers," or that they did not really feel that they were members of the group. Moreover, foremen of the higher-producing groups cited their sections as better than most in the way in which their men helped each other out on the job. Foremen of low-producing groups said their sections were not as good as most in this respect. Nor were these responses merely reflecting some general affect for the group. There was no difference between high and low producers in the characteristics they ascribed to their groups in the areas of skill, know-how, education, and the like. All this tends to support the notion of team spirit or pride in work group as a factor in productivity.

In summary, then, we have considered some research findings which suggest four classes of variables—the supervisor's ability to play a differentiated role, the degree of delegation of authority or closeness of supervision, the quality of supportiveness or employee-orientation, and the attitude of group pride—which have shown consistent relationships to productivity. A strong argument could be made that one of the things which these characteristics have in common is an inherent incompatibility with the machine analogy which has already been described. The data suggest that the most successful supervisor may be the one who acts to modify the very theory of organization which is often credited with his success.

Possible Solutions

We return then to the central dilemma of our times—the clash between the stifling effects of machine organization for the great majority of its members and the rich material returns of organized collective effort. Both from a theoretical analysis and from research findings, it becomes clear that not only are human satisfactions reduced and distorted by the regimented nature of modern industry, but that the motivation to produce is also curtailed. Proposed solutions to the problem are for the most part implausible. There may be no royal road to the Utopia where everyone in the great society can realize the rich potentialities of his unique personality and still coordinate his activities in an efficient way with millions of his fellow citizens. It may even be that to provide maximum opportunities for self-development and self-actualization we may choose to forego some of the efficiencies which could produce a more bountiful standard of living.

Though the proposed solutions leave much to be desired and though there may be no single answer, it is important to examine them critically and constructively in an effort to make what adjustments we can to maximize human satisfactions within organized collective effort.

(1) *Boot Strapping: Meeting Institutional Defects with More Institutionalization: The Gadget Approach*

The most common remedy and the least satisfactory is the addition to the machine structure of gadgets and devices which merely give more of the same type of institutionalization which creates the problem in the first place. Workers perform routine assignments in a factory with standardized work methods and uniform personnel procedures. To make them happy, to make them identify with the company, we set up a morale division which gives the workers a slick magazine, canned talks, and movies about the company. Then we wonder why they take so much more readily to the union news-sheet with its inferior paper and lack of pictorial material. In a complex organization there are difficulties in communication between units because the integrated process which turns out the joint product is integrated at the organizational rather than the individual level. So we set up coordinators, especially if we are in the federal government, to integrate the parts and make communication flow more freely and accurately. The coordinator's office comes out with new rules about the flow of information, memos flow across desks, clerks are instructed as in one large company, "Don't say it, write it; you can't file a conversation." The suggestion system is another example. To maintain a flow of communication from below, to utilize workers' ideas, and to make employees more involved in the company, many concerns have instituted suggestion boxes. The real problem here, however, is the lack of motivation to communicate and this is not necessarily supplied by a company drive to get the workers to drop their complaints and suggestions in the proper receptacle. In fact, the natural line of communication upward from worker through his supervisor is by-passed by this new institutional device and hence some of its merits may be vitiated by destroying further the inter-personal contacts between supervisor and worker.

The self-defeating nature of further institutionalization to meet the problems of institutionalization has been convincingly described by F. H. Allport in his *Institutional Behavior.* He points out how the many institutionalized activities of the child take him away from the home and break up the natural relationships that once existed between parent and child. Since the child now spends many of his waking hours in the school, in classes and extra-curricular activities, the parent loses contact. Hence we set up Parent-Teachers Associations to bring the parent in contact with the teacher, and thus remedy the break in this relationship. The PTA as an organization may hold meetings, elect officers, collect dues, but it provides little opportunity for the parent to get to know his child better.

(2) *Complete Mechanization: The Substitution of Machines for Men*

The logical conclusion of a machine theory of organization is such complete specialization and standardization of function that physical machines can take over all the activities performed by human beings. And in industry the trend toward mechanization has been ingeniously developed. Not only have machines supplanted men in producing things but intricate electronic equipment is increasingly employed in place of human beings for a variety of mental tasks. If this trend could be carried out more fully, our problem might disappear; in fact, there are those who hold that industry of the future will not require human robots but engineers and junior technicians who plan and repair the machines.

This push toward complete mechanization may well solve many of the motivational and human problems in certain types of industry. It will not, however, meet the difficulty that as men are freed from the industrial-production industries, they find places in distribution, promotional services, and sales activities where the same organizational defects are apparent.

(3) *The Re-Discovery of the Individual and the Primary Group: The Mayo Tradition*

Observation and research have demonstrated that organizations often function effectively not because of their adherence to the standard operating procedures, protocol, and paper administrative charts but because of the informal relations that develop, based upon the personalities of people and not on their robot or role characteristics. The fountainhead for the belief in the efficacy of these informalized interpersonal relationships in industry is Elton Mayo and his collaborators. They have discovered again the individual and the primary group of face-to-face colleagues. They have shown that the group standards of the face-to-face group are important in morale, in productivity, and in absenteeism. Informal social structure has been idealized in the writings and theories of Roethlisberger. This general approach in the field of industry has received support from the Lewinian group, which has carried forward studies of standards of the primary group, the communication process at the interpersonal level, group decision, and group productivity. Industry has finally accepted some of the tenets of this individualized approach and has given considerable attention to the training of foremen in human relations skills. The hope is that by improving the representative of management who has the most direct contact with individual workers, the satisfactions and performances of these workers can be increased. Perhaps the most sophisticated and thorough program illustrative of this philosophy is that of Professor N. R. F. Maier. The Maier training program utilizes the individual psychological theory of Carl Rogers and Maier's own theories of learning and frustration. If we change individuals and if we change them as they function in primary groups, we will have achieved a significant improvement in motivation, happiness, and effectiveness.

Monumental as are the contributions of this approach and sweeping as are its implications if carried out on an intensive and extensive scale, it is still important to recognize the social context and the social structure within which primary groups and individuals operate. The social structure and the specific organization within which the individual functions set the limits for variations in his behavior and define the values and permissible behaviors. The individual or small group trying to practice a philosophy of individualized human values in a large bureaucracy is like the small boy attempting to hold back the flood of waters breaking through a dam by sticking his hand in the hole he happens to notice in the breaking structure. Or it is like the small utopian group of socialists attempting to change a capitalistic economy by setting up a cooperative republic in somebody's back yard.

In other words, the emphasis upon informal social structure and interpersonal relations assumes one of two things. Either formal structure is of little importance and can be ignored or formal structure can be changed by strengthening the informal forces in the situation. In either case, there is a failure to make a realistic analysis of the power structure of the organization, which the formal set-up of the organization reflects. Since the real power in an industrial concern is vested in top management, a move to personalize relationships between workers and foremen can back-fire in that it may be perceived as a management attempt to manipulate in the interests of management. Thus *Ammunition,* the CIO publication, has described the milk-cow sociology which tries to make contented workers by group therapy.[12]

The defense of this movement is the possibility that if the primary group is encouraged in large organizations, and if it is given some small measure of decision-making, this democratic process will grow and over time affect the entire organization. A more fruitful application of this doctrine, however, would be an examination of the types of formal structures which can be adequately replaced by informal procedures. Still another application would be the insistence that the primary group be given some real share in decision-making on some basis of functional representation. This would be less an attack upon formal structure than upon its particular construction. Both of these applications will be considered in the next section.

Modifications in Present Principles of Machine Theory and Their Applications

Perhaps the most practical approach to the problem is to consider large-scale organization as indispensable and some aspects of machine theory as essentially correct but to analyze more carefully the basic tenets of this theory. In other words, some of its principles may need to be discarded completely; others may carry some elements of truth that have been hidden in too general a formulation; others may need more specification and flexibility in application; and even new principles may need to be formulated.

[12] ——— "Deep Therapy on the Assembly Line," *Ammunition,* Vol. VII, No. 4, 1949, pp. 47-51.

The following pages do not pretend to the type of analysis that is needed. They contain six suggestions toward such a formulation.

(1) An analysis of organizational theory should shart from the point of view of science and not from the point of view of our culture. Our social norms give us a frame of reference in which we perceive large organizations as having an objective character apart from human beings. Hence we adjust to the organization and regard it as part of a natural process outside of ourselves which can not be essentially changed. We can make minor alterations within the model of the institution, but the model itself is a *given.* Though it is essentially a social norm, it is perceived as a natural force. Hence, we do not raise the question of whether our particular form of organizing groups is the best method; we tend to think of it as the only method. Since we are creatures of our culture, it is very difficult to get outside of ourselves and take an objective view of our methods of social organization. This fact as much as any single fact has prevented us from gaining insight into the machine theory.

(2) The principles of uniformity, specialization, and centralization do not apply to relations between people in the same definite fashion as they apply to the relations between men and physical objects. It may be demonstrable that there is a best way of assembling a machine gun; time and motion study may determine the most efficient methods for operating a machine. Thus standard operating procedures can be written and taught to operators. But there is no readily ascertained best way of handling the interrelationships of people, and the machine principles are dangerously inappropriate.

Or to put it in another way, the same rules for turning out a physical product do not necessarily apply when we are providing a service or training people, i.e., turning out a human product or dealing with humans largely.

(3) The principles of machine theory need to be interpreted in terms of efficiency in relation to the purposes of the organization rather than of efficiency as a goal in itself. The efficiency goal when divorced from constant reference to specific purposes is one of the most deceptive perversions of machine theory. Efficiency thus becomes *ease* of administration for the administrator, not efficiency for the purpose of the group. Uniformity and standardization achieve needless exaggeration, because they make things easy for the administrator and keep the paper records straight. The army was (and is) full of standard operating procedures which make the machine run

by itself but do not necessarily maximize efficiency in terms of the over-all purpose of the organization. In any army training school it is not unusual for a course to be standardized, with stated materials to be memorized for given sessions in which the student parrots back the answer on his mimeographed sheet. The course is rated by the inspection officer on the basis of the automaton character of the proceedings, by the order and regularity of the room (are all the chairs in perfect line; are the window shades drawn evenly at all the windows?). This makes for training which runs by itself and which is efficient in the eyes of the administrator who neglects the purpose for which the training is given, namely, in order that learning shall take place.

In practice this shift to the efficiency of organizational purpose rather than efficiency for the ease of the administrator means a rejection of standardization, specialization, and uniformity where these principles do not contribute to productivity or organizational effectiveness. The weakness in moving toward standardization is that we seize upon the most obvious forms of behavior to institutionalize, whether or not they are related to our basic objective. This is obviously the difficulty that the army has in its training program, in the example just cited. It is important then in machine theory to introduce the concept of *functional relevance* whenever we talk about standardizing an operation, or fractionating it into specialized parts.

The criterion of functional relevance would reduce the degree of uniformity required in an organization, would reduce the amount of paper work and make it necessary to have fewer bosses and administrators. It would mean that we would not fractionate jobs, unless it could be demonstrated that productivity were actually increased thereby. It would mean that we would not move toward centralization of functions unless it contributed to real organizational efficiency so to do. Centralization of files, of services common to many divisions of the organization makes it easier for the bureaucrat to know where to find things and where to identify a function on an organizational chart, but it does not necessarily increase productivity.

(4) The principle of unity of command needs to be differentiated from the process of decision-making. An organization can follow a single policy in a unified way without that policy being determined by a few high-ranking officials. The decision-making process can involve all members of the organization and they can still move as one man, once the majority have expressed their will. All that is required

is the commitment of the individual, that he will abide by the wish of the majority once a group decision has been made. In fact, many groups outside of industry operate on this principle and show excellent coordination and integration of behavior. But we have formulated our unity of command principle as if it meant that the decision-making and decision-compliance were the same thing. Industry has missed the vitalizing effects of democratic decision-making because it has assumed that chaos would follow the involvement in policy determination of too many people in the organization. The one instance in which unity of command is disrupted by such decision sharing is in emergency situations. When a house is on fire there is no time for discussion and group involvement. This is the justification for dictatorial powers to the president in time of war. But industry is not regularly on a war-time basis and proper planning can permit more involvement of people in the organization in the determination of its activities.

(5) Decentralization, duplication of function, and the preservation of the competitive principle can be encouraged. There has been a strong tendency toward decentralization in large organizations. The growth in size makes the machine theory break of its own weight. The consequence is more horizontal and less vertical organization. Big companies break down into fairly autonomous divisions along parallel lines or they break on a mere geographic basis. They set up regional offices to take over the functions of the central office. This means essentially a violation of machine theory principles in that they are moving away from specialization and centralization and permitting duplication of function. Each divisional or regional part of the larger structure will duplicate some of the activities undertaken by the other and in fact, sometimes actually compete with one another. In our culture we have found no good substitute for the principle of individual or group competition. A machine organization destroys true competition. Though wasteful on paper, competitive practices pay off because of their motivational strength. General Bradley was in a more fortunate position when he had three armies competing to cross the Rhine than if there had been a completely centralized organization under him. During the war we benefited from the competition which the new war agencies gave to the old government departments whose functions they overlapped, because competition brought to light new and better ways than were apparent in the fossilized bureaucracies.

(6) The criterion of functional relevance, which needs to be added to the principles of organization operation, has already been applied to the tendency to make purposeless efficiency itself the goal. It has applications, however, to all the fundamental principles of machine theory. The major point to be made here is that the principles have been accepted in blanket fashion without an analysis of what makes them work when they are successful. The old essay of Charles Lamb on the discovery of roasting pigs by burning down a house is instructive here. Unity of command is accepted in blanket fashion as implying complete centralization of decision-making at the top of the hierarchy. The result is that top officials characteristically spend far too much time on decisions about details that could be more easily and more effectively decided down the line. This tendency to push all decision-making, no matter how trivial, up the line follows naturally from a rigid adherence to a formalized structure operating on machine theory basis. In the first place, since it is assumed at once that unity of command calls for topside decision-making about anything which can conceivably affect the institution's functioning, almost everything becomes relevant for the top executives. Boards of Regents retain the power to approve all appointments, all promotions, all curricular changes, because it is possible to make a case that every item under these headings can affect the welfare of the institution. As a matter of fact almost anything can be moved upward for approval on this criterion. This absolutist type of judgment needs to be replaced with some relative consideration of what is most important for the top board to decide in terms of their time and competence. Obviously they can only act as a rubber stamp for most of the details they consider, and generally when they do enter into decisions on appointments, promotions, and curricular matters, they are operating so far out of their line of competence, that they make frightful and costly mistakes.

Another reason for pushing decisions upward is the difficulty which most administrators have in delegating authority. To know when to delegate and how to delegate is a fine art, and if the administrator lacks skill and motivation there are no well-developed principles to guide him. Moreover, he has often moved up the ladder from lower positions and through habit takes the lower level responsibilities with him. Finally, the institution which literally follows the machine-theory model of functioning has a hierarchy which is so oriented upward that it has yes-men who are afraid to stick their necks out by making decisions themselves. Everything gets referred upward by the officials who hope to rise in the hierarchy.

The critical issue then is narrowing down to criteria for downward delegation and local autonomy. The most general principle to follow here is almost the opposite of what is usually done, namely, have no decisions made at a higher level which can be handled with reasonable competence at a lower level. There is no point in a factory superintendent making decisions for his foremen on technical matters that they may know more about than he does. This rule encounters all sorts of problems as any general principle would when it comes to specific situations and problems. It should be buttressed by another rule: Try to teach lower levels to take over decisions whenever possible; try to raise their level of competence for decision making; and try to give them adequate information. In these and in other ways yet to be learned, we may come to an increased enjoyment of the fruits of large-scale organization, and at the same time avoid the penalties in motivation and satisfaction which we now exact of ourselves.

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AN ECONOMIC EVALUATION OF THE GAINS AND COSTS OF TECHNOLOGICAL CHANGE

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I. *Evaluation is Qualitative*

THE ATTITUDES of the analyst are important determinants of his reaction to technological change. Some back through life with their attention focused on an earlier period. Others rush forward, without judging direction or worthwhileness of movement by reference to earlier times. Neither is correct; for movement may or may not be associated with progress.

As a matter of fact, this cleavage is reflected in society's attitudes toward change. On the one hand, society pursues forward movement constantly and eagerly. On the other hand, it appears to cast looks backward that are regretful and tender. Interestingly, closer scrutiny reveals that these apparently conflicting propensities spring from the same source—our impatience with contemporary affairs. This impatience leads us to surpass predecessor generations. But it also leads us to overemphasize their happiness. Though it may seem foolish to be impatient with conditions which are improving, we must remember that conditions improve because we are discontented. Satisfaction with the present would mean complacency, and complacency would result in the decay of our labors and contrivances to improve the future.

Thus, evaluating the economic effects of technological change is a qualitative process. It involves the application of certain criteria, explicit or implicit, by which a determination is made as to whether the economic effects are gains or costs. These criteria may be moral or ethical, as well as material. The very word gain in this connection is associative of good, as cost is associative of bad.

The critics of technological change reveal three basic fears: first, the fear of cultural deterioration or materialism; second, the fear of modern warfare; and, third, the fear of insecurity.

Oswald Spengler, Lewis Mumford, Werner Sombart, all three, have expressed the fear of cultural deterioration.[1] J. A. Hobson,

[1] Oswald Spengler, *Man and Technics* (New York: Alfred A. Knopf, 1932), p. 6. Werner Sombart, *A New Social Philosophy* (Princeton: Princeton University Press, 1937), p. 281. Lewis Mumford, *Technics and Civilization* (New York: Harcourt Brace, 1943), p. 104.

himself a profound critic of modern industry, provided a powerful reply. He said:

> . . . To those who brood upon these visions of the past our modern industrial development has often seemed a crude substitution of quantity of goods for quality, the character of labour deteriorating in the process. With the element of truth in such a judgment is mingled much falsehood. *There has never been an age or a country where the great bulk of labour was not toilsome, painful, monotonous, and uninteresting, often degrading in its conditions. Bad as things are, when regarded from the standpoint of a human ideal, they are better for the majority of the workers in this and in other advanced industrial countries than ever in the past, so far as we can reconstruct and understand that past.*[2]

War is as old as man, and older if one considers the larger animal world. Though it cannot be blamed on technological change, modern technics do make its conduct (destructiveness) seem more efficient and more terrible. In this connection, it seems well to remember two things. First, although modern war is more destructive than primitive in absolute or mass terms, it may not be so in relative terms. Second, fear of the destructiveness of modern war has tended to be overestimated (which is fortunate if it provides a deterrent).[3]

Fear of insecurity is perhaps the most pervasive of all. It is so important in the evaluation of technological change that it must be examined in great detail. Carroll R. Daugherty spoke of this fear with great understanding and feeling in these words:

> In a world of unexpected change and lurking dangers, most human beings appear to desire some system of social arrangements that will provide a measure of certainty and security. This seems to be as true of modern Americans as of their prehistoric forebears; the dangers may be different, but they are there. True, history suggests that there have been long-term fluctuations in the strength of the common urge for security; in the Middle Ages the main emphasis was on security whereas in the seventeenth through the nineteenth centuries there was a swing to adventure in many fields. But the need for certainty has never been absent or weak, and in the recent decades of the twentieth century, perhaps chiefly because of the technological, economic, political and social effects of the previous centuries' adventuring, there has been once more a mass search for security.[4]

[2] J. A. Hobson, *Work and Wealth* (Revised Edition, London: George Allen and Unwin Ltd., 1933), p. 76. Italics added.

[3] Stuart Chase, *Men and Machines* (New York: Macmillan, N. Y., 1929), pp. 314, 315, 316.

[4] Carroll R. Daugherty, "Employment Stability and Income Security," *The Annals of the American Academy of Political and Social Science,* March 1951, CCLXXIV, Labor in the American Economy, p. 39. Professor Daugherty added that job insecurity is the most important of all hazards. He listed four aspects of job insecurity: (1) arbitrary discharge by employer; (2) technological unemployment; (3) economic misfortune which strikes the employee's particular employer; and (4) general business depression.

Cultural aspects of technological change will be dealt with elsewhere in this volume. And war cannot be blamed on technics, so that control over the latter holds no hope with regard to eliminating the former. Therefore, *the first criterion significant to this evaluation is economic security. A second criterion is living standards,* defined in the widest sense. Of course, there are important qualitative elements in living standards. For example, critics have questioned the ends to which increased leisure is put. In this respect I admit optimism. I believe increased leisure is a necessary prerequisite to the development of behavior or activity standards more agreeable to the critics. *A third criterion is individual freedom,* so that each person may work at a job according to his tastes and abilities. *A fourth is resource allocation in accordance with consumer desires. Fifth is equitable income distribution.* Equity is complex, involving a recognition of three elements: economic contribution, need, and avoidance of extremes of inequality. Obviously, these five criteria are not completely consistent with each other.

In addition to setting forth the above criteria for judging the economic effects of technological change, it is important that we ask: what are the economic effects of technological stagnation? Thus, if security requires inhibiting technological progress, we shall have some idea of the price required for security.

One study seems especially pertinent. It is by the staff of the Joint Committee on the Economic Report, and concerns "Underemployment of Rural Families." The staff remarks:

What are the underlying forces which have caused entire communities and areas to develop into small, low-productive farming units and rural towns with inadequate employment for their workers? What are the differences between these communities and those in more productive areas which have developed the most efficient farming systems and the highest rural living standards in the world?

We noted that over 40 per cent of these under-employed farm families are tenants. Why haven't these tenant families moved to larger or more productive farms or into higher paying, non-farm employment? *Here again we do not find a few "poor" tenant families in otherwise prosperous farming communities. Rather, these low-productivity tenant families are the prevailing pattern throughout many of the Southern States.* There is no simple explanation for the persistence of these conditions today. Among the basic causes are the low level of income, education, and health of these families which keep them from learning of alternative opportunities and from taking advantage of better farming methods as they are developed. *Mechanization has been held back in these communities* *by the existence of a large labor force seeking employment and by prevailing low-wage levels.*[5] (Italics added.)

Of apparent importance in the above connection is the wasted manpower and underemployment associated with retarded technological conditions.

II. *The Economic Effects of Technological Change*

Five criteria have been suggested for the evaluation of the economic effects of technological change. Such an evaluation is now attempted, in an effort to assess costs and gains.

A. *Technological Change and Living Standards*

Technological change elevates living standards by expanding productivity (output per man-hour). The essence of this process is economic dynamism, involving greater productive efficiency in the combination of capital (tool power) with labor and natural resources. Such dynamism has been basic in the American economy, which Ewan Clague, Commissioner of Labor Statistics, described as characterized by speed and change.[6]

Coal mining is an outstanding example of the results of change in the United States, relative to changes in other countries. Thus, John L. Lewis ascribed the low output of coal per man-hour in England to the opposition of British labor unions to the introduction of machinery and to the utilization of power and automatic devices.[7]

Foreign countries know this. Thus, many trade missions have come to our shores from the countries of northern and western Europe, with the specific purpose of investigating our production techniques and developing studies of productivity. At the 1947 International Statistical Conference, Colin Clark described the relative U. S. position statistically by comparing earned income per hour worked for China, India, Italy, the Netherlands, Australia, and the United States

[5] *Underemployment of Rural Families,* by staff of Joint Comm. on Economic Report, 82nd Congress, 1st Session (Washington 1951), pp. 22-24.

[6] Ewan Clague, "The American Worker and American Industry," *Monthly Labor Review,* July, 1950, LXXI, No. 1, entitled: Fifty Years Progress of American Labor, pp. 5, 8.

[7] Statement, John L. Lewis, before Senate Committee on Labor and Public Welfare, March 7, 1947, pp. 1987-1989. See also: Ewan Clague, *International Comparisons of Wages, Labor Cost, and Productivity, with Special Reference to Strategic and Critical Minerals,* Statement before National Resources Economic Subcommittee, Senate Committee on Public Lands, June 13, 1947.

during the years 1925-1934.[8] Chinese received 3 cents per hour, Indians 8 cents, Italians 18 cents, Netherlanders 44 cents, Australians 64 cents, and Americans $1.00. The figures are, of course, comparable, being based on international units defined as the quantity of goods and services exchangeable for $1 during the period 1925 to 1934.

Of some significance in the relationship of technological change, productivity, and living standards is the fact that it is a two-way street. Improved living standards generate in turn, greater technological change and productivity.

Workers attach great importance to the physical conditions of employment. Among these are the dangers of accident and occupational illness, the work pace, plant appearance and facilities (sanitary, eating, first aid), and opportunities for rest and relaxation.

Significant changes have been made in these areas, particularly in the past 50 years. For example, considerable attention has been directed to the increasing intensity of work. More extensive application of machine processes and mechanically paced operations have imposed upon workers a rest and work rhythm predetermined by engineering considerations. Where workers still retain considerable control over the speed of operation, production standards, incentives, and preplanning of work have probably intensified the work pace. These developments have caused many students concern over the resultant monotony and fatigue, leading them to emphasize these as costs of technology. In this connection, I agree with J. A. Hobson's observation that "There has never been an age or a country where the great bulk of labour was not toilsome, painful, monotonous, and uninteresting, often degrading in its conditions."

As a matter of fact, recent strides in rest, vacation, and health programs, resulting from collective bargaining and employer policy, are major offsets to fatigue and monotony. Labor and management are acutely conscious of these problems and anxious to alleviate or overcome them. Paid vacations, longer week-ends, and rest periods to break the working-day are becoming general. Lately, collective bargaining has focused attention on medical and welfare programs. The apparel, steel, automobile, and mining industries are outstanding examples. These developments have made the workers' jobs more attractive. They have probably lengthened his working life and advanced the probability of more continuous active work and income.

[8] Colin Clark, *Theory of Economic Growth,* paper before International Statistical Conference, September 11, 1947.

Plant layout, appearance, and facilities have advanced in marked degree. Improved construction standards and work flow planning are, in considerable degree, responsible. However, there has also been a wide realization that worker efficiency is related to physical comfort on the job.

Of particular importance is the advancement in workmen's compensation legislation. By making the employer liable for certain occupational injuries and diseases, it has made improvement in the physical conditions of labor a direct economic advantage. At the beginning of the century such laws were almost nonexistent. Today they are enforced by all states. In addition, they have been expanded in their coverage. And this is not all. Safety programs are actively pursued. Much effort is expended so that new machinery will be fully equipped with safety devices. On balance, therefore, one is led to conclude that working conditions have improved in striking fashion.

In summary, improved American living standards, based on technological change and expanded productivity, have meant: (1) higher real wages; (2) shorter hours and increased leisure; (3) more extensive schooling; (4) a greater margin of family spending on items other than food, housing, and clothing; (5) a longer life expectancy at birth; (6) better working conditions (factory decentralization, less arduous labor, vacations, sick leaves, etc.); (7) improved nutrition; (8) improved housing (central heating, electricity, household appliances, baths, flush toilets, running water, etc.); (9) better family living (a growth of such noneconomic functions as recreation, travel, reading, plus the trend toward suburbanization); (10) improved status of women (more freedom outside the home, plus the great lightening of the once harsh and burdensome responsibilities of the housewife in food preparation, laundering, cleaning, and making and maintenance of family clothing); (11) ability of the economy to maintain an increasing proportion of the labor force in scientific and professional pursuits (yielding, in turn, a rich harvest in medical and technical research with ever-widening ability to apply the results of such research); and (12) an improved life for farmers (increased incomes and less arduous labor due to more extensive application of machinery, and a less isolated life due to automobile and radio).

This is an imposing list of material accomplishment. In its face extreme caution and skepticism must be the correct reaction to philosophers who would sacrifice it to a vague end they term "culture." It seems much too easy for them to identify the plodding resignation engendered by a life of long and arduous toil with "culture."

B. *Technological Change and Economic Security*

The desire for security is not limited to any one social or economic group. Propertied groups wish for the preservation of their property value, while labor groups are vitally concerned with the protection of their earning power. The latter face perhaps the greater economic problem, since they are individually less capable of protecting themselves against economic vicissitude than are the propertied groups. Specifically, labor requires protection against three hazards: accident and illness; old age; and unemployment. Accident and illness and old age are insurable hazards, in the sense they are predictable group risks without the likelihood of simultaneous, mass occurrence. This is not the case with unemployment. Thus, the insurable risks can be protected against by group action, so that both group and individual achieve security. In the case of unemployment, however, insurance cannot overcome the hazard for society.

Unemployment is of several types, some being unrelated to technological change (viz. arbitrary disciplinary action by employer, and employer misfortune due to altered consumer demand unrelated to the introduction of a new product). Some types, however, may be caused by technological change. These are: technological unemployment; cyclical unemployment; and secular unemployment.

Unfortunately, the effects of technological change upon employment are usually indirect, for there is no necessary concurrence in time and place between a specific change in technology and the displacement of large groups of employees. Where the introduction of an innovation generally through all industry is involved, the repercussions may cover a long period of time. In such a lengthy period, wars, business cycles, new innovations, fiscal and monetary changes, social and political changes, alterations in international trade, etc., enter and complicate the economic picture. The dynamic world in which technological change occurs makes it most difficult, if not impossible, to isolate its effects. As a consequence, we cannot be positive whether the three unemployment types noted above are distinct or whether they all derive from the same causes. The obscurity of causal relationships makes a theoretical examination necessary.

1. *Technological Unemployment.* This type of unemployment involves labor displacement due to: (a) new products or services; (b) altered input-output ratios; and, (c) new power sources or new materials. By definition, there can be no argument as to the relationship between technological change and unemployment in this instance.

However, it does not follow that technological unemployment is a clear and complete cost of technological change. Two factors warrant caution: first, technological change often creates employment which is an offset to its labor displacement effect; and, second, technological unemployment is usually not a permanent group phenomenon.

The employment creating effect of technological change would seem to be greatest where an innovation in product, service, power source or material is involved. In such instances new industries arise, causing three-fold expansion in the economy. First, employment opportunities are created in the production of the new item or service. Second, a stimulation of the capital goods industries occurs due to the need for new productive equipment. Third, new industries usually require activities in the fields of distribution, transportation, service, and maintenance. These developments may enlarge business borrowing and with a "multiplier" effect increase the volume of production, consumption, and employment. Of course, the elasticity of demand for the new product, service, power source, or material will also influence its employment-creating potential. Thus, it appears that 18 new manufacturing industries, which came into existence since 1879, absorbed almost one-seventh of all the labor employed in manufacturing in 1929.[9] In short, technological changes are complementary to, as well as substitutive of, labor.

Unfortunately, the employment creating impact of technological change is not always so great as indicated above. This would appear to be the case particularly with respect to alterations in input-output ratios. Thus, Corrington Gill, in a study for the Works Projects Administration, National Research Project, observed:

> . . . The particular feature of recent developments is the important part played by a multitude of refinements and improvements which are a day-to-day outgrowth of developing science and technology. . . . The typical changes in industrial processes at the present time are the day-to-day improvements of already existing equipment; they are usually not spectacular, and many of them require relatively small capital outlays.[10]

Consequently, the labor displacement effect of technological change must be judged on a *net* basis over the entire economy. This is quan-

[9] *Machinery, Employment and Purchasing Power* (New York: National Industrial Conference Board, 1935), p. 61. For labor-displacing effects of technology between 1899-1936, see F. Mills, *Employment Opportunities in Manufacturing Industries of the U. S.* (New York: National Bureau of Economic Research, 1938).

[10] Corrington Gill, *Unemployment and Technological Change* (Philadelphia: Works Projects Administration, National Research Project, Report No. G-7, April, 1940), p. 61.

titatively difficult to determine. However, it seems clear that we cannot conclude that the *net* effect of technological change is unemployment.

If the net effect of technological change, on an economy-wide basis, is not unemployment, it follows that the labor displacement which does occur is essentially temporary in nature. Though this may be true on an over-all basis it must not blind us to some very real costs of technological unemployment, due to changes in the location of activity, transformation in the nature of the employment offered, or change in the type of persons hired. These costs are: (a) erosion of individual skills and experience; (b) the need for changing one's job, and perhaps the locale to which one is attached; and, (c) the fact that some individuals never make the changes required. Consequently, they are freed from their bitter disappointment only by death.

Yale Brozen discussed the first of the above costs:

> . . . For reasons similar to those outlined by Stigler for not compensating thieves for remaining inactive, *the initiation of a policy which will hurt investors who have placed their capital in items or skills made obsolescent or obsolete should not be slowed or halted because of the harm to them.*
>
> This point is important in any discussion of innovations because the owners of specialized capital are peculiarly vulnerable to technological change. *Capital is embodied in production equipment and in human skills, most of which are fairly specific to the purposes for which they are intended.* The value of special purpose equipment and skills is dependent upon the value of the services produced in the specialized operation. If those services become less valuable, then the equipment or skills producing those services become less valuable. A capital loss is the result.
>
> Inventions have a strong effect upon the value of such special services. They may make services more valuable by creating new uses for them. More likely is the prospect that they will make services less valuable by creating means of producing them more cheaply or by replacing them. It is in this role that technological change has been severely castigated for causing great "waste" of the available quantity of capital through "unnecessary" obsolescence. Innovations often decrease the (subjective) quantity of capital by reducing the valuations of existing equipment.[11]

Corrington Gill discussed the second and third costs:

> The process of industrial change is by its very nature accompanied by a constant displacement and reabsorption of labor. New occupations, plants, and industries come into existence while old ones decline, new areas become industrialized while old ones become "stranded," a technological change results in a new product or process that displaces an old product or process, job requirements

[11] Yale Brozen, "Welfare Theory, Technological Change and Public Utility Investment," *Land Economics,* XXVII, No. 1 (Feb., 1951), p. 68. Italics added.

are altered, fewer workers are needed to meet the requirements of production, and as a result workers lose their jobs. Under these circumstances, even when such changes are accompanied by an absolute increase in the total amount of employment offered, unemployment of individuals and groups of individuals is continually being created because of changes in the location of activity, transformations in the nature of the employment offered, or changes in the type of persons hired.[12]

As a consequence, some have wished to regulate management's right to introduce technological changes (by reducing obsolescence and depreciation allowances in tax laws, by taxing technological changes directly, by licensing the introduction of technological changes, etc.). Others, while not interfering directly with technological change, insist upon the retention of redundant workers on payrolls (by output restriction and make-work rules). Both policies are unsatisfactory. They would sacrifice real long-term economic gains to short-run costs.

The proper policy would appear to be one which recognized and met the short-run costs, while avoiding any inhibition of the long-run gains. I believe the following measures constitute such a policy: (a) advance planning by management and notification of labor concerning expected displacements; (b) preference to displaced workers in filling vacancies; (c) vocational guidance and training, on an individual and group basis; (d) promoting the geographical mobility of labor; (e) encouraging the development of alternative employment; (f) shorter hours of work; and, (g) monetary assistance for displaced labor during the readjustment period (by unemployment insurance and relief, severance pay which should have limits so as not to inhibit technological change, etc.). These programs would, of course, require the cooperative participation of labor, management, and government. Thus, for example, business, trade union, and government employment services would have a significant role in advising and assisting displaced labor.

A conclusion, of considerable significance, is relevant at this point. It seems reasonably clear that the *necessary* relation of past costs of technological change to gains is less than the *actual* costs experienced. This is implicit in a program, such as the one just presented, to meet the costs of technological unemployment. It is also evident in the physical improvements in work conditions, earlier discussed, which offset the dangers of monotony, fatigue, illness, and accident. Conse-

[12] Corrington Gill, *op. cit.*, p. 11, See also; Harry Ober, "The Worker and his Job." *Monthly Labor Review*, July, 1950, pp. 13-14.

quently, it appears that the future course of technological change may be marked by more of the gains and less of the costs.

2. *Secular Unemployment.* A number of students have disagreed with the observation that technological unemployment, on an economy-wide basis, is essentially temporary in nature. They have maintained that technological change results in a permanent and increasingly numerous unemployed.

The belief that technological unemployment is secular, and not temporary, is at least a century old. Perhaps the strongest early proponent of this view was Karl Marx. In his theory of the "industrial reserve army," he summarized his views on the long-run effects of machine-industry on the laboring class. These long-run effects were determined by the "law of capital accumulation," or the growth of capital. This law underlay, in the Marxian view, the entire evolution of capitalistic industry, and determined the inherent trend of capitalism toward its own transformation.[13]

According to Marx, the industrial reserve army could be found in different countries in three forms—the floating, the latent, and the stagnant. The "floating" surplus of labor existed in the centers of modern industry and included in large part young persons who enter industry as boys and who are not given a permanent place in it. The latent surplus population is found largely in agriculture. The stagnant surplus population is formed by groups of labor living below "the average normal level" of the working class. They are recruited from decaying branches of industry and, as a rule, have large families and thus supply "an inexhaustible reservoir of disposable labour power." Marx illustrates this generalization by reference to miserable living conditions found among some strata of the working population of England and Ireland.

Another view, non-Marxian in nature, sees employment and unemployment as the result of four arithmetical factors: national productivity; the labor force; the national income or product; and the average hours of work. Technological change increases national productivity. This makes for a secular increase in unemployment unless offset by corrective movements in the other three factors. Normally, it is our hope and expectation that the offset will come primarily from an in-

[13] Karl Marx, *Capital*, Vol. 1, "The Process of Capitalist Production," translated from the 3rd German edition, by Samuel Moore and Edward Aveling and edited by Frederick Engels, revised and amplified according to the 4th German edition by Ernest Untermann (Chicago: Charles H. Kerr and Co., 1918), p. 693 *et seq.*

crease in national income, and secondarily from shorter hours or a relatively smaller labor force. However, if the other factors change perversely or insufficiently, then the productivity increase will result in a rising unemployment. An important aspect of this view is the idea, held by some, that secular unemployment could be controlled by public regulation of one or more of the arithmetic factors which determine it. Unfortunately, there isn't a precise *statistical* technique for quantitatively measuring the four factors. There is, therefore, an unhappy margin for error. The margin is sufficiently wide to involve policy mistakes which could be more serious than the ill they were designed to cure.

A third group foreseeing secular unemployment is the Stagnationist School. Five asserted developments play key roles in the thinking of this group: (1) a declining rate of population growth; (2) the passing of the frontier; (3) a dearth of new, heavy-investment industries; (4) the increasing importance of capital replacement; and, (5) the increasing conservatism of investors. According to the stagnationists, these five factors have made the United States a mature economy. Their view is Keynesian in orientation,[14] emphasizing that investment must be large enough to absorb all the savings that will be made at the national income level necessary to maintain full employment. They feel, additionally, that technological change has made innovations more efficient, so that less investment is required to produce any given output.

The opponents of the stagnationist position maintain there is little meaning to the mature economy argument of a limited number of available important investment outlets. In their view, the availability of investment outlets hinges on the anticipated profitability of a tremendous range of possible investments. According to them, continued income and employment growth requires: (a) price-cost flexibility and freedom from monopoly restraints; (b) a favorable climate for private investment; and, (c) facilitation of the savings-investment process.

Temporary technological unemployment can be dealt with as noted earlier, and does not arouse the dread specter of a constantly augmented army of workers without work. The latter fear is aroused most intensely in severe depressions. However, the fear of secular

[14] Report of the Subcommittee on Unemployment, Joint Committee on The Economic Report, Congress of the United States, pursuant to S. Con. Res. 26, 81st Congress, 2nd Session, pp. 87-89.

unemployment, which springs from recession and depression conditions, may be based on a projection into the future of an existing gloom. Before secular unemployment is accepted as a cost of technological change, and serious policies adopted to meet it, we *must* answer this query: Why have all depressions been succeeded, to date, by ultimate revivals and prosperity—in the face of a continuing, rapid rate of technological change? The fact of revival, coupled with continued technological change, constitutes a fundamental challenge to the thesis that technological change dooms us to secular unemployment. It is more than a century and a half since the birth of the Industrial Revolution. If technological change displaces labor over the long-run, how is it possible that advanced industrial nations are not peopled by hordes of unemployed, hopeless, totally displaced workers? Enough time has certainly elapsed for the secular trend, if there is such a trend, to manifest itself unmistakably and indisputably.

3. *Cyclical Unemployment.* Dr. Theodore J. Kreps stated before the Temporary National Economic Committee, which he was serving as economic adviser: "Technology for decades has been vigorously attacked as one of the major causes of depression, not only in the United States but throughout the world." [15]

Unfortunately, the complaint that technological change causes cyclical unemployment is not easily susceptible of proof. The basic reason is that the relationship between the two is tenuous and indirect. Two schools of thought are discernible among those relating technological change to cyclical unemployment: (a) the scale of enterprise school; and (b) the Marxian.

(a) *Scale of Enterprise School.* This group discerns a chain reaction running from technology, to increasing scale of enterprise, to greater concentration of enterprise, to price inflexibility and output restriction, to unemployment. Before the asserted chain reaction is accepted, however, the following propositions must be clearly documented: (1) Technological change is responsible historically for increasing the scale of enterprise, through shifting the optimum scale away from smaller enterprises; (2) The historical relationship thereby established is irreversible due to future technological change; (3)

[15] Hearings before the Temporary National Economic Committee, Congress of the United States, 76th Congress, 3rd session, pursuant to Public Resolution No. 113 (75th Congress). Investigation of Concentration of Economic Power, Part 30, *Technology and Concentration of Economic Power,* April 8, 1940, p. 16210. See also: Report of the Secretary of the Interior, 49th Congress, 1st Session, House of Representatives, Ex. Doc. 1, part 5, 1885, p. 11.

Larger scale enterprise is responsible for increasing the concentration of enterprise; (4) Concentration of enterprise is responsible for price inflexibility and output restriction; and, (5) Price inflexibility and output restriction are responsible for cyclical unemployment.

Many studies have been made which are pertinent to these propositions. John M. Blair, of the Federal Trade Commission, agrees that there has been a historical concurrence between growth of the scale of operations and changing technology.[16] The technological changes contributing to this trend were the use of new power sources (steam), new materials (steel), new machines and processes (expensive, single-purpose machines and mechanical processes), and new transportation forms (railroads). However, the trend toward increasing scale has not been universal or continuous. Mr. Blair believes the evidence indicates that in manufacturing the movement ended in the World War I period, with the proportionate importance of large plants with over 1,000 wage earners rising only slightly between 1923 (23.3 per cent) and 1937 (26.9 per cent)—years which were of roughly comparable levels of economic activity.[17]

Even if we were to grant that technological change was responsible for increasing scale, it would not follow that this connection could not be sundered by future technological developments. As a matter of fact new techniques are tending to promote a smaller scale of operations.[18] These technological changes are in the use of new power sources (electricity), new materials (light metals, alloys, plastics, and plywood), new machines and processes (more flexible and adaptable multi-purpose-machines and chemical processes), and new transportation forms (motor truck and automobile).

Stocking and Watkins see, on a purely economic basis, four basic forces encouraging concentration: technical, commercial, financial, and strategic. The technical forces influence the physical processes of production—the refining, fabricating, assembly, or delivery of goods. The commercial forces relate to the buying and selling of goods. The financial forces influence the provision of capital and the distribution of income. The strategic forces have to do with the maintenance or strengthening of a firm's market position, relative to other producers and consumers. Significantly, these two students state that "Probably

[16] John M. Blair, "Technology and Size," *American Economic Review,* XXXVIII, No. 2, (May 1948) Papers and Proceedings, pp. 125-126.

[17] George W. Stocking and Myron W. Watkins, *Monopoly and Free Enterprise,* (New York: Twentieth Century Fund, 1951), p. 68.

[18] John M. Blair, *op. cit.,* p. 129.

the most persistent and pervasive influence fostering growth in the size of business units has been the quest for power to control the market. . . ."[19]

There is some significant statistical evidence, relevant to the above points, which makes questionable the asserted relationship between size (concentration) and efficiency (optimum scale).[20] In this connection, Dr. Myron Watkins, who studied efficiency of consolidated ownership, observed:

> Since 1929, I have followed the reports of investigations along this line by numerous other students and frequent, often heated debates upon the significance of their findings. Some have used Census data, some have used corporation income tax data, others have used the published financial statements, as I did. Though a few have professed to find evidence of a positive correlation between size and earning power, in my judgment a closer scrutiny of the facts disproves such an interpretation.[21]

It would seem that concentration of enterprise was not fundamentally the result of anticipated savings due to improved efficiency. This does not, however, appear to be the case with regard to market control. *That* power is desired by businessmen for itself. We cannot, therefore, blame concentration solely upon technology. Further, an industry may be tightly monopolized despite a low concentration ratio (through a price-fixing agreement, etc.). And size does not invariably mean market power.

The tenuousness and roundabout character of the chain reaction, asserted by the scale of enterprise school to connect technological change and cyclical unemployment, seems clear. It dampens the idea that regulatory policies relative to the rate of technological change would be, or could be, effectively transmitted through the chain so as to reduce or eliminate cyclical unemployment. A more direct attack on concentration would appear to offer greater promise of influencing price inflexibility, output restriction, and cyclical unemployment.

(b) *The Marxians.* Karl Marx explained the business cycle in terms of the factory system in a capitalistic context. He said:

> So soon as the factory system has gained a certain breadth of footing and a definite degree of maturity, and especially, so soon as its technical basis, ma-

[19] *Op. cit.,* p. 81.
[20] Arthur S. Dewing, "A Statistical Test of the Success of Consolidations," *Quarterly Journal of Economics,* XXXVI (November 1921) pp. 90, 91. See also: John M. Blair, *op. cit.,* pp. 146, 147.
[21] Myron Watkins, TNEC Monograph No. 13, *Relative Efficiency of Large, Medium-Sized and Small Business,* 1941, pp. 138, 139.

chinery, is itself produced by machinery; so soon as coal mining and iron mining, the metal industries, and the means of transport have been revolutionized, so soon, in short, as the general conditions requisite for the production by the modern industrial system have been established, this mode of production acquires an elasticity, a capacity for sudden extension by leaps and bounds that finds no hindrance except in the supply of raw material and in the disposal of the produce.[22]

Briefly, employment expansion takes place by stops and starts, in the course of which labor is hustled from pillar to post and constant changes take place in the sex, age, and skill of the workers.

The Marxian concept is fundamentally different from that of the scale of enterprise school. The latter does not require the overthrow of capitalist institutions. The former does. Several observations seem pertinent: (1) Marx would certainly have opposed restricting technology, insisting instead that the economic system required altering; (2) an alteration of our economic system is not the core of this paper; and, (3) if such an alteration were suggested (as by Communists), I would reject the suggestion. This I would do on two fundamental grounds: first, the lugubrious prophecies of Marx have fallen before the amazing resiliency of capitalism and its ability to develop superior living standards for labor; and, second, communism in practice becomes totalitarian.

C. *Individual Freedom, Resource Allocation in Accordance With Consumer Desires, and Equitable Income Distribution.*

These three economic criteria are not usually discussed in connection with technological change, perhaps because the relationships seem less direct than is true in the case of living standards or security. Yet some brief, general observations appear proper.

Technological change has contributed unmistakably to increased geographic mobility, improved educational facilities, greater leisure, and an increased variety of goods and services. These developments have, in turn, had a great impact upon individual freedom and resource allocation in accordance with consumer preferences. The mass population shifts of the nineteenth century, based upon changes in transportation technology, were of unquestioned significance in the development of individual freedom in the political, social, and economic areas. And it seems impossible to overstate the significance of

[22] Karl Marx, *op. cit.*, p. 492.

greater leisure in terms of freedom. With man's spatial and time freedom vastly expanded, technology provided also a multitude of goods and services capable of contributing to the enjoyment of this freedom. Mass public education to high levels, possible only for a population raised above the bare subsistence level by technology, enabled the people to more profitably use their freedom. Not that mass standards of consumption or relaxation are always pleasing to the philosopher. They are not. But objection to the manner in which the mass uses its freedom of consumer choice and of relaxation must not blind an observer to its existence. I believe this freedom basic to any advancement in mass standards of consumption and relaxation.

Increased variety of goods and services means increased occupational and investment freedom of choice. Rising living standards and better general education enable the people to more effectively transmit their preferences as to the allocation of resources via the market mechanism. Of course, deception in quality and in advertising become possible on a mass basis too. But the answer to deception cannot be a halting of technological change. Rather, it must be the requirement that only honest information concerning a product be disseminated. And with an educated population the dissemination of honest information has a good chance of being understood and used.

Karl Marx was convinced industrial capitalism meant the degradation and misery of the laboring population. In his view, capitalism would, in its advanced prerevolutionary stage, contain two economic classes: the few great capitalists and the suffering proletarian masses. This was the Marxian concept of the impact of the factory system upon capitalistic institutions. Equity in income distribution was simply not possible in a capitalistic context. History has shown the extent of Marx's error. Need, a criterion of equity elevated to the highest level by Marxians, is recognized and provided for in advanced capitalistic societies to a degree believed impossible by Marx. Even equality has been considered to the extent of regulating extremes of inequality. Of course, the basic economic criterion of capitalistic distribution remains economic contribution to production, a criterion accepted as fundamental by the Soviet Union—followed some unhappy early experiences with the importance of individual incentives as a necessary inducement to individual effort. Withal, technological change within capitalism has enormously enriched living standards, and so demonstrated a clear ability to contribute to greater equity in income distribution.

III. *Should the Rate of Technological Change be Controlled?*

This appears to be the basic issue rising from the foregoing analysis. This question, however, may be broken down into several subordinate ones, viz. (A) Why should the rate of technological change be controlled? (B) Can a suitable rate of technological change be determined? (C) Who would establish and administer the rate of technological change?

A. *Why should the rate of technological change be controlled?* As seen in our earlier analysis, many students are convinced that technological change causes economic insecurity. Of these observers, some hold security to be the fundamental economic criterion. They believe an effort should be made to control technological change. Since economic security is so widely esteemed, this belief must be met squarely.

We have dealt with the various sorts of economic insecurity related to technological change, and rejected the idea that property values should be insulated against the influence of economic change. What of life values (earning power)? Accident, illness and old age are insurable hazards. And our society has been extending such insurance. Unemployment, however, remains essentially an uninsurable risk. Therefore, it is the fundamental type of insecurity underlying the demand for control over the rate of technological change. It is on this touchstone (job security) that we must judge the demand.

Technological change is responsible for a form of essentially temporary labor displacement, which has been called technological unemployment. A diversified program has been suggested which is aimed directly at this type of unemployment, and which does *not* require any regulation of the rate of technological change. This program, in its essential parts, was suggested by the International Labor Office.[28]

Unfortunately, however, this program is not of sufficient scope to deal effectively with such problems as cyclical and secular unemployment. But, as we have seen, regulating or inhibiting the rate of technological change is not at all sure to be effective as a contracyclical device. The relationship between technological change and cyclical unemployment is too tenuous and indirect. And there is a funda-

[28] *Technological Improvements in the Iron and Steel Industry and Their Effects on Employment,* Iron and Steel Committee, International Labour Organization, International Labor Office, Geneva, 1949.

mental question as to whether we face the problem of secular unemployment at all.

Two other observations appear pertinent in this connection. First, if we grant that inhibiting the rate of technological change would provide full employment (which is not at all certain), it would not be *efficient* full employment. Some, perhaps many, will be working less effectively than would be the case with no inhibitions on technological change. Therefore, are we not merely substituting one form of underemployment of our labor resources for another? Second, we must realize that many students would place other criteria (rising living standards, freedom) before security. Many would be loath to sacrifice rising living standards and freedom to security.

Fortunately, it appears that we need not face this harsh choice between important and desirable alternatives. Since there is no certain basis for believing that regulation of the rate of technological change would favorably influence cyclical unemployment, and since it is not certain that secular unemployment exists, it would appear foolhardy to introduce a program of regulating technological change. This is the conclusion to which the analysis impels us.

B. *Can a suitable rate of technological change be determined?* This question may be further divided into two subordinate ones, viz. (1) What statistical problems must be faced in determining a "suitable" rate of technological change? and (2) what qualitative problems must be faced in determining a "suitable" rate of technological change?

(1) *Statistical Problems.* It has been pointed out that unemployment is the result of four arithmetical factors: national productivity; the labor force; the national income or product; and the average hours of work. Productivity, of course, is assumed to be a function of technological change. The instant problem, therefore, would be to so regulate technological change (productivity) relative to the other three arithmetical factors, as to maintain full employment. Obviously, such a procedure requires sufficiently reliable and precise quantitative indicators of the five variables (including unemployment) involved. We do not have *precise* quantitative indicators of these variables. Let us take productivity and unemployment as examples.

Productivity. There are various concepts relative to measuring productivity. The most common involves relating units of input, hours of labor or units of electrical energy, to units of output. To be most meaningful, this procedure requires physical output units. Thus, the major quantitative productivity studies have applied mainly to manufacturing, mining, utilities, etc. These industries account for less than half of the national output. Also, in recent years, the major expansions in employment have taken place in trade, services, and government. In these sectors of the economy, productivity is extremely difficult to measure.

Solomon Fabricant has warned consumers of productivity data that it is not accurate to speak of a specific average annual percentage advance. According to him, it is more accurate to speak of a range (1.6 to 2.2%) within which average annual productivity advances fall.[24] But this range involves a wide variation from the lowest to the highest limit! Yet this is the data on which specific policies relative to regulating the rate of technological change would have to rest.

Unemployment. We have read citations from many studies concerned with the relationship between technology and unemployment. Certainly there has been considerable expenditure of time and effort for the purpose of ascertaining the facts, extending back over a decade to the depression conditions of the 1930's. Yet, in 1950, the Subcommittee on Unemployment of the Joint Committee on the Economic Report, Congress of the United States, observed:

> Probably the most significant need established by the subcommittee's investigation was the lack of information on the location, number, and characteristics of unemployed workers and their families. Who are these unemployed persons? Do they have families? How old are they? What skills and aptitudes do they have? And, where are they? Since the Nation has recognized its responsibility for high levels of employment, production and purchasing power (in the Employment Act of 1946), there should be available the necessary statistical measures to implement this responsibility. Consequently, the subcommittee recommends that study be given immediately to the problem of providing, on a regular basis, regional and area information on the volume of total unemployment.[25]

Lack of information is not the only problem met in working with unemployment data. There is the more fundamental one of defining "unemployment." Thus, in general, all persons over fourteen years of age actively seeking gainful employment are considered as comprising the labor force. Of these, those not having jobs are considered unemployed. But the definitions are broad, and statisticians disagree sharply over many of the details.

[24] Solomon Fabricant, "Of Productivity Statistics: An Admonition," *Review of Economics and Statistics*, XXXI, (November 1949) pp. 309-311.

[25] *Employment and Unemployment*, Report of the subcommittee on Unemployment of the Joint Comm. on the Economic Report, U. S. Congress, pursuant to S. Con. Res. 26, 81st Congress, 2nd Session, p. 1.

(2) *Qualitative Problems.* The determination of a "suitable" rate of technological change involves the application of those economic criteria presented in the early pages of this essay. Shall security be the touchstone of the proper rate, or living standards? What about freedom in the effort to enforce the rate of technological change? In setting a rate, and allocating productive resources in accordance with that predetermined rate, what shall rule—present or future living standards? How is the time preference of the society to be determined? These are but a few sample questions indicative of the qualitative problems involved in establishing a "suitable" rate of technological change.

Plainly, the quantitative and qualitative problems facing the one who would attempt to establish a proper rate of technological change are formidable.

3. *Who would establish and administer the rate of technological change?* The task would have to be undertaken by government. This bald statement, of course, brings us face-to-face with a basic question: Can the rate of technological change be planned by government without substituting a planned economy for an individualistic one?

With the rate of technological change planned, the allocation of the productive power of society would depend upon the decision of a central authority. Instead of allowing capital creation to be determined by individual decisions transmitted through the market mechanism, the government would decide how much capital ought to be produced. To be effective, production resources would then have to be assigned to produce the capital determined upon, with the remaining productive resources allocated to consumers' goods production. Of course this would be a planned economy.

If a centralized bureau were to attempt to direct the rate of technological change, within a capitalistic context, these problems would present themselves. Suppose a basic innovation cutting across industry lines. Which industry, or industries, would receive the benefits of the innovation first? What practical considerations would dictate this decision? Or, suppose the government bureau rejected a specific technological change. How would one go about initiating the change in the face of such a rejection? Obviously, either the freedom to introduce the change or the planning would have to be sacrificed. Under Capitalism there are a multitude of chances for the introduction of a change.

The final conclusion seems inescapable. The demand that the rate of technological change be controlled must be rejected because: (1) it would not guarantee economic security; (2) it would, at best, substitute one form of underemployment for another; (3) the quantitative indicators necessary for the effective application of such a policy are not sufficiently precise to guarantee against a potentially tragic margin of error; and (4) control over the rate of technological change would be likely to result in a fundamental alteration in our economic system in the direction of over-all planning.

ADJUSTMENT, INDIVIDUAL AND SOCIAL, TO TECHNOLOGICAL CHANGE

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Introduction

MANY OF THE HUMAN problems of industrialism, including adjustment to technological change, appear to have crept up on man when he wasn't looking—or perhaps when he was looking the other way or at something else. During the first industrial revolution in England—and for some generations thereafter—he was certainly looking very hard at a popular though abstract portrait of himself, Economic Man. Over the past thirty years—while mass production methods were coming of age—many factory managers and industrial engineers had their eyes fixed only on blueprints and time study calculations. If they occasionally looked up at the workers in their factories they saw Man—to borrow Peter Drucker's phrase—only as a rather "badly designed single purpose machine tool."

Impact of Major Technological Changes

The question of adjustment, individual or social, to technological change may be divided into two main problem areas: that connected with a major or revolutionary innovation and that comprising day to day cumulative shop changes.

Examples of the first, which perhaps come most readily to mind, are connected with those early basic inventions in the textile industry—which provoked the Luddite riots in England. Classic presentation of the social impact of these technical innovations, it is generally agreed, is the series of studies by J. L. and Barbara Hammond.[1]

Since the Hammonds did their brilliant pioneering work, general historians and historians of particular industries have treated later technological "revolutions" with increasing attention to their social and political effects. The sociologist, however, and the cultural anthropologist—and even the economist—have only in recent years come to make an intensive study of such phenomena.

[1] J. L. & Barbara Hammond, *The Village Laborer* (1911), *The Town Laborer* (1917), *The Skilled Laborer* (1919), (New York and London, Longman Green); also *The Rise of Modern Industry,* (New York, Harcourt Brace & Co., 1926).

In the thirties, Elliott Dunlop Smith and Carter Nyman were making their studies of labor and technology based on technological changes in the American textile industry.[2] In this material some of the violent repercussions of these changes in the rural south remind the reader of industrial England in the eighteenth century. In 1941, Sumner Slichter published *Union Policies and Industrial Management,* with its emphasis on the tactics of union resistance to technological change.[3] Finally, the Yankee City studies of Lloyd Warner and his associates included as part of the study of class an analysis of the effect of technological changes on social structure.[4]

Through the twenties and increasingly in the thirties, the impact of technological change attracted increasing public attention; and if only a few scientific monographs appeared on the subject, a great stream of words was pouring forth in public documents. The Hoover report entitled *Recent Social Trends,* published in 1933, discussed the problem, and in the late thirties union leaders and nationally known industrialists filled many pages with testimony and opinions in the hearings before the Temporary National Economic Committee.

Most dramatic testimony before that committee in the field of technological change centered on the creation of so-called "ghost towns" through displacement of hand rollers by the continuous strip and rolling mills throughout the steel industry.

Increasingly as the relation between technology and human behavior has grown to be a subject for serious study by social scientists, it has become evident that the historical approach—or the public hearings approach—is helpful but inadequate. What was needed was the study of major technological changes while they were occurring; it was obvious that the social scientist should be familiar with the human agents *effecting* and the human beings *affected by* change during as well as after the course of the change.

Unfortunately no one studied the great technological revolution in the steel industry referred to above at the time it was happening, although George Homans, of Harvard, followed close on the heels of it by systematically interviewing workers displaced by the new process

[2] Elliott Dunlap Smith, *Technology and Labor,* (New Haven: Institute of Human Relations, Yale University Press, 1939).

[3] Sumner Slichter, *Union Policies and Industrial Management,* (Washingtion, D. C.: The Brookings Institution, 1941).

[4] W. Lloyd Warner and J. O. Low, *The Social System of the Modern Factory,* (New Haven: Yale University Press, 1947), Ch. V., "The Break in the Skill Hierarchy."

in Newcastle, Pennsylvania. From the standpoint of the scientific observer, perhaps one competent study of the installation of say the continuous rolling mill *at the time of installation* might have been worth all the TNEC public hearings on the subject.

From available evidence, at least one important generalization may be made regarding the social costs of such major technological "revolutions." A very substantial part—though not all—of the sufferings of individuals and groups resulting from these innovations could be avoided if there were advance planning by the chief parties at interest—organized management, organized labor and the communities affected.[5]

Effects of Everyday Shop Changes

Important as are these problems of widespread disturbances, to the average practitioner of industrial relations or to the union leader the second problem area, that of shop changes, is the more important. To begin with, the average industrial relations manager or say the president of a local deals with a "major" technological innovation but once in a lifetime or not at all. The problems of shop changes and their disturbing effects, on the other hand, are always present.

Fortunately in the field of shop changes and human relations a considerable body of practical experience and wisdom is available. It is widely understood, for example, by industrial relations managers that there are practical steps which can be taken to remove fear of the effects of change—sometimes as important a cause of disturbance as the changes themselves—and that practical steps may also be taken to compensate for economic losses to workers affected. In addition, the *non*-economic effects of change on status and on social relationships are far better understood today.

It is my experience that every book with any pretense to professional competence in the fields of both human relations and industrial relations will now have a section or chapter on shop changes and their effects. This generalization applies also to general textbooks on industrial psychology and industrial sociology.

Of all the books which the author has read over the years, including the most recent touching this field, the two which in his judgment contain the wisest and most practical thinking on shop changes are

[5] Charles R. Walker, *Steeltown: An Industrial Case History of the Conflict Between Progress and Security,* (New York: Harper and Brothers, 1950), "Conclusions."

Golden and Ruttenberg's *The Dynamics of Industrial Democracy* [6] (still applicable, though published nearly ten years ago), especially because of its inclusion of actual case history material; and Selekman's *Labor Relations and Human Relations,* especially the chapter, "Resistance to Shop Changes." [7] After a very practical discussion of cases, of specific problems and specific proposals for meeting them, Selekman gives an admirable summary of the general problem from the point of view of the industrial administrator:

> Resistance to change in the shop, then, confronts management with a problem that for all its serious import has not yet even received recognition, not to mention a willingness to experiment with measures for its treatment. [This might now be modified to read "with certain notable exceptions," CRW]. Because they know that their ultimate objectives are right, the men who define their goal as the production of ever more goods at ever lower costs resent the interference of other men. Resentment, of course, is itself an emotion; it makes human resistance to shop changes seem like sheer human cussedness. The administrator then becomes hortatory and moralistic when he needs above all an open-minded willingness to approach human interference precisely as he does technical difficulties—as a problem to be studied and solved in terms of its causative factors. Resistance does have its causes; it stems from individual emotions and social interrelationships. The emotions are powerful, but they also are entirely normal. They must be accepted as the typical response of men faced with situations that seem to threaten their customary security systems. Yet change, too, must be accepted. If emotions are the dynamos of human response in social situations, change is the dynamo of technological production in industrial society. (p. 135).

Human Adjustment to the Technological Environment

"The environment of modern man," writes Professor Ogburn, of the University of Chicago, "is to a surprising degree made up of machines much as the environment of wild animals is made up of fauna, flora, wind, rain, and temperature. Even those men and women who do not work on a machine for a living are only once removed from it or its products." [8]

The concept of a *technological environment* which moulds to "a surprising degree" the life of the modern factory worker I have found highly suggestive in studying the problem of adjustment to technological change.

[6] Clinton S. Golden and H. J. Ruttenberg, *The Dynamics of Industrial Democracy,* (New York and London: Harper and Brothers, 1942).

[7] Benjamin M. Selekman, *Labor Relations and Human Relations,* (New York and London: McGraw-Hill Co., Inc., 1947).

[8] W. Fielding Ogburn, *Technological Trends and National Policy, Report of the Subcommittee on Technology to the U. S. National Resources Committee,* (Washington, D. C.: U. S. Government Printing Office, 1947), p. 8.

Economic historians are agreed that certain trends in technology and in work environment which had their roots in the nineteenth or early twentieth century only became powerful and prevailing sometime after the outbreak of the First World War. Nineteen-fourteen is a year easily fastened on as a milestone in this connection, both because it marked the beginning of the first truly mechanized war in history, and because it was the year in which Ford by paying unskilled workers $5 a day dramatized for the first time some of the revolutionary possibilities of the modern assembly line. *Mass production* is of course the term which sums up these developments.

What, then, are the characteristics—from the worker's point of view—of a mass production work environment? How important are they in determining a worker's satisfaction or dissatisfaction with his job in a modern factory? These questions relate, I believe, to the most basic formulation of the question of adjustment to technological change—adjustment, not of particular workers to particular shop changes, deeply important though they are to the workers and managements involved, but rather adjustment of workers generally to the *prevailing mass production characteristics* of the work environment of a modern factory.

There is one criticism commonly levelled at this formulation of the problem of adjustment to technological change. It is that the problem is too large and the statement of it too vague. Let it occupy the social philosopher, but not intrude the consciousness either of the administrator or the social scientist. The short answer to this criticism is that it has already invaded the consciousness of both. The problems of over-specialization and of repetitive work, to name but two characteristics of a mass production work environment, have long occupied the attention of both social scientists and works managers.

This particular formulation of the problem of change and adjustment first came into the writer's mind when he personally had experience with two sharply contrasting work environments many years ago. It became more precise in the past two years during systematic research into the problem of the adjustment of workers recruited from non-mass production occupations to jobs on an automobile final assembly line. The automobile assembly line illustrates, of course, an advanced application of mass production principles in modern industry. In this case the plant had been newly established in an area characterized by rural, service and small manufacturing occupations. Only a handful of the workers had been employed previously on jobs which had the mass production characteristics of an assembly line. In extensive interviews with a substantial sample of production workers, it was found that these workers were acutely conscious of the differences between their old work environments and their new one. Some reacted favorably toward these characteristics of their new jobs, others did not. What were these differences?

Characteristics of Mass Production Jobs

They may be expressed generally in terms of six characteristics:

1. Mechanically controlled work pace.
2. Repetitiveness.
3. Minimum skill requirement.
4. Predetermination of tools and techniques; this characteristic means that a man has little or no freedom in planning his work.
5. Minute subdivision of the product worked on.
6. Surface mental attention, in contrast to the "attention in depth" required by a job demanding skill, experience and judgment.

Our study shows that these were in fact the characteristics to which the workers from pre-mass production occupations were finding it difficult to adjust. The study is still in process, but one or two tentative conclusions may be mentioned, as well as certain unanswered questions on which we hope future research by ourselves and others will throw light.[8a]

A majority of the workers were highly critical of characteristics one and two, mechanical pacing and repetitiveness. On the whole, mechanical pacing or "being tied" to a moving belt was disliked more than the mere doing of repetitive work. A minority of workers, it should be added, were indifferent to both these characteristics, or even preferred them. It will be interesting and important, we believe, to explore the cultural and personality characteristics of that minority.

A second finding of considerable general interest concerns the relation of quality to morale. Although the assembly line studied is one of the most advanced in the world in terms of mechanization and of simplification of work elements, yet the study emphasized the critical importance of the human factor in "getting quality," as supervision put it, into the product. Despite their best efforts, the engineers had not succeeded in building all the requisite skills for automobile assembly into the machines. Quality, in other words, was still dependent at

[8a] The initial volume of this study, entitled *The Man on the Assembly Line,* is now in press and will be published by the Harvard University Press in 1952.

critical points on the skill, interest and good will of the workers. It was also a definite factor in morale. Expressions of satisfaction were emphatic when circumstances permitted workers to "get quality." Expressions of frustration were also emphatic when a worker felt that his job set-up or pace invited or compelled him to do his job badly.

Jobs on an automobile assembly line, when carefully examined, show a considerable range in *the incidence of mass production characteristics* from job to job. To illustrate, take repetitiveness, an obvious characteristic of any mass production work environment. In a sample of 180 jobs studied, fifty-seven required only one operation. Here, in other words, was *maximum* repetitiveness. Other jobs on the assembly line called for four or five operations, some up to ten, a few over ten—minimum repetitiveness. Other mass production characteristics as applied to actual jobs covered a similar range between extremes. It was found possible to make a correlation on the basis of this breakdown. By giving each job studied a rating according to the degree in which it embodied mass production characteristics, it was possible to *compare the behavior of those holding jobs with a higher and those holding jobs with a lower mass production rating.* Holders of jobs with a "high mass production rating," for example, exhibited a far higher record of absenteeism than holders of jobs with a low mass production rating. There was also an indication of a higher quit rate in the former group.

A general conclusion suggested by this and other studies is that there appears to be a law of diminishing returns in the application of certain mass production methods, notably in the over-simplification of the job of the individual worker. This point has been put very clearly and very well by James C. Worthy of Sears, Roebuck:

> We have found that where jobs are broken down too finely we are more likely to have both low output and low morale. Conversely, the most sustained efforts are exerted by those groups of employees who perform the more complete sets of tasks (*e.g.*, salesmen, supervisors, master machinists, etc.) and these likewise exhibit the highest levels of morale and esprit de corps.[9]

One of the six characteristics of mass production jobs named above was *predetermination of tools and techniques.* That characteristic is particularly evident in an automobile assembly line. Many men

[9] James C. Worthy, "Organizational Structure and Employee Morale," *American Sociological Review,* April, 1950, Vol. 15, No. 2, p. 174, (from a paper given at the Forty-Fifth Annual Meeting of the American Sociological Society, New York City, December 29, 1949).

indicated that they would have liked some freedom in planning their work and in the use of tools. Here is a characteristic, however, which is difficult to modify. For example, it would not be affected even if the jobs were somewhat enlarged and made less specialized, or if workers were rotated between jobs. But in spite of the fixed nature at present of this mass production characteristic, I suggest that it presents a fruitful field for experimentation.

For example, once a year at the time of model changes there is a period when tools and methods are changed, and when the whole process and organization are fluid. It is worth considering whether or not this period might offer a time for greater participation by the workers in the setting up of their jobs for the rest of the year. In other industries, the increased participation by workers in the methods and scheduling of work has proved a source of both job satisfaction and greater efficiency.

Peter Drucker discusses this point and suggests in effect that predetermination of tools and techniques has gone too far when it completely precludes any participation by workers in organizing their own jobs:

> The industrial engineer sees in the human being a tool and that means that, to him, the human being is the more productive, the more thoroughly his work has been set up and laid out *for* him.
>
> The social scientist lays stress on man's need to participate. He, therefore, concludes that the human being is the more productive and the more efficient, the more *he himself* designs and lays out his own work.
>
> The solution of this conflict seems to be to lie in the approach to the problem of the individual and the group . . .
>
> It would seem to follow . . . that the spot to apply scientific management is not perhaps the work of the individual but the work of the group. It would also follow that the place where the individual should be given and can be given participation in the decisions regarding his own work is the group. The work of the group, in other words, should be set up by scientific management and on industrial engineering standards. *But within the group there should be considerable latitude to enable the members to organize the work their own way.*[10] (Italics, CRW.)

Technology, Attitudes, and Morale

When studying what we have called the technological environment and the worker's adjustment to it, it is obviously important to evaluate

[10] Peter Drucker, "The Human Being in Industrial Production," *Proceedings, Fifth Annual Time Study and Methods Conference,* sponsored by Society for Advancement of Management and American Society of Mechanical Engineers, Management Division, New York City, April 20-21, 1950, p. 71.
p. 71.

all the *other* major factors in the total work situation. These factors are now thoroughly familiar to every student of industrial relations: the worker's relation to supervision, to his fellow workers, to his union, pay, steadiness or fluctuation in employment and so on, to name only a few. It is now a truism that it is no one of these, however important, which determines either on-the-job adjustment and satisfaction or effective performance. It is the composite impact of all of them. In administrative practice sometimes one, sometimes another receives special attention, for the science as well as the practical art of human relations in industry exhibits fashions in emphasis—as indeed do all sciences and most practical arts. Some years ago the emphasis went to methods of payment; then for a time the analysis of group behavior within the factory appeared to explain more about the worker's attitudes and his productivity than anything else. With all of this research there has also grown up over the years an increasing interest and awareness of the importance of immediate job content to the individual, and a modest literature has accumulated on the subject. In our terminology we would call this an interest and study in the *immediate work environment.* Some of this literature will be noticed briefly below.

Twenty years ago two English investigators of factory life wrote:

> The wholesale replacement of manual by mechanical methods of production that has occurred over a long period in the past and is still vigorously continuing, has tended to focus attention on the mental rather than the bodily effects of work, and as an influence in industrial life boredom is now rightly regarded as no less important than fatigue.

With these words Wyatt and Fraser, in 1929, prefaced one of a series of British government reports entitled *The Effects of Monotony in Work, A Preliminary Inquiry.* The whole series, sponsored by the British Medical Research Council, is one of the earliest attempts to study systematically human adjustment to a mechanized work environment.[11] With these British investigations Elton Mayo, of Harvard, was thoroughly familiar, and from them he quoted liberally when reporting his own early researches into human relations in industry.

[11] S. Wyatt and J. A. Fraser, *The Effects of Monotony in Work, a Preliminary Inquiry.* Industrial Fatigue Research Board, Report No. 56. London: His Majesty's Stationery Office, 1929. Other relevant British reports issued by the Board are Vernon and Wyatt, *The Extent and Effects of Variety in Repetitive Work,* Report No. 26, 1929, and Wyatt and Fraser, *The Comparative Effects of Variety and Uniformity in Work,* Report No. 52, 1928. These studies had been preceded by a large number of industrial reports upon physiological fatigue as related to productivity conducted by the British Government during the First World War.

Certain general phenomena of industrial behavior and attitude, observed by the British investigators, we find repeating themselves in any American mass production plant, and many observations made by Wyatt and Fraser have now become commonplace to students of industrial psychology. For example: " . . . conditions under which the work is done, such as remuneration on a piece rate basis, aggregation in groups, talking and other similar factors probably have an appreciable influence in eliminating or reducing the unpleasant effects of monotonous work."

With more specific significance for the study of a mass production work environment: ". . . a certain degree of mechanization where attention is *neither concentrated* nor *entirely free* is most favorable to the development of boredom, which might accordingly be relieved to some extent by *still further mechanization*." (Italics, CRW.) This point has been amply demonstrated by other studies, and was given a classic summary in Mayo's essay on "Monotony." [12]

One of the limitations of these early British studies for the student of a modern mass production work environment lies in the absence of strict *mechanical pacing* as a major component in the immediate work experience of most of the employees studied. In the general run of either American or foreign studies, this important component of work experience is not fully accounted for. Exceptions have been well noted by Georges Friedmann.[13] In auto and many other modern assembly lines, a majority of workers are of course closely "geared" to a moving line or belt. This fact for the majority appears to be of greater importance in daily job experience than repetitiveness or lack of variety which, for example, all the British papers studied and stressed. Again, the British studies reported correlations between repetitive *work*, *output*, and *"subjective impressions of more or less monotony."* In the paper entitled *The Comparative Effects of Variety and Monotony in Work*, the results of a great number of tests were summarized as follows: ". . . complete uniformity in manual repetitive work is generally less productive and leads to greater irregularity in the rate of working than a reasonable degree of variety, which is also preferred by the workers . . ." In contrast to the above tests and conclusions, it is of course impossible on an auto or other moving assembly line to

[12] Elton Mayo, *The Human Problems of an Industrial Civilization*, (New York: The MacMillan Co., 1933), pp. 32-54.

[13] Georges Friedmann, "Esquise de la travailler à la Chaine." *L'Añnee Sociologique*, Ser. 3, No. 1-2, 1940-1948.

correlate a "subjective impression of monotony" with output or productivity, because every worker on an assembly line, whatever he may *feel,* as a rule must *work* at the same pace. He cannot by *individual* effort increase the output or productivity of the "line." It is possible, however, to correlate the degree of repetitiveness of any given auto assembler's job on the line with the degree of satisfaction or dissatisfaction with his job. And the relation of that satisfaction or lack of it, while it cannot be directly related to an "output curve," *may be indirectly* related to output through correlations with absenteeism and turnover, and possibly in certain instances with work stoppages.

The British report says "complete uniformity in manual repetitive work" not only is generally less productive but leads to "greater irregularity in the rate of working." Again, because of the conveyor system of mechanical pacing, though little "irregularity in the rate of working" is possible on an American assembly line, "irregularity" in attendance and instability in the working force *may* be correlaries of too great "uniformity" in work.

Another stream of research of a different character from the one just discussed is also related to the study of a technological work environment. This is the growing body of American research into factors determining worker attitudes and opinions. *These investigations suggest that the content of the immediate job is of far greater importance* to the worker than many employers, union leaders—and also "experts" in industrial relations—had supposed. Immediate job content is usually a function of the "technological environment."

A nation-wide poll of eight morale items, for example, gave the following ratings of three thousand employees and several hundred employers. Credit for work done was put first by employees, seventh by employers. *Interesting work was rated second by the employees, and fair pay was third. The employers put fair pay at the head of the list.*[14] Daniel Katz, of the University of Michigan, summarizing the significance of this and other studies in morale and motivation, remarks:

> Though these specific studies do not really establish the fact that wages and security are less important than other factors, they are in agreement with general findings in the field that point to *the significance of the work itself,* the recognition given the workers, and the social satisfactions obtained from personal associates. (Italics, CRW.)

[14] R. Uhrbrock, "Attitudes of 4430 Employees," *Journal of Social Psychology,* 1934, No. 5, pp. 365, 377.

And again:

> The central fact about the outcome of the studies of worker morale is that they do not corroborate the general philosophy of management that emphasizes the importance of external rewards. Workers like jobs that give them a chance to display their skill and to show their worth, and they place considerable value upon being a member of a congenial work group.

Other comments in the same paper are appropriate:

> Another general type of finding . . . shows a relationship between job satisfaction and occupational status. In general people doing the more interesting types of work requiring greater skill are much happier in their jobs.
>
> People are more effectively motivated when they are given some degree of freedom in the way in which they do their work than when every action is prescribed in advance. . . . If the ego motivations of self-determination, of self-expression, of a sense of personal worth can be tapped, the individual can be more effectively energized.[15]

The study by Likert, of Michigan, of the clercial operatives of the Prudential Insurance Company (on highly rationalized operations) concludes that morale is not a "unitary concept," but must be thought of in several "dimensions." The dimensions investigated in this particular study were four: 1) intrinsic job satisfaction—that is, the satisfaction that derives from the content of the work itself; 2) pride in work group; 3) satisfactions with wages and with opportunities for promotion; and 4) identification with the company.

The Prudential study and others which analyze morale into components or "dimensions" suggest a crucial question: What is the effect of any particular technological environment, particularly of a highly mechanized one, on the several "dimensions" or components of morale?

The point suggested may be briefly illustrated. Consider what the Likert study calls the second dimension, "pride in work group."

It has been my experience that technological factors often determine and almost always condition sharply the range and character of social relations in the factory, including the type of "work group" to which the individual may belong. To give two simple examples:

In a seamless pipe mill, or in a steel strip or a steel rolling mill, the *process itself* demands a highly integrated and team-conscious crew, which usually becomes close-knit as a social as well as a producing

[15] Daniel Katz, *Morale and Motivation,* (Ann Arbor, Michigan: Survey Research Center, University of Michigan, 1949). Presented at the Conference on Trends in Industrial Psychology at the University of Pittsburgh, February 19, 1949. Quotes from pp. 5, 7, 5 and 9, respectively.

unit, and which provides both status satisfactions and economic rewards to its members. On the other hand, in an automobile assembly plant the situation is a different one. The prevailing work group is a loose-knit aggregation of individuals who work in close proximity on similar or identical operations, but do not stand in a team relationship to one another. Clearly, then, it is foolish to expect the same morale potential within the dimension of "pride in work group" in the automobile plant as in the rolling mill.

Another "dimension" seems even more clearly conditioned by technological factors. In a seamless pipe mill which the author studied intensively, there existed a high degree of "identification" with local plant management. In the automobile plant referred to above, the identification with management was found to be low or non-existent. There are probably many factors which explain this contrast, but an important one, I believe, is this: In the tube mill, social interaction during working hours was frequent between workers and upper supervision. In the automobile plant, social interaction between workers and all supervision above the rank of foreman was infrequent or non-existent. I cannot say with certainty how much the high or the low rate reflected management policy. I can say with certainty that *the technological process called for a high interaction rate in the pipe mill, and contrarywise that there was no functional need for frequent personal contacts on the automobile assembly line.* Here again, it would appear to be foolish to expect the same morale potential in the dimension of "identification with the company" in Company B as in Company A.

Certain questions suggest themselves: Within what dimensions—and to what degree—can factors in job satisfaction be developed in a highly mechanized mass production plant? If technology does impose limitations in one dimension, could another be developed by way of compensation? Another type of question also seems appropriate: Could the organization and *social structure* of the plant be modified by deliberate planning in the interest of greater job satisfaction? Are there ways in which the engineer—and the machine tool manufacturer—might remove or modify technological obstacles to job satisfaction? Finally, how far is joint union-management action possible in this field? Put negatively, a significant question would appear to be: Of what value is knowledge of the elements of job satisfaction, psychological or cultural, if technological necessity negates their constructive application?

Methods for Increasing Job Satisfaction

For a considerable part of this chapter, I have been suggesting that man's adjustment to the prevailing work environment of a mass production economy is a more basic and challenging problem for industry to solve than adjustment to particular technological changes, large or small. We have been asking a good many questions suggested by a mass production work environment. Have any answers been found by practical men or by social scientists? Certainly no one answer has been found to the problem of human adjustment to the modern work environment of a mass production economy. But in my judgment certain contributory answers have been found in at least three directions:

1. Through changes in work organization and in plant organization.
2. Through enlargement of job content.
3. Through increased mechanization.

1. *Work organization.* In a truck assembly plant, certain subassembly lines have been so organized that the men work in teams of four, each team directing itself to assembling a certain section of the body. Any one of the four jobs on the team would be boring if continuously performed by one worker, especially if he were in no functional relation with anyone around him. As organized in this plant, however, each man is a member of a team. Each helps the other on specific operations, and all rotate between jobs. Finally the *system* of rotation is up to the individual team. Some teams "change around" twice a day, some once a week. Management reports that this work arrangement has resulted in higher production than any other. The union to which all of the men belong has no objection to the arrangement.

In many factories which have modern machine and mass production methods, the numbers and costs of front line supervision, and of "middle management" as well, are of formidable size. Many works managers, however, are finding that they can both lower the number of levels in their plant hierarchies and reduce the number of supervisors. Significantly, these steps not only *reduce* costs but raise the morale of workers, especially those on repetitive and mass production jobs. One penalty of being an unskilled machine operative or assembly man is anonymity. A reduction in supervision commonly raises both the status and responsibilities of the hourly wage employees. Example: A manufacturing plant with which I am familiar was able to reorganize its manufacturing processes in such a way as to cut in half the number of its supervisors. At the same time, levels between workers and management were reduced from six to four. Productivity rose, and the number of grievances fell substantially.[16]

2. *Enlargement of job content.* It is often supposed that the engineering principles of mass production make it virtually impossible to provide workers with anything but over-simplified tasks, demanding little or no skill, interest and responsibility. A little consideration will show, I believe, that this is not true. The principle of breaking down any factory task into the simplest constituent elements is sound industrial engineering. It is essential to the efficient organization of a mass production factory. But to deduce from this principle that a given worker can learn and efficiently execute only a very small number of the motions prescribed by the time study expert is to introduce a psychological assumption into the application of an engineering principle. Among both machine operators and assembly men, an increase both in job satisfaction and output has been found to come in frequent instances from the opposite policy—*job enlargement.* This does not mean any return to a craft era where one or two mechanics assemble a whole automobile—but it does mean that within easily determined limits jobs are being recombined, enlarged and enriched for the individual worker in many factories. Results from such a policy have been satisfying to both management and workers. Three examples may be cited:

In a certain typewriter plant, workers were recently given jobs requiring four to five times as long a time cycle as formerly, together with added skill and responsibility. The workers insist that they would never go back to the simpler jobs they had formerly held.

In the machinery division of a large business machines manufacturing plant, the jobs of operators have been "enlarged" to include the duties of set-up men and inspectors. The company reports higher morale, and a great saving in rejects. A survey shows the men prefer the enlarged jobs.[17]

On the assembly line of a bottling concern, workers, instead of remaining stationary as the line moves past them and performing one

[16] F. L. W. Richardson and Charles R. Walker, *Human Relations in an Expanding Company,* (New Haven: Labor and Management Center, Yale University, 1948).

[17] Charles R. Walker, "The Problem of the Repetitive Job," *Harvard Business Review,* May, 1950, Vol. XXVIII, No. 3, pp. 54-58.

job only, move up the line and perform several jobs, with good results both in morale and output.

3. *More mechanization.* From the standpoint of the average worker, adjustment to a job which is so "mechanical" that it can "be done without thinking" is far easier than adjustment to a job which requires continuous but superficial mental attention. If the attention required is attention in depth, calling upon skill, judgment and experience, a job may become satisfying and absorbing. It is the jobs which require high surface attention but little or no skill or experience, however, that present the most difficult problems of adjustment. One answer, then, as Wyatt and Fraser and later Mayo have pointed out, is to increase the degree of mechanization till the operator can literally do the job without thinking, and release his mind for conversation with his fellow workers or for thinking his own thoughts.

I once asked an engineer who had been trained both in mechanical engineering and in automotive work to walk through the final assembly line of a newly-equipped automobile plant and comment on it from an engineering point of view. He came back with half a dozen suggestions for *further* mechanization which would have made human adjustment easier for the reasons stated above. I am convinced that there are few modern plants which could not be profitably re-studied from this point of view.

The reader may ask:

If mechanization can be pushed far enough—till we arrive at the wholly automatic factory—won't that be the answer to the whole problem? In recent years, this has probably been the layman's favorite answer to the social problems of the modern work environment. Especially since the development of electronic controls and of "mechanical brains," enthusiasts have insisted that the *completely* automatic factory was imminent. My own thinking is that the principle of automatization will increasingly release workers for other kinds of work, but that within any foreseeable future it will not solve many of the problems touched on in this chapter. For reasons of both cost and convenience, the bulk of manufacturing processes will continue to be far from fully mechanized and only partially controlled automatically.

With this proviso, however, I do look for a general increase throughout industry in the number of workers whose jobs are nonmanual, but concerned with reading gauges and manipulating a control board, and a great decrease in the number of workers who directly or with tools handle raw material or the product.

Human Relations Research and Technology

"Rapid change," the author wrote in 1945, "has now left most Americans a little breathless. So complex are effects of changing technology that they have overtaken mankind as problems rather than opportunities. If men are to utilize technology for the good life, they will have to find a substitute for time, which in the past permitted the human organism, and the community, to adjust to the pace of history." [18]

The best substitute for time, I believe, which the modern world has available is the young but growing science of Man, and in the present connection the science—and art—of human relations in industry. I would like, therefore, to close this chapter with a brief discussion of the meaning of science as applied to the study of work environments and of technological change.

As suggested in the opening paragraph of the chapter, the engineer's view of a modern factory is an abstraction. What he sees when he looks at an assembly line, for example, are certain principles in operation: the principle of interchangeable parts, of a continuous and orderly work-flow, of the breakdown of process into short cycle operations, of synchronization. The fact that these compose an abstraction does not mean that they are unimportant, or that they are unrelated to reality. Quite the contrary. They are very important, and they are also one way of describing the reality of an automobile assembly line.

If we turn now to our description of the assembly line in terms of its impact on the immediate experience, say, of workers on the job, is that reality? The experience is very real. But necessarily our description of it abstracts from that real experience. We have chosen, for example, to generalize the immediate job experience of many people in an assembly plant into six categories—mechanical pacing, repetitiveness, etc. No man experiences a category. His daily on-the-job experience is indivisible. We divide, abstract and categorize. Why? In order to comprehend more clearly, and usually in order—after certain logical processes—to take action. In other words, just as the engineer has his categories and abstractions for describing what interests him, so we have our categories and abstractions for what interests us. Both derive from reality. Neither of them is reality. Both serve a purpose for a certain kind of understanding and a certain kind of action.

[18] Charles R. Walker, "American Productivity: II," *Fortune*, January, 1946, Vol. XXXIII, No. 1, p. 168.

It is clear that if you neglect to use engineering abstractions and categories and pay attention only to the abstractions of social science you won't have any automobile factories—and you'll have no automobiles. If you neglect the abstractions and categories of social science you will not have—I believe—a healthy and workable society—either in the factory or outside of it.

Since the engineering categories with which men built the factory and organized it have developed for the most part without reference to categories based on human behavior—except in a casual and random fashion—and since the categories and abstractions of social science have for the most part developed with only casual contact with technological and engineering developments, the necessity arises of bringing them together into a *working relationship.*

FACTORS AFFECTING INTER-PLANT DIFFERENCES IN PRODUCTIVITY [1]

SAMUEL THOMPSON
Bureau of Labor Statistics

LABOR EXPENDED per unit of output differs greatly in many industries between plants producing the same or similar products. The range is surprisingly wide. Where data are available, it appears to be as much as 30 to 50 percent both ways from the mean.

Some idea of these wide differences between plants in unit man hours is given in Table 1, which shows the average man hours per unit of product for certain plants in three industries—Gray Iron Foundries, Mixed Fertilizer, and Men's Work Shirts. For each of these industries the reporting plants were arranged into quartiles or fourths, ranked according to their unit man hours from lowest to highest. In the melting operations of gray iron foundries the highest fourth averaged nearly four times as much labor time per thousand pounds of melt as the lowest fourth. In mixed fertilizer plants the ratio was three to one, in work shirts two to one.

MAJOR ELEMENTS: NATURE OF DATA

Such variations in labor requirements between plants are attributable, presumably, to a multitude of factors; but these factors can be grouped into broad categories like differences in capital equipment, degree of capacity utilization, materials and components, skills and attention of workers, the effectiveness of management in scheduling and directing the flow of work, and so on. Most of the elements are closely inter-related. The size of the plant, its equipment, its layout, and the production methods employed are dependent on the level of technological competence of management and on whether the management can provide or attract the capital necessary for improve-

[1] This chapter is in the nature of a progress report on work of the Bureau of Labor Statistics, U. S. Department of Labor, looking toward identifying and measuring the factors that affect productivity. Factual material here presented was drawn mainly from current projects; was assembled by Harry Greenspan with active collaboration by other staff members of the BLS Division of Productivity and Technological Developments. Interpretations and conclusions, where they appear, are those of the writer and do not necessarily express official opinions of the Bureau of Labor Statistics or the Department of Labor.

TABLE 1

Man Hours Per Unit of Output, Averages for Plants Grouped Into Quartiles According to Man Hours Required, Three Industries, United States, 1949

Industry and unit of output	Man hours per unit of product				
	All plants	Lowest fourth	Lower middle	Upper middle	Highest fourth
Gray Iron Foundries (melting operations only)					
Per 1000 pounds melted	0.96	0.44	0.76	1.03	1.63
Mixed fertilizer					
Per 1000 pounds mixed	2.9	1.7	2.3	3.1	4.7
Men's work shirts					
Per dozen	4.7	3.5	4.2	5.0	6.4

Source of data: Reports by individual plants to the Bureau of Labor Statistics.

ment. The volume of production, or the extent to which the capital facilities are used, depends on ability to market the product. All these factors are influenced by the level of competence of management. Managerial skill will also affect such important matters as methods of production planning and control, selection of materials and components, extent of subcontracting, methods of compensation for work, and the underlying and all-important area of human relations. Skills and attitudes of workers and their willingness to produce are no more important than these factors and are largely controlled by them.

Possibilities of identifying and perhaps of measuring the effect of these various influences on labor requirements are beginning to appear in data reported directly by manufacturing plants to the Bureau of Labor Statistics, such as those summarized in Table 1. This program of direct factory reports on productivity is relatively new (1946) and sharply limited in coverage. It is designed to provide direct measures of changes in levels and trends in productivity for specific plants and products, and also to identify the factors that caused these changes. The program is operated in close conjunction with the somewhat older series of "general" productivity measurements based on information on production and labor from various secondary sources rather than on direct primary reports.

Results of both programs are usually expressed in terms of output per man hour or (the reciprocal) man hours per unit of output; but the importance of other factors besides labor efficiency is clearly recognized by the users of the data. The general definition used by the Bureau is that productivity is the ratio between "specified amount of a specified output, and *one or more* of the factors of input required to produce that output." Usually (but not always) labor is the input factor of greatest interest and labor is always significant as being the universal factor of production, and the factor most immediately related to human welfare.

Some of the information that is beginning to appear in these direct factory reports has been abstracted and arranged in this article to illustrate how such information may shed light on the factors affecting differences in productivity. The factors here considered are the relative degree of mechanization (reflecting roughly the relative amount of capital investment per worker), the volume of production in relation to capacity, and certain practices in production planning. Conclusions drawn from the limited amount of data available thus far are indicative rather than conclusive. The main value of the work may well be to show that there are bright possibilities in further analysis and especially in the collection of more actual data to work with.

FACTORS RELATED TO CAPITAL PLANT

The influence of capital equipment on productivity is assumed to depend on the amount of equipment per worker, the type and condition of equipment used, and the over-all size of the plant operating unit.

The importance to productivity of the amount of capital per worker is easiest to illustrate on the basis of inter-country comparisons. Compared to most areas of the world, capital equipment is cheap in relation to labor in the United States. Nearly everyone agrees that this is an important reason why output per worker in most industries in the United States is so much greater than in other countries. There is little indication, however, that the difference is due to backwardness in technological knowledge or lack of management ability in other countries, at least not in Western Europe. In large part, the reason that an American plant uses more equipment per worker to produce a certain product, than a French plant, for example, making the same product, is the "cheapness" of capital equipment in relation to labor. Businessmen are more willing to lay out money for machinery to economize labor when labor costs $1.50 per hour and interest rates are 3 to 6 percent than they are when labor costs are but 10 to 50 cents per hour and interest rates are 6 to 15 percent. The machinery will pay for itself more quickly.

Amount of Equipment Per Worker

Variations in invested capital per worker are wide between plants within the same industry in the United States. Often this is reflected in what may be described as the "degree of mechanization" of a plant, or of a particular department or operation. For example, the melting departments of 102 gray iron foundries were classified according to their degree of mechanization. Labor in this department depends largely on the man hours needed for charging or loading the cupola. The average of plant man hours per 1,000 pounds of melt for foundries with different degrees of mechanization were as follows:

Completely mechanized	.85
Partially mechanized	1.05
Non-mechanized	1.34

These differences are largely attributable to differences in the kind of materials handling equipment used in the foundries studies. In recent years there has been widespread adoption of new types of such equipment in this industry. When a significant technological change is occurring in an industry, differences between plants widen in respect to the degree of mechanization, leading to a corresponding dispersion of man hours required per unit.

Capital equipment may be classified as plant or buildings, production machinery, and materials handling equipment. Gray iron foundries offer an example of a general revolution in materials handling equipment that has been occurring in different degrees in many American industries. In recent years management has frequently found that larger labor savings can be made by purchasing materials handling machinery than is possible from new production machinery. Throughout industry, therefore, there has been great emphasis upon applying power and mechanical developments to reducing labor in handling materials.

The fertilizer industry presents examples of large reductions in labor per unit through the adoption of powered materials handling equipment. Fertilizer manufacture, before World War II, particularly in the small plants in the South, was dependent largely upon manual labor for materials handling. Mechanization was not a pressing need because of low wages. During the war, when labor became scarce, wage rates increased, while demand for fertilizer continued high. This situation induced plants to substitute machinery for labor; specialized materials handling equipment was introduced widely. Tractors, car scoops, dump trucks, and conveyor belts were purchased to load and transport materials between processing equipment and storage. Small tractors with shovel attachments replaced three to four men using wheelbarrows in many plants. Car scoops (small tractors with power scoop attached) designed to unload the raw materials from freight cars, have been doing the work of 3 to 10 men (depending on plant layout).

Automatic bagging of fertilizer reduced man hours 40 to 50 percent for this operation. A bagging machine can be handled by one man. It automatically fills bags with required weight of fertilizer and then seals the bag. Sewing machine operators formerly needed are eliminated. Six to twenty bags are loaded on a pallet or rack and then handled together, with further saving in labor.

In the grinding of wood pulp, one plant which was using large amounts of labor reported, "Logs from the wood (storage) room are received in bins, stacked by hand onto hand trucks, delivered to the chippers and hand fed into the machines." The time required per ton of ground wood pulp was over 5 man hours. A second wood pulp plant used no storage; logs were sent directly from barking and rebarking units to the chippers by a sluiceway, and less than one man hour per ton was needed for the operation.

Age of Equipment

The productivity of a plant is influenced not only by the extent to which its machinery embodies the newest technological improvements, but also by how much the functioning of the machinery is impaired by aging, which may result in more shutdowns for repairs, slower operating speeds, reduced quality of output, etc. These two factors are often referred to as obsolescence and physical depreciation. Both depend on the rate of replacement of capital equipment and the quality of maintenance performed. Obsolescence and depreciation, however, are difficult to define and measure satisfactorily in practice; so it is sometimes useful to use the average age of machinery as a rough indication of the presence of these factors.

Plants with newer machinery would be expected, of course, to have an advantage over plants with older machinery. An indication of variations in the average age of production machinery in 1949 and 1950 is given in the tabulation below, which includes companies making Construction and Mining Machinery, General Industrial Equipment, Machine Tools, and Metal Forming Equipment. The average age of the machinery in most of the 85 firms which reported was between 6 and 15 years. Few firms had machinery which averaged 5 years or less in age, but a considerable number averaged 16 years or more.

Average age of machinery	Number of plants	
	1949	1950
0-5 years	3	4
6-10 years	33	33
11-15 years	31	30
16 years or more	17	18
Average age of machinery, all plants reporting	12.8	12.7

Direct conclusions as to the effect of age on productivity cannot be drawn from the data summarized above, especially since the effect of physical depreciation cannot be separated from that of obsolescence in this group of reports. It is interesting to note that more than half these plants were using machinery that *averaged* 11 years old or more.

Size of Plant; Direct and Indirect Labor

The relative size of plants or operating units appears to have some effect on productivity, although the causative factors are complex and perhaps conflicting. The optimum size for total cost may not be the same as that for labor cost.

Where the volume of sales expected by management over a period of time is large, a larger size of plant or operating unit may permit the use of types of machinery and production methods which require less labor per unit of output; special-purpose machines may become economical despite a high initial cost. Their labor saving over general purpose machines is well known in the automotive industry where a specially designed machine tool may automatically position, bore, drill, tap and grind the rough castings for engine blocks. Large volume also permits organization of production into a line process, which in some industries makes possible reduction of total labor requirements through the use of relatively greater numbers of indirect workers, whose functioning permits a finer division of labor.

In some industries larger plants appear to have a definitely higher output per man hour than small plants, but in others, the advantages of large size plants are slight or non-existent. In the example of mechanization in the melting operations of gray iron foundries, shown above, if the unit man hours are weighted according to the weight of metal melted it becomes evident that the larger plants require much less labor per unit of output as shown in the following tabulation:

Groups	Unit man-hours unweighted average	Unit man-hours Production weighted average
Competely mechanized	.85	.46
Partially mechanized	1.05	.85
Non-mechanized	1.34	.91

In soap and glycerine manufacture, paper manufacture, sugar refining, synthetic rubber, and other chemical industries large plants tend to have lower man hours per unit than small plants. For example, in synthetic rubber, man hours per unit in plants with designed capacity of 45,000 to 90,000 tons per year were 23 percent lower than in plants with a capacity of 30,000 tons. This occurred in spite of the fact that the larger plants were operating at average rates of capacity lower than those of the small plants.

In such "process" industries indirect labor (employees engaged in supervision, maintenance, production control, inspection, etc.) forms a large proportion of total plant employment. Requirements for these workers do not increase proportionately as size of plant increases, and therefore, the amount of this type of labor needed per unit of product is smaller in large than in small plants when operating at near capacity.

Large plants often can economically adopt methods requiring large capital investment which are not as feasible for small plants. Mechanization and automatic control of materials movement will more quickly and surely pay for itself in a large size, large volume plant.

In general, the process industries show larger differences in man hours per unit by size of plant. This is not true, however, of all process industries. In leather tanning, for example, large tanneries appear to have no advantage in unit man hours over small tanneries making similar types of leather. Large tanneries will have more vats, drums, staking machines, buffing machines, etc., but the number of workers at each will be about the same and will not depend on the size of the tannery. Wet hides and skins are still largely handled manually by direct labor into and out of machines and equipment. Indirect labor is generally less than 20 percent of total tannery labor.

Shoe manufacture and the needle trades are other examples of industries in which size of plant is a relatively unimportant factor.

Plants with less than 200 employees making coats for men's suits required (on the average) only about 7 percent more labor per coat than plants with over 600 employees, in the handful of cases reported below:

TABLE 2

Average Man-hours Expended per Unit for Sewing Sack Coats of Men's Suits, Grade 4, by Size of Plant—1950

Plant size	Number of establishments	Total man-hours
Small—under 200 employees	7	4.40
Medium—200-600 employees	6	4.27
Large—over 601 employees	4	4.10

Data from direct reports by selected plants to the Bureau of Labor Statistics.

In the work garment industry the experience reported for different types of clothing is somewhat varied. In work pants and dungarees the larger plants had about the same unit labor requirements as the smaller plants. In work shirts, plants with over 500 employees used 25 percent fewer man-hours per shirt than plants with less than 100 employees.

FACTORS RELATED TO OPERATIONS

The effect of production volume on productivity in a given plant depends on the extent to which the production facilities are used, as well as on the size of plant. There is a level of production which results in lowest man-hours per unit of output for each plant; but this is not necessarily the same as for lowest *total* costs. In most years and most industries, a large proportion of the plants operate below their most efficient levels for a considerable share of the time, although occasionally production is pushed beyond those levels in order to meet demand.

In this discussion, we are considering that the maximum volume that can be produced at minimum man-hours per unit represents plant capacity.

Fluctuations in volume of production, or utilization of plant capacity, may be due to general business conditions or to conditions that are peculiar to an industry. When sales come easy, raw materials and skilled labor may be hard to find; also, poor marketing or production practices in individual plants may lead to short term fluctuation in volume. In any one or two year period an appreciable change in

TABLE 3

Average Man-Hours Expended Per Dozen, Five Types of Men's Work Garments by Number of Employees; Selected Reporting Establishments, United States, 1950

Product and size group	Number of reports	Average man-hours per dozen garments		
		Total factory labor	Direct labor	Indirect labor
Work Shirts				
Under 100	8	4.83	4.35	0.48
100-249	9	4.28	3.92	0.36
250-499	11	3.88	3.50	0.38
500 and over	6	3.68	3.28	0.40
Work Pants				
Under 100	6	6.75	6.08	0.68
100-249	15	6.52	5.70	0.82
250-499	16	6.65	5.79	0.86
500 and over	4	6.57	5.43	1.14
Dungarees				
Under 100	11	3.98	3.50	0.48
100-249	10	3.67	3.12	0.54
250-499	9	4.03	3.38	0.65
500 and over	2	......[1]	......[1]	......[1]
Bib Overalls				
Under 100	5	7.13	6.09	1.03
100-249	9	5.51	4.70	0.81
250-499	10	5.02	4.29	0.73
500 and over	3	4.32	3.66	0.66
Coveralls				
Under 100	3	9.04	8.19	0.85
100-249	4	7.35	6.20	1.15
250-499	5	7.02	5.98	1.04
500 and over	2	......[1]	......[1]	......[1]

Data from direct reports to the Bureau of Labor Statistics.
[1] Not shown to avoid disclosure of individual plants.

volume can be the most important productivity factor in a plant or an industry.

In the synthetic rubber industry data were available for a comparison between per cent of rated capacity utilized and labor required per unit for the period 1945-49. (Table 4).

The importance of capacity utilization is probably greatest in line production and continuous process industries partly because it is in these industries that the per cent of indirect labor to total labor is highest.

TABLE 4

Average Unit Man-Hour Requirements for the Manufacture of Synthetic Rubber (GR-S), by Per Cent of Capacity Utilized, Selected Plants, United States, 1945-49

Average per cent of capacity used	Average man-hours per ton
Over 90	19.9
80 to 90	22.6
Under 80	26.7

Total employment in synthetic rubber manufacture is little affected by changes in volume. Direct labor requirements are relatively small and constant as long as a process unit operates at all. Indirect labor, particularly for maintenance, is high and fairly constant regardless of the number of units in operation or the amount of output of each unit.

As the technology of synthetic rubber production tended to stabilize after the war, changes in capacity utilization were the main causes of changes in average unit man-hours. From 1947 to 1948, a 23 per cent increase in capacity utilized was accompanied by a 20 per cent decline in unit man-hours. From 1948 to 1949 capacity utilization decreased 21 per cent and unit man-hours increased 15 per cent.

Where measures of capacity are not available, changes in the volume of output from one year to the next may be considered to reflect changes in capacity utilization if we assume the plant size remains fairly constant over short periods. In the post-war period, when production increased in fertilizer plants and tanneries, labor requirements per unit of output decreased, as shown in Table 5. Those plants whose production declined tended to have higher unit labor requirements. Less sensitivity to volume change was shown in the men's work garment and shoe industries.

Fluctuations in Volume

The reasons why productivity in the work garment industry is relatively insensitive to changes in volume are clear on examination of the operations. Indirect labor is only 10 to 15 per cent of total plant labor. Most of the direct labor is in the cutting and sewing departments, with about three-fourths of it in sewing. Most of this labor is in handling and positioning the garment, very little of it in actual machine operation. As a result the work is largely paced by the operators. Except for the small proportion of indirect labor and some direct man-hours in the cutting room, the amount of labor can be and is adjusted almost in proportion to the amount of work.

TABLE 5

Changes in Unit Man-Hour Requirements Associated with Changes in Volume of Output, Four Industries, United States, Various Years 1946 to 1950

Year to year changes in volume of output[1]	Per cent change in man-hours required per unit of production							
	Mixed fertilizer		Leather tanning		Footwear		Men's work garments	
	No. of repts.	Per cent change	No. of repts.	Per cent change	No. of repts.	Per cent change	No. of repts.	Per cent change
Up 20% or more	13	− 9.3	36	−7.6	19	−17.7	42	−5.1
Up 5% to 19.9%	19	− 6.5	34	−0.2	28	−10.1	33	+2.6
Less than 5% change (up or down)	19	− 2.9	57	−0.4	28	−10.0	26	+0.3
Down 5% to 19.9%	13	+ 4.9	64	+1.6	18	+ 3.5	22	+1.2
Down 20% or more	9	+10.0	37	+8.9	4	+ 9.0	26	+5.6

[1] Data for leather tanning are for the years 1948-49 and 50; footwear and men's work garments 1946, 47, 48, 49; mixed fertilizer 1948, 49. Source of data: direct reports to the Bureau of Labor Statistics.

Individual plants in a given industry do not change their output in equal proportion to the industry as a whole and some may even move counter to the general trend. Since volume changes in individual plants can affect man-hour requirements significantly, different rates of change may lead to significant differences in labor needed per unit of output between plants. This effect may—and apparently often does—outweigh technological and other factors over short periods of time.

Production Planning

Different methods of production scheduling can lead to differences between plants in labor used per unit of output, even with no other change. A shift from lot or batch production to line fabrication or assembly usually results in greater productivity if the volume of standardized items is large enough. The automobile and airframe industries provide striking illustrations.

There may exist a misconception that reductions in man-hours are always associated with the adoption of continuous line production. That this is not always true is shown by the experience of the work garment industry.

In recent decades there were two production methods in making work garments—the bundle system and the progressive bundle system. Line production was advocated by some engineers of the industry in the early and middle 1930's as a means of increasing productivity, and several firms converted from the bundle to the line system of production. But according to reports to the Bureau of Labor Statistics, plants using the line method in 1949 usually had the highest man-hours per dozen garments and plants using the progressive bundle method usually had the lowest (Table 6). In the period 1945-49, five companies reported shifts in production methods away from straight line to the progressive bundle system. The disadvantage of straight line methods in the work garment industry arises from the difficulty of balancing the line. Production is worker-paced rather than machine-paced, and the presence of a slow worker at one station reduces the efficiency of all workers in the line. The difficulty of balancing the line is reported to be due in part to relatively low wages and high turnover of employees in this industry.

TABLE 6

Average Man-Hours Expended Per Dozen Men's Work Garments, by Method of Production; Selected Reporting Plants, United States, 1949

Product	Production method							
	Bundle		Progressive bundle		Line		Combination	
	No. of repts.	Unit man-hours	No. of repts.	Unit man-hours	No. of repts.	Unit man-hours	No. of repts.	Unit man-hours
Work shirts	10	4.10	10	3.79	2	......[1]	9	3.86
Work pants	6	7.41	17	6.22	9	7.76	7	6.78
Dungarees	10	3.69	13	3.11	4	4.96	3	4.67
Bib overalls	7	6.06	13	4.40	4	6.66	3	6.54
Coveralls	3	10.04	9	7.02	2	......[1]	0	—

[1] Not shown to avoid disclosure of individual plants.
Data from direct reports to the Bureau of Labor Statistics.

Other Factors

The discussion up to this point has covered some of the effects on inter-plant differences attributable to the factors of capital equipment, volume of production and methods of production planning. It is difficult or probably impossible to measure changes in management or labor efficiency or their effects on productivity changes or differences apart from those of other factors.

It is hard to overemphasize the importance of the factor of management, especially in our enterprise system. Yet, how can we measure objectively the differences or changes in the quantity or quality of the decision-making, leadership, and control functions exercised by management?

The problem of intensity of effort by the worker appears superficially to be easier to measure. Many studies have been made with a view to showing the relationships between labor efficiency and various kinds of factors at work, in given plants or circumstances, from the adequacy of lighting and the effect of color, to the facts as to whether or not workers are employed under collective bargaining agreements. So far it has been found impossible to devise satisfactory schemes for measuring the effect of such factors on a basis sufficient to produce valid generalization. For example, there are studies which show evidence of restriction of output among organized workers, and others which show that unorganized workers practice such restriction to about the same extent. The point need not be labored that it has not been found possible to obtain conclusive answers to such questions.

The measurement of the efficiency of human effort is a problem fraught with constant difficulty, and it is not easy to be optimistic about the prospects of its solution. Such evidence as we have does suggest one significant generalization—that willingness to produce appears to be closely associated with stable demand for goods and labor. It is the recognition of this factor which underlies the importance of local work stabilization and national full employment policies as necessary prerequisites for efforts to promote improvement in productivity generally.

It is expected that as time goes on, the Bureau of Labor Statistics will accumulate comprehensive information on all measurable factors affecting productivity. In the period which lies ahead, it is hoped that fuller information will be obtained on the effect, from plant to plant, and from industry to industry, of incipient and expected shortages of workers and materials.

The information on interplant differences available from the direct reports program is now being supplemented by a new type of study instituted by the Bureau in 1951—the factory performance studies. These are intensive surveys of plants conducted on a case study basis, which analyze the factors associated with man-hours differences between plants by department, process, or operation step in the output of various products. This kind of micro-analysis promises to provide a link between measurement of productivity at the work bench to measurement of productivity in the industry, together with a deeper understanding of the factors which account for productivity differences. In the near future, it is expected the findings of these studies will be made generally available.

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