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# I

## Some Characteristics of Manufacturing

MANUFACTURING comprises the largest single division of the productive system. Through manufacturing industries pass the bulk of the physical goods produced each year. Here occur the chief increases in their value and in their usability. Here, in 1929, originated approximately one-fourth of total national income and here was employed a like percentage of the nation's working force. Along a wide front, men and machines in manufacturing industries are engaged in transforming the shape and character of unfinished goods, making them more useful and better adapted to satisfy human needs.

### SCOPE AND METHOD OF THE SURVEY

The manufacturing process may be studied in several ways. For example, changes in manufacturing activity may be indicated by a comparison of output during certain successive periods. This method of analysis usually gives acceptable measures of the varying success of the manufacturing process but tells little about the manufacturing process itself. Nothing is indicated of the relative importance of various types of manufacturing activity, or the relative proportions in which productive resources are employed in the manufacture of different types of goods. Information on such matters is best gained by an examination of various records pertaining to

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manufacturing industries for a given period; in other words, by an analysis, not of changes from period to period, but of a cross-section of manufacturing activity.

A cross-section picture of manufacturing is intended to describe manufacturing operations at some given time. Accordingly a cross-section study is essentially descriptive, and in form suggests a 'static' analysis of an admittedly dynamic economy. Artificial in certain respects as such a study must be, it should yield fruitful information. For if our interest lies in the changes that mark the development of an evolving economic system, the first step is their appraisal in the light of the circumstances of some particular time. Every investigator of the changing composition of manufacturing output, for example, or of the changing characteristics of manufacturing operations, must have some benchmark for his findings. In order properly to evaluate his conclusions he must know the relative importance of the various elements that concern him.

In many ways the following study of manufacturing, which is in effect a cross-section study of the sort just discussed, is similar to a survey of the amount and distribution of national income in any year. Each is an attempt to describe, as of a given time, certain aspects of a continuing economic system. Each is informative of the specific historical record of the year to which the data relate. And in varying degrees each throws light on internal relationships of wider interest.

Since any cross-section study must pertain to some one period, its findings will reflect circumstances peculiar to the time of observation—the combination of forces tending to continue relationships of a prior period and forces making for change. Any given year presents an admixture of continuous and transitory elements. Since this admixture is almost certainly of various proportions in the different aspects and relations studied, some of the measures obtained in the survey will vary more from period to period than others.

The significance of a cross-section view of an operating manufacturing system, for periods other than the one studied, is thus dependent upon the relative importance of these continuous and transitory elements, and may be expected to be greater for some portions than for others.

A complete analysis of the continuous and transitory elements present in any set of cross-section observations is impossible without an extensive survey covering a series of years. It has not been the purpose of this study to separate this admixture, or even to indicate the probable degree of year-to-year variation in the different measures presented. Decisions on such questions must await the completion of similar investigations for other years and their analysis in terms of other studies in the general field. The justification of this study rests first on the body of data presented concerning manufacturing operations during an important 'benchmark' year, 1929, on its place in a possible series of similar investigations, and on its examination of certain measurable characteristics of an important segment of the country's productive system.

This survey is not an inventory of various attributes of manufacturing as of a given day. Since it is a study of manufacturing operations, it refers, not to a single point in time, but to a period during which the system has operated. This period might conceivably be a month, a year, a succession of years, or even a decade. Certain advantages might accrue from the selection for study of any one of the intervals suggested. Differential long run changes would have least influence on data relating to a single month, but differing seasonal patterns would limit the comparability of different parts of the total. The use of a period longer than a year would increase the possibility of historical changes affecting the measures, though for certain purposes a long run average might provide measures within which the transitory changes offset one another. Considerable merit attaches, however, to a more restricted period, such as a single year, which has

two advantages—concreteness and a reasonable degree of homogeneity. Since most of the essential data are available only annually (or biennially), the selection of a single year as the period for the survey was clearly indicated.

Chiefly because of the very detailed information available, 1929 was chosen for the study of manufacturing operations. The 1929 Census of Manufactures, being a part of the fifteenth decennial Census, provides particularly extensive and detailed reports. In addition, the Bureau of the Census has issued several special studies relating to manufacturing operations in 1929. There is also available for this year a considerable volume of trade statistics on the consumption of manufacturing commodities that is necessary to the successful conclusion of the study we have attempted. A similar study might readily be made for 1919, using the data of the fourteenth decennial Census. Likewise the reports for 1935 provide information that would make possible another cross-section view of manufacturing operations. But it is doubtful if any year other than 1929 would provide so favorable an opportunity for an initial examination into the characteristics of the manufacturing operations studied.

A cross-section view of manufacturing, such as we plan, gives an insight into what may be called the structure of manufacturing production. In broad terms this 'structure' has been defined as "the productive mechanism of an economy, considered with reference to its organization, the mutual relations among its working parts, and the character of the commodities it is geared to produce".<sup>1</sup> While, because of the presence of the transitory elements discussed earlier, only partial information is provided by a single cross-section view, a step is made toward a more precise delineation of the manufacturing structure by the examination of the 1929 relationships. A series of cross-section studies might go far toward establishing the general magnitudes and the

<sup>1</sup> Frederick C. Mills, *On the Changing Structure of Economic Life*, in *Economic Essays in Honor of Wesley Clair Mitchell* (Columbia University Press, 1935), p. 364.

variation to which these relationships are subject during business fluctuations. Such studies might also indicate the non-recurring structural changes that are continually modifying what may be termed the persistent characteristics of the productive system.

We have evidence of the changing structure of manufacture in the diverse rates at which industries grow and in the changing character of manufacturing enterprise. We observe the increasing output of durable goods over long periods relative to the output of nondurable goods. We see manifestations of an increasing use of capital in production—extensive capital investments and continued diversion of current production to capital replacement and expansion. There have been remarkable increases in production, in large part the fruition of these capital investments together with new skills of workmen and improved modes and processes of manufacture. Increases in labor productivity have gone hand in hand with this changing structure of manufacturing.

There have also been significant changes in organization. The corporate form has become dominant: in 1929 over 92 per cent of all manufacture was under corporate control. There has been an increasing integration of industry, with ownership forcing its way backward to control primary materials and contributory industries, forward to command distributive channels.<sup>2</sup> Frequently enterprises have spread out to take in competitors or to strengthen quasi-monopoly positions; just as frequently expansion has been into other areas, more or less related to the company's primary activity. There have been shifts in the geographical concentration of industries. In countless ways, persistent forces continually modify the character of the manufacturing structure.<sup>3</sup>

Two major aspects of manufacturing operations are ex-

<sup>2</sup> In 1929 over 26 per cent of the sales of manufacturing concerns not made directly to industrial and other large consumers were made through the manufacturers' own wholesale or retail branches. This was 19 per cent of their total sales (U. S. Bureau of the Census, *Distribution of Sales of Manufacturing Plants, 1929*, p. 26).

<sup>3</sup> For a discussion of various aspects of these changes, see the article by Frederick C. Mills in *Economic Essays in Honor of Wesley Clair Mitchell* previously cited.

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amined in this monograph. First we are concerned with the composition of the manufactured product and the distribution of productive resources among different classes of manufactured goods. What types of goods were produced in 1929 and in what proportions were various productive resources employed in their fabrication? Evidence on these points, based on the records of the Bureau of the Census, is presented in Chapter II. The second part of the study concerns the interrelations of productive factors in manufacturing operations. Materials that bear upon this aspect of manufacturing are presented in Chapter III. Comparison is made of the relative importance of different elements of manufacturing cost—materials, wages, and overhead items—and of different productive factors—wage earners, salaried employees, capital. These relationships are examined according to type of product. Do particular groups of industries show different cost patterns? Are there wide variations from industry to industry? What is the relative use made of labor and capital?

The assembly of the material into relevant groups for the purposes of the study has meant an industry-by-industry analysis of products and their appropriate combination according to the particular classification studied. Measures relating to four major classifications are presented, based on: (1) the destination of the ultimate product, (2) the stage of the manufacturing operation, (3) the durability in use of the final product, (4) the source of the major material. Thus we distinguish capital and consumption goods; 'finished' and 'unfinished' goods; durable, semidurable, and transient goods; and products made for the most part from farm, forest, or mineral materials. In addition, various cross-classifications have been made, with the emphasis placed upon the division according to final use.

MEASURABLE ASPECTS OF MANUFACTURING ACTIVITY, 1929  
Before examining how productive energies were spent in

1929, we may appraise briefly certain of these resources and various magnitudes descriptive of them. We are restricted to the measurable aspects of manufacturing and for the most part to certain basic data compiled in the Census of Manufactures.<sup>4</sup> It is the division of these data according to different attributes of the manufactured product that will later concern us.

#### *Value of product and elements of cost*

Manufacturing operations in 1929, as defined and reported by the Bureau of the Census, were conducted in 210,959 establishments. The total value of the products manufactured, as measured by the sales of these concerns, was \$70,435 million. The increase in value at the manufacturing stage as measured by value of product less cost of materials purchased (i.e., value added by manufacture) was \$31,885 million. Manufacturers spent \$38,550 million in buying raw and semimanufactured goods, including fuels, from other manufacturers or primary producers.<sup>5</sup>

<sup>4</sup> All activities reported in the 1929 Census of Manufactures have been considered within the scope of our survey. Certain borderline activities are thus included. The cutting of lumber and operation of sawmills and the manufacture of cement, lime, and marble and other stone products are included although these are activities closely allied with the production of raw materials, and frequently identified with nonmanufacturing enterprises. Also included is the construction and repair of railroad rolling stock in railroad repair shops, though this is a borderline activity not unlike the servicing and repair of automobiles, which is excluded. Also included is the making of manufactured gas but not the generation of electricity at central power stations, the making of motion pictures but not their projection in theatres. While most manufacturing activities are so classified without difficulty, there are marginal cases in which classification is a matter of arbitrary decision. Since the source of almost all the information about manufacturing that we have used is the Census of Manufactures, we have followed Bureau of Census classifications. These classifications differ somewhat from those adopted by other reporting agencies, for example, the Treasury Department in reporting corporate income accounts and balance sheets, or in other investigations, for example, compilations of national income. Recent estimates of national income compiled by the U.S. Department of Commerce exclude from the manufacturing group the following industries here included: coffee and spices, roasting and grinding; peanuts and other nuts, pressed or shelled; flax and hemp, dressed; dairymen's supplies; manufactured gas; motion pictures; railroad repair shops; ship and boat building (*National Income in the United States, 1929-35*; Washington, 1936; p. 249).

<sup>5</sup> These are the figures reported in the 1929 Census; the minor revisions appearing in later volumes have been ignored.

There is considerable duplication in the gross sales figures since many products are

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The value added by manufacture in 1929 represented \$11,621 million paid as wages and \$3,595 million paid as salaries. The rest, \$16,669 million, represented payments for diverse purposes—capital service, taxes, other items of overhead costs, and profits. The various payments by manufacturers reflect contributions by the labor factor, on the one hand, and by the capital and management factors, on the other. The importance of these factors may also be measured directly. This method is particularly useful in the analysis of the capital factor, since the heterogeneous 'overhead plus profits' item, which includes the payments for the use of capital, is an inadequate measure of return on capital investment. Also for many purposes the actual number of persons engaged in manufacturing activity and the extent of their participation is of interest. Accordingly, direct measures of the labor and capital factors have been examined.

### *Number of wage earners and salaried employees*

The average number of wage earners employed in manufacturing in 1929 was 8,839 thousand, the number of salaried workers, 1,359 thousand. Another 208 thousand persons were employed in the administrative offices of manufacturing concerns having central offices. The total number of employees in manufactures was thus some 10.4 million, which represents 30 per cent of employment in all lines of activity.<sup>6</sup>

In the analysis of labor effort in manufacturing operations, account should be taken of varying hours worked by different groups of employees. To supplement the measures of num-

sold to other manufacturers for further fabrication. There is also some small amount of duplication in the value added figures arising from the double counting of contract work. In Ap. IV this duplication is estimated at \$352 million.

<sup>6</sup>The basic figures refer to full time employment and exclude entrepreneurs such as independent farmers and storekeepers. The number of employees (full time equivalent) in all activities covered in the estimates of national income in 1929 is 34.7 million; the total number gainfully occupied, including entrepreneurs, was 44.6 million, *National Income, 1929-36* (U.S. Department of Commerce, 1937), p. 20. The number employed in manufacturing given in this report is somewhat less than our figure by reason of the omission of certain industries from the manufactures total (see footnote 4).

ber of wage earners, we have therefore estimated aggregate man hours of employment. Although from a social point of view the individual workman is the unit of greatest interest, aggregate hours of work is the more significant figure in appraising the cost of manufacturing operations and the extent to which physical energies are devoted to these ends. It is estimated that approximately 22 billion man hours were worked by wage earners and some 3 billion man hours by salaried employees in manufacturing enterprises in 1929.<sup>7</sup>

### *Capital investment*

The Census of Manufactures does not report the amount of capital invested in manufacturing establishments. Difficulties of appraisal and especially the problem of apportioning investment among the plants owned by a single concern explain the omission. Estimates of capital invested in manufacturing operations, and in the manufacture of various types of goods, have been prepared from the balance sheets reported to the Bureau of Internal Revenue by corporations engaged principally in manufacturing activities.<sup>8</sup> Such estimates place the extent of fixed capital—plant and equipment less depreciation—utilized in manufacture at \$27 billion. This is about 15 per cent less than the total value added by manufacture in 1929. Circulating capital (inventories and cash) amounted to roughly \$16 billion.<sup>9</sup> Miscellaneous items of capital assets bring the total to \$50 billion. Although these figures are rough estimates, they do furnish measures whose apportionment according to different productive uses indicates the relative importance of capital as a productive factor in manufacturing operations.

<sup>7</sup> See Ap. III for a description of the derivation of these estimates.

<sup>8</sup> The methods followed in estimating these capital values, and the limitations imposed upon them by the inadequacies of the data, are described in Ap. VI.

<sup>9</sup> Accounts receivable have not been included in circulating capital or in the total of all capital because they tend to be offset by accounts payable. From the point of view of the manufacturing structure as a whole it seems desirable to exclude them. For comment on the inclusion of cash see Ap. VI.

*Horsepower*

The power capacity of primary movers used in manufacturing establishments has also been studied. Despite the varied character of power equipment, the allocation of the 42,931 thousand horsepower capacity reported by manufacturing establishments in 1929 is not without value. There is some evidence that the admitted defects in the horsepower statistics are not serious,<sup>10</sup> although their adequacy as measures of capital use is questionable. However, they serve to supplement the capital estimates and have the distinct merit of being expressed in physical rather than monetary terms.

Keeping in mind the qualifications of the approach, and having considered certain of the magnitudes relating to all manufactures that can be analyzed, we now attempt to find answers to the various questions that have been raised concerning manufacturing activity.

<sup>10</sup> The chief difficulty arises from the lumping into one total of rated capacities of prime movers (steam engines, turbines, water wheels, etc.) and the rated capacity of electric motors run by purchased power. The capacity of electric motors ordinarily exceeds the needed power capacity of the equipment they operate, but the capacity figures for prime movers also overstate the power drawn from them, because of wastage and reserve capacity. These tend to be offsetting factors (in that each element is subject to the same bias) but lead to a general overstatement of power installations. Comparisons between industries in a given year should not be affected as seriously as comparisons over a period of years, in which the increasing dependence on purchased power introduces a baffling trend bias.

The approximate equivalence of the degree of overstatement in the two types of power rating is seen from the following figures. In the *1929 Census of Manufactures* (I, 112) it is estimated that of the total of 20,155,397 horsepower capacity of prime movers, about 11,690,000 horsepower was devoted to the operation of generators furnishing current for the electric motors not run by purchased current, the rest being delivered directly through belts and shafting. The reported capacity of these electric motors run by electricity generated within the plant was 12,376,376 horsepower, a rating not greatly different from that given the corresponding primary movers. Therefore no marked discrepancy seems to arise from the different character of power equipment that is primary from the standpoint of the manufacturing establishment.

For a discussion of limitations on the horsepower statistics of the Census see *Horsepower Statistics for Manufactures* by W. L. Thorp, *Journal of the American Statistical Association*, December 1929, pp. 376-85.