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Chapter 6

Manufacturing in the National Economy

ALTHOUGH we have progressed only a few steps toward an understanding of the developments in manufacturing employment and production during the twentieth century, we have had to hack our way through a rather thick jungle of facts and figures. At this final point we shall review our journey and conclude by noting how trends in the field of manufacturing are related to the general economic development of the United States.

A SUMMARY OF CHANGES IN AMERICAN FACTORIES

Manufacturing employees in 1937, the last peak year of business preceding the present war, numbered ten million, as compared with five million in 1899. Factory jobs therefore doubled in the four decades between these two years.

The rise in number of factory workers after 1899, impressive though it was, fell far short of the almost fourfold increase in factory output during the same period. The number of workers employed in factories to turn out a unit of manufactured product thus declined by 50 percent during the four decades. And this cut probably understates the actual decline in employment per-unit if only because of improvements in the quality of manufactured products, for which no allowance is made in our output index. Unit labor requirements fell more sharply than even such a refined figure, if we had it, would imply; for the decrease in employment of factory

workers per unit of product was accompanied by a very considerable drop in weekly hours of labor. A full-time week shrank from an average of about 60 hours per person in 1899 to about 40 hours in 1937. Since the number of workers needed per unit of product was cut in half, and hours were reduced by a third, there was a drop of two thirds in aggregate manhours per unit. In short, by 1937 only about one third as many manhours of factory work went into the fabrication of a given quantity of goods as 38 years earlier.

The factors making for reductions in labor per unit of product have not had the same impact on all manufacturing industries. For this reason the average for manufacturing in the aggregate conceals wide differences among industries. In some there were only minor decreases or even rises in the labor-output ratio; in others the declines were precipitate.

In eight of the 51 industries for which our information covers the period 1899-1937, employment per unit of product was cut by seven tenths or more. Heading the list is automobile manufacture (with a decline of nine tenths), followed by industries as diverse as beet sugar, silk and rayon goods, industrial chemicals, and blast-furnace products. At the bottom of the list are eight industries in which the employment-output ratio rose: three in the field of transportation equipment (railroad cars, locomotives and ships), and five others (turpentine and rosin, lumber-mill products, meat packing, linen goods and wool-felt hats).

The indexes of manhours per unit, too, vary from industry to industry with respect to rate of change, although they declined in all except two of the industries covered by separate indexes. The exceptions are locomotive manufacture and shipbuilding. These are among the eight industries in which employees per unit of output rose; the other six join the industries in which labor per unit of product was cut when their labor input is measured in terms of manhours instead of men.

No doubt the exceptional position of the few industries that did not succeed in reducing labor per unit of output appreciably is to be attributed in some degree to our inability to take statistical account of advances in the quality of their products. Perhaps the more important consideration, however, is suggested by the interesting fact that those industries which lagged in cutting down on the labor needed to turn out a unit of product either failed to expand their output between 1899 and 1937 or actually curtailed it. On the other hand, the industries at the head of the list usually expanded output faster than the average. Indeed, it was the industries with particularly large increases in *both* employment and output between 1899 and 1937 which tended to have exceptionally large declines in employment per unit, whereas those with under-average increases in both tended to reduce employment per unit less sharply than the average. Jobs per unit of product fell most precipitately in the automobile industry, in which we find the largest expansions both in total employment and in output. Again, in industrial chemicals employment increased eightfold and output multiplied twenty-five times, with a consequent decline of almost three quarters in labor per unit. In lumber mills, on the other hand, employment per unit went up by a fifth; at the same time the number of workers decreased in the same proportion and the volume of product fell off by a third.

We may conclude, then, that when an industry's output has grown rapidly, even a substantial decrease in the number of workers employed per unit has not usually meant fewer jobs in that industry. If output has expanded only moderately, however, a decline in the ratio of men employed to units produced has commonly coincided with rather slow growth in the number of jobs, and sometimes has actually resulted in a reduced volume of employment. Yet an increase in workers employed per unit has not necessarily been accompanied by increase in the labor force in the few industries

that ran counter to the general trend, for these were usually the ones whose output shrank at the same time.

Exceptionally large declines in labor per unit have been characteristic of rapidly growing industries. These industries have other interesting features in common as well. They have tended to effect particularly large reductions not only in labor per unit but also in wage costs per unit of product, in unit value added (that is, wage and overhead costs, including profits), and in selling price. In automobile manufacturing we find a striking combination of all these tendencies: here output and manhours of employment were increased between 1909 and 1937 by percentages larger than those in any other industry covered here (5,000 and 300, respectively); and in this same industry unit labor requirements, unit wage costs, unit value added, and average selling price were cut by the largest percentages (92, 70, 75 and 40, respectively). Petroleum refining, chemicals, beet sugar, and canned foods also are to be singled out for these relationships. Conversely, the industries that fell behind in reducing unit labor requirements and in expanding output and employment were slow to cut unit costs and prices. Among the laggards we find the industries manufacturing cotton goods, woolen and worsted goods, carpets and rugs, lime, and lumber.

The inverse relation we have noted between employment and output on the one hand and the employment-output ratio on the other holds for changes over specific periods, 1899-1937 or 1909-1937. Obviously all industries were not in the same phase of development during these years—some were coming into being, some were reaching their prime, some were already on the way out. The relationships for 1899-1937 or 1909-1937 therefore represent averages for industries at various stages of their careers. This observation leads us to the question: How are employment, output, and the labor-output ratio related during each of the successive stages through which an industry passes?

The growth of an industry, in terms of output, proceeds at a rate that diminishes more or less steadily from decade to decade, until, when peak output is attained, it becomes zero, and finally negative. The course of retardation may be illustrated by the cigar industry. Between 1869 and 1879 the output of cigars rose by 7.5 percent per annum, and between 1879 and 1889, by 6.1 percent. During each of the next two decades cigar manufacture increased annually by 3.3 percent, but between 1909 and 1919 the rate was only 0.1 percent. In the two following decades it fell: by 1.2 percent per year between 1919 and 1929, and by 2.7 percent in 1929-37. In an industry with an initial spurt as meteoric as that of automobile production one discovers an extremely rapid rate of retardation: the output of automobiles rose at an annual rate of 43 percent during the first decade of the present century, 32 percent in the second decade, and 13 in the third; then a decline set in, and production dropped at the rate of 1.3 percent per annum between 1929 and 1937.

Employment, too, grows at a decelerating rate. Just as output in most industries has tended to expand less and less rapidly with the passage of time, so the percentage increase in employment has usually diminished. Reductions in hours of labor have modified this pattern, but have not radically altered its general outline.

Retardation of growth in both output and the number employed by an industry does not mean, of course, that the movement of employment is exactly the same, at any one time, as that of output. Because of widespread and more or less persistent declines in employment per unit of product, aggregate employment in any one period usually grows more slowly than output; and maximum peaks in the former frequently precede maximum peaks in the latter. Among 72 industries which reached peaks in both employment and output prior to 1939, the high point in employment followed the peak in output in only 11. In 23, mainly because of cyclical

and random fluctuations impressed on both series, the two dates coincide. In the other 38 industries, over half of the sample, employment reached a peak and began to recede while output was still expanding; and in as many as 15 of these, output reached its peak more than a decade later than employment. There is evidence, moreover, that the highest peak in *manhours* leads the highest peak in output in a proportion of industries greater than 38 out of 72, and that the average lead of the manhour peak over the output peak is longer than the average lead of the employment peak over the output peak.

If we may judge by the statistics analyzed in this report, during the early stages of a manufacturing industry's career employment goes upward with output while employment per unit shrinks; during the middle stages the number of workers employed also tends to drift downward, although output is still advancing; and during the late stages all three tend to drop. In young industries, whose output characteristically shoots up quickly, the enormous gains in production usually more than counterbalance the declining trend in the labor-output ratio; as a consequence, employment too expands rather rapidly. During the mature phase of an industry's development output expands slowly, if at all; now the gain in volume of product is not great enough to offset the declining trend in the labor-output ratio, and as a result jobs decrease unless the working week is cut sufficiently to compensate for the lessening need of labor per unit. In old and waning industries, falling output offers no counterweight to diminishing unit labor requirements, so that even substantial cuts in the hours of work per week fail to halt reductions in the number of workers employed.

When we look at manufacturing in the aggregate, we see that change in total factory employment is the net result of the shift of workers into new industries, the rapid multiplication of jobs in the young industries that survive in the initial

struggle for breathing space, the moderate growth (but from a higher level) of industries close to maturity, the stagnation in older industries, the decline in waning industries, and finally the disappearance of employment in defunct industries. Technological changes contribute to all these developments, for they are basic not only to the ebb of employment in mature and decadent industries but also to the emergence and exploitation of new fields of employment. Technological evolution is thus a factor in the hiring of workers as well as in their firing.

Capital investment, too, if it can be considered apart from developments in technology, has played a dual role in the opening up of employment opportunities and in their industrial distribution. On the one hand, an industry's output (and the employment it offers) has seldom expanded unless capital has flowed into it; whereas industries with shrinking output and employment have not commonly increased their aggregate assets at the same time. There have been exceptions, of course. Since an influx of capital is only one of the means by which an industry's output is augmented, some industries may have grown, during some periods, with little or no increase, or even a decrease, in their capital assets; and it is conceivable that capital assets, by displacing other factors of production, have swelled even in a few declining industries. Nevertheless, what we know of industrial history bears out the broad observation made here. Between 1904 and 1937 the largest increases in both jobs and output occurred in the major groups of manufacturing industries whose fixed assets, in terms of net book values, grew most rapidly. Automobiles, petroleum refining, electrical machinery, chemical and rubber products stand out in this respect. And among the groups with relatively slight increases in output and employment, notably tobacco, textiles, leather, and forest products, are the industries with less-than-average increments to capital assets.

It is equally true, however, that an inflow of capital has

usually been accompanied by sharp cuts in labor requirements per unit. Inevitably, then, when output fails to expand sufficiently to balance the decline in unit labor, new capital investment is associated with fewer jobs. Here also the change in the employment offered by an industry is seen to correspond in direction with change in capital investment at certain stages of an industry's growth. Though adequate statistical information is lacking, it seems likely that in the early stages capital investment is accompanied by an increase in jobs; that in the mature period it coincides with static or declining employment, and that in the later stages disinvestment of capital parallels displacement of labor and dwindling output.

MANUFACTURING PRODUCTIVITY AND INDUSTRIAL DEVELOPMENT

The great reduction since 1899 in the factory labor utilized per unit of output (one half in terms of workers, two thirds in terms of manhours), and the corresponding advance in output per worker or per manhour, provide us with a rough indication of the growth of manufacturing productivity. These changes cannot, of course, be regarded as exact measures of the gain in the power and efficiency of manufacturing industry, for shifts in the ratio between output and labor input may have come about through the substitution of other production factors for workers, or of one type of labor for another. For example, if costs are incurred in the operation and maintenance of the cigar machines which displaced cigar makers, or in the purchase of the electric power which superseded the factory production of power, the measurable reduction in labor per unit must overstate the net gain in productivity. On the other hand, the substitution of unskilled for skilled labor (say, cigar-machine operators for hand workers) may signify an economy that is not reflected in the measures

of labor input available to us. (Of course, if the skill of the displaced workers is thereby rendered obsolete, as it often is, the gain is merely a gross gain, in the accounting sense, from the viewpoint of society at large; for in casting up its accounts the nation must give full consideration to the negative consequences of any industrial development.) Similarly, capital-saving innovations lead to advances that can hardly be gauged by any productivity ratio we are able to compute. Yet even liberal allowance for biases of this sort would not invalidate the conclusion that productivity has soared upward rather generally throughout manufacturing enterprise.

This enhancement of factory efficiency cannot be credited entirely to our manufacturing industry. Nor, indeed, because manufacturing constitutes merely one sector of our economy, can its productivity be fully understood or explained when viewed in isolation. The career of any single industry, great or small, is a thread woven into a complex pattern, to which it contributes its share of color, texture, and design, and from which it derives most of its meaning.

There is ample evidence that the labor-output ratio in manufacturing is affected by the kind and quality of the materials secured from nonmanufacturing industry. It is widely known, for instance, that selection of seed and technological advances have raised the sugar content of beets, so that there has been a gain in the sugar yield obtained by manufacturers per ton of beets treated. And in another field, the introduction of the flotation process, which led to the concentration of an increasing fraction of copper ores by the mining industry, has lessened the effort expended in the factory to derive a given quantity of copper in the smelting process. Similarly, such forms of nonmanufacturing endeavor as engineering and independent research have made their contributions to manufacturing. They have been the original source of many ideas concerning materials, products, processes, as well as organization and management, and have

helped also to transmit ideas from one industry to another. For all ideas do not originate in the industries utilizing them. They spring up in different areas of the industrial cosmos and merge in a common pool drawn upon by all types of enterprise.

Perhaps the stellar role in the contribution of nonmanufacturing industries to factory productivity has been played by transportation, and in particular by the railroad system, which has opened up many new sources of raw materials. Thus lumber manufacturers have extended their operations to virgin forests, thereby at least postponing increases in their costs. Again, highly concentrated localization of factories, with the fine division of labor and other advantages it implies, depends upon cheap and efficient transportation not only from sources of supply to factory but also among specialist plants. The immense expansion of the factory system would have been inconceivable without the extension of the railway system.

The growth of the economy at large has augmented the scale of operations and raised the level of productivity in manufacturing perhaps even more rapidly than in other fields of industry, for fabricated goods have acquired a favored place in consumers' budgets as incomes have risen. It is true, of course, that in some instances an expansion of the scale of operations may press upon limited natural resources, thus causing the employment of more, rather than less, labor per unit of product. Occasionally such a tendency is noted in mining, and, if demand leads to the exploitation of mines yielding low grades of ore, the result may even be an adverse effect upon manufacturing productivity. But the evidence gathered in this study indicates that growth of factory output has usually been associated with more, rather than less, output per worker employed.

The relation of manufacturing to the entire economy has always been a reciprocal one. Changes in one industry stimu-

late changes in others, through imitation, competition and cooperation. Many new devices and materials have resulted from a collaboration between producing industries on the one hand, and consuming industries on the other. Steel companies have helped to develop new materials for many of their smaller customers and for some of their large ones as well—notably the railroads. Less direct, perhaps, but even more obvious in its results is the sort of cooperation that yields improvements both in engines and in types of fuel and lubricants. Specifically, it is interesting to observe the high degree of correlation between trends in octane numbers of gasoline and in compression ratios of automobile engines. And then, of course, there are the specialist “assistant industries”—accountants, advertising agencies, engineers, commercial laboratories, efficiency advisers, and so on—which not only work out new techniques but also act as transmission belts for those developed elsewhere.

Just as nonmanufacturing industries have contributed to the expansion of manufacturing, so the latter has served to stimulate industry in other segments of the economy. Manufacturing has enhanced the productivity of nonmanufacturing industry both by taking over some of the tasks formerly done outside the factory and by supplying better and cheaper tools and materials for nonmanufacturing use. The substitution of the factory-made tractor for the farm-bred horse set free the farm labor that formerly was devoted to rearing, feeding, and caring for draught animals. And this is only one of a multitude of examples to which the reader can easily add from his own store of information and experience.

Growth in the efficiency of any single industry or group of industries—manufacturing or nonmanufacturing—is thus intimately related to developments elsewhere in the economy. Advance in manufacturing productivity is part of the evolution of the entire industrial system. For this reason we must learn to look not only within but beyond factory walls for an

understanding of the rise of manufacturing industries, and come to regard the increase in output per unit of labor in manufacturing as merely one observation on the change in the productivity of the entire economy.

FACTORY EMPLOYMENT AND OUTPUT AND THE NATIONAL ECONOMY

Like the growth of factory productivity, the trends that have characterized employment and output in manufacturing industry are aspects of the development of the economy at large. Factory output itself rose more rapidly than the total national product; the national income, adjusted for changes in prices, went up about 130 percent from 1899 to 1937, while the output of fabricated goods almost quadrupled. Factory output thus advanced about 50 or 60 percent more than the total product. But such a relative increase should not have been unexpected during this stage of our development. The rise in national income per capita brought with it a greater demand for processed commodities. It made possible the transfer of domestic chores like baking, canning, cooking, and sewing from the home to the factory, and it lessened the burden of many other tasks which factory-made goods (washing machines, vacuum cleaners, and other devices) could now accomplish more easily and efficiently. Aside from the relative increase in the volume of final consumer commodities passing through factories, these enterprises undertook a greater share of the production of other commodities. Such processes as butter- and cheese-making and animal slaughter were shifted from farm to factory, and the work of the farmer was eased by the increased fabrication of fertilizers, agricultural machinery, tractors and fuel. Factories turned to producing more and more of the "horse" power consumed in farm operations. A similar development characterized the relations between factories and nonagricultural industries such as mining, where mechanical excavators and loaders

took over much of the labor formerly needed at the pit. Factory output grew also because manufactured products came to occupy a larger place among our exports.

Just as factory output rose with the national income, between 1899 and 1937, so factory employment increased with the total number of jobs held by the gainfully occupied population. Once again we find that the trends did not run exactly parallel. Factory employment rose more rapidly than total employment and thus reflected a rise in the fraction of our available human resources devoted to manufacturing operations. But the disparity between the two trends in employment was less marked over the entire period 1899-1937 than that between the two output trends during the same period. The explanation is to be found in the more rapid increase in output per worker in factories than in the economy as a whole, a fact which was undoubtedly associated with the more rapid rise in factory output than in the total national product.

The changes in the relation between manufacturing and the entire economy did not take place at a uniform rate during the four decades beginning with 1899. Factory output climbed rapidly throughout the first three decades, but changed only fractionally between 1929 and 1937; and the increase in factory output, relative to the national product, came almost entirely during the first two decades. Factory employment rose only during the first two decades, both absolutely and in relation to total employment. During the 1920's and 1930's it remained unchanged, except for cyclical fluctuations, and in relation to total employment it actually declined during the 1920's.

During the 1920's, therefore, the gain in factory output was accomplished entirely by an increase in output per factory worker. In this period the newcomers to our working population apparently were not needed in manufacturing and could be diverted to nonmanufacturing operations, espe-

cially trade and service. Even in these occupations, it is possible that they contributed in some part to the increase in factory productivity and thus to the rise in factory output, for, as we have seen, factory productivity reflects many more changes than those occurring exclusively within factories.

Between 1929 and 1937, the maintenance of the level of factory output was accomplished by an increase in output per manhour, since the number of workers remained unchanged as a result of the sharp cut in hours of labor. In this period employment in nonmanufacturing industries also failed to grow, so that the annual increase in the number of our working population served merely to swell the ranks of the unemployed.

When viewed against the background of retardation in the growth of employment in individual manufacturing industries, the failure of total factory employment to rise during the 1920's and the decline in manhours of employment during the 1930's seem to indicate that manufacturing is approaching, or has already reached, maturity. There is some evidence, indeed, that the ratio of factory personnel to the total number of persons gainfully occupied has suffered retardation in recent decades. But the evidence is not conclusive: the ratio rose 12 percent from 1870 to 1880; 6 percent from 1880 to 1890; 8 percent from 1890 to 1900; 2 percent from 1900 to 1910; and 19 percent from 1910 to 1920; from 1920 to 1930 it fell 13 percent, but in 1930-37 it rose again, though only by about 2 percent.¹ The figures reveal a tendency to decline with the passage of time, but the variation about the downward trend is rather considerable. For output, adequate data are not available for the years prior to 1899. While the information covering the last four decades is not inconsistent with the presence of retardation in factory out-

¹ The figures for 1870-1930 are derived from Daniel Carson's analysis of the Census of Occupations (*Labor Supply and Employment*, unpublished manuscript of the National Research Project); and those for 1930-37 from Department of Commerce estimates.

put, it, too, can hardly be considered as proof of such a tendency.

On the statistical side, therefore, one may well doubt whether the growth of factory employment and output has consistently decreased in speed in relation to the rate of developments in the remainder of the economy, and thus whether the rates of change since 1919 and particularly from 1929 to 1937 are part of a clearly-defined trend. Yet even if retardation were to be considered accurately descriptive of the past relative growth of our factories, it is questionable that it could be interpreted as a sign of the approaching maturity of manufacturing. There is, of course, the complication raised by the present war, during which manufacturing has already expanded enormously. But aside from this "deviation," one is confronted by the inherent difficulty of characterizing as mature any major division of an economy, especially one as heterogeneous as manufacturing. Only a homogeneous industry can be treated as a single entity, so that an inference concerning its future may be hazarded from its past trend. But factories produce commodities at various stages of completion (pig iron, steel sheets, machine tools, and automobiles); and articles satisfying diverse wants (foods, textiles, construction materials, capital equipment, and durable consumers' goods). It is true that the pace of the shift of production from the household to the factory may slacken and ultimately cease, if it has not already done so; and full mechanization of farm and mine may finally be accomplished. In that event these forces, which in the past have stimulated rapid growth in our factories, may no longer operate. Yet there also exist potential factors that may cause manufacturing to grow. Among these are further developments of new processed materials, such as plastics; the shift of work from the construction site to the factory if extensive prefabrication of building materials becomes practicable; the full-fledged mechanization of trade and the service industries;

and the development of various new consumer goods. These possibilities, if realized, may cause a resurgence of manufacturing.

Qualifications concerning predictions as to the future of factory output apply equally to forecasts of the trend in factory employment. Whether the failure of factory employment to rise during the 1920's and 1930's portends a corresponding horizontal trend (or even an actual recession) after the present war boom has ended it is impossible to predict. There are snares in simple reasoning. And as is true of factory output, the future course of factory employment cannot be determined merely by a consideration of the variables related directly to manufacturing.

Nor can the significance of past trends in factory employment be appraised if attention is confined to factories alone. Stable or declining numbers of factory workers are not of themselves tragic omens. If employment in the rest of the economy is rising, as it was up to 1929, declining factory employment may mean either a diversion of energy from one type of production to another, or an advantageous reduction in the amount of labor required to fabricate a given amount of product. In that case, not only the growth but also the stagnation of factory employment falls into perspective as an aspect of our general economic advance. And if employment in all types of industry fails to rise, as during the 1930's, the roots of the problem posed by a declining number of factory workers reach far outside factory walls, and the solution of that problem must be sought in study of an area broader than manufacturing alone.