

## THE INFLUENCE OF MACHINERY UPON EMPLOYMENT.

IN discussing the influence of machinery upon demand for labor we must distinguish its effects upon (1) the number of workers employed; (2) the regularity of employment; (3) the skill, duration, intensity and other qualities of labor.

### I. *Upon the Number of Workers.*

The motive which induces capitalist employers to introduce into an industry machinery which shall either save labor by doing work which labor did before, or assist labor by making it more efficient, is a desire to reduce the expenses of production. Looked at from the standpoint of a given quantity of production, a new machine always displaces and throws out of employment a certain amount of labor, assuming that the labor of producing the new machines and of working them is paid at no lower rate of remuneration than the labor which is displaced. What is meant, then, by the statement so frequently made, that machinery gives more employment than it takes away — that its wider and ultimate effect is not to diminish the demand for labor? If we set against the displaced labor in a given business the labor of producing, maintaining and working the new machines, there must be still a net diminution in employment of labor; for otherwise no economy would be effected. This is of course beyond dispute. But, it is maintained, the economy afforded by labor-saving machinery in the expenses of production will, through competition of producers, be reflected in a lower scale of prices, and the fall of prices will stimulate consumption. When we add together the labor spent in producing the machinery to assist the enlarged production, the labor spent in maintenance and working of the same, and the labor of conveying and distributing the enlarged production, it will be

found that more labor is required under the new than under the old conditions of industry. So runs the argument.

If for convenience we omit all consideration of the probability that the economy in production will swell profits instead of reducing prices, the value of the argument evidently turns upon the effect of a fall of price in stimulating increased consumption. Now the problem how far a given fall in price will stimulate increased consumption is shown by Professor Marshall, in his interesting treatment of "flexibility of demand,"<sup>1</sup> to involve extremely intricate knowledge of the circumstances of each case and refined calculations of human motives. If we apply a similarly graduated fall of prices to two different classes of goods, we shall observe a widely different effect in the stimulation of consumption. A reduction of fifty per cent in the price of one class of manufactured goods may treble or quadruple the consumption, while the same reduction in another class may increase the consumption by only twenty per cent. In the former case it is probable that the ultimate effect of the machinery which has produced the fall in expenses of production and in prices will be a considerable increase in the aggregate demand for labor, while in the latter case there will be a net displacement. It is therefore impossible to argue *a priori* that the ultimate effect of machinery must be an increased demand for labor, and that the labor displaced by machinery will be directly or indirectly absorbed in forwarding the increased production caused by machinery.

Moreover the industrial history of a country like England can furnish no valuable data for a wider judgment of the case. The enormous expansion of production induced by the application of machinery in certain branches of textile industry during the first half of this century indisputably led to an increased demand for English labor in industries directly or indirectly connected with textile production. But in the first place this cannot be regarded as a normal result of a fall of prices due to textile machinery, but is largely attributable to an expansion in the area of consumption—the establishment

<sup>1</sup> Principles of Economics, bk. iii., ch. iv.

of vast new markets — in which greater efficiency and cheapness of means of transport played the most considerable part. Secondly, assuming that the more pressing needs of the vast body of consumers are already reached and satisfied by machine-produced textile goods, we are not at liberty to conjecture that any further cheapening of goods owing to improved machinery will have a correspondent effect upon consumption and the demand for labor. If England had been a self-contained country, manufacturing only for her own market, the result of machinery applied to textile industries would undoubtedly have been a considerable net displacement of textile labor, making all allowance for growth of population and increased domestic consumption of textile fabrics. The expansion of English production under the rapid development of machinery in the nineteenth century cannot be taken as a measure of the normal effects of the application of machinery.

What direct evidence we have of the effect of machinery upon demand for labor is very significant. Mr. Booth, in his *Occupations of the People*, presents an analysis of the census returns showing the percentages of the population engaged in various employments at decennial points from 1841 to 1881. If we turn to manufactures, upon which, together with transport, machinery exercises the most direct influence, we find that the aggregate of manufactures shows a considerable increase in demand for labor up to 1861, that is to say, in the time when English wares still kept the lead they had obtained in the world-market, but that since 1861 there is a considerable decline in the percentage of the population employed in manufactures. The percentages run as follows:

1841	. . .	27.1
1851	. . .	32.7
1861	. . .	33.0
1871	. . .	31.6
1881	. . .	30.7

If we take the staple manufactures, employing the largest number of workers, we shall find that for the most part they

show a rising demand for labor up to 1861, a stationary or falling demand after that date. The foundational industries — machinery and tools, ship-building, metal-working — whose demand for labor during the period 1841 to 1861 increased by leaps and bounds, still show a slightly increased proportion of employment, partly due to the rise since 1861 of a large export trade in machinery. Fuel, gas, chemicals and other general subsidiary trades offer a steady rise in proportionate employment. The textile and dyeing industries, on the other hand, showing an increased proportionate employment up to 1851, by which time the weaving industry was taken over by machinery, present a continuous and startling decrease in the proportion of employment since that year. A considerably smaller proportion of workers are employed in these trades than were employed in 1841. The dress-making industries show the same result, a continuous rapid decline of employment since 1851. The following are the percentages:<sup>1</sup>

	Textile and Dyeing.	Dress.
1841 . . .	9.1	7.8
1851 . . .	11.1	10.3
1861 . . .	10.2	9.8
1871 . . .	9.3	8.5
1881 . . .	8.2	8.1

This failure of demand for labor to keep pace in its growth with the growth of production in the main branches of the spinning and weaving industries is emphasized by Mr. Ellison. Comparing 1850 with 1878, he says:

In spinning mills there is an increase of about 189 per cent in spindles, but only 63 per cent in hands employed; and in weaving mills an increase of 360 per cent in looms, but only 253 per cent in operatives. This, of course, shows that the machinery has become more and more automatic or self-regulating, thus requiring the attendance of a relatively smaller number of workers.<sup>2</sup>

When all the subsidiary branches of textile industry are added, the results point still more conclusively in the same direction.

<sup>1</sup> Booth, *Occupations of the People*, pp. 68, 69.

<sup>2</sup> T. Ellison, *Cotton Trade of Great Britain*, p. 74.

	No. of Spindles.	No. of Looms.	No. of Operatives.
1850 . . .	20,977,817	249,627	330,924
1878 . . .	44,206,690	514,911	482,903

The more recent statistics of Mr. Booth show that the relative diminution of employment in the textile industries has passed into an absolute diminution. The total number of operatives in textile and dyeing industries was :

1851 . . .	346,200
1861 . . .	462,400
1871 . . .	414,500
1881 . . .	396,400 <sup>1</sup>

The significance of these figures in relation to the demand for labor receives further emphasis when the large and rapid displacement of male by female labor is taken into account. To this I refer later.

The branches of manufacture which show a large increase in the proportionate employment they gave in 1881, as compared with 1861, are printing and bookbinding, wood furniture and carriages, fuel, gas, chemicals and unspecified trades (chiefly connected with machinery). Machinery and tools, metals and ship-building, among the larger industries, show a small proportionate increase of employment.

From these facts two deductions may be made bearing upon the effects of machinery. First, so far as the aggregate of manufactures is concerned, the net result of the increased use of machinery has not been to offer an increased demand for labor keeping pace with the growth of the working population. Second, an increasing proportion of the manufacturing population is employed in the smaller industries, which are either subsidiary to the large industries or are engaged in providing miscellaneous comforts and luxuries.

When we turn from manufactures to other employments, we perceive that while manufactures, together with mining and building, employ about the same proportion of the working population as in 1851, agriculture offers a rapidly diminishing employment, descending from 20.9 per cent in 1851 to 11.5

<sup>1</sup> Occupations of the People, p. 10.

per cent in 1881. On the other hand, the proportion of the workers engaged in transport trades, in dealing and in industrial service has risen very largely.

	Transport.	Dealing.	Industrial Service.
1841 . . .	2.2	5.3	5.4
1851 . . .	4.1	6.5	4.5
1861 . . .	4.6	7.1	4.0
1871 . . .	4.9	7.8	6.0
1881 . . .	5.6	7.8	6.7

To this we may add a large increase in the proportionate supply of public and professional service, rising from 3.6 per cent in 1841 to 5.6 in 1881.

When we look at these figures there can be no question that an indirect result of the increased production due to the application of machinery has been increased employment in distributing industries. It should, however, be clearly recognized that the direct effect of machinery upon these industries also is to diminish the proportionate employment of labor. A comparison of the two chief branches of the transport trade yields the same results. Machinery occupies a very different place in the railway from that which it holds in the steamship. The engine only indirectly determines and regulates the work of the majority of railway workers. Most of them are not tenders of machinery. Engineer, stoker and guard are alone in close, direct association with the machine. To them must be added those engaged in the workshops in construction and repair. Pointsmen and certain station officials come next in proximity to the machine; shunters and porters are also "tending machinery," though their work is more directly dominated by general business considerations. But are we to say that the army of plate-layers, navvies, *etc.*, engaged along the track are serving machinery instead of using tools? The work of ticket clerks and collectors is only governed by the locomotive in a very indirect way. Though the steam locomotive is the central factor in railway work, the bulk of the labor is skilled or unskilled work in remote relation to the machine. This explains why the growth of railway industry is not attended by

a diminishing proportion of employment. On the contrary, we find that railway employment increases faster than mileage and railway capital. The following figures illustrate the movement between 1860 and 1890 in railways of the United Kingdom:

Year.	Mileage.	Capital (paid up).	Operatives.
1851 . . .	—	—	25,200
1861 . . .	10,865	£362,327,338	53,400
1871 . . .	15,376	552,661,551	84,900
1881 . . .	18,175	745,528,162	139,500

But when we turn to the shipping trade, where a much larger proportion of workers are directly engaged with machinery, and trace the effect upon employment of the application of steam, the result is very different:

	Sailing Vessels (tonnage).	Steamers (tonnage).	Men on Sailing Ships.	Men on Steamships.
1850 . . .	3,396,359	168,474	142,730	8,700
1860 . . .	4,204,360	454,327	145,487	26,105
1870 . . .	4,577,855	1,112,934	147,207	48,755
1880 . . .	3,851,045	2,723,488	108,668	84,304
1890 . . .	2,907,405	5,037,666	84,008	129,366 <sup>1</sup>

If we take the period 1870–1890, during which there is an absolute shrinkage of sailing tonnage, we find that this shrinkage is accompanied by a less than corresponding diminution in employment. On the other hand, the tonnage of steamships has increased nearly fourfold, but has brought an increase of employment which is not quite threefold. This comparison of railway and shipping illustrates the degree of dominion exercised by machinery in the respective branches of transport industry.

<sup>1</sup> The aggregate effect of the change upon the employment of seamen is shown by the following figures, in which the aggregate tonnage of sailing and steam vessels is given:

	Tonnage.	Men.
1850 . . .	3,564,833	151,430
1860 . . .	4,658,687	171,592
1870 . . .	5,690,789	195,962
1880 . . .	6,574,513	192,972
1890 . . .	7,945,071	213,374

These facts and figures seem to support the following conclusions:

1. That along with the increased application of machinery to the textile and other staple manufactures there has been a decrease of employment relative to production.

2. That in the transport industries the increase of employment is in inverse proportion as machinery is introduced into the several branches as a dominating factor.

3. That the rapid diminution of agricultural employment is not compensated by any proportionate increase of manufacturing employment, but that the displaced agricultural labor finds employment in such branches of the transport and distributive trade as are less subject to machinery.

In the rough estimate of the effect of machinery upon employment, its influence upon English agriculture has been left untouched by reason of the inherent complexity of the forces which are operative. But it must not be forgotten that by far the most important factor in the decline of English agricultural employment is the transport machinery which has brought the produce of distant countries into direct competition with English agricultural produce.

So far, therefore, as the statistics of employments present a just register of the influence of machinery upon demand for labor, we are driven to conclude that the net influence of machinery is to diminish employment so far as those industries are concerned into which machinery directly enters, and to increase the demand in those industries which machinery affects but slightly or indirectly. If this is true of England, which, having the start in the development of the factory system, has to a larger extent than any other country specialized in the arts of manufacture, it is probable that the net effect of machinery upon the demand for labor throughout the industrial world has been to throw a larger proportion of the population into industries where machinery does not directly enter. This general conclusion, however, for want of exact statistical enquiries conducted upon a single basis, can only be accepted as probable.



## II. *Upon the Regularity of Employment.*

The influence of machinery upon regularity of employment has a twofold significance. It has a direct bearing upon the measurement of demand for labor, which must take into account not only the number of persons employed but the quantity of employment given to each. It has also a wider general effect upon the moral and industrial condition of the workers, and through this upon the efficiency of labor, which is attracting increased attention among students of industrial questions. The former consideration alone concerns us here. We have to distinguish : (1) the effects of the introduction of machinery as a disturbant of regularity of labor ; (2) the normal effects of machine production upon regularity of labor.

1. The direct and first effect of the introduction of machinery is, as we have seen, to displace labor. The machinery causes a certain quantity of unemployment, apart from the consideration of its ultimate effect on the number of persons to whom employment is given. Professor Shield Nicholson finds two laws or tendencies which operate in reducing this disturbing influence of machinery. He holds (1) that a radical change made in the methods of production will be gradually and continuously adopted ; (2) that these radical changes — these discontinuous leaps — tend to give place to advances by small increments of invention.<sup>1</sup>

History certainly shows that the fuller application of great inventions has been slow, though Professor Nicholson somewhat overestimates the mobility of labor and its ability to provide against impending changes. The story of the introduction of the power loom discloses terrible sufferings among the hand weavers of certain districts, in spite of the gradual manner in which the change was effected. The fact that along with the growth of the power loom the number of hand looms was long maintained, is evidence of the immobility of the hand weavers, who kept up an irregular and ill-paid work through ignorance and incapacity to adapt themselves to changed cir-

<sup>1</sup> J. S. Nicholson, *Effects of Machinery on Wages*, p. 33.

cumstances.<sup>1</sup> In most of the cases where great distress has been caused, the directly operative influence has not been introduction of machinery but sudden change of fashion. This was the case with the crinoline-hoop makers of Yorkshire, the straw-plaiters of Bedfordshire, Bucks, Herts and Essex.<sup>2</sup> The suddenly executed freaks of protective tariffs seem likely to be a fruitful source of disturbance. So far as the displacement has been due to new applications of machinery, it is no doubt generally correct to say that sufficient warning is given to enable workers to check the flow of labor into such industries and to divert it into other industries which are growing in accordance with the new methods of production.

Mr. Nicholson's second law is, however, more speculative and less reliable in its action. It seems to imply some absolute limit to the number of great inventions. Radical changes are no doubt generally followed by smaller increments of invention; but we can have no guarantee that new radical changes quite as important as the earlier ones may not occur in the future. There are no assignable limits to the progress of mechanical invention, or to the rate at which that progress can be effected. If certain preliminary difficulties in the general application of electricity as a motor can be overcome, there is every reason to believe that, with the improved means of rapidly communicating knowledge we possess, our factory system may be reorganized and labor displaced far more rapidly than in the case of steam, and at a rate which might greatly exceed the capacity of labor to adjust itself to the new industrial conditions. At any rate we are not at liberty to take for granted that the mobility of labor must always keep pace with the application of new and labor-disturbing inventions. Since we are not able to assume that the market will be extended *pari passu* with the betterment in methods of production, it is evident that improvements in machinery must be reckoned as a normal cause of insecurity of employment. The loss of employment may be only "temporary," but as the life of a workingman is

<sup>1</sup> Babbage, *Economy of Manufactures*, p. 230.

<sup>2</sup> Cf. Thorold Rogers, *Pol. Econ.* (1869), pp. 78, 79.

also temporary, such loss may as a disturbing factor in the working life have a considerable importance.

2. Whether machinery, apart from the changes due to its introduction, favors regularity or irregularity of employment, is a question to which I think a tolerably definite answer can be given. The structure of the individual factory, with its ever-growing quantity of expensive machinery, would seem at first sight to furnish a direct guarantee of regular employment, based upon the self-interest of the capitalist. Some of the "sweating" trades of London are said to be maintained by the economy which can be effected by employers who use no expensive plant or machinery, and who are able readily to increase or diminish the number of their employees so as to keep pace with the demands of some "season" trade, such as fur-pulling or artificial flowers. When the employer has charge of enormous quantities of fixed capital, his individual interest is strongly in favor of full and regular employment of labor. On this account, then, machinery would seem to favor regularity of employment. On the other hand Professor Nicholson has ample evidence in support of his statement that

great fluctuations in price occur in those commodities which require for their production a large proportion of fixed capital. These fluctuations in prices are accompanied by corresponding fluctuations in wages and irregularity of employment.<sup>1</sup>

In a word, while it is the interest of each producer of machine-made goods to give regular employment, some wider industrial force compels him to irregularity. What is this force? It is uncontrolled machinery. In the several units of machine production, the individual factories or mills, we have admirable order and accurate adjustment of parts; in the aggregate of machine production, we have no organization, but a chaos of haphazard speculation. "Industry has not yet adapted itself to the changes in the environment produced by machinery." That is all.

But, it may be asked, how is machinery to blame for the fluctuation of prices and the correspondent irregularity of

<sup>1</sup> Effects of Machinery on Wages, p. 66.

employment? Professor Nicholson has with admirable candor set on the one hand the orthodox economic theory, that, since ultimately commodities exchange for commodities, there can be no such thing as over-production; on the other hand, the universal belief of the business man that bad trade is due to over-production, and that general bad trade implies not merely the theoretic possibility, but the actual existence, of a condition which is properly described as general over-production. Business men see that all the markets are congested with goods which remain unsold, that all kinds of machinery are in excess, that owing to an increase of supply in relation to demand, prices are falling all round; and they are naturally not contented with the airy declaration of economists that over-production is impossible. Would it not be better for economists to recast their theory, so as to be in harmony with facts? Going a little behind the business view, might they not admit that under-consumption, the reluctance of those who hold the purchasing power to demand consumptive goods, is the true cause of the disease which figures on the surface as over-production? Under a monetary system of commerce, though commodities still exchange for commodities, it is an essential condition of that exchange that those who possess purchasing power shall be willing to use a sufficient proportion of it to demand consumptive goods. Otherwise the production of productive goods is stimulated unduly while the demand for consumptive goods is checked,—the condition which the business man rightly describes as over-supply of the material forms of capital. When production was slower, markets narrower, credit less developed, there was less danger of this big miscalculation, and the corrective forces of industry were more speedily effective. But modern machinery has enormously expanded the size of markets, the scale of competition, the complexity of demand, and no longer produces for a small local present demand, but for a large world future demand. Hence machinery is the direct material cause of these great fluctuations which bring, as their most evil consequence, irregularity of wages and employment.

How far does this tend to right itself? Professor Nicholson believes that time will compel a better adjustment between machinery and its environment.

The enormous development of steam communication and the spread of the telegraph over the whole globe have caused modern industry to develop from a gigantic star-fish, any of whose members might be destroyed without affecting the rest, into a *μέγα ζῶον* which is convulsed in agony by a slight injury in one part. A depression of trade is now felt as keenly in America and even in our colonies as it is here. Still, in the process of time, with the increase of organization and decrease of unsound speculation, this extension of the market must lead to greater stability of prices; but at present the disturbing forces often outweigh altogether the supposed principal elements.<sup>1</sup>

The organization of capital under the pressure of these forces is doubtless proceeding, and such organization, when it has proceeded far enough, will indisputably lead to a decrease of unsound speculation. But these steps in organization have been taken precisely in those industries which employ large quantities of fixed capital, and the admitted fact that the severest fluctuations take place in these industries is proof that the steadying influences of such organization have not yet had time to assert themselves to much purpose. The competition of larger and larger masses of organized capital seems to induce heavier speculation and larger fluctuations. Not until a whole species of capital is organized into some form or degree of "trust" is the steadying influence of organization able to predominate. But there is also another force which, in England at any rate, under the increased application of machinery, makes for an increase rather than a diminution of speculative production. It has been seen that the proportion of workers engaged in producing comforts and luxuries is growing, while the proportion of those producing the prime necessities of life is declining. How far the operation of the law of diminishing returns will allow this tendency to proceed, we cannot here discuss. But statistics show that this is the present tendency

<sup>1</sup> *Op. cit.* p. 117.

both in England and in the United States. Now the demand for comforts and luxuries is essentially more irregular and less amenable to commercial calculation than the demand for necessities. The greatest economies of machine production are found in industries where the demand is largest, steadiest and most calculable. Hence the effect of machinery is to drive ever and ever larger numbers of workers from the less to the more unsteady industries — those which are most exposed to the influences of taste, caprice or changing income. Nor is this difficulty met by the admission that the comforts of one class or generation acquire the steadiness of necessities as the standard of comfort rises. For the development of new comforts and luxuries, not less fluctuating, attends each rise in the standard of comfort. Nothing but a general change in morals, inducing a general increased regularity in methods of consumption, will diminish this tendency which makes for irregularity of employment.

On the whole it seems reasonable to conclude that the present net influence of machinery is towards an increased irregularity of employment, except in industries where (1) the demand for the commodities produced is regular and (2) supply is regulated by the organized action of those who control production.

Our reasoning from the ascertained tendencies of machinery inclines to the conclusion that, taking into consideration the two prime factors, namely, the number of those employed and the regularity of employment, machinery does not favor an increased steady demand for labor. It tends, apparently, to drive labor in three directions :

(1) To the invention, execution and maintenance of machinery to make machines, the labor of making machines being continually displaced by machines, and being thus driven to the production of machines further remote from the machines directly engaged in producing consumptive goods. The labor thus engaged must be in an ever diminishing ratio to a given quantity of consumption. Nothing but a great increase in the quantity of consumption or the opening of new varieties of

consumption can maintain or increase the demand for labor in these machine-making industries.

(2) To continual specialization and refinement in the arts of distribution. The multiplication of merchants, middlemen and retailers, which, in spite of the tendency to centralization in distributive work, is so marked a feature of English industry during the last forty years, is directly traceable to the influence of machinery.<sup>1</sup>

(3) To the supply of new wants, which are either (a) wholly non-material, *i.e.*, intellectual, artistic or other personal services, (b) partly non-material, *e.g.*, works of art chiefly the embodiment of individual taste or spontaneous energy, or (c) too irregular or not sufficiently extended to admit the application of machines. The learned professions, art, science and literature, and those branches of labor engaged in producing luxurious materials or services, furnish a steadily increasing employment. So long, then, as a community grows in numbers, so long as individuals desire to satisfy more fully their present wants, and combine to develop new wants forming a higher or more intricate standard of comfort, there is no evidence to show that machinery has an effect in decreasing the aggregate demand for labor, but there is strong reason to believe that it tends to make employment more unstable and precarious of tenure and more fluctuating in its market value.

### III. Upon the Quality of Labor.

In considering the influence of machinery upon the quality of labor, *i.e.* skill, duration, intensity, *etc.*, we have first to meet two questions: What are the qualities in which machinery surpasses human labor? What are the kinds of work in which machinery displaces man? Now, since the whole of industrial work consists in moving matter, the advantage of machinery must consist in the production and disposi-

<sup>1</sup> The following are the percentages of the employed engaged in dealing and industrial service:

	1841	1851	1861	1871	1881
Dealing . . . .	4.4	5.6	6.5	7.1	7.5
Industrial Service .	4.3	3.8	3.9	4.5	6.2

tion of motive power. The general economies of machinery are two: (1) The increased quantity of motive force it can apply to industry; (2) Greater exactitude in the regular application of motive force (*a*) in time—the exact repetition of the same acts at regulated intervals, or greater evenness in continuity, (*b*) in place—exact repetition of the same movements in space. All the advantages imputed to machinery in the economy of human time, the utilization of waste material, the display of concentrated force or the delicacy of manipulation are derivable from these two general economies. Hence it follows that wherever the efficiency of labor power depends chiefly upon the output of muscular force in motive power, or precision in the regulation of muscular force, machinery will tend to displace human labor. Assuming, therefore, that displaced labor finds other employment, it will be transferred to work where machinery has not the same advantage over human labor, that is to say, to work where the muscular strain or the need for regularity of movement is less. At first sight it will thus seem to follow that every displacement of labor by machinery will bring an elevation in the quality of labor, that is, will increase the proportion of labor in employments which tax the muscles less and are less monotonous. This is in the main the conclusion towards which Professor Marshall inclines.<sup>1</sup>

So far as each several industry is concerned, it has been shown that the introduction of machinery signifies a net reduction of employment, unless the development of trade is largely extended by the diminution in expenses of production. It cannot be assumed as a matter of course that the labor displaced by the introduction of automatic folders in printing will be employed in less automatic work connected with printing. It may be diverted from muscular monotony in printing to the less muscular monotony of providing some new species of luxury, the demand for which is not yet sufficiently large or regular to justify the application of labor-saving machinery. But even assuming that the whole or a large part of the displaced labor

<sup>1</sup> Principles of Economics, (2d ed.), pp. 314, 322.



is engaged in work which is proved to have been less muscular or less automatic by the fact that it is not yet undertaken by machinery, it does not necessarily follow that there is a diminution in the aggregate of physical energy given out, or in the total "monotony" of labor.

One direct result of the application of an increased proportion of labor-power to the kinds of work which are less "muscular" and less "automatic" in character, will be a tendency towards greater division of labor and more specialization in these employments. Now the economic advantages of increased specialization can only be obtained by increased automatic action. Thus the routine or automatic character which constituted the monotony of the work in which machinery displaced these workers, will now be imparted to the higher grades of labor in which they are employed, and these in their turn will be advanced towards a condition which will render them open to a new invasion of machinery.

Nor is it shown that the introduction of machine production tends to diminish the physical strain upon the worker. As regards those workers who pass from ordinary manual work to the tending of machinery, there is a good deal of evidence to show that their new work taxes their physical vigor quite as severely as the old work. Professor Shield Nicholson quotes the following striking statement from the *Cotton Factory Times*:

It is quite a common occurrence to hear young men who are on the best side of thirty years of age declare they are so worked up with the long mules, coarse counts, quick speeds and inferior material, that they are fit for nothing at night only going to bed and taking as much rest as circumstances will allow. There are few people who will credit such statements; nevertheless they are true, and can be verified any day in the great majority of the mills in the spinning districts.

Professor Nicholson thus sums up his evidence upon this head:

It is clear that the use of machines, though apparently labor-saving, often leads to an increase in the *quantity of labor*; nega-

tively by not developing the mind, positively by doing harm to the body.<sup>1</sup>

When any muscular or physical effort is required, it is pretty evident that an increased duration or a greater continuity in the slighter effort may tax the body quite as severely as the less frequent application of a much greater bodily force. There can be no question that in a competitive industrial society, there exists a tendency to compensate for any saving of muscular or other physical effort afforded by the intervention of machinery, in two ways: first, by "forcing the pace"—compelling the worker to tend more and more machines, and to increase the strain, if not upon the muscles, then upon the nerves; secondly, by extending the hours of labor. A lighter form of labor spread over an increased period of time may of course amount to an increased tax upon the vital energy. It is not disputed that a general result of the factory system has been to increase the average length of the working day, if we take under our survey the whole area of machine production in modern industrial communities. This is only in part attributable to the fact that workers can be induced to sell the same daily output of energy as before, while a longer time is required for its expenditure. Another influence of equal potency is the economy of machinery effected by longer hours.

These two forces operating together have lengthened the average working day. Certain subsidiary influences also deserve notice, in particular the introduction of cheap illuminants. Before the cheap provision of gas, the working time of those engaged in retail trade was limited by daylight. Now a part of nature's rest is annexed to the working day. There are of course powerful social forces working for the curtailment of the working day, and these very forces are, as we shall observe, powerfully though indirectly aided by ma-

<sup>1</sup> Page 82. Babbage, in laying stress upon one of the "advantages" of machinery, makes an ingenuous admission of this "forcing" power of the machine: "One of the most singular advantages we derive from machinery is in the check which it affords against the inattention, the idleness or the knavery of human agents." — *Economy of Manufactures*, p. 39.

chinery. But the direct economic influence of machinery is in favor of an extended working day. The full significance of this is not confined to the fact that a large proportion of the worker's life is consumed in the growing monotony of production. The curtailment of the portion of time in which he figures as consumer must be set against any increase in real wages or power of consumption which has come to him from the increase of productive power under machinery.<sup>1</sup> So far therefore as the age of machinery has converted handicraftsmen into tenders of machinery, it seems as if Mill were almost justified in his somewhat rhetorical verdict: "It is questionable if all the mechanical inventions yet made have lightened the day's toil of any human being."

Now to come to the question of "monotony." Is the net tendency of machinery to make labor more or less monotonous, to educate the worker or to brutalize him? Does labor become more intellectual under the machine? Professor Marshall, who has thoughtfully discussed this question, inclines upon the whole in favor of machinery. It takes away manual skill, but it substitutes higher or more intellectual forms of skill.<sup>2</sup> "The more delicate the machine's power, the greater is the judgment and carefulness which is called for from those who see after it."<sup>3</sup> Since machinery is daily becoming more and more delicate, the tending of machinery would become more and more intellectual. The judgment of Mr. Cooke Taylor, in the conclusion of his admirable work, *The Modern Factory System*, is the same: "If man were merely an intellectual animal, even only a moral and intellectual one, it could scarcely be denied, it seems to us, that the results of the factory system have been thus far elevating."<sup>4</sup> Mr. Taylor indeed admits of the operative population that "they have deteriorated artistically; but art is a matter of faculty, of perception, of aptitude, rather than of intellect." This curious and significant admission deserves more attention than I can here bestow upon it.

<sup>1</sup> Patten, *The Theory of Dynamic Economics*, ch. xi.

<sup>2</sup> Marshall, *op. cit.*, p. 315.

<sup>4</sup> Page 435.

<sup>3</sup> *Ibid.*, p. 316.

The question of the net intellectual effects of machinery is not one which admits of positive answer. It would be open to one to admit with Mr. Taylor that the operatives were growing more intellectual, and that their contact with machinery exercises certain educative influences, but to deny that the direct results of machinery upon the workers were favorable to a wide cultivation of intellectual powers, as compared with various forms of freer and less specialized manual labor. The intellectualization of the town operatives (assuming the process to be taking place) may be attributable to the thousand and one other influences of town life rather than to machinery, save indirectly so far as the modern industrial center is itself the creation of machinery. It is not, I think, possible at present to offer any clear or definite judgment. But the following distinctions seem to have some weight in forming our opinion.

The growth of machinery has acted as an enormous stimulus to the study of natural laws. A larger and larger proportion of human effort is absorbed in processes of invention, in the manipulation of commerce on an increasing scale of magnitude and complexity, and in such management of machinery and men as requires and educates high intellectual faculties of observation, judgment and speculative imagination. Of that portion of workers who may be said, within limits, to control machinery, there can be no question that the total effect of machinery has been highly educative. Some measure of these educative influences descends even to the "hand" who tends some minute portion of machinery.

So also allowance should be made for the skilled work of making and repairing machinery. The engineer's shop is becoming every year a more and more important factor in the equipment of a factory or mill. But though "breakdowns" are essentially erratic and must always afford scope for ingenuity in their repair, even in the engineer's shop there is the same tendency for machinery to undertake all work of repair which can be brought under routine. So the skilled work in making and repairing machinery is continually being reduced

to a minimum, and cannot be regarded, as Professor Nicholson is disposed to regard it, as a factor of growing importance in connection with machine production. The more machinery is used, the more skilled work of making and repairing will be required, it might seem. But the rapidity with which machinery is invading these very functions turns the scale in the opposite direction, at any rate so far as the making of machinery is concerned. Statistics relating to the number of those engaged in making machinery and tools, show that the proportion they bear to the whole working population is an increasing one; but the rate of this increase is by no means proportionate to the rate of increase in the use of machinery. While the percentage of those engaged in making machinery and tools rises from 1.7 in 1861 to 1.8 in 1871 and 1.9 in 1881, the approximate increase of steam power applied to fixed machinery and locomotives shows a much more rapid rise,—from 2,100,000 horse power in 1860 to 3,040,000 in 1870 and 5,200,000 in 1880.<sup>1</sup> Moreover, an increased proportion of machinery production is for export trade, so that a large quantity of the labor employed in those industries is not required to sustain the supply of machinery used in English work. In repairs of machinery, the economy effected by the system of interchangeable parts is one of growing magnitude, and tends likewise to minimize the skilled labor of repair.<sup>2</sup>

Finally it should be borne in mind that in several large industries where machinery fills a prominent place, the bulk of the labor is not directly governed by the machine. This fact has already received attention in relation to railway workers. The character of the machine certainly impresses itself upon these in different degrees, but in most cases there is a large amount of detailed freedom of action and scope for individual skill and activity.

Making allowance, then, for the intelligence and skill used in the invention, application, management and repair of machinery, what are we to say of the labor of him who, under the

<sup>1</sup> Mulhall, Dictionary of Statistics, p. 545.

<sup>2</sup> Cf. Marshall, Princ. of Econ., vol. i. p. 315.

minute subdivision enforced by machinery, is obliged to spend his working life in tending some small portion of a single machine, the whole work of which is to push some single commodity a single step along the journey from raw material to consumptive good?

His work, it is urged, calls for "judgment and carefulness." So did his work in manual labor before the machine took it over. His "judgment and carefulness" are now confined within narrower limits than before. The responsibility of the individual worker is greater, precisely because it is narrowed down so as to be related to and dependent on a number of other operatives in other parts of the same machine with whom he has no direct personal concern. Such realized responsibility is an element in education, moral and intellectual. But this responsibility is a direct result of the minute subdivision. It is, I think, questionable whether the vast majority of machine workers get any considerable education from the fact that the machine in conjunction with which they work represents a huge embodiment of the delicate skill and invention of many thousands of active minds, though some value may be accorded to Mr. Cooke Taylor's contention that "the mere exhibition of the skill displayed and the magnitude of the operations performed in factories can scarcely fail of some educational effect."<sup>1</sup> Professor Shield Nicholson expresses himself more dubiously on the educational value of the machine: "Machinery of itself does not tend to develop the mind as the sea and mountains do, but still it does not necessarily involve deterioration of general mental ability."

The work of tending machinery is not of course to be regarded as absolutely automatic. To a certain limited extent the "tender" of machinery rules as well as serves the machine: in seeing that his portion of the machine works in accurate adjustment to the rest, the qualities of care, judgment and responsibility are evoked. A great part of modern inventiveness, however, is engaged in devising automatic checks and indicators for the sake of dispensing with human skill and

<sup>1</sup> *The Modern Factory System*, p. 435.

reducing the spontaneous or thoughtful elements of tending machinery to a minimum. When this minimum is reached the highly paid skilled workman gives place to the low-skilled woman or child, and eventually the process passes over entirely into the hands of machinery. So long, however, as human labor continues to co-operate with machinery, certain elements of thought and spontaneity adhere to it. These must be taken into account in any estimate of the net educative influence of machinery. But though these mental qualities must not be overlooked, exaggerated importance should not be attached to them. The layman is often apt to esteem too highly the nature of skilled specialist work. A locomotive superintendent of a railway was recently questioned as to the quality of engine-driving. "After twenty years experience he declared emphatically that the very best engine-drivers were those who were most mechanical and unintelligent in their work, who cared least about the internal mechanism of the engine."<sup>1</sup> Yet engine-driving is far less mechanical and monotonous than ordinary tending of machinery.

So far as the man follows the machine and has his work determined for him by mechanical necessity, the educative pressure of the latter force must be predominant. Machinery like everything else can only teach what it practices. Order, exactitude, persistence, conformity to unbending law,—these are the lessons which must emanate from the machine. They have an important place as elements in the formation of intellectual and moral character. But of themselves they contribute a one-sided and very imperfect education. Machinery can exactly reproduce; it can, therefore, teach the lesson of exact reproduction, an education of quantitative measurements. The defect of machinery, from the educative point of view, is its absolute conservatism. The law of machinery is a law of statical order, that everything conforms to a pattern, that present actions precisely resemble past and future actions. Now the law of human life is dynamic, requiring order not as valuable in itself, but as the condition of progress. The law of human

<sup>1</sup> The Social Horizon, p. 22.

life is that no experience, no thought or feeling is an exact copy of any other. Therefore, if you confine a man to expending his energy in trying to conform exactly to the movements of a machine, you teach him to abrogate the very principle of life. Variety is of the essence of life, and machinery is the enemy of variety. This is no argument against the educative uses of machinery, but only against the exaggeration of these uses. If a workman expend a reasonable portion of his energy in following the movements of a machine, he may gain a considerable educational value; but he must also have both time and energy left to cultivate the spontaneous and progressive arts of life.

It is often urged that the tendency of machinery is not merely to render monotonous the activity of the individual worker, but to reduce the individual differences in workers. This criticism finds expression in the saying: "All men are equal before the machine." So far as machinery actually shifts upon natural forces work which otherwise would tax the muscular energy, it undoubtedly tends to put upon a level workers of different muscular capacity. Moreover, by taking over work which requires great precision of movement, there is a sense in which it is true that machinery tends to reduce the workers to a common level of skill, or even of un-skill.

Whenever a process requires peculiar dexterity and steadiness of hand, it is withdrawn as soon as possible from the cunning workman, who is prone to irregularities of many kinds, and it is placed in charge of a peculiar mechanism, so self-regulating that a child can superintend it.<sup>1</sup>

That this is not true of the most highly skilled or qualitative work, must be conceded, but it applies with great force to the bulk of skilled labor. By the aid of machinery, *i.e.*, of the condensed embodiment of the inventor's skill, the clumsy or weak worker is rendered capable of assisting the nicest movements on a closer equality with the more skilled worker. Of course piece work, as practised in textile and hardware industries, shows that the most complete machinery has not

<sup>1</sup> Ure, *Philosophy of Manufactures*, ch. i., p. 19.



nearly abolished the individual differences between one worker and another. But assuming that the difference in recorded piece wages accurately represents difference in skill or capacity of work,—which is not quite the case,—it seems evident that there is less variation in capacity among machine-workers than among workers engaged in employments where the work is more muscular, or is conducted by human skill with simpler implements. The difference in productive capacity between an English and a Hindoo navvy is considerably greater than the difference between a Lancashire mill-operative and an operative in an equally well-equipped and organized Bombay mill.

But this is by no means all that is signified by the “equality of workers before the machine.” It is the adaptibility of the machine to the weaker muscles and intelligence of women and children that is perhaps the most important factor. The machine in its development tends to give less and less prominence to muscle and high individual skill in the mass of workers, more and more to certain qualities of body and mind which not only differ less widely in different men, but in which women and children are more nearly on a level with men. The tendency of machine industry to displace male by female labor is placed beyond all question by the statistics of occupations in England, which show since 1851 a regular and considerable rise in the proportion of women to men workers in almost all branches of manufacture.<sup>1</sup> Legal restrictions, and in the more civilized communities, the growth of a healthy public opinion, prevent the economic force from being operative to the same degree so far as children are concerned.

<sup>1</sup> The following statistics, drawn from Booth’s Occupations of the People, relate to the displacement of male by female labor:

Textiles and dyeing: From 1851 to 1881 males show continuous decline in absolute numbers, females continuous increase.

	Males.	Females.
1851 . . .	462,400	472,100
1861 . . .	439,700	526,500
1871 . . .	414,500	555,500
1881 . . .	396,400	566,200

Those very qualities of care and judgment, of detailed attention, of regularity and patience which, as we saw, are characteristic of machine work, are common human qualities, in the sense that they are within the capacity of all and that even in the degree of their possession and practice there is less difference between the most highly trained mechanic and the raw "half-timer" than in the possession and practice of such powers as machinery has superseded. It must, I think, be recognized that machinery does exercise a certain equalizing

The figures of dress industries are equally significant:

	Males.	Females.
1851 . . .	397,500	471,200
1861 . . .	378,600	550,900
1871 . . .	363,300	552,700
1881 . . .	344,700	609,300

These figures show a quickening of the pace of displacement in the last decennial period. If we take other manufacturing industries in which women are engaged in considerable numbers, a similar movement is traceable in all: the relative rate of increase in the employment of women exceeds that of men, even where the numbers of the latter do not absolutely decline. Such industries are wood-furniture and carriages; printing and bookbinding; feathers, leather, glues; paper, floorcloths and waterproof; earthenware, machinery and tools; food, drink and smoking. In many other industries in which no women or very few were occupied in 1841, women have effected an entrance and are growing in numbers more rapidly than men. Such are fuel, gas, chemicals; operative building; quarrying and bricklaying; watches, instruments and toys; navigation and docks. They have even made an entry in road-making and ship-building, salt and water works and railways. The only group of machine industries in which their numbers have not increased more rapidly than those of men since 1851 is the metal industries. Even here, however, they nearly hold their own.

It appears, then,

1. That the tendency of modern industry is to increase the quantity of employment given to women as compared with that given to men. (As against the numerical increase of employment, consideration should be taken of the greater irregularity of woman's work and the fact that a larger number of women returned as industrial workers give only a portion of their day to industry.)

2. That this tendency is chiefly confined to manufacturing industries. (The increase of female employment in dealing and industrial service is not larger than the increase of male employment between 1851 and 1881.)

3. In the manufacturing industries, omitting a few essentially male industries where the muscles are even under machinery severely taxed, the increased rate of employment is greatest in those industries where machinery has been most highly developed, as for example, the textile industries and dress.

It is thus proved that machinery favors the employment of female rather than male labor.

effect by assigning a larger and larger relative importance to those faculties which are specific, as compared with those which are individual. The antagonism between machinery and art in this respect is fundamental and irreconcilable. So long and so far as the public continue to sink their individual differences as consumers and employ their expanding powers of purchase in demanding increased quantities of the same kinds of consumptive goods, machinery, with its economic faculty of exact, cheap and rapid reproduction, will gain an increasing control over the processes of production. When the public becomes more individualistic in its consumption, in demanding greater variety and adaptability to individual taste, instead of immense quantity, this new character of consumption will reduce the advantages enjoyed by machinery, and will operate as an increased demand for art in the sense of individual effort of production.

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