

On the Changes in the Locality and Processes of Textile Manufactures consequent on the Application of Steam to their Production. By W. Cooke Taylor, LL.D.

Circumstances, with the details of which it is not necessary to trouble this society, have led me to pay much attention to the factory system in connexion with the production of textile fabrics, and particularly of cottons and woollens. I propose to-night briefly to investigate one phenomenon of this branch of production; its tendency to locate and confine itself to particular districts, and to inquire how far this is to be attributed to certain natural advantages and facilities possessed by these districts, and how far it may be ascribed to artificial circumstances, which may be regarded as placed more or less within human control. A very brief summary of the growth of the cotton manufacture in South Lancashire, will greatly aid us in approximating to a correct solution of the problem proposed.

Antiquarians have been not a little perplexed in examining this subject by a curious coincidence of name. Cottons, a corruption of *coatings*, was the name given to a coarse kind of serge or flannel, before the vegetable substance called cotton was known in England. Hence, in the very imperfect records of manufacturing industry existing before the reign of George III. it is very difficult to determine which of the two *cottons* is meant, and, therefore, I have not been able to determine the precise date when foreign cotton began to be spun in England. The first record on which any reliance can be placed dates about the year 1760; and it was then calculated that the spinning and weaving of cotton gave employment to about forty thousand persons, and the value of the goods produced was estimated at a little more than six hundred thousand pounds. It was at this time almost wholly a domestic manufacture. The cotton was spun at first by the families of the weavers; but, after the invention of the fly-shuttle and the drop-box by the Kays, about the date I have mentioned, the process of weaving was so much facilitated, that the demand for weft became much greater than the former spinners could supply, and spinning was extensively introduced as a new branch of industry among the agricultural families in the hills of Lancashire. Still the demand for weft continued to exceed the supply; and, hence, ingenuity was stimulated to devise some means for facilitating the operation of spinning. The water-frame, for spinning with rol-

lers, was invented, or at least claimed as an invention, by Arkwright, and received its name from water being used as a propelling power. The jenny, in which the upright spindle was substituted for the horizontal, and several spindles worked in the same frame, was devised by Hargraves; and the mule-jenny, in which the principles of both inventions were combined, was discovered by Crompton, a poor weaver near Bolton.

It is of importance to observe that all this development of manufacture was of natural growth; so early as the age of Elizabeth, South Lancashire had been the seat of a spinning and weaving industry; cotton was first employed as a weft, the warp being of flax or wool, which, from the greater length of their fibre, could alone, under the forms of manufacture then in use, afford thread of sufficient strength to serve as a warp. So far was the growth of this manufacture from being favored by legislative protection, that it had actually to struggle against prohibition. To encourage British manufactures, a law had been passed prohibiting the wearing of dyed or printed calicoes, which not being then manufactured in England, were imported from India and China. Goods, in which the warp was of flax or wool, do not appear to have been included in this law; but when Arkwright's water-frame produced yarn sufficiently strong to serve as a warp, his rivals menaced him with the penalties of the act of George I. As this act was passed against foreign calicoes, the legislature consented to its repeal so soon as it appeared that calicoes could be manufactured in England. A petition against the repeal of this act was presented by the principal cotton manufacturers of Lancashire; and when we reflect what fortunes they since made, by the introduction of the very manufacture against which they petitioned, we cannot avoid saying with Mr. Baines, that this is one of the most singular illustrations of the "blundering effects of commercial jealousy on record."

Two circumstances gave an extraordinary stimulus to the cotton trade towards the close of the last century. Sir Richard Arkwright's patent having been set aside, his invention was thrown open to the public; and nearly about the same time, the steam-engine was applied to the propelling of spinning machinery. In the year 1801 the quantity of cotton imported into the united kingdom was fifty-four millions, and the official value of manufactured cotton exported was seven millions pounds sterling. In 1844, the latest returns I possess, the weight of cotton wool imported was 554 millions of pounds avoirdupois, and the official value of the exported goods was ninety-one millions of pounds sterling.

An increase of British manufacture of 500 millions of pounds weight, and of value to the amount of 82 millions sterling, is a phenomenon unparalleled in the history of the world. We have now to inquire why this increase was confined to a few localities, since, after the setting aside of Arkwright's patent, the trade in all its branches was open for competition to all parts of the empire.

Liverpool and Glasgow are ports favorably situated for commerce with the United States and the West Indies, whence the greater

part of the raw cotton is imported, and hence the facilities for obtaining a supply of the raw material had some influence in directing the cotton trade to the west rather than to the east of England. Streams of pure water for scouring, bleaching, or turning a little mill, were abundant in South Lancashire, and this no doubt aided in determining the choice of a locality. But the principal and most obvious cause was the abundance of cheap fuel afforded by the great coal-field of Lancashire, and the facilities for its distribution supplied by the Bridgewater Canal.

Now, it has been remarked that Bristol, in all these respects, is able to compete with Liverpool and Glasgow: why, then, did not some share of the cotton trade fall to the share of Bristol? The simple reason is, that Liverpool had Manchester behind it, just as Glasgow has Paisley; that there was not merely an abundant, but a trained population, ready to take up the increased production; and that industrial occupations have ever a perceptible tendency to aggregate round a nucleus which has once been formed, rather than to implant themselves in new ground, even where natural advantages would seem to establish a preference for the new locality.

Another reason is, that Manchester had many advantages as a mart for the home sale. The manufacturing industry of Lancashire was originally established, and may still be said to be confined to districts of little natural fertility, but which are in close proximity to excellent agricultural soils. The man of Lancashire did not attempt to raise corn, because his family could spin and weave the means of purchasing the corn with less expenditure of capital and toil than farming operations on an ungrateful soil would have required. For the very same reason, the man of Cheshire neither spun nor wove, because he could raise the means of purchasing the cloth at less expense than he could produce the cloth itself. This division of labour, this reciprocal exchange of clothing for food, had existed in Manchester and its neighbourhood for some centuries, and the difference of occupations was based on the answer to the question, "Whether can we more cheaply produce the article or the means of purchasing the article?"

The advantages of South Lancashire over either Somersetshire or Gloucestershire may be thus compared:—In facilities for the import of raw materials and the export of manufactured goods they were equal; the advantage, if any, being on the side of the West of England. In the supply of water and coal, Lancashire had a slight, but still a perceptible advantage; but its decided superiority consisted in its having a trained population and established markets, forming a basis from which extension could be conveniently carried onwards.

There are many reasons which tend to detain a manufacture in a place where it has once been established. One of the least noticed is the continuous, though hardly perceptible, progress of mechanical improvements. There is hardly a factory in which the machinery does not receive some change or alteration every month—small, indeed, in amount, but great in importance when reference is made to the mass of production over which its influence ranges.

A cotton-mill, in the machinery of which no changes had been made for twenty years, would be left so far behind in the march of improvement, that it could hardly be worked with profit. Now, where several factories of the same kind are aggregated, there is a constant demand and an adequate remuneration for invention; but this is not the case where a factory, isolated and unconnected, is for the first time established. It is to this cause mainly that the cotton-spinners of Lower Normandy attribute their inferiority to their English rivals; for though the free export of machinery is permitted, yet after a few months some improvement, easily effected by slight modifications in a place where mechanics abound, gives the Manchester manufacturers a start, and the French cannot get up to them without importing an entire set of new machinery.

In reference to this subject, I may mention that I have seen a very detailed account of an abortive attempt to establish a cloth manufactory in Ireland, if I remember aright, in the county of Kilkenny, in the year 1796. The capitalist who undertook it was an Englishman from the west riding of Yorkshire. He stated that he found the Irish operatives he employed fully equal to those of Leeds in attention, aptitude, and regularity; that he had an abundance of water-power at little more than a fourth of the cost at which it could be obtained in England, and that during the first two years of the experiment, he believed himself certain of making a fortune. But when from ordinary wear and tear his machinery began to require partial renewal, his troubles and perplexities rapidly accumulated; the establishment was too small to support the expenses of a staff of mechanics; he had to send apparently the most trifling implements for repair to England; and though he spared no cost in procuring the best machinery, he was always from six to twelve months behind his competitors in the march of improvement. In 1799 he abandoned the attempt, and returned to England. A similar result of an effort to transplant a manufacture has been exhibited in Manchester within the last few years. It is not generally known that the greater part of the fine yarns, from which Scotch muslins are woven, is spun in Lancashire; the Manchester people not unreasonably believed, that they could weave muslins as well and as cheap as Scotchmen, especially as the yarn of which it was composed could be had without any expense of carriage, at their own doors. Many efforts to accomplish this have been made, but they have all failed; and it is curious, that the attempts made to introduce the peculiar manufactures of Manchester in Paisley and Glasgow, have been similarly unsuccessful.

Even when accident has chiefly led to the selection of a locality, it will be found that a manufacture, once established, soon becomes permanent and exclusive. In the Luddite campaigns against machinery, no objects were so odious to the rioters as the power-looms. Numbers of these had just been established at a village near Blackburn, and the hand-loom weavers of that town and neighbourhood, secretly encouraged, it is said by some persons of rank and station, combined to destroy the power-looms, and did so with

the greatest ferocity. Banished from the neighbourhood of Blackburn, the power-loom sought shelter at the then obscure village of Staleybridge, where, at the time, there was neither church, chapel, resident magistrate, clergyman, or decent dwelling-house. Staleybridge is now a corporate town, containing about twenty thousand inhabitants; its operatives are the most thriving of the population of Lancashire; it is the great metropolis of the power-weaving trade; while the village where the power-looms were first erected, and afterwards destroyed, is one of the most miserable spots in all England, and has never been the seat of any form of manufacturing industry since the period of the riots.

In a similar way, the violence of the frame-breakers in Nottingham drove the most profitable branches of the lace trade from their county to Tiverton, Barnstaple, Taunton, and Chard, places farther beyond London to the south, than Nottingham is to the north. In most, if not all of those places, however, in which this trade settled, there had previously been a domestic manufacture of handicraft lace, which gave the inhabitants some aptitude to learn the uses and application of lace machinery.

The most decisive instance of a manufacture changing its locality, solely with reference to natural advantages, is the transfer of the cloth manufacture from the south and west of England, to the West Riding of Yorkshire. So long as the woollen manufacture was a handicraft trade, its settlements were in places where the breed of sheep were noted for soft and short-stapled fleeces, as is usually the case with the animals reared in the south-western counties of England. But when power began to be extensively applied to the production of cloth, the peculiar facilities for steam and water-power possessed by Yorkshire, attracted, and still attracts thither, the woollen trade; while the people of Wiltshire, seeing their old staple manufactures passing from them, are as much perplexed by the phenomenon, as some are by the exhibition of similar results in our own country.

So soon as machinery becomes generally prevalent in any district, and possesses ample resources in its motive agents for its unlimited application, it will attract to that district a great many manufactures in addition to the indigenous, and may, in fact, by the influence of such advantages, deprive other places of their original staple trade. Thus, the silk manufacture is steadily migrating from Spitalfields to Manchester, exactly in the proportion that it is found practicable to apply machinery to the simplification of manufacture, and to economizing the cost of production. The silk throwing mills of Manchester are the best in the kingdom; there is, however, but little advantage in applying power to the manufacture of fancy goods. The most successful example of which I am aware is, the Bavarian embroidery frame introduced into Manchester by the late Mr. Lewis Schwabé, and which multiplied embroidery designs on a principle analogous to that of the pantagraph. It was not a very successful invention, and it certainly was not applicable to the production of complicated and elaborate designs.

Having now stated a few striking examples of the settlement of manufactures in a particular locality, and of their migration from one locality to another, I think it will be seen that in all these cases, the selection made by capitalists and manufacturers has been based on one common principle—economy in the cost of production. Every circumstance which we have been able to ascertain, as a probable guide to choice, has been something by which the production was facilitated and cheapened. Facilities of obtaining the raw material has placed cotton-mills in the vicinity of sea-ports; iron-works, where iron is interstratified with coal; the worsted trade in Leicestershire, and the adjoining districts, where the long-wooled breed of sheep has been reared with the greatest success; cloth-weaving, so long as it was handicraft, in the countries where fleeces were softer and shorter in their staples; and potteries in the vicinity of the most ductile clays.

Where power is applied to production, choice is determined by the result of the inquiry, where power, or, in other words, coal and water, can be had at the cheapest rate. And to this, in several very marked cases, has been added the element of skill in the workmen and willingness to use machinery. The importance of this last element will be better understood, when we come to say a few words respecting the processes which the application of power has alone rendered possible.

In almost every country in Europe, observation of the wealth and power which England has derived from the mills and factories of South Lancashire and the West Riding of Yorkshire has suggested the desirableness of establishing native manufactures. Many, in their anxiety to effect this desirable object, have quite left out of view the preliminary inquiry whether these manufactures should be established at a profit or a loss; for they must obviously be established at a national loss, wherever the cost of production exceeds the cost of import and purchase. If a Frenchman can produce a piece of calico at a cheaper rate than he could produce the quantity of wine which he could exchange for that calico in the market, it is obviously his advantage to abandon the vintage for spinning and weaving; but if, for the same cost that the production of one piece of calico involves, he could produce as much wine as would purchase him two pieces, he wastes the price of one piece, and has subtracted its price from the wealth which productive industry adds to a country, as effectually as if he had been absolutely an idle consumer for the period that the weaving of a piece of calico requires. In the same way, if a country can raise corn and cattle to purchase manufactured goods at a cheaper rate than it could produce those goods, the diversion of any portion of its labour from agriculture to manufacture would be a national injury instead of a national benefit. The propriety of establishing a national manufacture, and thus encouraging what is termed native industry must, therefore, be solely determined by the result of the preliminary inquiry, whether it is cheaper to produce directly, or to import and purchase?

The process to which I wish to direct attention, as that which

most forcibly illustrates the economic value of power and skill in production, is called "drawing" in the cotton manufacture. Any one who takes up a piece of raw cotton, will find that the fibres of this short-stapled wool are twisted and tangled in every direction. If he will then take a thread of fine cotton yarn, and pull it to pieces, he will find that all the fibres are perfectly short and laid parallel to each other. Again, if he will compare some very ancient cotton yarn, such as may be picked out of old muslin, he will find that the old threads are of uneven thickness, while the slightest inequality cannot be found in yarns of modern date.

Now, the first operation for pulling the cotton fibres short is carding; but the best carding engine will not perform this work perfectly; for whenever the tooth of a card gets hold of the middle of a fibre it just bends it in two. As the cotton comes out of the carding engine, it is gathered by passing through a conical groove into a kind of loose rope of cotton having little evenness or cohesion, and nearly all the subsequent operations of the cotton-mill are designed by successive operations of rollers to form this thick clumsy rope into a thin and uniform yarn. So striking is the analogy between this operation and wire-drawing, that the first inventor of the application of rollers to the spinning of cotton was Wyatt, a manufacturer of Birmingham, who took out a patent for his invention about half a century before Arkwright was heard of. Bearing this in mind, it is obvious that the first and most important operation must be to give uniformity of texture to the card-end or sliver of cotton, because any inequalities in it would produce unevenness in the thread into which it is elongated in the process of manufacture. To effect this, is the purpose of the drawing-frame.

The first drawing-head unites six or eight card-ends into one, of no greater thickness than any of the eight, by passing them through three sets of rollers, moving with different velocities, which equalize and extend the rope or riband of cotton, and lay its constituent fibres in parallel lines, the fluting of the rollers pulling those fibres straight which had been left doubled by the carding engine. Four of the slivers that have passed through the first drawing-head are then united in passing through the second; seven from the second are associated in the third, and six are usually united in the fourth, fifth, and sixth drawings. Thus the number of doublings and the consequent chances of uniformity in the texture of the sliver amount altogether to the product of

$$8 \times 4 \times 7 \times 6 \times 6 = 42,384.$$

The number of the doublings, however, varies according to the quality of the yarn required. In very coarse yarns, the union of 324 slivers forms the final sliver. But in fine spinning, the doubling of the fibre sometimes exceeds one hundred thousand fold, for the purpose of producing uniformity in the finished yarn. Now this is a task far too delicate and too tedious to be performed by human fingers, and it is one which requires much acuteness.

Skill rather than strength is sought in the factory operative.

But though these operations do not involve fatigue, they require careful attention, delicacy of touch, and practised skill in nice adjustments. Supposing, then, that two countries were perfectly equal in all other circumstances, the advantages of economy of production would be on the side of that which possessed the greater number of workmen skilled in the management of machinery; and before setting up a new manufacture, it would be necessary to consider carefully how far this circumstance would affect the comparison between the cost of production and the cost of import and purchase.