

The transformation of industry and the economy in Britain between the 1780s and the 1850s is called the ‘first industrial revolution’. This had far-reaching effects in Britain. Later, similar changes occurred in European countries and in the USA. These were to have a major impact on the society and economy of those countries and also on the rest of the world. However the industrialisation that occurred in different countries followed different patterns depending upon their own historical, social and geographical features.

This early phase of industrial development in Britain is strongly associated with new machinery and technologies. These made it possible to produce goods on a massive scale compared to handicraft and handloom industries. This chapter outlines the changes in the cotton and iron industries. Steam, a new source of power, began to be used on a wide scale in British industries. Its use led to faster forms of transportation, by ships and railways. Many of the inventors and businessmen who brought about these changes were often neither personally wealthy nor educated in basic sciences like physics or chemistry.

Industrialisation led to greater prosperity for some. But, in the initial stages it was linked with poor living and working conditions of millions of people, including women and children. This sparked off protests, which forced the government to enact laws for regulating conditions of work. The term ‘Industrial Revolution’ was used by European scholars – Georges Michelet in France and



Fig. 15.1: Industries in London at the time of Industrial Revolution.

- What were the difficulties faced by women and children during industrial revolution?

Friedrich Engels in Germany. It was used for the first time in English by the philosopher and economist Arnold Toynbee (1852-83), to describe the changes that occurred in British industrial development between 1760 and 1820.

Why Britain?



Map 1: Britain (England): The Iron Industry

Britain was the first country to experience modern industrialisation. It had been politically stable since the seventeenth century, with England, Wales and Scotland unified under a monarchy. It became the pioneer of the European countries to experience the process of change in production and reaping its fruits, and was looked upon as the ‘Workshop of the World’. It was due to many favourable conditions or pre-requisites that were present in England towards setting up of flourishing industries. The other countries experienced the change later.

It was blessed with modest climate, which suited very much to cotton industry. There was no scarcity of water power. There was no dearth of raw material in England. Coal and iron were available in abundance, and side by side. The coal fields were larger and closer to important harbours than in any other European countries, like France or Germany, and so, it was convenient for transport by water.

“On the basis of iron, coal, and textiles” Fisher compliments, ‘Britain built up a type of civilisation which has been copied all round the world’.

Raising capital was not a problem in England as the wealth was available in abundance, and again, it was due to many reasons. Britain was known for its commercial pursuits with other countries from the beginning of the seventeenth century, and earned huge profits.

But, mere availability of wealth is of no use, unless it is invested in the right way. The part played by the Bank of England in speeding of the use of capital is in no way to be underestimated. The rise of London money market, joint-stock banks, and Joint Stock Corporation made the finance simple and easy.

Workers also were available from different sources in large numbers in England to be employed in the newly set up factories or industries for carrying out the production on a large scale. British population was also growing. The old and unprofitable system of agriculture was replaced by improved methods of cultivation i.e., by scientific rotation of crops. This increased the food supply, and consequently, the population. It was further facilitated by the immigration of some continental European Labour into England in the eighteenth century. The gradual destruction of old peasant farming, due to enclosure movement, supplied the agricultural labour to the newly set up industries.

It was well equipped by eighteenth century for sea - borne trade. It had a good number of ports. Inland transport was improved and modernised by building a net work of roads and canals. It was fortunate in having a handful of remarkable Scots and English who succeeded in inventing machines to be applied in the process of production, and thus transforming the economic life of the country.

- Discuss the developments in Britain and in other parts of the world in 18th century that encouraged British Industrialisation

Coal and Iron

England was fortunate in that coal and iron ore, the staple materials for mechanisation, were plentifully available, as were other minerals – lead, copper and tin – that were used in industry. However, until the eighteenth century, there was a scarcity of usable iron. Iron is extracted as pure liquid metal from the ore by a process called smelting. For centuries, charcoal (from burnt timber) was used for the smelting process. This had several problems: charcoal was too fragile to transport across long distances; its impurities produced poor-quality iron; it was in short supply because forests had been destroyed for timber and it could not generate high temperatures.

The solution to this problem had been sought for years before it was solved by a family of iron-masters, the Darbys of Shropshire. In the course of half a century, three generations of this family – grandfather, father and son, all called Abraham Darby –

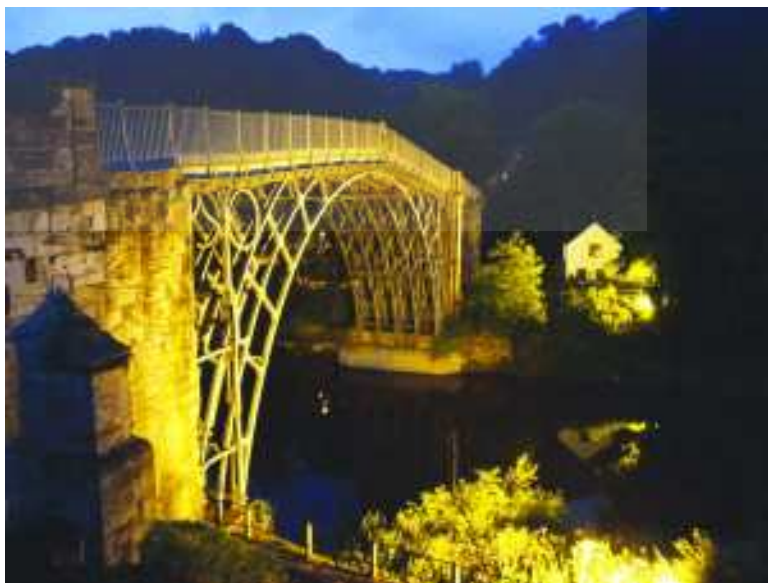


Fig. 15.2: The Cast Iron Bridge near Coalbrookdale, designed by the third Darby.

brought about a revolution in the metallurgical industry. It began with an invention in 1709 by the first Abraham Darby (1677-1717). This was a blast furnace that would use coke, which could generate high temperatures. Coke was derived from coal by removing the sulphur and impurities. This invention meant that furnaces no longer had to depend on charcoal. The melted iron that emerged from these furnaces permitted finer and larger castings than before.

The process was further refined by more inventions. The second Darby (1711-68) developed wrought-iron (which was less brittle) from pig-iron. Henry Cort (1740-1823) designed the puddling furnace (in which molten iron could be rid of impurities) and the rolling mill, which used steam power to roll purified iron into bars. It now became possible to produce a broader range of iron products. The durability of iron made it a better material than wood for everyday items and for machinery. Unlike wood, which could burn or splinter, the physical and chemical properties of iron could be controlled.

Britain was lucky in possessing excellent coking coal and high-grade iron ore in the same basins or even the same seams. These basins were also close to ports. There were five coastal coalfields which could deliver their products almost straight into ships. As a result ship building and the shipping trade increased.

- Why is high quality steel and iron necessary for industrialisation? Discuss in the class.
- Why do you think the mining of iron ore and coal received equal importance?
- Why do you think the early industrial centres were situated near the iron and coal mines?

The British iron industry quadrupled its output between 1800 and 1830, and its product was the cheapest in Europe. In 1820, a tonne of pig iron needed 8 tonnes of coal to make it, but by 1850 it could be produced by using only 2 tonnes. By 1848, Britain was smelting more iron than the rest of the world put together.

Cotton Spinning and Weaving

The British had always woven cloth out of wool and flax (to make linen). From the seventeenth century, the country had been importing bales of cotton cloth from India at great cost. As the East India Company's political control of parts of India was established, it began to import, along with cloth, raw cotton, which could be spun and woven into cloth in England.

Till the early eighteenth century, spinning had been so slow and laborious that 10 spinners (mostly women, hence the word 'spinster') were required to supply sufficient yarn to keep a single weaver busy. Therefore, while spinners were occupied all day, weavers waited idly to receive yarn. But a series of technological inventions successfully closed the gap

- Write two important inventions which revolutionised the textile industry.

between the speed in spinning raw cotton into yarn or thread, and of weaving the yarn into fabric. To make it even more efficient, production gradually shifted from the homes of spinners and weavers to factories.

From the 1780s, the cotton industry symbolised British industrialisation in many ways. This industry had two features which were also seen in other industries. Raw cotton had to be entirely imported and a large part of the finished cloth was exported. This sustained the process of colonisation, so that Britain could retain control over the sources of raw cotton as well as the markets. The industry was heavily dependent on the work of women and children in factories.

Steam Power

Steam power was first used in mining industries. As the demand for coal and metals expanded, efforts to obtain them from ever-deeper mines intensified. Flooding in mines was a serious problem and steam engines were used to drain the mines. But the technology was still very imperfect to be used on a large scale.

James Watt's (1736-1819) invention converted the steam engine from being a mere pump into a 'prime mover' capable of providing energy to power machines in factories. Backed by the wealthy manufacturer Matthew Boulton (1728- 1809), Watt created the Soho Foundry in Birmingham in 1775. From this foundry James Watt's steam engines were produced in steadily growing numbers. By the end of the eighteenth century, Watt's steam engine was beginning to replace hydraulic power. In 1840, British steam engines were generating more than 70 per cent of all European power.



Map 2: The cotton industries in



Fig. 15.3: James Watt's Steam Engine.

Transportation

The need to transport raw materials and manufactured products led to the improvement of roads and the digging of canals in England. Mc Adam devised the method of making '*pakka*' or 'macadamamised' roads.

Canals were initially built to transport coal to cities. This was because the bulk and weight of coal made its transport by road much slower and more expensive than by barges on canals. The demand for coal, as industrial energy and for heating and lighting homes in cities, grew constantly. The making of the first English canal, the Worsley Canal (1761) by James Brindley (1716-72), had no other purpose than to carry coal from the coal deposits at Worsley (near Manchester) to that city. After the canal was completed the price of coal fell by half. Thousands of kilometres of canals were built by 1830 and were used to transport commodities cheaply. They were mostly built by landowners to enhance the value of their properties.

The first steam locomotive, Stephenson's Rocket, appeared in 1814. Railways emerged as a new means of transportation that was available throughout the year, both cheap and fast, to carry passengers and goods. They combined two inventions, the iron track which replaced the wooden track in the 1760s, and haulage along it by steam engine.

The invention of the railways took the entire process of industrialisation to a second stage. The first railway line connected the cities of Stockton and Darlington in 1825, a distance of 9 miles that was completed in two hours at the speed of upto 5 mph. The next railway line connected Liverpool and Manchester in 1830. Within 20 years, speed of 30 to 50 miles an hour was usual.

In the 1830s, the use of canals revealed several problems. The congestion of vessels made movement slow on certain stretches of canals, and frost, flood or drought limited the time of their use.

Who were the inventors?

It is interesting to find out the individuals who brought about these changes. Few of them were trained scientists. Education in basic sciences like physics or chemistry was extremely limited until the late nineteenth century, well after the technological inventions described above. Since these breakthroughs did not require a full knowledge of the laws of physics or chemistry on which they were based, advances could be and were made by brilliant, intuitive thinkers and persistent experimenters. They were helped by the fact that England had certain features which other European countries did not. Dozens of scientific journals and published papers of scientific societies appeared in England between 1760 and 1800.

There was a widespread thirst for knowledge even in the smaller towns. This was met by the activities of the Society of Arts (founded in 1754), by travelling lecturers, or in ‘coffee houses’ that multiplied through the eighteenth century.

Most inventions were more the product of determination, interest, curiosity, even luck, than the application of scientific knowledge. Some inventors in the cotton industry, like John Kay and James Hargreaves, were familiar with the skills of weaving and carpentry. Richard Arkwright, however, was a barber and wig-maker, Samuel Crompton was not technically skilled and Edmund Cartwright studied literature, medicine and agriculture, initially wished to become a clergyman and knew little of mechanics.

By contrast, in the area of steam engines, Thomas Savery, an army officer, Thomas Newcomen, a blacksmith and locksmith, and James Watt, with a strong mechanical bent, all had some knowledge relevant to their inventions. The road-builder John Metcalf, who personally surveyed surfaces for roads and planned them, was blind. The canal builder James Brindley was almost illiterate, with such poor spelling that he could never spell the word ‘navigation’, but he had tremendous powers of memory, imagination and concentration.

Changed lives

In these years, therefore, it was possible for individuals with talent to bring about revolutionary changes. Similarly, there were rich individuals who took risks and invested money in industries in the hope that profits could be made and that their money would ‘multiply’. In most cases this money – capital – did multiply. Wealth, in the form of goods, incomes, services, knowledge and productive efficiency, did increase dramatically.

There was, at the same time, a massive negative human cost. This was evident in broken families, new addresses, degraded cities and appalling working conditions



Fig. 15.4: (A) Coalbrookdale, Carpenters' Row, cottages built by the company for workers in 1783; (B) The houses of the Darbys; painting by William Westwood, 1835.

in factories. The number of cities in England with a population of over 50,000 grew from two in 1750 to 29 in 1850. This pace of growth was not matched with the provision of adequate housing, sanitation or clean water for the rapidly growing urban population. Newcomers were forced to live in overcrowded slums in the congested central areas of towns near factories. The rich inhabitants escaped this situation, by shifting their homes to the suburbs where the air was cleaner and the water safe to drink.

The Workers

A survey in 1842 revealed that the average lifespan of workers was lower than that of any other social group in cities: it was 15 years in Birmingham, 17 in Manchester, 21 in Derby. More people died, and died at a younger age, in the new industrial cities, than in the villages they had come from. Half the children failed to survive beyond the age of five. The increase in the population of cities was because of immigrants, rather than by an increase in the number of children born to families who already lived there.

Deaths were primarily caused by epidemics of disease that sprang from the pollution of water, like cholera and typhoid, or of the air, like tuberculosis. More than 31,000 people died from an outbreak of cholera in 1832. Until late in the nineteenth century, municipal authorities were negligent in attending to these dangerous conditions of life. The medical knowledge to understand and cure these diseases was unknown.

Women, Children and Industrialisation

The Industrial Revolution was a time of important changes in the way that children and women worked. Children of the rural poor had always worked at home or in the farm at jobs that varied during the day or between seasons, under the watchful eye of parents or relatives. Likewise, in villages women were actively involved in farm work; they reared livestock, gathered firewood and spun yarn on spinning wheels in their homes.

Work in the factories, with long, unbroken hours of the same kind of work, under strict discipline and sharp forms of punishment, was completely different. The earnings of women and children were necessary to supplement men's meagre wages. As the use of machinery spread, and fewer workers were needed, industrialists preferred to employ women and children who would be less agitated about their poor working conditions and work for lower wages than men.

They were employed in large numbers in the cotton textile industry in Lancashire and Yorkshire. Women were also the main workers in the silk, lace-making and knitting industries, as well as (along with children) in the metal industries of Birmingham. Machinery like the cotton spinning jenny was designed to be used by child workers with their small build and nimble fingers. Children

were often employed in textile factories because they were small enough to move between tightly packed machinery. The long hours of work, including cleaning the machines on Sundays, allowed them little fresh air or exercise. Children caught their hair in machines or crushed their hands. Some died when they fell into machines as they dropped off to sleep from exhaustion.

Coal mines were also dangerous places to work in. Roofs caved in or there could be an explosion, and injuries were therefore common. The owners of coal mines used children to reach deep coal faces where the approach path was too narrow for adults. Younger children worked as 'trappers' who opened and shut doors as the coal wagons travelled through mines, or carried heavy loads of coal on their backs as 'coal bearers.'

Factory managers considered child labour to be important training for future factory work. The evidence from British factory records reveals that about half of the factory workers had started work when they were less than ten years old and 28 per cent when they were under 14. Women may well have gained increased financial independence and self-esteem from their jobs; but this was more than offset by the humiliating terms of work they endured, the children they lost at birth or in early childhood and the squalid urban slums that industrial work compelled them to live in.



Fig. 15.5 : Woman in gilt-button factory, Birmingham. In the 1850s, two thirds of the workforce in the button trade was women and children. Men received 25 shillings a week, women 7 shillings and children one shilling each, for the same hours of work.

- Mention two important industrialisation effects on women and children's life.

Industrialisation in Germany and France

While industrialisation began early in England in the 18th century, it was not until 1850s and 1870s that industrial production became prominent in Germany and France. As you may remember, Germany was not yet united till 1870 and France was still undergoing turmoil of wars and revolutions. Unlike Britain which had extensive colonies, Germany and France lacked colonial resources. They thus had to make up for these disadvantages.

- Discuss the effects of early industrialisation on British town and villagers and compare these with similar situation in India.

In both the countries industrialisation received a boost by the introduction of railways in 1830s. Railways stimulated trade, communication and economic growth. By 1850 the various German states had constructed half as much railways as Britain and twice as much as France.

Prussia, exploited its rich coalfields (Silesia and the Rhineland -the Ruhr) and iron deposits (Bohemia) in order to create a flourishing steel industry. Alfred Krupp had established a small iron foundry at Essen in 1810. By 1870 Krupp of Essen, had been transformed into a giant company employing thousands of workers and making a fortune for the Krupp family with its railway locomotive and armaments production. In turn, the invention of the electric dynamo by Werner Siemens in 1866, laid the foundations of a new electrical industry in which Germany would lead the world. The defeat of France in 1870 and the creation of a united Germany in 1871 stimulated industrialisation even further, because the new politically united Germany could now exploit the rich iron-fields of Lorraine taken from France.

Condition of child labourers

The horrible condition of child labourers is stated in the evidence collected by a committee of British Parliament in 1816. The following information was collected from a one-time master of apprentices in a cotton mill. He was asked questions by the committee on the condition of child labourers in his factory.

'At what age were they taken?'

'Those that came from London were from about eight or ten to fifteen.'

'Up to what period were they apprenticed?'

'One –and–twenty.'

'What were the hours of work?'

'From five O'clock in the morning till eight at night.'

'Were fifteen hours in the day the regular hours of work?'

'Yes.'

'When the works were stopped for the repair of the mill, or for any want of cotton, did the children afterwards make up for the loss of that time?'

'Yes.'

'Did the children sit or stand to work?'

'Stand.'

'The whole of their time?'

'Yes.'

'Were there any seats in the mill?'

'None. I have found them frequently upon the mill-floors, after the time they should have been in bed.'

'Were any children injured by the machinery?'

'Very frequently.'

German industrialisation was greatly facilitated by the German government which not only provided a large market for its industries besides investing in building roads and railways and developing mines. The German army required huge quantities of arms and ammunitions and many of the leading industrialists focused on the armament industry. The government also controlled working class movement with a heavy hand and at the same time provided for many social benefits and insurance for the workers. This enabled the factory owners to control their workers and pay less.

- Compare the industrialisation in Germany and France. Identify similarities and differences.
- Why do you think France lagged behind in industrial development?
- What factors enabled Germany to outstrip England and France in industrialisation?

German industry also benefitted from the technical developments achieved by Britain and USA. They directly borrowed the new technology which other countries had developed over a long time. For this of course they needed heavy capital investment which they received from large banks. Thus German industries developed as large concentrated units and even surpassed British industries in size and scope.

German industrialisation initially had to contend with the leadership of Britain over many key sectors like cotton textiles and machine building. However, soon Germany developed iron and steel, chemical and electrical industries which were new generation industries and overtook Britain in these areas. By the beginning of 20th century, Germany had developed a powerful industrial base and was challenging Britain as Europe's major industrial power. Britain was still producing more coal, but Germany was producing more steel. What was worrying about this situation for Britain and France was the fact that a great proportion of this industrial production was used to build up Germany's military and naval power.

France, in contrast was slow in industrialising. Even by the end of 19th century she remained a rural country with a large majority of people cultivating small plots of land. Manufacturers found it more profitable to give out work to rural workers who worked at home rather than to set up factories in towns. Such rural domestic production began to decline after 1850 resulting in economic adversity for the people. Machines in towns began to take over much of the work and only delicate hand work was given out to rural workers. Much of French

The Krupp Family

The Krupp family established what was to become the world's largest arms factory. This first factory specialised in field gun manufacture and, by 1887, it supplied arms to forty six different countries.

During World War I the Krupp factories made guns for the German artillery.

The Krupps supported Hitler in the German general election of 1933. As Nazi Germany occupied neighbouring countries, Alfred Krupp seized new land to make more factories. Many of these factories used slave-labour from the Nazi concentration camps.

industrialisation was a result of the spread of railway and road networks after 1860 which created a wide market for its industrial goods.

France also did not develop Banks which could mobilise large amount of capital and lend them to industrialists. As a result most of French manufacturers depended upon family resources. They remained small companies as a result. It also made them slow in adopting new ideas and technologies.

Heavy industry based on iron and coal was slow to develop in France as she did not have good reserves of coal and depended upon expensive imports. Thus French industrialisation remained focused on consumer products like textiles, which were basically small scale enterprises. This was in contrast to the German and British Industrial situation where heavy industries predominated.

Key words

1. Industrialisation
2. Transformation
3. Industrial Revolution
4. Steam Power
5. Hydraulic Power

Improve your learning

Fill in the blanks with correct options:

1. Britain did not depended on different parts of the world for _____ and _____ (labourers; raw material; capital; inventions)
2. Two important types of transport during the Industrial revolution were _____ and _____ (road; air; water; rail)
3. Write two sentences each on following aspects in the context of Industrial revolution:
 - a) technology
 - b) financing and money
 - c) agriculture revolution
 - d) transport systems
4. What do you think is special about inventions happening during the industrial revolution?
5. How were the lives of different classes of British women affected by the industrial revolution?
6. Compare the effects of the coming of the railways in different countries in the world.
7. What were the relative advantages of canal and railway transportation?
8. Locate the places where iron and textile industries are mainly concentrated in England during industrial revolution.
9. Prepare a table on invention during the time of Industrial Revolution.

Project

Mention the consequences of the industrial revolution in the economic field. Write a report and present in your class.