THEME 9

THE INDUSTRIAL REVOLUTION

11090CH09

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.*

This 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. The 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, as will be seen from glances into the backgrounds of some of them.

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.

**In the second one, after about 1850, new areas like the chemical and electrical industries expanded. In that period, Britain fell behind, and lost its position as the world's leading industrial power, as it was overtaken by Germany and the USA.*

The term 'Industrial Revolution' was used by European scholars – Georges Michelet in France and 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. These dates coincided with those of the reign of George III, on which Toynbee was giving a series of lectures at Oxford University. His lectures were published in 1884, after his untimely death, as a book called *Lectures on the Industrial Revolution in England: Popular Addresses, Notes and Other Fragments*.

Later historians, T.S. Ashton, Paul Mantoux and Eric Hobsbawm, broadly agreed with Toynbee. There was remarkable economic growth from the 1780s to 1820 in the cotton and iron industries, in coal mining, in the building of roads and canals and in foreign trade. Ashton (1889-1968) celebrated the Industrial Revolution, when England was 'swept by a wave of gadgets'.

Why Britain?

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. This meant that the kingdom had common laws, a single currency and a market that was not fragmented by local authorities levying taxes on goods that passed through their area, thus increasing their price. By the end of the seventeenth century, money was widely used as the medium of exchange. By then a large section of the people received their income in the form of wages and salaries rather than in goods. This gave people a wider choice for ways to spend their earnings and expanded the market for the sale of goods.

In the eighteenth century, England had been through a major economic change, later described as the 'agricultural revolution'. This was the process by which bigger landlords had bought up small farms near their own properties and enclosed the village common lands, thus creating very large estates and increasing food production. This forced landless farmers, and those who had lived by grazing animals on the common lands, to search for jobs elsewhere. Most of them went to nearby towns.

'The man of wealth and pride
Takes up a space that many poor supplied;

Space for his lake, his park's extended bounds,
Space for his horses, equipage, and hounds;

The robe that wraps his limbs in silken sloth
Has robbed the neighbouring fields of half their growth.'

– Oliver Goldsmith (1728-74), The Deserted Village.

Towns, Trade and Finance

From the eighteenth century, many towns in Europe were growing in area and in population. Out of the 19 European cities whose population doubled between 1750 and 1800, 11 were in Britain. The largest of them was London, which served as the hub of the country's markets, with the next largest ones located close to it.

London had also acquired a global significance. By the eighteenth century, the centre of global trade had shifted from the Mediterranean ports of Italy and France to the Atlantic ports of Holland and Britain. Still later, London replaced Amsterdam as the principal source of loans for international trade. London also became the centre of a triangular trade network that drew in England, Africa and the West Indies. The companies trading in America and Asia also had their offices in London. In England the movement of goods between markets was helped by a good network of rivers, and an indented coastline with sheltered bays. Until the spread of railways, transport by waterways was cheaper and faster than by land. As early as 1724, English rivers provided some 1,160 miles of navigable water, and except for mountainous areas, most places in the country were within 15 miles of a river. Since all the navigable sections of English rivers flow into the sea, cargo on river vessels was easily transferred to coastal ships called coasters. By 1800, at least 100,000 sailors worked on the coasters.

ACTIVITY 1

Discuss the developments in Britain and in other parts of the world in the eighteenth century that encouraged British industrialisation.

The centre of the country's financial system was the Bank of England (founded in 1694). By 1784, there were more than a hundred provincial banks in England, and during the next 10 years their numbers trebled. By the 1820s, there were more than 600 banks in the provinces, and over 100 banks in London alone. The financial requirements to establish and maintain big industrial enterprises were met by these banks.

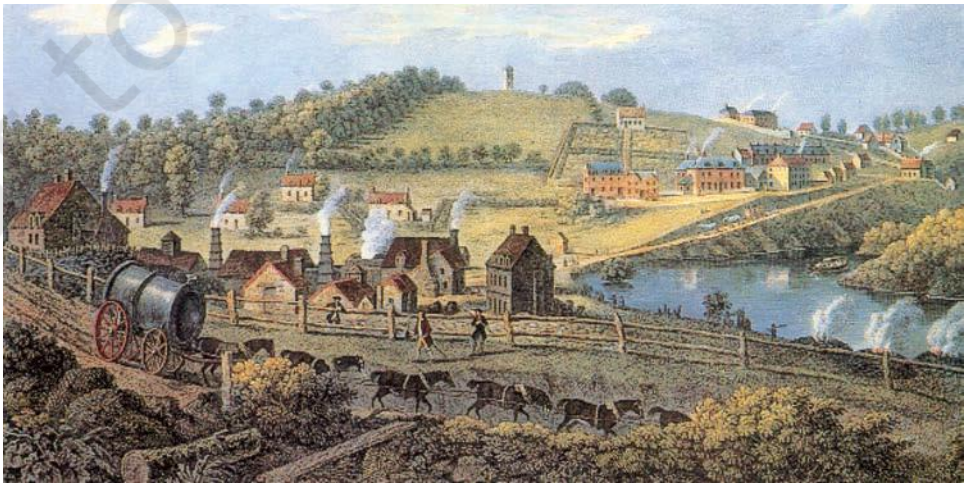
The industrialisation that occurred in Britain from the 1780s to the 1850s is explained partly by the factors described above – many poor people from the villages available to work in towns; banks which could loan money to set up large industries; and a good transport network.

The following pages will describe two new factors: a range of technological changes that increased production levels dramatically and a new transport network created by the construction of railways. In both developments, if the dates are read carefully, one will notice that there is a gap of a few decades between the development and its widespread *application*. One must not assume that a new innovation in technology led to it being used in the industry *immediately*.

Of the 26,000 inventions recorded in the eighteenth century, more than half were listed for the period 1782-1800. These led to many changes. We shall discuss the four major ones: the transformation of the iron industry, the spinning and weaving of cotton, the development of steam 'power' and the coming of the railways.

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 drawn out from ore as pure liquid metal 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



Coalbrookdale: blast-furnaces (left and centre) and charcoal-ovens (right); painting by F.Vivares, 1758.

forests had been destroyed for timber; and it could not generate high temperatures.

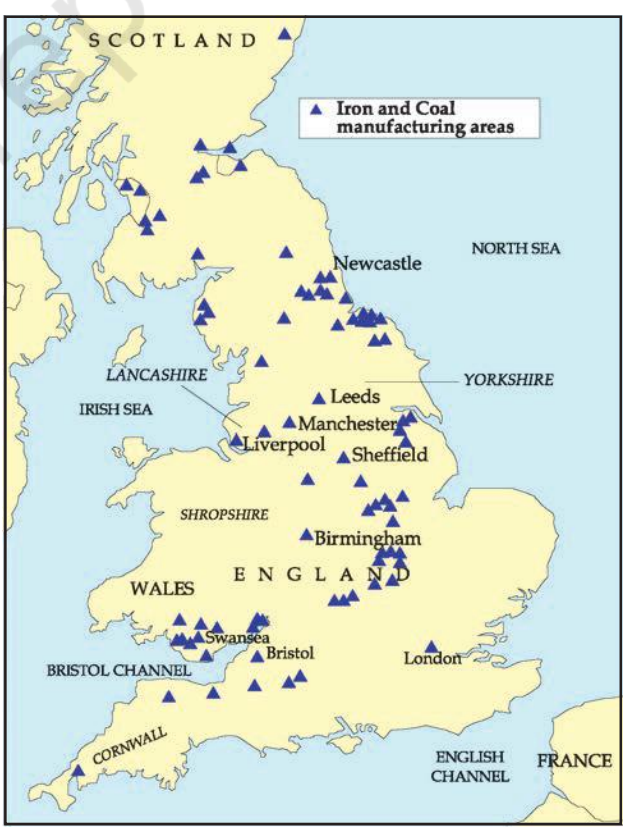
The solution to this problem had been sought for years before it was solved by a family of iron-masters, the Darbys of Shropshire. In the course of half a century, three generations of this family – grandfather, father and son, all called Abraham Darby – brought about a revolution in the metallurgical 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 Cast Iron Bridge near Coalbrookdale, painting by William Williams, 1780.

*This area later grew into the village called Ironbridge.

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. In the 1770s, John Wilkinson (1728-1808) made the first iron chairs, vats for breweries and distilleries, and iron pipes of all sizes. In 1779, the third Darby (1750-91) built the first iron bridge in the world, in Coalbrookdale, spanning the river Severn*. Wilkinson used cast iron for the first time to make water pipes (40 miles of it for the water supply of Paris).

MAP 1: Britain: The iron industry



The iron industry then came to be concentrated in specific regions as integrated units of coal mining and iron smelting. 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. Since the coalfields were near the coast, shipbuilding increased, as did the shipping trade.

ACTIVITY 2

Ironbridge Gorge is today a major 'heritage site'. Can you suggest why?

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

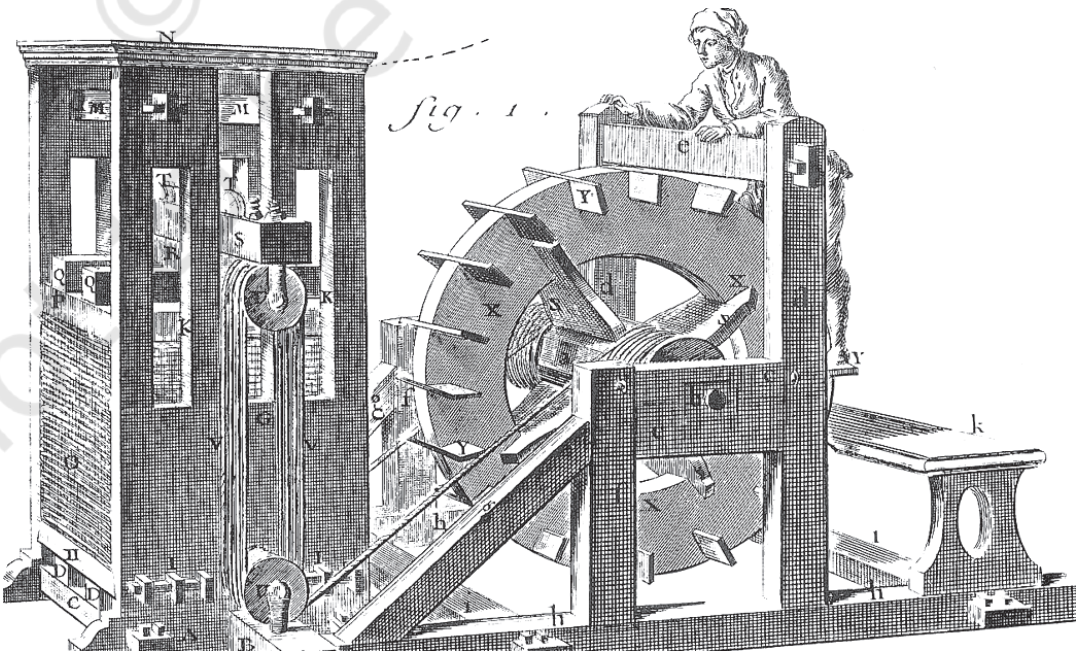
Cotton Spinning and Weaving

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 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,



Manpower (in this picture, woman-power) worked the treadmill that lowered the lid of the cotton press.

1. The **flying shuttle loom**, *designed by John Kay (1704-64) in 1733 made it possible to weave broader fabrics in less time and consequently called for more yarn than could be supplied at the prevailing pace of spinning.*

2. The **spinning jenny** *was a machine made by James Hargreaves (1720-78) in 1765 on which a single person could spin several threads of yarn simultaneously. This provided weavers with yarn at a faster rate than they could weave into fabric.*

3. The **water frame**, *which Richard Arkwright (1732-92) invented in 1769, produced a much stronger thread than before. This also made it possible to weave pure cotton fabrics rather than fabrics that combined linen and cotton yarn.*

4. The **mule** *was the nickname for a machine invented in 1779 by Samuel Crompton (1753-1827) that allowed the spinning of strong and fine yarn.*

5. The cycle of inventions in the cotton textile industry that sought to maintain a balance between the tasks of spinning and weaving concluded with the invention of the **powerloom** *by Edmund Cartwright (1743-1823) in 1787. This was easy to work, stopped automatically every time a thread broke and could be used to weave any kind of material. From the 1830s, developments in this industry concentrated on increasing the productivity of workers rather than bringing new machines into use.*

MAP 2: Britain: The cotton industry

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. This exemplified the ugly face of early industrialisation, as will be described below.

Steam Power

The realisation that steam could generate tremendous power was decisive to large-scale industrialisation.

Water as hydraulic power had been the prime source of energy for centuries, but it had been limited to certain areas, seasons and by the speed of the flow of water. Now it was used differently. Steam power provided pressure at high temperatures that enabled the use of a broad range of machinery. This meant that steam power was the only source of energy that was reliable and inexpensive enough to manufacture machinery itself.

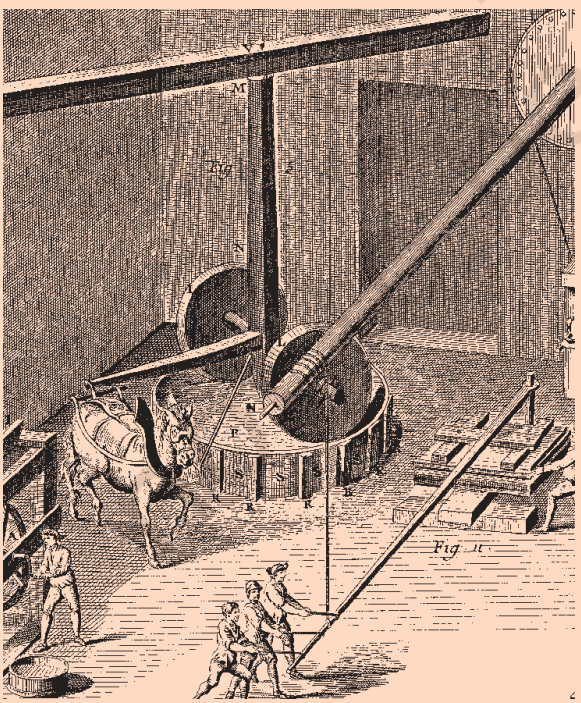
Steam power was first used in mining industries. As the demand for coal and metals expanded, efforts to obtain them from ever-deeper mines intensified. Flooding in mines was a serious problem. Thomas Savery (1650-1715) built a model steam engine called the Miner's Friend in 1698 to drain mines. These engines worked slowly, in shallow depths, and the boiler burst under too much pressure.

Another steam engine was built by Thomas Newcomen (1663-1729) in 1712. This had the major defect of losing energy due to continuous cooling of the condensing cylinder.

The steam engine had been used only in coal mines until James Watt (1736-1819) developed his machine in 1769. Watt's 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 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.

After 1800, steam engine technology was further developed with the use of lighter, stronger metals, the manufacture of more accurate machine tools and the spread of better scientific knowledge. In 1840, British steam engines were generating more than 70 per cent of all European horsepower.

Watt's inventions were not limited to the steam engine. He invented a chemical process for copying documents. He also created a unit of measurement based on comparing mechanical power with that of the previous universal power source, the horse. Watt's measurement unit, horsepower, equated the ability of a horse to lift 33,000 pounds (14,969 kg) one foot (0.3 m) in one minute. Horsepower remains as a universally used index of mechanical energy.



Horses turned the wheels to grind metal. The use of steam reduced the dependence on manpower and horsepower.

Canals and Railways

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.

Canals were usually built by big landowners to increase the value of the mines, quarries or forests on their lands. The confluence of canals created marketing centres in new towns. The city of Birmingham, for example, owed its growth to its position at the heart of a canal system connecting London, the Bristol Channel, and the Mersey and Humber rivers. From 1760 to 1790, twenty-five new canal-building projects were begun. In the period known as the 'canal-mania', from 1788 to 1796, there were another 46 new projects and over the next 60 years more than 4,000 miles of canal were built.

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. In 1801, Richard Trevithick (1771-1833) had devised an engine called the 'Puffing Devil' that pulled trucks around the mine where he worked in Cornwall. In 1814, the railway engineer George Stephenson (1781-1848) constructed a locomotive, called 'The Blutcher', that could pull a weight of 30 tons up a hill at 4 mph. 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 speeds of up to 24 kph (15 mph), and the next railway line connected Liverpool and Manchester in 1830. Within 20 years, speeds of 30 to 50 miles an hour were 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. The railways now appeared as a convenient alternative. About 6,000 miles of railway was opened in Britain between 1830 and 1850, most of it in two short bursts. During the 'little railway mania' of 1833-37, 1400 miles of line was built, and during the bigger 'mania' of 1844-47, another 9,500 miles of line was sanctioned. They used vast amounts of coal and iron, employed large numbers of workers and boosted activity in the construction and public works industries. Most of England had been connected by railway by 1850.

Who were the inventors?

It is interesting to find out who the individuals were 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 but intuitive thinkers and persistent experimenters. They were helped by the fact that England had certain features which 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 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.

Far left: Coalbrookdale, Carpenters' Row, cottages built by the company for workers in 1783.
Left: The houses of the Darbys; painting by William Westwood, 1835.

Newcomers were forced to live in overcrowded slums in the congested central areas of towns near factories, while the rich inhabitants escaped, by shifting to homes in the suburbs where the air was cleaner and the water safe to drink.

Edward Carpenter eloquently described such cities in about 1881, in his poem 'In a Manufacturing Town'

'As I walked restless and despondent through the gloomy city,
And saw the eager unresting to and fro – as of ghosts in some sulphurous Hades –*
And saw the crowds of tall chimneys going up, and the pall of smoke covering the sun, covering the earth, lying heavy against the very ground –
And saw the huge-refuse heaps writhing with children picking them over,
And the ghastly half-roofless smoke-blackened houses, and the black river flowing below, –
As I saw these, and as I saw again faraway the Capitalist quarter,
With its villa residences and its high-walled gardens and its well-appointed carriages, and its face turned away from the wriggling poverty which made it rich, …
I shuddered.'

**The gates of Hell.*

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 and 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,

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

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, while 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 or those 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.

A lane in the poorer quarters of London; engraving by the French artist Dore, 1876.

In his novel Hard Times, Charles Dickens (1812-70), perhaps the most severe contemporary critic of the horrors of industrialisation for the poor, wrote a fictional account of an industrial town he aptly called Coketown. 'It was a town of red brick, or of brick that would have been red if the smoke and ashes had allowed it; but as matters stood it was a town of unnatural red and black like the painted face of a savage. It was a town of machinery and tall chimneys, out of which interminable serpents of smoke trailed themselves for ever and ever, and never got uncoiled. It had a black canal in it, and a river that ran purple with ill-smelling dye, and vast piles of building full of windows where there was a rattling and a trembling all day long, and where the piston of the steam-engine worked monotonously up and down, like the head of an elephant in a stare of melancholy madness.'

ACTIVITY 3

Discuss the effects of early industrialisation on British towns and villages, and compare these with similar situations in India.

D.H.Lawrence (1885-1930), British essayist and novelist, writing seventy years after Dickens, described the change in a village in the coal-belt, change which he had not experienced, but about which he had heard from older people.

'Eastwood…must have been a tiny village at the beginning of the nineteenth century, a small place of cottages and fragmentary rows of little four-roomed miners' dwellings, the homes of the old colliers…But somewhere about 1820 the company must have sunk the first big shaft…and installed the first machinery of the real industrial colliery…Most of the little rows of dwellings were pulled down, and dull little shops began to rise along the Nottingham Road, while on the down-slope…the company erected what is still known as the New Buildings…little four-room houses looking outward into the grim, blank street, and the back looking into the desert of the square, shut in like a barracks enclosure, very strange.'

Protest Movements

The early decades of industrialisation coincided with the spread of new political ideas pioneered by the French Revolution (1789-94). The movements for 'liberty, equality and fraternity' showed the possibilities of collective mass action, both in creating democratic institutions like the French parliamentary assemblies of the 1790s, and in checking the worst hardships of war by controlling the prices of necessities like bread. In England, political protest against the harsh working conditions in factories kept increasing, and the working population agitated to be given the right to vote. The government reacted by repression and by new laws that denied people the right to protest.

England had been at war with France for a long time – from 1792 to 1815. Trade between England and Europe was disrupted, factories were forced to shut down, unemployment grew and the price of essential items of food, like bread and meat, soared to heights beyond the level of average wages.

Parliament in 1795 passed two Combination Acts which made it illegal to 'incite the people by speech or writing to hatred or contempt of the King, Constitution or Government'; and banned unauthorised public meetings of over 50 persons. Protest, nonetheless, continued against 'Old Corruption'. This term was used for privileges linked to the monarchy and Parliament. Members of Parliament – landowners, manufacturers and professionals – were opposed to giving the working population the right to vote. They supported the Corn Laws, which prevented the import of cheaper food until prices in Britain had risen to a certain level.

As workers flooded towns and factories, they expressed their anger and frustration in numerous forms of protest. There were bread or

food riots throughout the country from the 1790s onwards. Bread was the staple item in the diet of the poor and its price governed their standard of living. Stocks of bread were seized and sold at a price that was affordable and morally correct rather than at the high prices charged by profit-hungry traders. Such riots were particularly frequent in the worst year of the war,1795, but they continued until the 1840s.

Another cause of hardship was the process known as 'enclosure' – by which, from the 1770s, hundreds of small farms had been merged into the larger ones of powerful landlords. Poor rural families affected by this had sought industrial work. But the introduction of machines in the cotton industry threw thousands of handloom weavers out of work and into poverty, since their labour was too slow to compete with machines. From the 1790s, these weavers began to demand a legal minimum wage, which was refused by Parliament. When they went on strike, they were dispersed by force. In desperation, in Lancashire, cotton weavers destroyed the powerlooms which they believed had destroyed their livelihood. There was also resistance to the introduction of machines in the woollen knitting industry in Nottingham; protests also took place in Leicestershire and Derbyshire.

In Yorkshire, shearing-frames were destroyed by croppers, who had traditionally sheared sheep by hand. In the riots of 1830, farm labourers found their jobs threatened by the new threshing machines that separated the grain from the husk. The rioters smashed these machines. Nine of them were hanged and 450 were sent to Australia as convicts (see Theme 10).

The movement known as Luddism (1811-17), led by the charismatic General Ned Ludd, exemplified another type of protest. Luddism was not merely a backward-looking assault on machines. Its participants demanded a minimum wage, control over the labour of women and children, work for those who had lost their jobs because of the coming of machinery, and the right to form trade unions so that they could legally present these demands.

During the early years of industrialisation, the working population possessed neither the vote nor legal methods to express their anger at the drastic manner in which their lives had been overturned. In August 1819, 80,000 people gathered peacefully at St Peter's Fields in Manchester to claim democratic rights – of political organisation, of public meetings, and of the freedom of the press. They were suppressed brutally in what became known as the Peterloo* Massacre and the rights they demanded were denied by the Six Acts, passed by Parliament the same year. These extended the restrictions on political activity introduced in the two Combination Acts of 1795. But there were some gains. After Peterloo, the need to make the House of Commons more representative was recognised by liberal political groups, and the Combination Acts were repealed in 1824-25.

*This name was made up to rhyme with 'Waterloo'; the French army had been defeated at Waterloo in 1815.

Reforms through Laws

How attentive was the government to the conditions of work of women and children? Laws were passed in 1819 prohibiting the employment of children under the age of nine in factories and limiting the hours of work of those between the ages of nine and sixteen to 12 hours a day. But this law lacked the powers needed for its enforcement. It was not until 1833, after intense protest by workers throughout the north of England, that an Act was passed that permitted children under nine to be employed only in silk factories, limited the hours of work for older children and provided a number of factory inspectors to ensure that the Act was enforced. Finally, in 1847, after more than 30 years of agitation, the Ten Hours' Bill was passed. This limited the hours of work for women and young people, and secured a 10-hour day for male workers.

These Acts applied to the textile industries but not to the mining industry. The Mines Commission of 1842, set up by the government, revealed that working conditions in mines had actually become worse since the Act of 1833, because more children had been put to work in coal mines. The Mines and Collieries Act of 1842 banned children under ten and women from working underground. Fielder's Factory Act laid down in 1847 that children under eighteen and women should not work more than 10 hours a day. These laws were to be enforced by factory inspectors, but this was difficult to do. The inspectors were poorly paid and easily bribed by factory managers, while parents lied about the real ages of their children, so that they could work and contribute to family incomes.

ACTIVITY 4

Argue the case for and against government regulation of conditions of work in industries.

The Debate on the 'Industrial Revolution'

Until the 1970s, historians used the term 'industrial revolution' for the changes that occurred in Britain from the 1780s to the 1820s. From then, it was challenged, on various grounds.

Industrialisation had actually been too gradual to be considered a 'revolution'. It carried processes that already existed towards new levels. Thus, there was a *relatively* greater concentration of workers in factories, and a *wider* use of money.

Until well into the nineteenth century, large regions of England remained untouched by factories or mines and therefore the term 'industrial revolution' was regarded as inaccurate: England had changed in a *regional* manner, prominently around the cities of London, Manchester, Birmingham or Newcastle, rather than throughout the country.

Could the growth in the cotton or iron industries or in foreign trade from the 1780s to the 1820s be called revolutionary? The impressive growth of cotton textiles, based on new machinery, was in an industry that relied on a non-British raw material, on sales abroad (especially

India), on non-metallic machinery, and with few links to other branches of industry. Metallic machinery and steam power was rare until much later in the nineteenth century. The rapid growth in British imports and exports from the 1780s occurred because of the resumption of trade with North America that the War of American Independence had interrupted. This growth was recorded as being sharp only because it started from a low point.

Indicators of economic change occurring before and after 1815-20 suggest that sustained industrialisation was to be seen *after* rather than *before* these dates. The decades after 1793 had experienced the disruptive effects of the French Revolutionary and Napoleonic Wars. Industrialisation is associated with a growing investment of the country's wealth in 'capital formation', or building infrastructure and installing new machinery, and with raising the levels of efficient use of these facilities, and with raising productivity. Productive investment, in these senses, grew steadily only after 1820, as did levels of productivity. The cotton, iron and engineering industries had accounted for less than half of the industrial output until the 1840s. Technical progress was not limited to these branches, but was visible in other branches too, like agricultural processing and pottery.

In searching for an answer as to why British growth may have been faster after 1815 than before, historians have pointed to the fact that from the 1760s to 1815, Britain tried to do two things simultaneously – to industrialise, and to fight wars in Europe, North America and India – and it may possibly have failed with one. Britain was at war for 36 out of 60 years from 1760. Capital that was borrowed was used to fight the wars rather than invested. As much as 35 per cent of the cost of the war was met by taxing people's incomes. Workers were transferred out of factories and farms to the army. Food prices rose so sharply that the poor had little money left for buying consumer goods. Napoleon's policies of blockade, and British reactions to them, closed the European continent, the destination for more than half of British exports, to British traders.

The word 'industrial' used with the word 'revolution' is too limited. The transformation extended beyond the economic or industrial sphere and into society and gave prominence to two classes: the bourgeoisie and the new class of proletarian labourers in towns and in the countryside.

In 1851, visitors thronged the Great Exhibition at the specially constructed Crystal Palace in London to view the achievements of British industry. At that time, half the population was living in towns, but of the workers in towns as many were in handicraft units as in factories. From the 1850s, the proportion of people living in urban areas went up dramatically, and most of these were workers in industry – the working class. Only 20 per cent of Britain's workforce now lived in rural areas. This was a far more rapid rate of industrialisation than had been witnessed in other European countries. In his detailed study of British industry, the historian A.E. Musson has suggested that

The Great Exhibition of 1851 displayed "the Works of Industry of all Nations", particularly the spectacular progress of Britain. It was held in London's Hyde Park, in the Crystal Palace, made of glass panes set in iron columns manufactured in Birmingham.

'There are good grounds for regarding the period 1850-1914 as that in which the Industrial Revolution really occurred, on a massive scale, transforming the whole economy and society much more widely and deeply than the earlier changes had done.'

Exercises

ANSWER IN BRIEF

1. *How did Britain's involvement in wars from 1793 to 1815 affect British industries?*
2. *What were the relative advantages of canal and railway transportation?*
3. *What were the interesting features of the 'inventions' of this period?*
4. *Indicate how the supply of raw materials affected the nature of British industrialisation.*

ANSWER IN A SHORT ESSAY

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.*