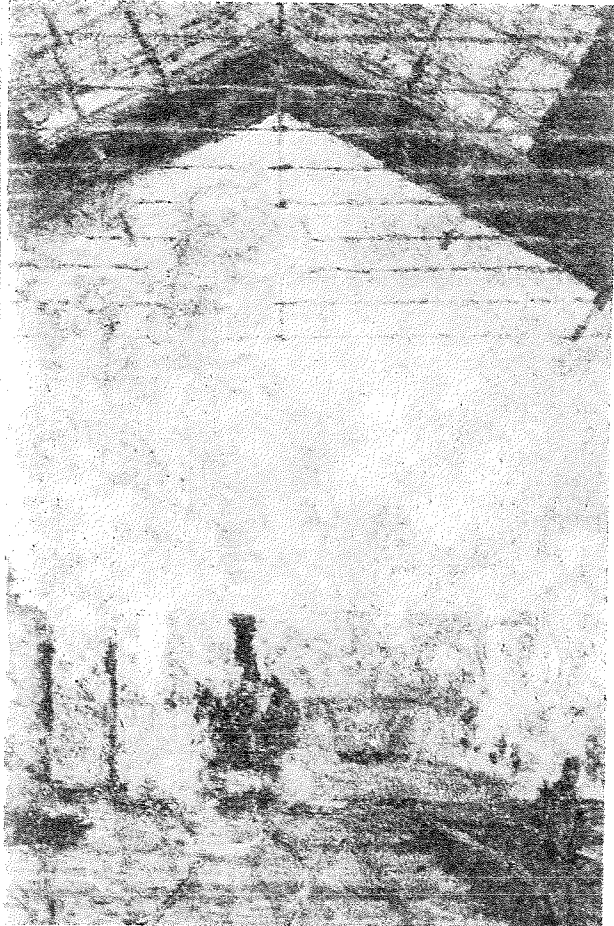
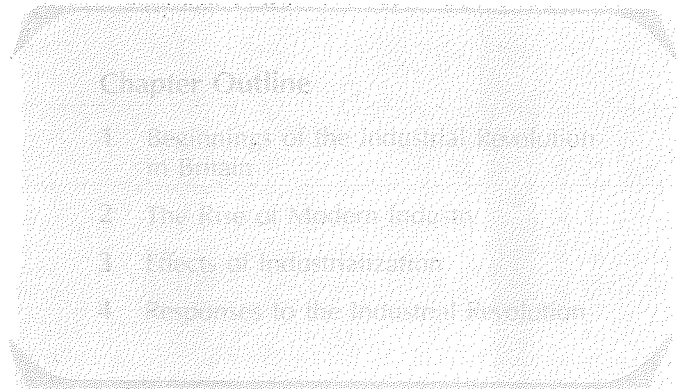


# 5 The Industrial Revolution

(1750-1914)



Detail from *St. Lazare Station*, by Claude Monet.



To one British author, Charles Dickens, whose novel *Hard Times* was published in 1854, a typical factory town 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 buildings full of windows where there was a rattling and 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 state of melancholy madness."

To Dickens, the people of the town shared the same "melancholy madness." They were "equally like one another. . . all went in and out at the same hours, with the same sound upon the same pavement, to do the same work and to whom every day was the same as yesterday and tomorrow, and every year the counterpart of last and the next."

The conditions Dickens described were the result of the Industrial Revolution. The Industrial Revolution was neither sudden nor swift. It was a long, slow process in which production shifted from hand tools to machines and in which new sources of power such as steam and electricity replaced human and animal power.

The Industrial Revolution had two distinct stages. During the first stage, from about 1750 to 1850, Great Britain took the lead in shifting to new methods of production. During the second stage, from the mid-1800s to about 1914, the nations of Western Europe and North America developed into modern industrial powers. The Industrial Revolution was to completely transform the patterns of life in these nations.

# 1 Beginnings of the Industrial Revolution in Britain

By the mid-1700s, new methods of producing goods were being developed in Great Britain and France. Many of these new methods were outgrowths of inventions made during the Enlightenment, a time when people began to apply scientific principles to practical problems. (See page 4.) During the late 1700s, the French Revolution disrupted the political and economic life of France. This was one reason that Britain emerged as the leader of the Industrial Revolution.

## The Agricultural Revolution

One key to the beginning of the Industrial Revolution in Britain was a revolution in agriculture that greatly increased the amount and variety of food produced. During the 1700s, farmers began growing new crops, such as potatoes and corn, that had been introduced from the Americas. They also developed new ways of using the land that made it more productive.

Since the Middle Ages, farmers had planted the same crop in a given field year after year. Every third year, they left the field fallow to prevent the soil from wearing out. In the 1730s, Charles Townshend discovered that fields did not have to be left fallow if farmers would rotate the crops they planted in a field. He suggested that farmers grow wheat or barley in a field for one or two years and then plant clover or turnips in the field for one or two years.

Townshend's ideas helped revolutionize agriculture. Crops such as clover and turnips replenished the soil with the nutrients that wheat and barley used. Moreover, clover and turnips provided excellent feed for animals. Thus, farmers could raise cattle and sheep for food. As meat became available at lower cost, people could add more protein to their diet.

The invention of machines also increased food production. Jethro Tull found a

method of planting seeds that was better than scattering them randomly. When the seeds were scattered, they would grow wherever they landed, and fields became a tangle of crops and weeds. Tull developed a seed drill that planted the seeds in straight rows. The seed drill reduced the amount of seed used in planting. It also allowed farmers to weed around the straight rows of growing crops.

During the 1700s, iron plows replaced less efficient, wooden plows. In the 1800s, mechanical reapers and threshers began to replace hand methods of harvesting crops. This further increased farm production.

Changing patterns of land ownership in Britain also contributed to the Agricultural Revolution. Since the Middle Ages, farmers had worked small strips of land in scattered fields. They grazed their animals and gathered timber on common, or public, lands. In the 1500s, wealthy landowners began claiming the right to these common lands. The *enclosure movement*, fencing off of public lands by individual landowners, spread rapidly in the 1700s.

The enclosure movement made agriculture more efficient because wealthy landowners farmed larger amounts of land and experimented with new crops. However, it forced many small farmers off land they had worked for years. Some became tenant farmers on land owned by others. Others drifted to the towns in search of work.

The Agricultural Revolution helped set the stage for the Industrial Revolution. Increased food production improved people's diet and health, which contributed to rapid population growth. As the population increased, the demand for manufactured goods, such as clothing, grew. Furthermore, more efficient methods of farming meant that fewer people were needed to work the land. Unemployed farmers, including those forced off the land by the enclosure movement, formed a large new labor force.

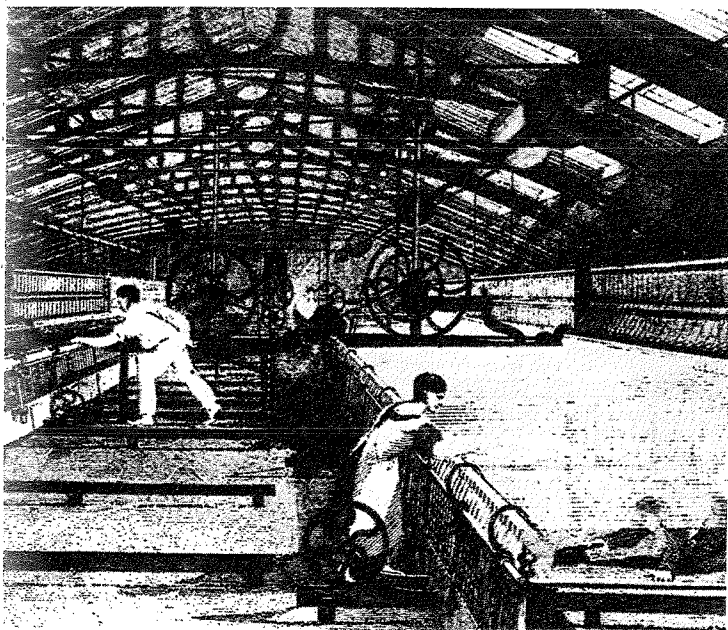
## Changes in the Textile Industry

While improvements in agriculture released many workers from farming, inventions—especially in the British textile industry—created new demands for laborers. During the 1500s and 1600s, entrepreneurs developed a system of having work done in the countryside, known as the *domestic system*. Rural families were supplied with raw wool and cotton. In their own cottages, family members cleaned and spun the wool or cotton into thread. They then used hand looms to weave the thread into cloth.

The domestic system could not keep up with a steadily rising demand for cloth, especially cotton cloth. In the 1700s, practical-minded individuals developed ways to improve the manufacture of cloth. Each invention triggered others, revolutionizing the whole textile industry.

**Mechanical inventions.** In 1733, the clockmaker John Kay invented the flying shuttle, which replaced the hand-held

*The Industrial Revolution began in the textile industry. By the early 1800s, large spinning mills like this one were operating all over England. Steam-powered looms required constant tending. Notice the worker at right who is cleaning debris from under the threads. The air inside the mills was kept hot and humid because threads broke less often under such conditions.*



shuttle used in weaving. This invention greatly speeded up the weaving process. Weavers were soon using thread faster than spinners could produce it.

In 1764, James Hargreaves, a carpenter, developed a way to speed up spinning. He attached several spindles to a single spinning wheel. Using this spinning jenny, as it was called, a person could spin several threads at once. In 1769, Richard Arkwright devised a machine that could hold up to 100 spindles. Arkwright's invention was too heavy to be operated by hand, so he used water power to turn it. Thus, the machine was called the water frame. Ten years later, Samuel Crompton developed the spinning mule, which used features of Hargreaves' spinning jenny and Arkwright's water frame. Once again, the production of cotton thread was increased.

With more thread now available, the need arose for faster looms. In 1785, Edward Cartwright built a loom in which the weaving action was powered by water. Using this power loom, a worker could produce 200 times more cloth in a day than had previously been possible.

In 1793, the American Eli Whitney gave the British cotton industry a further boost. Before cotton fibers could be spun into cloth, workers had to remove sticky seeds, an extremely slow process. Whitney invented the cotton gin, a machine that tore the fibers from the seeds, thus speeding up the process of cleaning cotton fibers. The invention of the cotton gin helped the British cotton industry because it increased the production of raw cotton and made it cheaper. By the 1830s, Britain was importing 127 000 t (tonnes) of raw cotton every year and had become the cotton manufacturing center of the world.

**The factory system.** The new spinning and weaving machines were expensive. They also had to be set up near rivers, where running water was available to power them.\* Inventors such as Arkwright built spinning mills and started hiring hundreds of workers to run the new machines.

\* Water flowing down a stream or river turned a water wheel that produced power to run the machines.





Coal fueled the early Industrial Revolution. In this 1814 print, a coal miner stands in front of a steam engine that is pulling a load of coal. The print is the first English picture of a steam-powered vehicle. Despite the use of steam engines, work in the coal mines remained largely dependent on the backbreaking labor of men, women, and children.

The early textile mills were examples of the factory system, which gradually replaced the domestic system of production. The *factory system* brought workers and machines together in one place to manufacture goods. Everyone had to work a set number of hours each day, and workers were paid daily or weekly wages.

### Development of the Steam Engine

Many early inventions in the textile industry were powered by running water, but soon steam became the major source of energy. The idea of a steam-powered engine had existed for a long time. In 1698, Thomas Savery constructed a steam-driven pump to remove water from flooded coal mines. Unfortunately, Savery's pump often exploded because of the intense pressure of the steam.

In the early 1700s, Thomas Newcomen developed a safer steam-powered pump. But Newcomen's engine broke down frequently and required a lot of coal to fuel it. Finally, in the 1760s, James Watt, who had repaired several Newcomen engines, developed ways

of improving the engine. Watt's steam engine got four times more power than Newcomen's engine from the same amount of coal.

The British found many uses for steam power. Steam engines were used in the growing textile industry. They also became important in coal mining.

### Development of the Iron and Coal Industries

Producing and operating the new machines, including the steam engine, required large quantities of iron and coal. Fortunately, Britain had extensive deposits of both. During the Industrial Revolution, the iron and coal industries benefited from improved production techniques.

Iron was produced by a smelting process. Iron ore, which contains only small amounts of iron, was heated to high temperatures to burn off impurities. Then the molten iron was poured off. Charcoal, a fuel made by partially burning hard woods, was used to heat the ore. But hard woods were



becoming scarce in Britain. Ironworkers experimented with using coal instead of charcoal. However, coal had many gases that mixed with the molten iron, making the iron hard to work. In the early 1700s, Abraham Darby helped solve this problem. He developed a way to use coke, or coal with the gases burned off, in place of charcoal.

Iron making was further improved in the 1780s, when Henry Cort developed a puddling process in which molten iron was stirred with a long rod to allow impurities to burn off. Iron produced in this manner was stronger than iron produced in other ways and less likely to crack under pressure. Cort also developed a technique to run molten iron through rollers to produce sheets of iron.

Improved production methods enabled Britain to quadruple iron production between 1788 and 1806. In addition, the demand for coal, both for making iron and for powering steam engines, triggered a boom in coal mining.

In the 1850s, the iron industry received another boost when Henry Bessemer developed a procedure that made the production of steel, an alloy of iron and other materials, cheaper and easier. In the *Bessemer process*, blasts of cold air were blown through heated iron to remove impurities. The result was stronger, more workable steel. As steel became readily available, it triggered the growth of other industries.

### **Advances in Transportation and Communication**

Industry requires a good transportation system to bring raw materials to factories and distribute finished goods. In the 1700s, the need for rapid, inexpensive transportation led to a boom in canal building in Britain. In 1759, the Duke of Bridgewater built a canal to connect his coal mines and his factories. Soon, canals were being built all over the country.

The 1700s were also a time of road building in Britain. The Scottish engineer John McAdam invented a road surface made

of crushed stone. This surface made roads usable in all weather. By the 1800s, road travel in England had become almost as fast as it had been in Roman times.

The need for good transportation led to the development of the railroad industry. For years, mine carts had been pulled along iron rails by workers or donkeys. In 1829, George Stephenson, a mining engineer, developed the Rocket, the first steam-powered locomotive. The Rocket could barrel along iron rails at 36 miles per hour (58 km/h), an astounding speed at the time.

Between 1840 and 1850, the British built over 5,000 miles (8,000 km) of railway tracks. As steel rails replaced iron rails, trains reached speeds of 60 miles per hour (96 km/h). Railroads brought raw materials, factories, and markets closer together than ever before. They also increased the demand for coal and steel.

In the 1800s, Britain led the way in railroad building and shipbuilding. However, it was an American engineer, Robert Fulton, who developed a way to use steam power for ships. In 1807, Fulton successfully tested the *Clermont*, a paddle-wheeled steamship, on the Hudson River. Other inventors improved the steamship. By 1850, steamships regularly crossed the oceans.

The railroad and the steamship improved communications within nations and across the world. Britain introduced an inexpensive postal system, which further improved communication. In 1837, Samuel F.B. Morse, an American, devised the telegraph, which sent messages by electrical impulses. Messages that once would have taken days to arrive now took minutes or seconds. In 1851, the first underwater telegraph cable was installed under the English Channel. It made rapid communication between Britain and the continent possible.

### **Why Britain Led the Industrial Revolution**

Britain enjoyed many advantages that helped it take an early lead in the Industrial Revolution. As you have read, with the Agri-

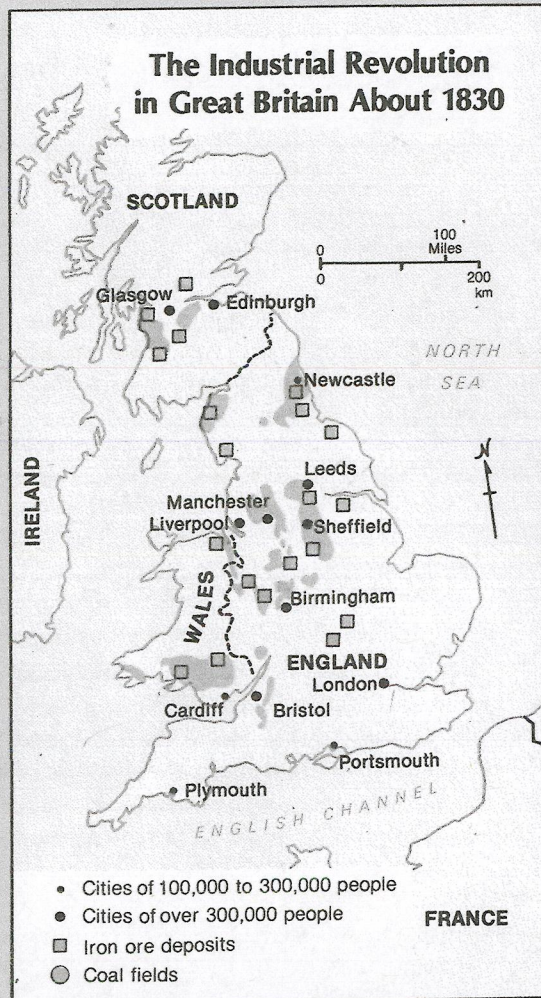


## The Industrial Revolution in Great Britain: Reading Thematic Maps

Maps provide much useful information about how geography can influence historical events and developments. Many of the maps you have studied in this text have shown topographical features, such as rivers and oceans, as well as political boundaries. Some have also given information about military advances.

However, there are other kinds of maps that give valuable information about population, natural resources, rainfall, and crop production. Maps that provide this kind of specialized information are called thematic maps. Practice reading thematic maps by studying the map at right. Then follow these steps.

- Decide what is shown on the map.** On a thematic map, the legend tells you what the symbols mean. Answer the following questions about the map: (a) What is the topic of the map? (b) What do the areas shaded orange represent? (c) What do the purple squares represent? (d) What other information is given on the map?
- Read the information on the map.** Answer the following questions about the map: (a) Name two cities on the map with populations of 300,000 or over. (b) Name two cities with populations of 100,000 to 300,000. (c) Which cities with populations over 300,000 were located near iron and coal resources? (d) Which large cities were probably ports?
- Draw conclusions about a historical event or development.** (a) What relationship does the map show between areas with coal and iron resources and those with large cities? (b) What areas of Britain were



probably the most industrialized? Explain.  
(c) What areas were probably the least industrialized? Explain.

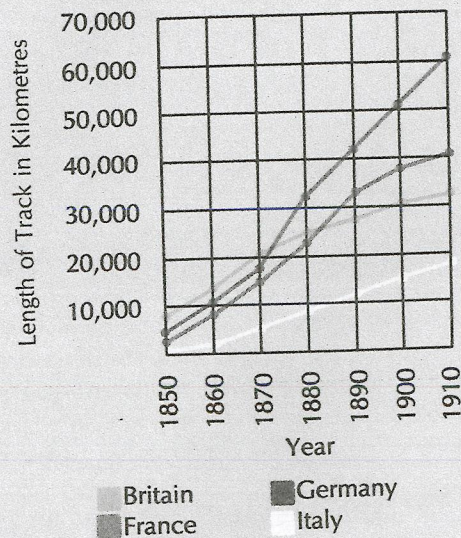
cultural Revolution came increased food production, freeing many laborers to work in industry. Moreover, Britain had plentiful iron and coal resources, and it developed an excellent transportation system to speed the flow of goods.

Britain was also the leading commercial power in Europe. Since the 1500s and 1600s,

British merchants had made huge profits from the international trade in tobacco, sugar, tea, and slaves. As a result, British entrepreneurs had the financial resources to invest in industries such as textiles, mines, railroads, and shipbuilding. Britain also had a large colonial empire that supplied raw materials to its factories. In addition, people in



## Growth of Railroads 1850-1910



Source: B.R. Mitchell, *European Historical Statistics*.

■ The building of railroads stimulated industrial growth in many countries. Because large amounts of iron and coal were needed to build railroads, the iron and coal industries grew. Once completed, railroads carried vital resources to factories and finished products to market.

omy. Trade expanded to meet the demands for raw materials and markets. Goods, services, and money flowed across the world. Regions distant from each other became dependent on one another as suppliers or consumers of goods. Investors in one country often organized companies in another. Many corporations and banks in Europe and North America sought new opportunities in overseas business ventures such as building railroads in Asia and Africa. As a result, governments became increasingly involved in protecting the international markets and investments of their citizens.

### SECTION REVIEW

1. Identify: Alessandro Volta, Michael Faraday, Alexander Graham Bell, Guglielmo Marconi, Thomas Edison, Gottlieb Daimler.
2. Define: interchangeable parts, assembly line, mass production, corporation, monopoly, vertical integration.
3. (a) Which European nations industrialized rapidly after 1850? (b) Which European nations remained largely agricultural?
4. Give one example of how scientific research affected industry.
5. Describe one result of the development of the assembly line.

## 3 Effects of Industrialization

Before 1800, most people in Europe and North America farmed the land. They lived and worked in the country or in small towns. They owned their own tools and were generally self-employed. The Industrial Revolution radically changed these patterns of life. By 1900, between one third and one half of the people in the industrialized countries of Western Europe and North America lived in cities. Most were employed in industry rather than agriculture. Furthermore, more workers had become wage earners, and fewer were self-employed workers and artisans.

### The Population Explosion

The beginning of the Industrial Revolution was marked by a population explosion that was to have far-reaching effects. Between 1750 and 1914, the population of Europe grew from one hundred and forty million people to four hundred and sixty-three million.

The Agricultural Revolution improved the diets of many people, so the people were healthier. The Industrial Revolution also contributed to the population growth. Medical discoveries and public sanitation reduced the numbers of deaths caused by



## Populations of Six European Nations, 1750–1910

(in thousands)

	1750	1800	1850	1880	1910
Belgium	2,150	2,960	4,426	5,520	7,422
Britain	10,012	14,997	27,201	34,623	44,915
France	24,600	27,800	35,630	37,450	39,528
Germany	12,770	17,200	35,310	45,093	64,568
Italy	13,150	16,900	*	28,211	34,377
Russia	*	31,000	60,000	85,200	142,500

\*Not available

Source: Witt Bowden, et. al., *An Economic History of Europe Since 1750*.

■ The population of European nations grew dramatically between 1750 and 1910, as you can see from this table. Between which years did the population of Germany increase the most?

disease. Furthermore, in the 1800s, European nations fought no major wars. Industry provided jobs as well as goods for the growing population.

### Problems of Growing Cities

Until the 1800s, cities, which were often located along land or water trade routes, served mainly as marketplaces. But the Industrial Revolution changed the nature of cities. Cities seemed to spring up almost overnight as people flocked to mill and factory sites. When people poured into these fast-growing cities in search of jobs, living conditions rapidly grew worse.

The city of Manchester, England, provides an example of what often happened during the Industrial Revolution. In 1750, Manchester was a fairly quiet market town with 16,000 residents. Manchester proved to be an attractive site for industry because there were iron and coal deposits nearby. Textile manufacturers built factories there. By 1855, Manchester was the center of the British cotton industry, and its population had grown to 455,000.

The rapid growth of Manchester brought severe problems. Thousands of factory workers crowded into poorly built houses. A family of six or ten might live in a

single dark, airless room. The city had an inadequate water system and almost no sanitation system. Overcrowded city slums became the breeding grounds for disease. Sewage was simply flung into open trenches along the streets. In many cities, pigs roaming the streets were the only “garbage collectors.” Manchester was not even chartered as a city so it could not tax citizens to raise money for improving living conditions. Nor could it pass laws to ensure that housing met minimum standards of safety or sanitation.

Living conditions in rural areas had often been difficult, but in the country, people usually could count on help from their neighbors. During the early Industrial Revolution, one writer described the plight of city people who sat “in their little cells; divided by partitions of brick and board, they sit strangers. . . . They do not work together, but scramble against each other.”

### Working in a Factory

Most of the new city residents found themselves working in factories, where working conditions were as miserable as living conditions outside the factory. The supply of unskilled workers was large, so wages were very low. Often a whole family worked to



survive. Women and children—some of whom started to work at age five—were in great demand because they worked for even lower wages than men.

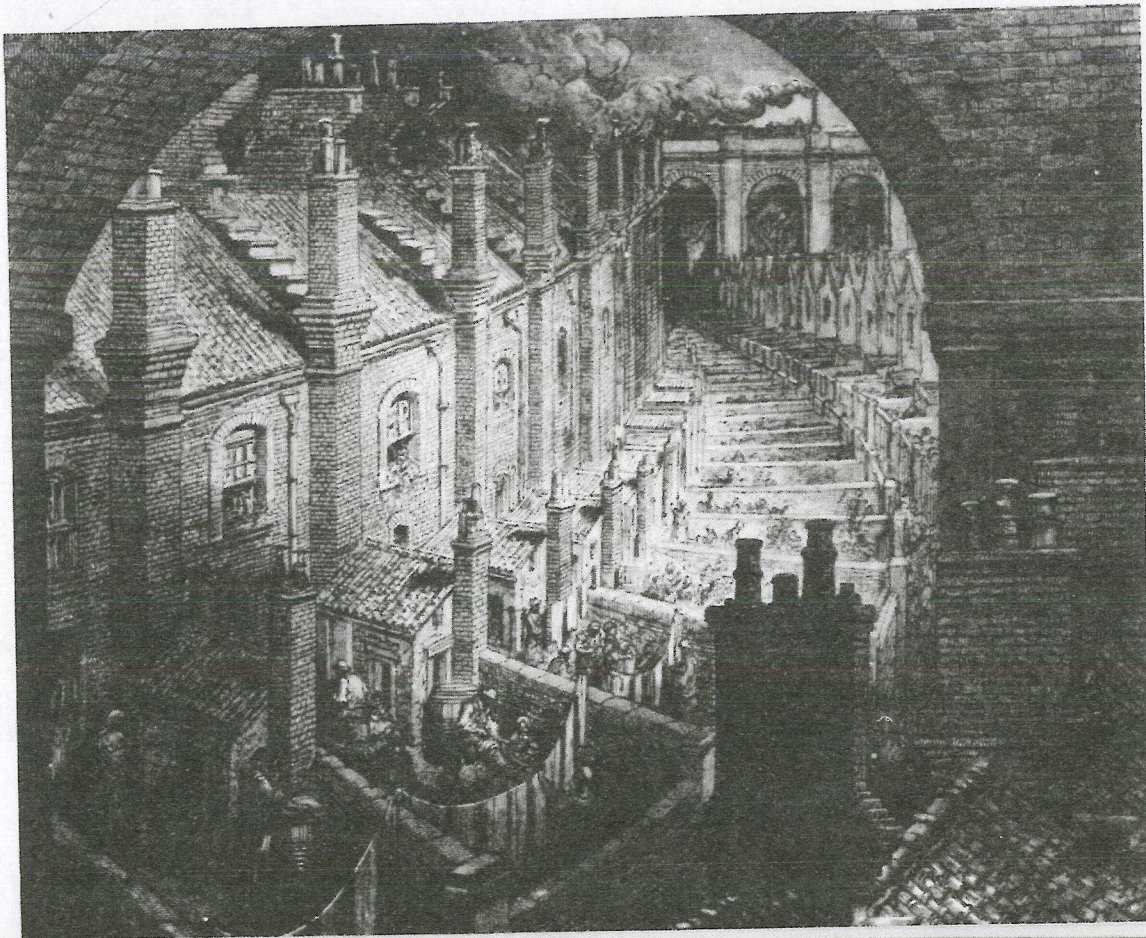
Work days lasted from 12 to 16 hours, or from sunrise to sunset. Men, women, and children worked six days a week. There were no paid holidays, vacations, or sick leaves. Factories were often unhealthy, dangerous places to work. Fumes from machines combined with poor ventilation made the air foul. The loud, monotonous noise of machines assaulted the ear. Lighting was poor, and machines were not equipped with safety devices, so accidents occurred frequently. A worker injured on the job received no compensation. If an injured worker could no longer do the job, he or she was thrown out of work.

## A New Social Structure

The Industrial Revolution transformed the social structure of Europe. Before industrialization, the wealthy, landowning aristocracy occupied the highest social position. Below the aristocracy was a relatively small middle class, which included merchants, lawyers, and the clergy. Next came skilled workers such as shoemakers, potters, and silversmiths. Finally, the vast majority of the people were small farmers or farm workers.

During the 1800s, the middle class expanded and challenged the landowning aristocracy in wealth and power. The wealthiest and most powerful members of the new middle class were factory and mine owners, bankers, financiers, and merchants. The middle class also included managers and the

*The French artist Gustave Doré made this engraving, called *Over London By Rail*, in 1872. The artist conveys the bleak, overpowering sameness of a London working class neighborhood. In the smoke-filled industrial cities of Europe, most working class families lived in just one room. Crowded conditions, open sewers, polluted rivers, and filthy streets bred crime and disease.*







*The Industrial Revolution forced many women to seek jobs outside the home. Employers often exploited women workers by paying them lower wages than men. In this printing shop, The Victoria Press in London, women work as compositors, setting type for books and newspapers.*

owners of small businesses. They were joined by professional people such as doctors and lawyers. Farther down the scale, artisans and business clerks also entered the ranks of the middle class.

Wealthy members of the middle class tried to adopt the customs of aristocrats. They bought magnificent country estates, which they decorated luxuriously. They took up aristocratic sports such as horseracing and sailing. Other members of the middle class lived comfortably but on a less lavish scale. Most middle class families were very conscious of their social position. They were constantly striving to live what they considered to be polite, respectable lives.

The Industrial Revolution produced a new social class of industrial workers. Largely unskilled, they occupied the lowest rank in society. Industrial workers were very much aware that they belonged to a separate social class. They saw themselves as people with little political or economic power. By mid-century, workers began banding together to change their working and living conditions, as you will read.

### **Changing Roles for Women**

Traditionally, most women had either helped farm the land or worked in the home earning money through the domestic system.

Some women also worked as servants in the homes of the wealthy. The Agricultural Revolution and new farm machinery reduced the need for both men and women on the farms. As the Industrial Revolution got underway, the factory system replaced the domestic system.

To help support their families in the industrial economy, many women went to work in the factories or the mines. Often, the entire family worked in the same place. In mines, for example, men often dug the coal, women dragged coal trucks through low tunnels, and children sorted coal.

Working in a factory added greatly to a woman's responsibilities. She worked outside her home for 12 to 16 hours a day. Yet, she still had to cook, clean, and sew for her family. A woman's role was made even more difficult by the squalid living conditions in the factory towns and cities.

By the late 1800s, however, other developments affected the role of women in industrialized nations. As you will read in the next section, the standard of living and wages of workers began to improve. Thus, it became possible for many working class families to live on the income of only one person. As a result, a new pattern of family life emerged. Husbands tended to be the sole wage earners, and women remained at home.



At the same time, the demand for domestic servants in the cities was growing. Middle class families could afford to hire domestic servants to work as cooks, maids, and nurses for children. Many women, especially single women, left their homes to take these jobs. In Britain in the late 1800s, about one third of all women working outside the home were employed as domestic servants.

Few middle class women worked outside their homes because the social attitudes of the time encouraged women to marry and stay at home to raise their children. During the 1800s, a comfortable home became the ideal of many families as popular songs about "Home, sweet home" and mottoes

such as "East, west, home's best" demonstrate.

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### SECTION REVIEW

1. Give two reasons why the population of Europe increased in the 1800s.
  2. What problems did factory workers face in industrial cities such as Manchester?
  3. Why were factories often dangerous places in which to work?
  4. How did the makeup of the middle class change during the Industrial Revolution?
  5. Why did women take jobs in factories early in the Industrial Revolution?
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## 4 Responses to the Industrial Revolution

During the early Industrial Revolution, many members of the middle class were indifferent to the suffering of workers. Factory owners, for example, had little sympathy for workers. They had invested their entire capital in risky undertakings, and they wanted to ensure survival of their businesses. As industrialization continued, however, some people began to call for reforms to improve conditions for workers.

### Demands for Change in Britain

Because the Industrial Revolution began in Britain, workers there were the first to feel its effects. They suffered from low wages, dangerous working conditions, and frequent unemployment. They protested against conditions in the new industrial system, sometimes violently.

Between 1811 and 1816, workers in many parts of Britain smashed the machines that they considered the cause of their suffering. In 1819, a demonstration in Manchester was attended by about 80,000 workers who demanded economic and political reforms. Nervous soldiers fired on the orderly crowd, killing 11 men and women and wounding about 400. Initially, the British Parliament had little sympathy for the work-

ers, and it applauded the actions of the soldiers. However, worker discontent continued to erupt in violence both in Britain and on the continent.\*

**Parliament investigates.** Eventually, in 1831, Parliament began a series of investigations of factory and mine conditions. Middle class liberals opposed reforms that would regulate working conditions. They believed the government should not interfere in business. However, conservatives sometimes attacked the conditions in factories and mines. As aristocratic landowners, they despised the way industrialization was changing life. The findings of investigators confirmed workers' complaints and shocked many middle class people.

One cotton mill worker told investigators that the workday of his entire family lasted "from six in the morning till half-past eight at night." His children were worn out at the end of the long day. He and his wife "cried often when we have given them the little food we had to give them; we had to shake them, [or] they would have fallen asleep with the food in their mouths many a time."

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\* As you read in Chapter 3, workers in Paris helped overthrow the French monarchy in the revolutions of 1830 and 1848.