

>> Industrial cities and towns grew up around factories like this one. Factories provided resources, goods, and jobs.  
**Explain** Based on this image, how do you think life changed because of industrialization?

**Interactive Flipped Video**

**4.1** For thousands of years following the rise of civilization, most people lived and worked in small farming villages. Then a chain of events set in motion in the mid-1700s changed that way of life. Today, we call this period of economic change the Industrial Revolution. Production shifted from simple hand tools to complex machines, and sources of energy shifted from human and animal power to steam and, later, electricity.

### >> Objectives

**Describe** how changes in agriculture helped spark the Industrial Revolution.

**Analyze** why the Industrial Revolution began in Britain.

**Explain** the role of steam technology and textile manufacturing in the Industrial Revolution.

**Describe** how the factory system and transportation revolution advanced industry.

**Trace** how the Industrial Revolution spread.

### >> Key Terms

- Industrial Revolution
- anesthetic
- enclosure
- James Watt
- smelt
- capital
- enterprise
- entrepreneur
- putting-out system
- Eli Whitney
- turnpike
- Liverpool
- Manchester

# The Industrial Revolution Begins

## New Ways of Working Change Life

Like the Enlightenment, which occurred around the same time, the Industrial Revolution was partly an outgrowth of the Scientific Revolution of the 1600s and 1700s. The Scientific Revolution focused attention on the physical world, and thinkers used the scientific method to conduct controlled experiments. This scientific approach helped inventors to devise new technologies to improve life. These technologies would change the way work was done.

In contrast with most political revolutions, the Industrial Revolution was neither sudden nor swift. It was a long, slow, uneven process. Yet it affected people's lives as much as previous political changes and revolutions had. From its beginnings in Britain, it spread to the rest of Europe, to North America, and around the globe.

**A Rural Way of Life** In 1750, most people worked the land, using handmade tools. They lived in simple cottages lit by firelight and candles. They made their own clothing and grew their own food. In nearby towns, they might exchange goods at a weekly outdoor market.

Like their ancestors, these people knew little of the world that existed beyond their village. The few who left home traveled only as far as their feet or a horse-drawn cart could take them. Those bold adventurers who dared to cross the seas were at the mercy of the winds and tides.

**Growing Cities** With the onset of the Industrial Revolution, the rural way of life began to disappear. By the 1850s, many country villages had grown into industrial towns and cities. Those who lived there were able to buy clothing and food that someone else produced.

**Industrialization Brings Great Change** Unlike earlier times, industrial-age travelers were able to move rapidly between countries and continents by train or steamship. Urgent messages flew along telegraph wires. New inventions and scientific “firsts” poured forth each year.

Between 1830 and 1855, for example, an American dentist first used an **anesthetic**, or drug that prevents pain during surgery; an American inventor patented the first sewing machine; a French physicist measured the speed of light; and a Hungarian doctor introduced antiseptic methods to reduce the risk of women’s dying in childbirth. By the early 1900s, our familiar world of skyscraper cities and carefully planned suburbs had begun to emerge.

How and why did these great changes occur? Historians point to a series of interrelated causes that helped trigger the industrialization of the West. The “West” referred originally to the industrialized countries of western Europe and North America, but today includes many more.

**? IDENTIFY MAIN IDEAS** How did the Industrial Revolution lead to social and economic changes in Europe?

## A New Agricultural Revolution

Oddly enough, the Industrial Revolution was made possible in part by a change in the farming fields of western Europe. The first agricultural revolution took place some 11,000 years ago, when people learned to farm and domesticate animals. Then, about 300 years ago, a second agricultural revolution took place that greatly improved the quality and quantity of farm products.

**Farmers Reclaim Land and Renew Soil** The Dutch led the way in this new agricultural revolution. They built earthen walls known as dikes to reclaim land from the sea. They also combined smaller fields into larger ones to make better use of the land, and they used fertilizer from livestock to renew the soil.

In the 1700s, British farmers expanded on Dutch agricultural experiments. Educated farmers exchanged news of experiments through farm journals. Some farmers mixed different kinds of soils to get higher crop yields. Others tried out new methods of crop rotation.

Lord Charles Townshend urged farmers to grow turnips, which restored exhausted soil. Jethro Tull invented a new mechanical device, the seed drill, to aid farmers. It deposited seeds in rows to maximize land use rather than scattering them over land, a practice that wasted seeds by spacing plants irregularly.

**Wealthy Landowners Enclose Lands** Meanwhile, wealthy landowners pushed ahead with a practice called **enclosure**. Enclosure is the process of taking over and consolidating, or combining, lands formerly shared by peasant farmers. In the 1500s, landowners had enclosed land to gain more pastures for sheep in order to increase wool output. By the 1700s, they wanted to create larger fields that could be cultivated



>> An American dentist demonstrates the use of ether as a surgical anesthetic in 1846.

more efficiently. The British Parliament passed laws that made it easier for landowners to enclose lands.

As millions of acres were enclosed, farm output rose. Profits also rose because consolidated fields needed fewer workers. However, such progress had a human cost. Many farm laborers were thrown out of work, and small farmers were forced off their land because they could not compete with large landholders. Villages shrank when people left in search of work.

This shift in the labor force became a key factor in industrialization. Jobless farm workers migrated to towns and cities. Many found work in the new factories, tending to the machines of the Industrial Revolution.

### Population Grows Because of Better Farming

Not only did people move to towns and cities, but an overall boom in population also occurred. The improved farming practices of the agricultural revolution contributed to this rapid population growth. Precise population statistics for the 1700s are rare, but those that do exist are striking. Britain's population, for example, soared from about 5 million in 1700 to almost 9 million in 1800.

The population of Europe as a whole shot up from roughly 120 million to about 180 million during the same period. Such growth had never before been seen.

Why did this population increase occur? The population boom was due more to declining death rates than to rising birth rates. The agricultural revolution reduced the risk of famine. Since people ate better, they were healthier. Also, by the late 1800s, better hygiene and sanitation, along with improved medical care, further slowed deaths from disease. During the Industrial Revolution, this growing population tended to buy the machines and bought the goods produced by factories.

**? CHECK UNDERSTANDING** How did an agricultural revolution contribute to population growth?

## Coal, Steam, and the Energy Revolution

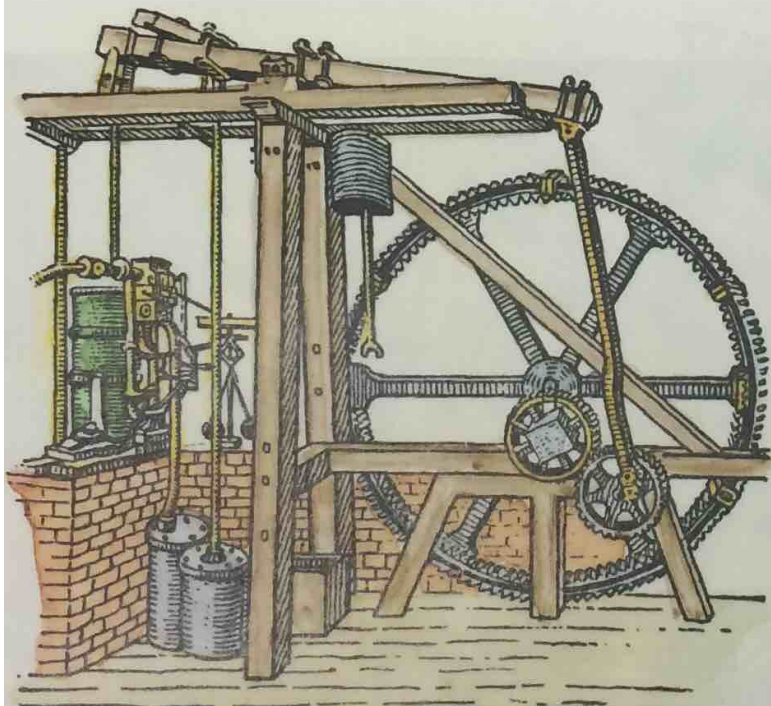
Another major factor that contributed to the Industrial Revolution was an "energy revolution." In the past, the energy for work came mostly from the muscles of humans and animals. In the 1700s, inventive minds found ways to use water power more efficiently and harnessed new sources of energy. Among the most important energy sources was coal, which was used to develop the steam engine.

**James Watt and the Steam Engine** In 1712, inventor Thomas Newcomen developed a steam engine powered by coal to pump water out of mines. Later, in 1764, Scottish engineer **James Watt** looked at Newcomen's invention and set out to make improvements on the engine in order to make it more efficient. Watt's engine would become a vital power source of the Industrial Revolution.

The steam engine was first used to power machines, but later was adapted to power locomotives and steamships.

**Producing Better Iron** Coal was also a vital source of fuel in the production of iron, a material needed for the construction of machines and steam engines. The Darby family of Coalbrookdale, England, pioneered new methods of producing iron. In 1709, Abraham Darby used coal instead of charcoal to **smelt** iron, or separate iron from its ore.

Darby's experiments led him to produce less expensive and better-quality iron, which was used to produce parts for the steam engines. Both his son and grandson continued to improve on his methods. In fact, Abraham Darby III built the world's first iron bridge. In the decades that followed, high-quality iron was used



### WATT'S STEAM-ENGINE

>> Watt's engine used steam and atmospheric pressure to power pistons and rods that moved machinery. It had a separate condenser to keep the water hot, conserving energy.

## Resources and Industry in England, 1750



**Analyze Maps** Notice where various resources and industries were located in 1750. Why is the location of navigable rivers important to resources and industry?

more and more widely, especially after the world turned to building railroads.

**IDENTIFY SUPPORTING DETAILS** What did the Darby family contribute to the Industrial Revolution?

## Why Did the Industrial Revolution Start in Britain?

Historians have fiercely debated why the Industrial Revolution began in Britain in the 1700s. They have identified a number of advantages Britain had. No single one was unique to Britain, but taken together they helped Britain take an early lead. This complex combination included natural resources, labor, capital, and entrepreneurship. Economists call these the four factors of production; that is, the elements necessary to produce goods. In addition to these factors, growing demand for goods and new technology provided the essential building blocks for Britain's leap forward.

**Natural Resources and Geography** During the 1700s, Britain began to take greater advantage of its abundant natural resources. Although Britain was a relatively small nation, it had large supplies of coal to

power steam engines. Britain also had plentiful iron, which was used to build machines.

Britain's geography also provided an advantage. As an island nation with many ports, Britain had long benefited from trade. Its ships brought raw materials from its overseas empire and exported finished goods. Britain also had streams and rivers that could be harnessed to provide water power. Many rivers were later developed with canals and then used to transport goods to internal markets.

**Labor and Capital** A large number of workers were needed to mine the coal and iron, build the factories, and run the machines. The agricultural revolution of the 1600s and 1700s freed many men and women from farm labor. The population boom that resulted from changes in agriculture further swelled the available work force. The growing population also increased the demand for goods, which industry supplied.

To develop mining and other industries, capital was needed. **Capital** is money used to invest in enterprises. An **enterprise** is a business organization in an area such as shipping, mining, railroads, or factories. Many businesspeople were ready to risk their profits in new ventures. The capital that helped Britain industrialize came from landowners, banks, and merchants who profited from overseas trade, including the slave trade.

**Entrepreneurs and Inventors** Britain also had plenty of skilled mechanics. They developed practical new inventions and partnered with entrepreneurs to profit from them. An **entrepreneur** is someone who manages and assumes the financial risks of starting new businesses.

Technology was important to the Industrial Revolution, but did not cause it. Only when other necessary conditions existed, including demand and capital, did technology pave the way for industrialization.

**A Favorable Climate for Business** In addition to the advantages already cited, Britain had a stable government that supported economic growth. Other countries in Europe imposed heavy river tolls and other barriers to growth. Britain had far fewer blocks to the movement of goods. The government built a strong navy that protected its empire, including shipping and overseas trade.

Social attitudes adjusted to changing economic conditions. Although members of the upper class looked down on business and business people, they did not reject the great wealth produced by the new entrepreneurs. Religious groups encouraged thrift

and hard work. These goals led inventors, bankers, and other risk-takers to devote their energies to new enterprises.

**? CHECK UNDERSTANDING** What conditions in Britain paved the way for the Industrial Revolution?

## Textile Industry Initiates Industrialization

The Industrial Revolution first took hold in Britain's largest industry—textiles. In the 1600s, cotton cloth imported from India had become popular. British merchants tried to organize a cotton cloth industry at home. They developed the **putting-out system**, also known as the cottage industry, in which raw cotton was distributed to peasant families who spun it into thread and then wove the thread into cloth in their own homes. Skilled artisans in the towns then finished and dyed the cloth.

**Technology Speeds Production** Under the putting-out system, production was slow. The process of using manually operated machines for spinning and weaving took time. As the demand for cloth grew, inventors came up with a series of remarkable devices that revolutionized the British textile industry. For example, John Kay's flying shuttle enabled weavers to work so fast that they soon outpaced spinners. James Hargreaves solved that problem by producing the spinning jenny in 1764, which spun many threads at the same time. Five years later, Richard Arkwright patented the water frame, a spinning machine that could be powered by water.

Meanwhile, in America, these faster spinning and weaving machines presented a challenge—how to produce enough cotton to keep up with England. Raw cotton grown in the South had to be cleaned of dirt and seeds by hand, which is a time-consuming task. To solve this, **Eli Whitney** invented a machine called the cotton gin that separated the seeds from the raw cotton at a fast rate. He finished the cotton gin in 1793, and cotton production increased at a rapid rate.

**The First Factories** The new machines doomed the putting-out system. They were too large and expensive to be operated at home. Instead, manufacturers built long sheds to house the machines. At first, they located the sheds near rapidly moving streams, harnessing the water power to run the machines. Later, machines were powered by steam engines.

Spinners and weavers now came each day to work in these first factories, which brought together workers



>> Generations of women made textiles at home as part of the putting-out system. These women are making lace. **Make Predictions** What impact do you think machines and industrialization will have on the putting-out system?

and machines to produce large quantities of goods. Early observers were awed at the size and output of these establishments. One onlooker noted: "The same [amount] of labor is now performed in one of these structures which formerly occupied the industry of an entire district."

**? IDENTIFY CAUSE AND EFFECT** What technology brought about advances in the British textile industry?

## A Revolution in Transportation

As production increased, entrepreneurs needed faster and cheaper methods of moving goods from place to place. Some capitalists invested in **turnpikes**, private roads built by entrepreneurs who charged travelers a toll, or fee, to use them. Goods traveled faster as a result, and turnpikes soon linked every part of Britain. Other entrepreneurs had canals dug to connect rivers together or to connect inland towns with coastal ports. Engineers also built stronger bridges and upgraded harbors to help the expanding overseas trade.


**Canals Improve Transportation** During the late 1700s and early 1800s, British factories needed an efficient, inexpensive way to receive coal and raw materials and then to ship finished goods to market. In 1763, when the Bridgewater Canal opened, it not only made a profit from tolls, but it shortened the trip enough to cut in half the price of coal in Manchester.

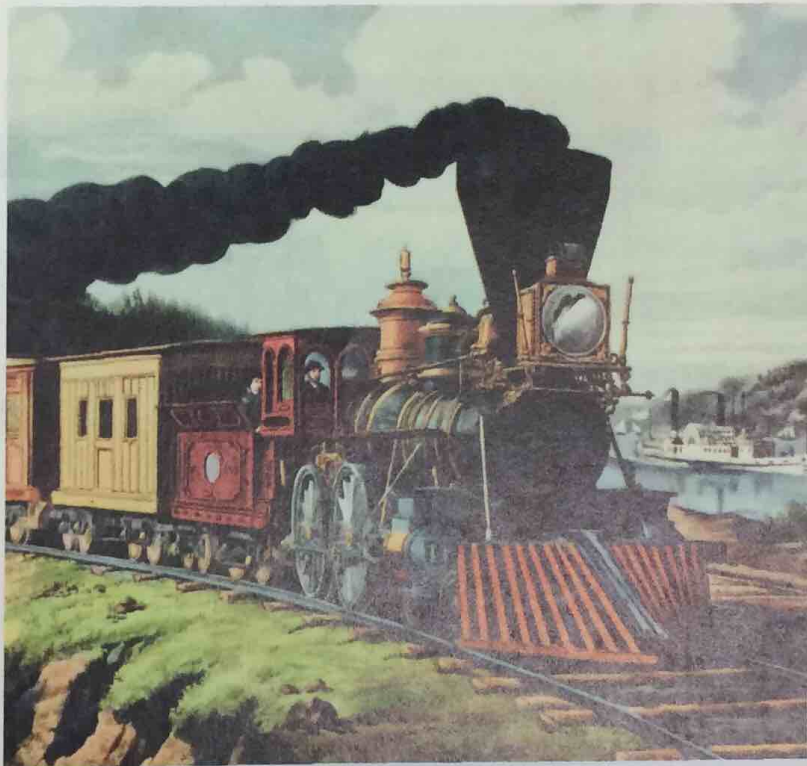
The success of this canal set off a canal-building frenzy. Entrepreneurs formed companies to construct canals for profit. Not all the canals that were built had enough traffic to support them, however, and bankruptcy often resulted. Then, beginning in the 1830s, canals lost their importance as steam locomotives made railroads the new preferred form of transportation.

**The Steam Locomotive Drives Railroads** It was the invention of the steam locomotive that made the growth of railroads possible. In the early 1800s, pioneers like George Stephenson developed steam-powered locomotives to pull carriages along iron rails. The railroad did not have to follow the course of a river. This meant that tracks could go places where rivers did not, allowing factory owners and merchants to ship goods swiftly and cheaply over land. The world's first major rail line, from **Liverpool to Manchester**, opened in England in 1830.



>> Workers and machines filled the early factories of the Industrial Revolution. Machines dramatically increased the quantity of goods that could be produced.

 **Interactive Gallery**



>> Steam locomotives made travel faster than ever before. The locomotives burned coal to produce steam and traveled overland routes on iron rails.

 **Interactive Map**

In the following decades, railroad travel became faster and railroad building boomed. By 1870, rail lines crisscrossed Britain, Europe, and North America.

**Cheaper Goods Lead to More Demand** As the Industrial Revolution got under way, it triggered a chain reaction. Once inventors developed machines that could produce large quantities of goods more efficiently, prices fell. Lower prices made goods more affordable and thus attracted more consumers. Additional consumers then further fed the demand for goods. This new cycle caused a wave of economic and social changes that dramatically affected the way people lived.

**? DRAW CONCLUSIONS** How did the development of railroads advance the Industrial Revolution?

## Industrialization Spreads

The start of industrialization had largely been forged from iron, powered by steam engines, and driven by the British textile industry. By the mid-1800s, the Industrial Revolution entered a second phase. By then, it had spread outside Britain. New industrial powers emerged. Factories powered by electricity

used innovative processes to turn out new products. Changes in business organization contributed to the rise of giant companies. As the twentieth century dawned, this second Industrial Revolution transformed the economies of the Western world.

**Other Nations Industrialize** During the early Industrial Revolution, Britain stood alone as the world's industrial giant. To protect its head start, Britain tried to enforce strict rules against exporting inventions.

For a while, the rules worked. Then, in 1807, British mechanic William Cockerill opened factories in Belgium to manufacture spinning and weaving machines. Belgium became the first European nation after Britain to industrialize. By the mid-1800s, other nations had joined the race, and several newcomers were challenging Britain's industrial supremacy.

How were other nations able to catch up with Britain so quickly? First, nations such as Germany, France, and the United States had more abundant supplies of coal, iron, and other resources than Britain did. Also, they had the advantage of being able to follow Britain's lead. Like Belgium, latecomers often borrowed British experts or technology. The first American textile factory was built in Pawtucket, Rhode Island, with plans smuggled out of Britain. American inventor Robert Fulton powered his steamboat with one of James Watt's steam engines.

Centers of Industry, 1871



**>> Analyze Maps** By 1871, industrialization had spread through Europe and across the Atlantic to America. Which major industrial cities were probably shipping centers as well? Identify two nations that were at a disadvantage for industrialization.

Two countries in particular—Germany and the United States—thrust their way to industrial leadership. Germany united into a powerful nation in 1871. Within a few decades, it became Europe's leading industrial power. Across the Atlantic, the United States advanced even more rapidly, especially after the Civil War.

With a large labor force, plenty of resources, and entrepreneurs who had capital, by 1900 the United States was manufacturing about 30 percent of the world's industrial goods. It had surpassed Britain as the leading industrial nation.

**Industry Spreads Unevenly** Other nations industrialized more slowly, particularly those in eastern and southern Europe. These nations often lacked natural resources or the capital to invest in industry. Although Russia did have resources, social and political conditions slowed its economic development. Only in the late 1800s, more than 100 years after Britain, did Russia move toward industrialization.

In East Asia, however, Japan offered a remarkable success story. Although Japan lacked many basic resources, it industrialized rapidly after 1868 because of a political revolution that made modernization a priority. Canada, Australia, and New Zealand also built thriving industries during this time.

**Social, Economic, and Political Changes** Like Britain, the new industrial nations underwent social changes, such as rapid urbanization. Early in the history of industrialization, men, women, and children worked long hours in difficult and dangerous conditions. By 1900, however, these conditions had begun to improve in many industrialized nations.

The factory system produced huge quantities of new goods at lower prices than ever before. In time, ordinary workers were buying goods that in earlier days only the wealthy could afford. The demand for goods created jobs, as did the building of cities, railroads, and factories. Politics changed, too, as leaders had to meet the demands of an industrial society.

Globally, industrial nations competed fiercely, altering patterns of world trade. Because of their technological and economic advantage, the Western powers came to dominate the world more than ever before.

**2 ANALYZE INFORMATION** What factors allowed other nations to industrialize after Britain?



>> A street scene in Chicago, Illinois, from the early 1900s shows how the urban landscape was altered by industrialization. **Compare and Contrast** How is the scene similar to and different from a typical city street today?

## ASSESSMENT

1. **Identify Patterns** What would you identify as the important changes in human life caused by the Industrial Revolution?
2. **Identify Cause and Effect** How did technological advances in agriculture affect the Industrial Revolution?
3. **Generate Explanations** Why was a supply of coal crucial to the Industrial Revolution?
4. **Synthesize** How did the four factors of production determine which nations were able to industrialize after Britain? Cite specific examples from the text.
5. **Cite Evidence** How did industrialization enable Western powers to dominate world affairs?