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The Beginnings of Industrialization

TERMS & NAMES

- Industrial Revolution
- enclosure
- crop rotation
- industrialization
- factors of production
- factory
- entrepreneur

MAIN IDEA

The Industrial Revolution started in England and soon spread elsewhere.

WHY IT MATTERS NOW

The changes that began in Britain paved the way for modern industrial societies.

SETTING THE STAGE In the United States, France, and Latin America, political revolutions brought in new governments. A different type of revolution now transformed the way people did work. The **Industrial Revolution** refers to the greatly increased output of machine-made goods that began in England during the 18th century. Before the Industrial Revolution, people wove textiles by hand. Beginning in the middle 1700s, machines did this and other jobs as well. The Industrial Revolution started in England and soon spread to Continental Europe and North America.

The Industrial Revolution Begins

By 1700, small farms covered England's landscape. Wealthy landowners, however, bought up much of the land that village farmers had once worked. Beginning in the early 1700s, large landowners dramatically improved farming methods. These agricultural changes amounted to an agricultural revolution. They eventually paved the way for the Industrial Revolution.

The Agricultural Revolution After buying up the land of village farmers, wealthy landowners enclosed their land with fences or hedges. The increase in their landholdings enabled them to cultivate larger fields, using new seeding and harvesting methods. Within these larger fields, called **enclosures**, landowners experimented to discover more productive farming methods to boost crop yields. The enclosure movement had two important results. First, landowners experimented with new agricultural methods. Second, large landowners forced small farmers to become tenant farmers or to give up farming and move to the cities.

Jethro Tull was one of the first of these scientific farmers. He saw that the usual way of sowing seed by scattering it across the ground was wasteful. Many of the seeds failed to take root. He solved this problem with an invention called the seed drill in about 1701. The seed drill allowed farmers to sow seeds in well-spaced rows at specific depths. A larger share of the seed germinated, boosting crop yields.

Crop Rotation The process of **crop rotation** proved to be one of the best developments of the scientific farmers. The process improved upon older methods of crop rotation, such as the medieval three-field system. One year, for example, a farmer might plant a field with wheat, which exhausted soil nutrients. The next year he planted a root crop, such as turnips, to restore nutrients. This might be followed in turn by barley, then clover.

Livestock breeders improved their methods, too. In the 1700s, for example, Robert Bakewell increased his mutton output by allowing only his best sheep to breed. Other farmers followed Bakewell's lead. Between 1700 and 1786 the average weight for lambs climbed from 18 to 50 pounds.

THINK THROUGH HISTORY

A. Recognizing

Effects What were some of the effects of enclosure and crop rotation?

Unresolved Problems

Feeding a Growing Population

Charles Townsend was a landowner in England. He encouraged the use of a four-crop rotation system using turnips, grain, and clover. These crops were used to feed humans and animals. The technique was so successful that Townsend gained the nickname "Turnip."

Changes in farming practices resulted in more and cheaper food. For example, in 1700 each English farmer produced enough food for 1.7 people. By 1800 that farmer could produce enough food for 2.5 people.

See Epilogue, p. 595.



These improvements in farming that began in the early 1700s made up an agricultural revolution. As food supplies increased and living conditions improved, England's population mushroomed. An increasing population boosted the demand for food and goods. As farmers lost their land to large enclosed farms, many became factory workers.

Britain's Advantages Why did the Industrial Revolution begin in England? In addition to a large population of workers, the small island country had extensive natural resources. And **industrialization**—the process of developing machine production of goods—required such resources. These natural resources included 1) water power and coal to fuel the new machines; 2) iron ore to construct machines, tools, and buildings; 3) rivers for inland transportation; 4) harbors from which its merchant ships set sail.

Economic Strength and Political Stability In addition to its natural resources, Britain had an expanding economy to support industrialization. Businesspeople invested in the manufacture of new inventions. Britain's highly developed banking system also contributed to the country's industrialization. People were encouraged by the availability of bank loans to invest in new machinery and expand their operations. Growing overseas trade, economic prosperity, and a climate of progress contributed to the increased demand for goods.

Britain's political stability gave the country a tremendous advantage over its neighbors. Though Britain took part in many wars during the 1700s, none of these struggles occurred on British soil. Furthermore, their military and political successes gave the British a positive attitude. Parliament also passed laws that protected business and helped expansion. Other countries had some of these advantages. However, Britain had all the **factors of production**. These were the resources needed to produce goods and services that the Industrial Revolution required. They included land, labor, and capital (or wealth).

THINK THROUGH HISTORY

B. Recognizing Effects How did population growth spur the Industrial Revolution?

THINK THROUGH HISTORY

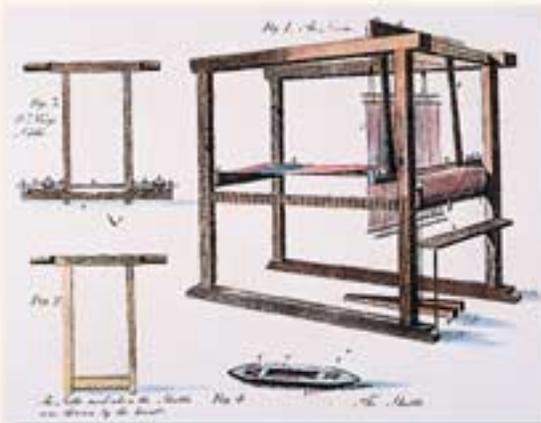
C. Making Inferences How might Britain's advantages and early industrialization have affected its prosperity in the 19th century?

Global Impact: Revolutions in Technology

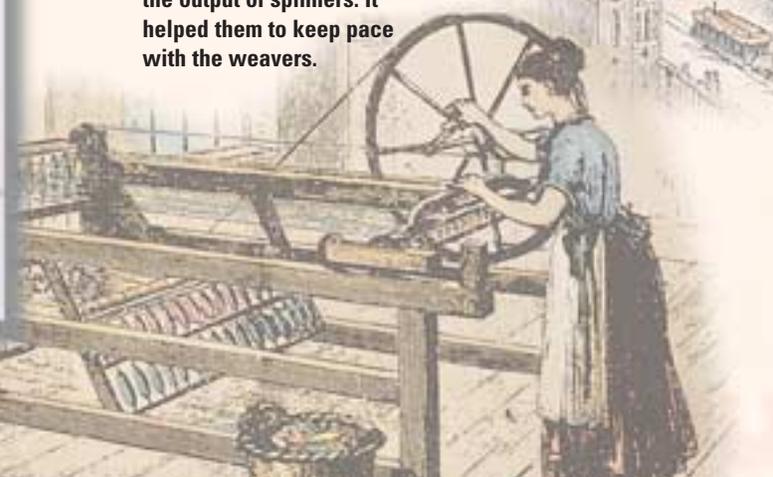
Technology in the Textile Industry

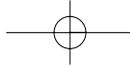
The Industrial Revolution that began in Britain was spurred by a revolution in technology. This is most obvious in the textile industry where inventions in the late 1700s transformed the manufacture of cloth. These developments, in turn, had an impact on the rest of the world. For example, England's cotton came from plantations in the American South, where cotton production skyrocketed from 1790 to 1810 in response to demand from the textile mills of England.

John Kay's flying shuttle speedily carried threads of yarn back and forth when the weaver pulled a handle. The flying shuttle greatly increased the productivity of weavers.



James Hargreaves's spinning jenny dramatically increased the output of spinners. It helped them to keep pace with the weavers.





Inventions Spur Technological Advances

In an explosion of creativity, inventions now revolutionized industry. Britain's textile industry clothed the world in wool, linen, and cotton. This industry was the first to be transformed. Cloth merchants boosted their profits by speeding up the process by which spinners and weavers made cloth.

Major Inventions in the Textile Industry By 1800, several major inventions had modernized the cotton industry. One invention led to another. In 1733, a machinist named John Kay made a shuttle that sped back and forth on wheels. This flying shuttle, a boat-shaped piece of wood to which yarn was attached, doubled the work a weaver could do in a day.

Because spinners could not keep up with these speedy weavers, a cash prize attracted contestants to produce a better spinning machine. Around 1764, a textile worker named James Hargreaves invented a spinning wheel he named after his daughter. Hargreaves's spinning jenny allowed one spinner to work eight threads at a time.

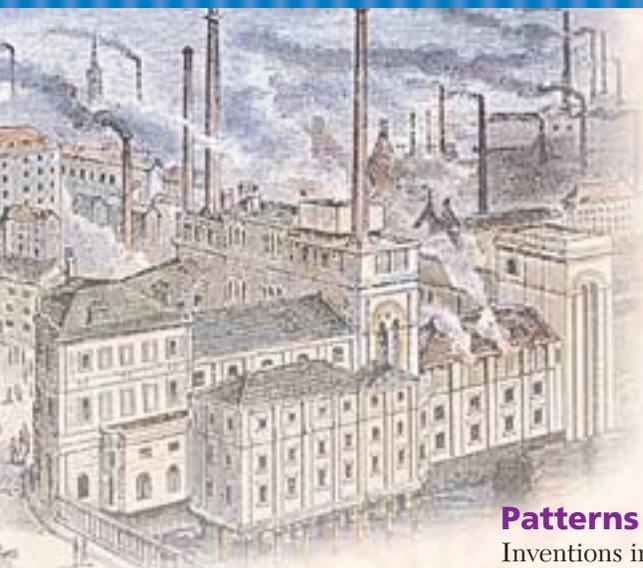
At first, textile workers operated the flying shuttle and the spinning jenny by hand. Richard Arkwright invented the water frame in 1769. The machine used the water-power from rapid streams to drive spinning wheels.

In 1779, Samuel Crompton combined features of the spinning jenny and the water frame to produce the spinning mule. The spinning mule made thread that was stronger, finer, and more consistent than earlier spinning machines. Run by water-power, Edmund Cartwright's power loom sped up weaving after its invention in 1787.

The water frame, the spinning mule, and the power loom were bulky and expensive machines. They took the work of spinning and weaving out of the house. Wealthy textile merchants set up the machines in large buildings called **factories**. At first,

Background

The spinning mule was so named because, just as a mule is the offspring of a horse and donkey, this machine was the offspring of two inventions.



The first factories were built to house spinning and weaving machines in the textile industry and to keep the processes secret. Such factories were built close to rivers and streams, which provided a source of energy.

All work, even cotton spinning, is noble; work is alone noble.

—Scottish writer Thomas Carlyle in 1843

Patterns of Interaction

Inventions in the textile industry started in Britain and brought about the Industrial Revolution. This revolution soon spread to other countries in Europe and the United States. The process of industrialization is still spreading around the world, especially in Third World countries. A similar technological revolution is occurring in today's world of electronics. The telephone, television, and (more recently) the computer and the Internet are transforming the spread of information around the world.



VIDEO *Technology Transforms An Age: The Industrial and Electronic Revolutions*

Connect to History

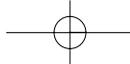
Synthesizing Technological innovation and industrialization took place in the textile industry during the Industrial Revolution. How might these forces have provided a model for other industries?



SEE SKILLBUILDER HANDBOOK, PAGE R18

Connect to Today

Hypothesizing How might the textile industry be affected by new technology, including the computer?



the new factories needed waterpower, so they were built near sources of water such as rivers and streams:

A VOICE FROM THE PAST

. . . A great number of streams . . . furnish water-power adequate to turn many hundred mills: they afford the element of water, indispensable for scouring, bleaching, printing, dyeing, and other processes of manufacture: and when collected in their larger channels, or employed to feed canals, they supply a superior inland navigation, so important for the transit of raw materials and merchandise.

EDWARD BAINS, *The History of Cotton Manufacture in Great Britain* (1835)

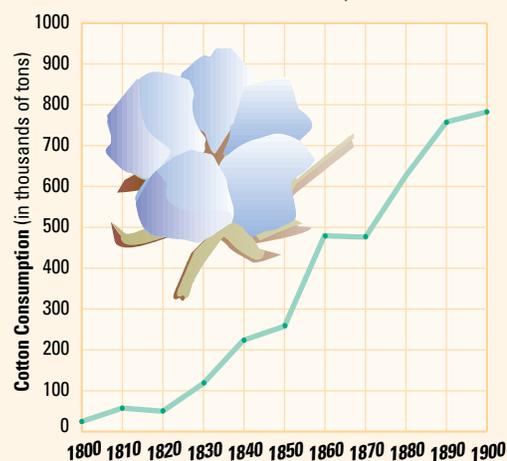
THINK THROUGH HISTORY

D. Summarizing

What were the major inventions in the textile industry?

British Cotton Consumption

New inventions led to a big increase in the production and consumption of textiles, including cotton. The consumption of cotton rose dramatically in Britain during the 1800s. The following chart shows the increase in cotton consumption as measured in thousands of metric tons for each decade of the century.



Source: *Historical Statistics of the United States*

SKILLBUILDER: Interpreting Graphs

1. In what decade did the steepest increase in cotton consumption in Britain take place?
2. In what two decades did the consumption of cotton level off or slightly decrease?

England's cotton came from plantations in the American South in the 1790s. Removing seeds from the raw cotton by hand was hard work. In 1793, an American inventor named Eli Whitney invented a machine to speed the chore. His cotton gin multiplied the amount of cotton that could be cleaned. American cotton production skyrocketed from 1.5 million pounds in 1790 to 85 million pounds in 1810.

Improvements in Transportation Progress in the textile industry spurred other industrial improvements. The first such development, the steam engine, stemmed from the search for a cheap, convenient source of power. The earliest steam engine was used in mining as early as 1705. But this early model gobbled great quantities of fuel, making it expensive to run.

James Watt, a mathematical instrument maker at the University of Glasgow in Scotland, thought about the problem for two years. In 1765, Watt figured out a way to make the steam engine work faster and more efficiently while burning less fuel. In 1774, Watt joined with a businessman named Matthew Boulton. This **entrepreneur** (AHN·truh·pruh·NUR)—a person who organizes, manages, and takes on the risks of a business—paid Watt a salary and encouraged him to build better engines.

Water Transportation Steam could also be used to propel boats. An American inventor named Robert Fulton ordered a steam engine from Boulton and Watt. After its first successful trip in 1807, Fulton's steamboat,

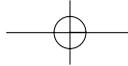
the *Clermont*, ferried passengers up and down New York's Hudson River.

In England, water transportation improved with the creation of a network of canals, or human-made waterways. By the mid-1800s, 4,250 miles of inland channels slashed the cost of transporting raw materials.

Road Transportation British roads improved, too, thanks largely to the efforts of John McAdam, a Scottish engineer. Working in the early 1800s, McAdam equipped roadbeds with a layer of large stones for drainage. On top, he placed a carefully smoothed layer of crushed rock. Even in rainy weather heavy wagons could travel over the new "macadam" roads without sinking in mud.

Private investors formed companies that built roads and then operated them for profit. People called the new roads turnpikes because travelers had to stop at tollgates (turnstiles or turnpikes) to pay a toll before traveling farther.

The Railway Age Begins Steam-driven machinery propelled English factories in the late 1700s. A steam engine on wheels—the railroad locomotive—drove English industry after 1820.

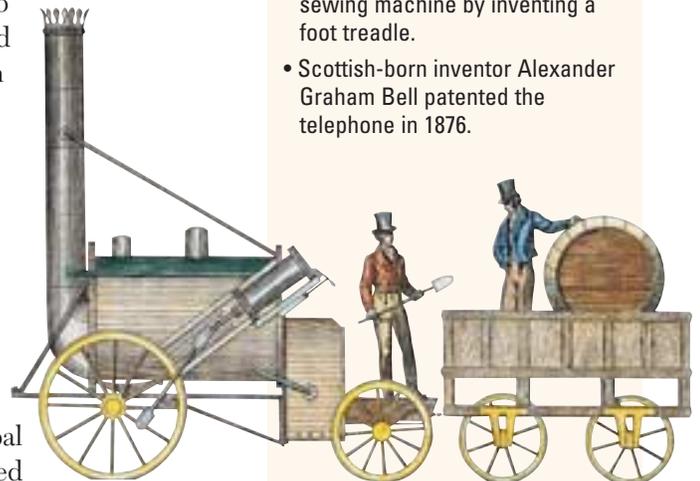


In 1804, an English engineer named Richard Trevithick won a bet of several thousand dollars. He did this by hauling ten tons of iron over nearly ten miles of track in a steam-driven locomotive. Other British engineers soon built improved versions of Trevithick's locomotive. One of these early railroad engineers was George Stephenson. He had gained a solid reputation by building some 20 engines for mine operators in northern England. In 1821, Stephenson began work on the world's first railroad line. It was to run 27 miles from the Yorkshire coalfields to the port of Stockton on the North Sea. In 1825, the railroad opened. It used four locomotives that Stephenson had designed and built.

The Liverpool-Manchester Railroad News of this success quickly spread throughout Britain. The entrepreneurs of northern England wanted a railroad line to connect the port of Liverpool with the inland city of Manchester. The track was laid. In 1829 trials were held to choose the best locomotive for use on the new line. Five engines entered the competition. None could compare with the *Rocket*, designed by Stephenson and his son. Smoke poured from its tall smokestack and its two pistons pumped to and fro as they drove the front wheels. The *Rocket* hauled a 13-ton load at an unheard-of speed—more than 24 miles per hour. The Liverpool-Manchester Railway opened officially in 1830. It was an immediate success.

Railroads Revolutionize Life in Britain

First, railroads spurred industrial growth by giving manufacturers a cheap way to transport materials and finished products. Second, the railroad boom created hundreds of thousands of new jobs for both railroad workers and miners. These miners provided iron for the tracks and coal for the steam engines. Third, the railroads boosted England's agricultural and fishing industries, which could transport their products to distant cities. Finally, by making travel easier, railroads encouraged country people to take distant city jobs. Also, railroads lured city dwellers to resorts in the countryside. Like a locomotive racing across the country, the Industrial Revolution brought rapid and unsettling changes to people's lives.



SPOTLIGHT ON

Inventions in America

Across the Atlantic in the United States, American inventors worked at making railroad travel more comfortable. They invented, for example, adjustable upholstered seats that converted into couches so that everyone could travel first class.

American inventors also revolutionized agriculture, manufacturing, and communications:

- Cyrus McCormick's reaper, invented in 1831, boosted American wheat production.
- In 1837, a New England painter named Samuel F. B. Morse first sent electrical signals over a telegraph.
- In 1851, I. M. Singer improved the sewing machine by inventing a foot treadle.
- Scottish-born inventor Alexander Graham Bell patented the telephone in 1876.

THINK THROUGH HISTORY
E. Synthesizing
 How did improvements in transportation promote industrialization in Britain?

Section 1 Assessment

1. TERMS & NAMES

Identify

- Industrial Revolution
- enclosure
- crop rotation
- industrialization
- factors of production
- factory
- entrepreneur

2. TAKING NOTES

Create a two-column chart like the one below that lists four natural resources needed for industrialization and how each is used.

Natural Resource	Use
1. coal	
2.	
3.	
4.	

3. MAKING INFERENCES

What effect did entrepreneurs have upon the Industrial Revolution?

THINK ABOUT

- new technological developments
- business opportunities
- increase in prosperity

4. THEME ACTIVITY

Science and Technology

Write a letter as a British government official during the Industrial Revolution. Write to a government official in a non-industrial nation about how the railroad has changed Britain.