Origins of the Industrial Revolution

The Main Idea
Conditions in Great Britain led to revolutionary new methods of agriculture and manufacturing.

The Story Continues
A new era of peace after 1815 brought growing prosperity to western Europe. New agricultural methods and improved systems of transportation and communication helped to stimulate progress. One well-known writer noted that "The benefit of... Turn-pikes [toll roads] appears now to be so great, and the People in all Places begin to be so sensible of it, that it is incredible what Effect [turnpike construction] has already had upon Trade in the Countries where it is more completely finish'd..."

The Agricultural Revolution

Before the 1600s most European villagers worked their own plots of land in order to grow food for their families. They also used common public lands for grazing animals such as sheep and cattle. In the 1500s and 1600s common lands in England began to be enclosed, or fenced off, into individual plots. At the same time, smaller landholdings were being combined into more efficient, larger holdings. This enclosure movement continued into the 1700s. It reached its height by the early 1800s in Great Britain, as a growing population increased demand and raised prices for agricultural products. Wealthy landholders benefited from this movement, while many small landowners lost their lands and their traditional livelihood.

The enclosure movement had several effects. As large landowners added to their holdings, former small-plot owners were forced to become tenant farmers or move to the cities. Also, with the common lands vanishing, farmers no longer had to get permission from other villagers to try new farming methods. In the early 1700s, for example, landowner Jethro Tull was concerned about the amount of seed wasted by hand-scattering it over the fields. Tull invented a seed drill that made it possible to plant seeds in straight rows. He also made a horse-drawn hoe to dig up weeds between the rows and break up soil before planting.

Another English landowner, Charles “Turnip” Townshend, copied a successful Dutch practice. English farmers usually left some fields unplanted for a year to let the soil rebuild its nutrients. Townshend found that planting different crops in the fields each year had the same result. For example, he planted wheat or barley one year and root crops such as turnips the next. This system, called crop rotation, helped farmers to produce more crops using the same amount of land.

During this Agricultural Revolution, other improvements increased production and made farm labor easier. Iron plows replaced wooden ones. An American, Jethro Wood, invented a plow with a replaceable blade, which eliminated the need to buy a whole new plow. Some of these improvements were very expensive. Only wealthy farmers could afford them. By the 1800s many farm workers, replaced by machines and forced off the land, were moving to the cities. They formed a huge labor force.

✓ READING CHECK: Identifying Cause and Effect
How did the enclosure movement lead to the development of improved technology in agriculture?
Factors of Production

An era of rapid industrial development known as the **Industrial Revolution** followed the Agricultural Revolution. It began in Great Britain, which had a favorable combination of needed factors—land, capital, and labor. Economists call these the **factors of production**. Land refers to all natural resources. Great Britain had a rich supply of such resources, particularly coal and iron ore. Its many rivers provided waterpower and inland shipping routes, and its many harbors encouraged trade both within and beyond the British Isles. Great Britain also had rich sources of capital, including the tools, machinery, equipment, and inventory used in production. Capital also included money, which those who had grown rich during the 1700s used to invest in new businesses. Great Britain also had a large supply of labor for industry, fueled by the growth in population and migration into cities.

**READING CHECK: Finding the Main Idea** Why did the Industrial Revolution begin in Great Britain?

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**The Industrial Revolution in Great Britain, 1715–1851**

**Interpreting Maps** In most cases, industrial centers in Britain developed around rich coal deposits and navigable rivers. Canal systems helped to link these areas to markets and shipping points.

**Skills Assessment: Physical Systems** What geographical factors may have helped to speed industrial development in the city of Liverpool?
The Textile Industry

In the 1600s men and women in England spun thread and wove cloth by hand in their homes. It was a slow process. England could not meet the growing demand for cloth. As a result, automatic machinery was used to increase production. This was known as mechanization. Author Daniel Defoe, writing in the early 1700s, described an enormous silk-spinning machine that automatically performed in minutes operations that took many workers days to complete by hand.

Drawing Conclusions According to Defoe’s account, what source of power was used to drive the silk-spinning machine that he described?


New inventions. A first step toward mechanization was the invention of a mechanized loom for weaving cloth. A loom is a frame with threads stretched lengthwise from top to bottom. These threads are known as “warp” threads. A worker pushed a shuttle holding another thread—the “weft” thread—over and under the warp threads to weave cloth. In about 1733 British engineer John Kay invented the flying shuttle, which moved the weft-carrying shuttle quickly across the loom. Weavers could now make cloth so fast they outran the supply of thread from the old-fashioned spinning wheels.

In the 1760s British weaver James Hargreaves invented the spinning “jenny.” This machine could produce eight times more thread than a single spinning wheel. Richard Arkwright later invented a way to drive the machine by waterpower. Arkwright brought workers and waterpower together and opened a spinning mill during the 1780s. Workers put in a certain number of hours each day for a fixed pay. This spinning mill was the beginning of the modern factory system.

Improvements in the spinning process followed, but workers still could not meet the demand for cloth. In about 1785 English minister Edmund Cartwright invented a water-powered loom. One person could now weave as much cloth as 200 hand-loom operators. This rapid change in spinning and weaving showed how inventions built on one another. The flying shuttle created a need for more thread, which faster spinning produced. This was followed by improved weaving machines. Each invention created a new need, and human ingenuity filled the gap.

Effects of mechanization. As supply increased, the price of cotton cloth went down. As a result, demand increased and so did the need for more raw cotton. Raw cotton imports by England went from 4 million pounds in 1761 to 100 million pounds in 1815. Most of it came from the southern United States. Cleaning seeds from the cotton fiber was slow, manual work. In 1793 American Eli Whitney invented the cotton gin, a machine that could clean much more cotton in a day than hand laborers could. With Whitney’s invention, the southern United States became the cotton-producing center of the world. As production soared, so did the profits made by using slave labor to plant and pick cotton. Thus, the cotton gin had the unintended side effect of helping to expand slavery in the United States.

✓ READING CHECK: Analyzing Information Why were there so many new inventions in the textile industry in such a short period of time?
Steam Engines, Iron, and Steel

Early machines in the Industrial Revolution were driven by waterpower. Although much better than human, animal, and wind power, waterpower had its drawbacks. A factory had to be located on a stream or river, preferably next to a waterfall or dam. Often this site was not near raw materials, a labor supply, overland transportation, or markets. Water flow also varied from season to season. A more portable and dependable power supply was needed. It was found in steam.

The power of steam had been known since ancient times. Not until about 1712, however, did English engineer Thomas Newcomen harness that power in an engine. The first, crude steam engines were expensive to operate. Scotsman James Watt studied and improved on Newcomen’s machine. In about 1769 he patented the modern steam engine. British engineer Matthew Boulton financed the first factory to manufacture steam engines. Industry quickly adapted the engine to drive the new spinning and weaving machines. Steam replaced water as industry’s major power source.

Iron and steel. More machines meant more iron was needed to make them. From early times, people in Britain had separated iron from its ore using wood or charcoal to fuel the forges. Coal worked even better because it generated more heat. Iron and coal became the two major raw materials of modern industry. Great Britain had plenty of both.

Early steam engines often exploded, however, because iron could not withstand high steam pressure. Steel, an iron alloy, was much stronger, but it was expensive to produce. In the 1850s American William Kelly and Englishman Henry Bessemer, working independently, developed what came to be known as the Bessemer process—a cheaper and more efficient method of making steel. The process injected air into molten pig iron, the material from which steel was produced, in order to remove impurities. The injection of air also increased the temperature at which the conversion of pig iron into steel took place. This prevented the molten metal from solidifying during production.

**READING CHECK:** **Identifying Cause and Effect** How did developments in the textile industry result in inventions in steelmaking?

Other Industrialization

British manufacturers applied new technology to other industries. Production of shoes, clothing, ammunition, and furniture was mechanized. Machines were used for printing, papermaking, lumber and food processing, and making other machines. Some new processes had important by-products. Gases released from coal were burned to give light. In the 1810s London was one of the first cities to burn gas in street lamps. By the 1850s gaslight was common in city streets.

American Charles Goodyear discovered how to make rubber less sticky. This **vulcanization** process is the basis of the modern rubber industry. The oil industry began around the mid-1800s, when people began using crude oil to make paraffin for candles, lubricating oil for machinery, and kerosene for lighting and heating.

**READING CHECK:** **Drawing Conclusions** What were several ways in which industrialization spread?
Transportation

Transportation had changed little between the Middle Ages and the beginning of the Industrial Revolution. Stage-coaches, packhorses, and heavy, clumsy horse-drawn wagons were common. As industrial production increased, factories needed more raw materials and finished goods had to reach markets quickly. Improvements such as stonetopped roadways were built. Canals were dug to link rivers. The newer canals had locks to regulate the level of water.

Watt’s steam engine was used to speed transportation, both on land and water. In about 1814 English engineer George Stephenson perfected a steam locomotive that ran on rails. About 15 years later, a locomotive pulled a line of railway cars from Liverpool to Manchester. Railways soon were being built all over the world.

American engineer Robert Fulton was the first to build a profitable steamboat. In 1808 his boat, the Clermont, began regular trips on the Hudson River between New York City and Albany. Soon steamboats appeared on rivers and lakes all over the world. In the 1830s a steam-powered ship crossed the Atlantic Ocean. The voyage took about 17 days, less than half the time of a sailing ship. Soon Samuel Cunard of Great Britain was providing regular steamboat service across the Atlantic. Ships built of iron and steel now moved goods all over the world quickly and cheaply.

✓ READING CHECK: Making Generalizations What invention stimulated the rapid improvement of transportation around the world?

The Communications Revolution

Early inventions such as the steam engine were mainly the work of amateur engineers. In communications technology, however, scientific research played a more important role.

Prior to the 1800s people may have known that electricity and magnetism were related, but they had not found a practical use for this knowledge. Then in about 1800 Italian scientist Alessandro Volta built the first battery, providing a steady flow of electric current for the first time. In the 1820s André Ampère of France worked out principles governing the magnetic effect of electricity. American Samuel Morse put this work to practical use. Morse sent an electric current through a wire, causing a machine at the other end to click. By about 1838 Morse had worked out a system of dots and dashes—the Morse code—by which these clicks could be translated into letters of the alphabet. By 1844 Morse’s invention, the telegraph, had become a practical communications device. Telegraph wires soon stretched across continents and oceans, spreading ideas at the speed of electricity.

✓ READING CHECK: Contrasting What was a major difference between new inventions in textiles and transportation and new inventions in communication?
Effects of Industrialization on Lancashire

Industrialization in Great Britain had many effects. The economic and social life of some regions of the country were forever changed by new technologies and industries. Lancashire County in northwest England experienced some of the greatest change. Anchored by the manufacturing towns of Manchester and Liverpool, Lancashire became a major industrial center.

Identifying the causes of historical events and determining their effects helps us understand history. Historical events usually have several causes. Underlying causes are long term. Immediate causes lead directly to the event. Cause-and-effect relationships can be shown in many different kinds of diagrams including concept maps, sequences, and webs.

Skills Reminder

To determine cause and effect, identify the focus of your study—for example, the outcome of an election. This is the effect in question. Then determine the underlying, or most basic, causes. For example, how satisfied were voters with the present office holder? Next, identify the immediate causes—those occurring near at hand. For example, did the weather affect who voted? Form a conclusion about the relative importance of the various causes you have identified.

Skills Practice

Study the information above.

1. What factors of physical geography may have been underlying causes of industrial development in Lancashire County?
2. What were the probable immediate causes of railroad and canal construction in Lancashire County?
3. Draw a diagram that summarizes the probable short-term and long-term causes and effects of industrialization in Lancashire County.
The Spread of Industry

Industrial growth in other European countries lagged behind Great Britain. They had not developed their raw materials or markets for their products. The wars following the French Revolution also disrupted their economies.

The French government helped local industry by imposing high tariffs on foreign goods. They also encouraged the building of railroads. However, in the 1800s, most French workers were still farmers and peasants. Germany did not have a central government to aid industrial growth. Not until the 1870s did German industrialization approach that of Great Britain.

The United States had both a strong central government and rich natural resources. It also had a rapidly increasing population. British inventions and methods were adopted in the United States. Inventions like the cotton gin and mechanical reaper boosted agricultural production. Canals and railroads were built, and the steel and machinery industries boomed. By 1869 a railroad stretched from the East Coast to the West Coast. America had joined the Industrial Revolution.

✓ READING CHECK: Sequencing  List some of the principal developments that led to industrialization in the United States.

SECTION 1 REVIEW

1. Define and explain the significance:
   - enclosure movement
   - crop rotation
   - Industrial Revolution
   - factors of production
   - mechanization
   - factory system
   - vulcanization

2. Identify and explain the significance:
   - Jethro Tull
   - Richard Arkwright
   - Eli Whitney
   - James Watt
   - Henry Bessemer
   - Robert Fulton
   - Samuel Morse

3. Categorizing  Copy the web diagram below. In each box, list some of the advances made during the Industrial Revolution.

   ![Web Diagram]

4. Finding the Main Idea
   a. Which inventions of the late 1600s and the 1700s do you think had the greatest influence on industrialization? Why?
   b. Why was Great Britain an ideal place for the start of the Industrial Revolution?

5. Writing and Critical Thinking
   Analyzing Information  Imagine that you are a journalist on the staff of a magazine for young people. Write a 150-word article explaining the factors of production that influenced the start of the Industrial Revolution.
   Consider:
   - the great variety of resources included in the factors of production: land, capital, and labor
   - how the absence or shortage of some of these resources would have made industrialization more difficult