The Steelmaking Process

By the 1880s, steel had replaced iron as the great symbol of the Industrial Revolution. In huge steel mills, visitors watched with awe as tons of molten metal were poured into giant mixers:

As night the scene is indescribably wild and beautiful. The furnaces present the terrific gush of heat, the gaping, glowing mouth of the giant chest, the quivering light from the liquid iron, the roar of a noisy converter . . . combine to produce an effect on the mind that no words can translate.

—J. H. Bridge, The Inside History of the Carnegie Steel Company

Focus Question

How did science, technology, and big business promote industrial growth?

New Industrial Powers Emerge

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 Matthew Boulton opened a factory to manufacture spinning machines. Britain became the first European nation after Britain to industrialize. By the early 1800s, other nations had joined the race, and several newcomers were challenging Britain’s industrial supremacy.

Nations Race to Industrialize

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 did Britain. Also, they had the advantage of being able to follow Britain’s lead. Like Belgium,
Teach

New Industrial Powers Emerge

Introduce: Vocabulary Builder
Have students read the Vocabulary Builder term and definition. Ask them to predict how the theme expressed by the word *dominate* would be key to understanding how the industrialized Western nations would influence the rest of the world.

Teach
Ask How did Belgium, Germany, France, and the United States industrialize? (They had abundant supplies of natural resources, and they were able to borrow the ideas and technology of the British.) How did industrialization affect these nations? (The factory system allowed more people to buy cheaper goods than ever before; industrialization bolstered the economy by creating jobs; industrialized Western nations grew in power.)

Quick Activity
Draw students' attention to the map on this page. Point out that the United Kingdom had the most major industrial cities. Ask students why they think the United Kingdom became an important center of industry. Have students access Web Code *nbp-2111* to take the Geography Interactive Audio Guided Tour and then answer the map skills questions in the text.

Answers
Map Skills
1. Locate (a) Belgium (b) Germany (c) Saar (d) Ruhr
2. Region Which American city probably grew because of its location near coal fields?
3. Draw Inferences Why would you expect Lyon, France, to become a major industrial city?

Advanced Readers
To maintain its economic supremacy and combat industrial espionage, Britain enacted a law that forbade inventors and workers in key industries from emigrating. Have students debate the measures that a country should take today to protect such industries as computers, microelectronics, and defense technology. Some of the specific issues students might touch upon in their debate include patent rights, freedom of speech, freedom of movement, and national security.

Gifted and Talented
An increase in manufacturing created a demand for workers. Children began running machines and mining coal (right).

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An increase in manufacturing created a demand for workers. Children began running machines and mining coal (right). Half from everything that is pleasant, with no chance to learn... grinding their little lives away in this dusty room, they are no more than the wire screens that separate the great lumps of coal from the smaller. They had no games, when their day's work is done, they are too tired for that. They knew nothing but the difference between slate and coal.

—"The Labor Standard," 1877

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Centers of Industry, 1871

Map Skills
Deposits of raw materials such as iron and coal were essential to a nation's industrial success.
1. Locate (a) Belgium (b) Germany (c) Saar (d) Ruhr
2. Region Which American city probably grew because of its location near coal fields?
3. Draw Inferences Why would you expect Lyon, France, to become a major industrial city?
Independent Practice
Have students fill in the Outline Map Europe About 1870.

Monitor Progress
Circulate to make sure students are filling in their Outline Maps accurately. Administer the Geography Quiz.

Answers
Graph Skills United States; Great Britain

Other nations had abundant supplies of natural resources and were able to use the ideas and technology that Britain had developed.

Life in the Industrial Age

latoomakers often borrowed British expertise 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.

Two countries in particular—Germany and the United States—threatened 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. By 1900, the United States was manufacturing about 30 percent of the world’s industrial goods, surpassing Britain as the leading industrial nation.

Uneven Development 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 had some resources, social and political conditions stunted its economic development. Only in the late 1800s, more than 100 years after British, did Russia lumber 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.

Effects of Industrialization Like Britain, the new industrial nations underwent social changes, such as rapid urbanization. Men, women, and children worked long hours in difficult and dangerous conditions. As you will read, by 1900, 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 advantages, the Western powers came to dominate the world more than ever before.

Checkpoint What factors led to the industrialization of other nations after Britain?

Technology Sparks Industrial Growth
During the early Industrial Revolution, inventions such as the steam engine were generally the work of gifted tinkerers. They experimented with simple machines to make them better. By the 1880s, the pace of change quickened as companies hired professional chemists and engineers to create new products and machinery. The union of science, technology, and industry spurred economic growth.

Steel Production and the Bessemer Process American inventor William Kelly and British engineer Henry Bessemer independently developed a new process for making steel from iron. In 1856, Bessemer developed a new process for making steel from iron. In 1856, Bessemer
patented this process. Steel was lighter, harder, and more durable than iron, so it could be produced very cheaply. Steel quickly became the major material used in tools, bridges, and railroads.

As steel production soared, industrialized countries measured their success in steel output. In 1880, for example, the average German steel mill produced less than 6 million metric tons of steel a year. By 1910, that figure reached nearly 15 million metric tons.

Innovations in Chemistry
Chemists created hundreds of new products, from medicines such as aspirin to perfumes and soaps. Newly developed chemical fertilizers played a key role in increasing food production. In 1880, the German chemist Alfred Nobel invented dynamite, an explosive much safer than others used at the time. It was widely used in construction and, to Nobel’s dismay, in warfare. Dynamite earned Nobel a huge fortune, which he willed to fund the famous Nobel prizes that are still awarded today.

Electric Power Replaces Steam
In the late 1800s, a new power source—electricity—replaced steam as the dominant source of industrial power. Scientists like Benjamin Franklin had tinkered with electricity a century earlier. The Italian scientist Alessandro Volta developed the first battery around 1800. Later, the English chemist Michael Faraday created the first simple electric motor and the first dynamo, a machine that generates electricity. Today, all electrical generators and transformers work on the principles of Faraday's dynamo.

In the 1870s, the American inventor Thomas Edison made the first electric light bulb. Soon, Edison’s “incandescent lamps” illuminated whole cities. The pace of city life quickened, and factories could continue to operate after dark. By the 1890s, cables carried electrical power from dynamos to factories.

New Methods of Production
The basic features of the factory system remained the same during the 1800s. Factories still used large numbers of workers and power-driven machines to mass-produce goods. To improve efficiency, however, manufacturers designed products with interchangeable parts, identical components that could be used in place of one another. Interchangeable parts simplified both the assembly and repair of products.

By the early 1890s, manufacturers had introduced another new method of production, the assembly line. Workers on an assembly line add parts to a product that moves along a belt from one work station to the next. A different person performs each task along the assembly line. This division of labor in an assembly line, like interchangeable parts, made production faster and cheaper, lowering the price of goods. Although dividing labor into separate tasks proved to be more efficient, it took much of the joy out of the work itself.

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The dynamo generated electricity that powered the machines.
Transportation and Communication Advances

Instruct

■ Introduce Have students read how Marconi transmitted a transatlantic radio message in 1901. Use the Idea Wave strategy (TE, p. T22) and ask How is radio used today? Why is it important? (entertainment, news, emergency broadcasts, weather warnings, communications)

■ Teach Ask What did Nikolaus Otto invent? (a gasoline-powered internal combustion engine) What effect did his invention have on the Industrial Revolution? (Because it powers automobiles, threshers, reapers, and airplanes, it had a huge impact on transportation, farm production, and the economies of industrialized Western nations that produced these products.)

■ Quick Activity Display Color Transparency 122. Inventors and Inventions. Use the lesson suggested in the transparency book to guide a discussion on the new technologies of the industrial age.

□ Color Transparencies, 125

Independent Practice

Have students examine the infographic, The Modern Office. Then ask them to write a paragraph on how advances in transportation and communication created massive change in business offices in the late 1800s.

Monitor Progress

Ask students to restate the introductory paragraph under the red heading Transportation and Communication Advances. Then ask them to explain the importance of the growth of railroads to industry.

Answers

Thinking Critically

1. As corporations expanded, they needed more office space.
2. Sample: Telephones would have had the greatest impact on offices because they would have enabled faster communication and therefore faster production.

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Transportation and Communication Advances

During the Industrial Revolution, transportation and communication were transformed by technology. Steamships replaced sailing ships and railroad building took off. In Europe and North America, rail lines connected inland cities and seaports, mining regions and industrial centers. In the United States, a transcontinental railroad provided rail service from the Atlantic to the Pacific. In the same way, Russia built the Trans-Siberian Railroad, linking Moscow in European Russia to Vladivostok on the Pacific. Railroad tunnels and bridges crossed the Alps in Europe and the Andes in South America. Passengers and goods rode on rails in India, China, Egypt, and South Africa.

The Automobile Age Begins

The transportation revolution took a new turn when a German engineer, Nikolaus Otto, invented a gasoline-powered internal combustion engine. In 1886, Karl Benz received a patent for the first automobile, which had three wheels. A year later, Gottlieb Daimler (DYM lur) introduced the first four-wheeled automobile. People laughed at the "horseless carriage," but they quickly transferred transportation.

The French moved out the Germans as early automakers. Then the American Henry Ford started making models that reached the breathtaking speed of 25 miles per hour. In the early 1900s, Ford began using the assembly line to mass-produce cars, making the United States a leader in the automobile industry.

Airplanes Take Flight

The internal combustion engine powered more than cars. Motorized threshers and reapers boosted farm production. Even more dramatically, the internal combustion engine made possible sustained, pilot-controlled flight. In 1903, American bicycle makers Orville and Wilbur Wright designed and flew a flimsy airplane at Kitty Hawk, North Carolina. Although their flying machine stayed aloft for only a few seconds, it ushered in the air age.

Soon, daredevil pilots were flying airplanes across the English Channel and over the Alps. Commercial passenger travel, however, would not begin until the 1930s.

Rapid Communication

A revolution in communications also made the world smaller. An American inventor, Samuel F. B. Morse, developed technology, such as the telephone and the fax machine, quickly became indispensable to business. With the advent of cell phones, personal handheld devices, and wireless Internet, people could conduct business from practically anywhere. Some relished the flexibility, while others resented that they could no longer leave work at the office.

Connections to Today

Ever since the telegraph was invented in the mid-nineteenth century, people in business have been grappling with the ever-increasing speed of business and communications. “The businessmen of the present day must be continually on the jump,” said a New York merchant in 1866. “He must use the telegraph.” New communication technologies, such as the telephone and then the fax machine, quickly became indispensable to business. With the advent of cell phones, personal handheld devices, and wireless Internet, people could conduct business from practically anywhere. Some relished the flexibility, while others resented that they could no longer leave work at the office.
the telegraph, which could send coded messages over wires by means of electricity. His first telegraph line went into service between Washington, D.C., and Baltimore, in 1844. By the 1860s, an undersea cable was relaying messages between Europe and North America. This trans-Atlantic cable was an amazing engineering accomplishment for its day.

Communication soon became even faster. In 1876, the Scottish-born American inventor Alexander Graham Bell patented the telephone. By the 1900s, the Italian pioneer Guglielmo Marconi had invented the radio. In 1901, Marconi received a radio message, using Morse code, sent from Britain to Canada. Radios would become a cornerstone of today’s global communications network.

Checkpoint How did technological advances in transportation and communications affect the Industrial Revolution?

Business Takes a New Direction

By the late 1800s, what we call “big business” came to dominate industry. Big business refers to an establishment that is run by entrepreneurs who finance, manufacture, and distribute goods. As time passed, some big businesses came to control entire industries.

Rise of Big Business

New technologies required the investment of large amounts of money, or capital. To get the needed capital, owners sold stock, or shares in their companies, to investors. Each stockholder became owner of a tiny part of a company. Large-scale companies, such as steel foundries, needed so much capital that they sold hundreds of thousands of shares. These businesses formed giant corporations, businesses that are owned by many investors who buy shares of stock. With large amounts of capital, corporations could expand into many areas.

Move Toward Monopolies

Powerful business leaders created monopolies and trusts, huge corporate structures that controlled entire industries or areas of the economy. In Germany, Alfred Krupp inherited a steelmaking business from his father. He bought up coal and iron mines as well as ore deposits—supply lines or raw materials that fed the steel business. Later, he and his son acquired plants that made tools, railroad cars, and weapons. In the United States, John D. Rockefeller built Standard Oil Company into an empire. By gaining control of oil wells, oil refineries, and oil pipelines, he dominated the American petroleum industry.

By the 1800s, however, world demand for oil failed to meet OPEC expectations. The oil cartel was then torn by disputes among those who wanted to reduce production in order to raise prices and those who wanted to increase production in order to maintain their earnings. Since that time, OPEC has seen its influence and share of the oil market decline.

In 1901, Guglielmo Marconi (left) was in Newfoundland to receive the first overseas radio transmission from his assistant in England. Did Marconi’s prediction come true? Explain.

Primary Source

Instruct

■ Introduce Ask students to read the paragraph under the red heading Business Takes a New Direction. Ask What is “big business”? Ask students to identify what is big about big business. Why were they successful? (Business leaders who dominated entire industries had control over their industries.)

■ Teach Ask: How did company owners get the capital needed to run businesses? (They sold stock and formed giant corporations.) Why was there a move toward monopolies? (Business leaders who dominated entire industries could squeeze out competing companies and charge any price for a product or service.) What are the benefits of regulating monopolies? (Regulations would allow for competition, better pricing, and fair business practices.)

■ Quick Activity Display Color Transparency 126: Features of a Monopoly. Use the lesson suggested in the transparency book to guide a discussion on the widespread concern about the harmful effects of monopolies in the late 1800s.

Independent Practice

Divide students into pairs. Ask them to explain the following terms to their partner: big business, monopoly, regulation.

Monitor Progress

Check Reading and Note Taking Study Guide entries for student understanding of the major developments of the second Industrial Revolution.

Answers

In 1901, Guglielmo Marconi (left) was in Newfoundland to receive the first overseas radio transmission from his assistant in England. Did Marconi’s prediction come true? Explain.

Primary Source

Yes, advances in communications such as cellular phones and e-mail have made worldwide communication almost instantaneous.

Advances in transportation and communication changed the way that people lived. People could travel faster and farther by steamship, railroad, car, and airplane. They could also communicate nationally and internationally by telegraph, telephone, and radio.
Analyzing Political Cartoons

One View of Big Business

To some critics, the growth of monopolies had a dangerous effect on society. This 1899 American cartoon shows a monopoly as an octopus-like monster. Do you think this cartoonist favored or opposed government regulation of business? Explain.

In their pursuit of profit, ruthless business leaders destroyed competing companies. With the competition gone, they were free to raise prices. Sometimes, a group of corporations would join forces and form a cartel, an association to fix prices, set production quotas, or control markets. In Germany, a single cartel fixed prices for 170 real mines.

Move Toward Regulation

The rise of big business and the creation of such great wealth sparked a stormy debate. Some people saw the Krupp and Rockefellers as “captains of industry” and praised their vision and skills. They pointed out that capitalists invested their wealth in worldwide ventures, such as railroad building, that employed thousands of workers and added to the general prosperity.

To others, the aggressive magnates were “robber barons.” Destroying competition, critics argued, damaged the free-enterprise system, or the laissez-faire economy. Reforms called for laws to prevent monopolies and regulate large corporations. Despite questionable business practices, big business found support from many government leaders. By the early 1900s, some governments did move against monopolies. However, the political and economic power of business leaders often hindered efforts at regulation.

Checkpoint: Why were big business leaders “captains of industry” to some, but “robber barons” to others?

Section 1 Assessment

1. Sentences should reflect an understanding of each term, person, or place listed at the beginning of the section.

2. New technology, inventions, power sources, production methods, and business practices all led to widespread industrialization.

3. A British mechanic opened a factory in Belgium in 1807. Other countries acquired British technology and created new technologies.

4. Scientists developed new products and technologies, such as a process for producing steel, dynamite, and the dynamo for generating electricity.

5. To raise needed capital, large companies became corporations and sold shares of the business to investors.

6. Sample: As business leaders gain power and influence on politics, government may begin to favor big business or grow corrupt.

For additional assessment, have students access Progress Monitoring Online at Web Code nba-2111.