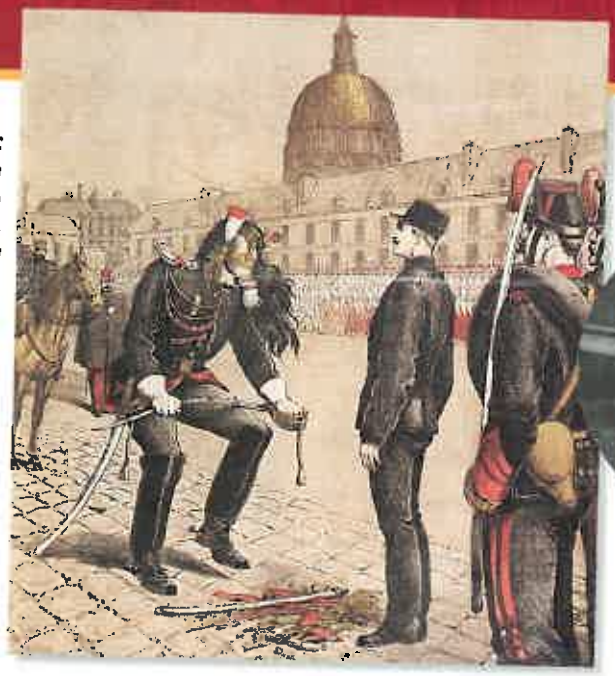


The public humiliation of French army captain Alfred Dreyfus

A steelworker in Andrew Carnegie's largest mill in Pittsburgh, Pennsylvania

1884
The Arts
Mark Twain publishes *The Adventures of Huckleberry Finn.*

1890
Politics
The Sherman Antitrust Act is passed, outlawing monopolies and trusts that restrain trade.

1894
World Events
Alfred Dreyfus is convicted of questionable treason charges, leading to political upheaval in France.

1901
Business and Finance
Andrew Carnegie sells his steel company to J. P. Morgan for nearly $500 million.

1889 — 1897 — 1905

1886
Politics
1,500 labor strikes erupt in the United States.

trike turns violent in Chicago, Illinois.

1894
Daily Life
The U.S. Congress establishes Labor Day as a national holiday.

1903
Science and Technology
The Wright brothers test their airplane near Kitty Hawk, North Carolina.

1893
Daily Life
The first motorcar to be built in the United States is completed by the Duryea brothers.

The Duryea brothers ride in their horseless carriage.

hat's Your Opinion?

emes
rnal

Do you **agree** *or* **disagree** *with the following statements? Support your point of view in your journal.*

nomics The economic growth created by nological innovations is worth its costs.

Science, Technology, and Society New technologies bring social changes and improve people's daily lives.

Citizenship The actions of both American business leaders and labor organizers lead to greater equality and an expansion of democracy.

SECTION 1

The Age of Invention

READ TO DISCOVER

1. How did the development of steel and oil refining affect U.S. industry?
2. What innovations were made in transportation?
3. How did innovations in communications technology change business practices and daily life in the United States?
4. How did Thomas Edison's research laboratory change American life?

DEFINE

patent
transcontinental railroad
trunk lines
telegraph

IDENTIFY

Bessemer process
Edwin L. Drake
Elijah McCoy
George Westinghouse
Alexander Graham Bell
Thomas Alva Edison
Lewis Latimer

WHY IT MATTERS TODAY

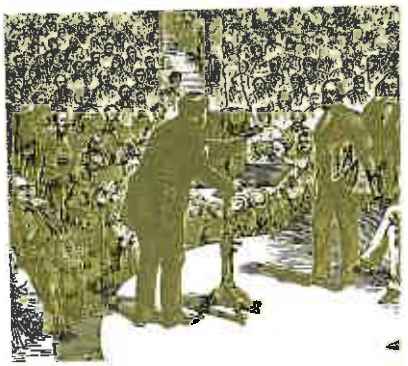
New inventions are still changing our world, and scientists are constantly seeking new sources of energy. Use CNN Student News or other **current events** sources to find out about new developments in technology or energy sources. Record your findings in your journal.

CNN Student News.com

EYEWITNESSES TO HISTORY

"The telephone is a curious device that might fairly find place in the magic of Arabian Tales. Of what use is such an invention? Well, there may be occasions of state when it is necessary for officials who are far apart to talk with each other."

—*New York Tribune* reporter, quoted in *America in 1876*, by Lally Weymouth



Demonstration of sound transmission in 1876

A reporter visiting the 1876 Centennial Exposition in Philadelphia discussed in the *New York Tribune* his amazement at the invention of the telephone. In the years following the Civil War, the United States experienced a wave of scientific discoveries and inventions. Americans celebrated this "age of invention" at the exposition in Philadelphia. Inventors presented new technologies such as the telephone to the public for the first time. The potential impact of these inventions on the future of American business and daily life was uncertain.

Industrial Innovations

From 1865 to 1905 the United States experienced a surge of industrial growth. The years marked the beginning of a Second Industrial Revolution. This new era of indu trial transformation began with numerous discoveries and inventions that signi cantly altered manufacturing, transportation, and the everyday lives of Americar

Coal and steam made possible the original Industrial Revolution in the Unit States. Coal-fed steam engines powered factories. These factories in turn produc the goods that generated economic growth. In the late 1800s an abundance of st helped spur a second period of industrialization. Steel was used in the constructi of heavy machinery that mass-produced goods. Steel was also used to build ra road tracks, bridges, and tall city buildings.

Steel. Before the mid-1800s, the process of converting iron ore into steel was t expensive to be used practically. In the 1850s Henry Bessemer in Great Britain a William Kelly in the United States both developed a method of steelmaking t burned off the impurities in molten iron with a blast of hot air. Known as **Bessemer process**, this method could produce more steel in one day than the ol techniques could turn out in one week. American engineer Alexander Hol adapted and improved the Bessemer process. Largely because of this proc American steel production skyrocketed from about 15,000 tons in 1865 to m than 28 million tons by 1910.

The production of steel required iron ore. Barges and steamers car unprocessed iron ore from the Midwest through the Great Lakes to the south shores of Lake Michigan and Lake Erie. Cities such as Gary, Indiana; Clevel Ohio; and Pittsburgh, Pennsylvania, became major centers for steel manufactur

Coal mined in Pennsylvania and West Virginia provided an inexpensive source of fuel for steel production.

The increased availability of steel in the late 1800s resulted in its widespread industrial use. The railroad industry began replacing iron rails with stronger, longer-lasting steel ones. Builders began to use steel in the construction of bridges and buildings. Using steel to create a skeletal frame in buildings allowed architects to design larger, multistory buildings. Steel's resistance to rust also made it an ideal material for everyday items such as nails and wire.

Oil. Like the advances in steel production, the development of a process to refine oil also affected industrial practices. American Indians and settlers had known of the existence of crude oil for hundreds of years. By the late 1850s, chemists and geologists had made significant progress in developing a process to refine crude oil. With this process, crude oil could be turned into kerosene, which could be burned in lamps to produce light or used as a fuel. Kerosene provided a cheap substitute for whale oil, which had become difficult to acquire.

Noting the growing demand for this inexpensive fuel, **Edwin L. Drake** used a steam engine to drill for oil near Titusville, Pennsylvania, in 1859. The venture seemed so impractical that curious onlookers questioned Drake's sanity, calling the project Drake's Folly. When the oil began to flow at a rate of some 20 barrels a day, however, other prospectors, or "wildcatters," hurried to dig their own wells. Like the California Gold Rush of 1849, the oil boom in western Pennsylvania encouraged prospecting. Prospectors even referred to oil as "black gold." By the 1880s oil wells dotted Ohio, Pennsylvania, and West Virginia. Production topped 25 million barrels of oil in 1880 alone.

Drake's success led others to search for oil. In 1901 a group led by engineer Anthony F. Lucas stuck oil at Spindletop, near Beaumont, Texas. This strike marked the beginning of the Texas oil boom. Oil production there peaked in 1902 at more than 17 million barrels. Nearly 20 percent of the oil produced in the United States that year came from Spindletop. By 1904 its reserves were drained, and it was producing only 10,000 barrels of oil a day.

Although kerosene remained a primary product of oil refining, by 1880 refiners had developed other petroleum products that increased the industrial uses of oil. Refiners developed waxes and lubricating oil for use in new industrial machines. **Elijah McCoy** made a significant contribution to the industrial use of oil. The son of runaway slaves, McCoy invented a lubricating cup that fed oil to parts of a machine while it was running.

Like other inventors, McCoy received a **patent**—a guarantee to protect an inventor's rights to make, use, or sell the invention. McCoy's innovative breakthrough helped many kinds of machines operate more smoothly and quickly.

READING CHECK: Identifying Cause and Effect How did the advances in steel production and oil refining affect U.S. industry?

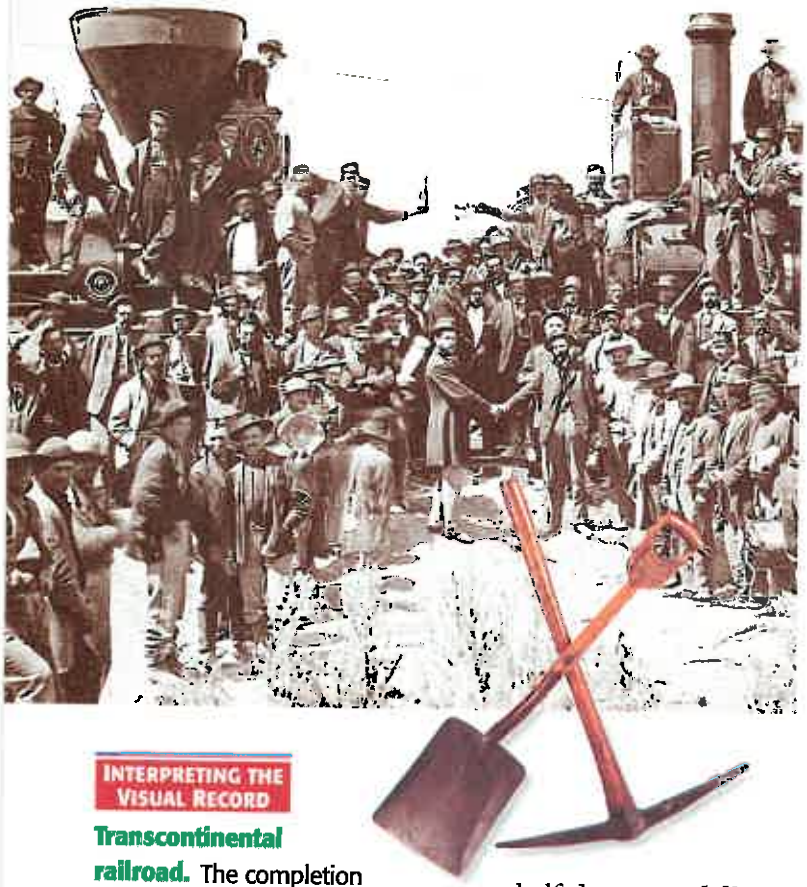
INTERPRETING THE VISUAL RECORD

Black gold. Edwin L. Drake, wearing a top hat, visits his oil well drilled in 1859 near Titusville, Pennsylvania. ***What materials did Drake use to construct his well?***

Transportation

Innovations in the steel and oil industries led to a surge of advances in the transportation industry. Many of the discoveries during this "age of invention" contributed to the development of new, more technologically advanced forms of transportation.

New technology in the late 1800s resulted in a massive expansion of the American railroad network. Entirely new discoveries laid the groundwork for air flight and the automobile. These developments in transportation made travel much more efficient and brought Americans into closer contact with each other. Railroads linked isolated regions of the country to the rest of the United States.



INTERPRETING THE VISUAL RECORD

Transcontinental railroad. The completion of the first transcontinental railroad in 1869 allowed trains to transport goods and people from coast to coast in a matter of days. ***How does this photograph reveal the importance of this moment to U.S. history?***

Railroads. The availability of cheap steel provided by the Bessemer process had a significant impact on railroad expansion. As steel production soared, prices dropped dramatically. Steel that had sold for $100 a ton in 1873 went for $12 a ton by the late 1890s. The availability of cheaper steel encouraged railroad companies to lay thousands of miles of new track.

The rapid increase of railroad lines led to a more efficient network of rail transportation. Prior to the Civil War, most railroads in the United States were short. They averaged some 100 miles in length and primarily served local transportation needs. In 1860, passengers and freight traveling between New York and Chicago, for example, had to change lines 17 times over a period of two days. By the next decade, however, the rapid expansion of rail lines allowed passengers and freight to make the same trip in less than 24 hours without changing trains.

The country's first **transcontinental railroad** was completed in 1869. The project was finished when the Central Pacific and Union Pacific Railroads were joined to create a single rail line from Omaha, Nebraska, to the Pacific Ocean. To celebrate its completion, railroad tycoon Leland Stanford hammered in the last spike at Promontory, Utah. By 1900 almost a half-dozen **trunk lines**, or major railroads, crossed the Great Plains to the Pacific coast. Feeder, or branch, lines connected the trunk lines to outlying areas. This huge railroad grid joined every state and linked remote towns to urban centers.

Additional innovations further improved rail transportation. Bigger, more efficient locomotives made it possible to pull larger loads at faster speeds. **George Westinghouse** developed a compressed-air brake. It increased railroad safety by enabling the locomotive and all its cars to stop at the same time. Granville T. Woods improved Westinghouse's air brake. He also developed a communications system that enabled trains and stations to send and receive messages.

Changes in track design also improved rail service. Double sets of tracks allowed trains traveling in opposite directions to pass each other. Equally important,

the adoption in the 1870s of a standard gauge, or width between the rails, made rail transportation faster and cheaper. Passengers and freight no longer had to be transferred from train to train each time they reached a different line.

The growth of railroads had far-reaching consequences. Railroads increased western settlement by making travel affordable and easy. They also stimulated urban growth. Wherever railroads were built, new towns sprang up, and existing towns grew into major cities.

The economic impact of the railroads was immeasurable. For much of the late 1800s, railroad companies provided many of the country's jobs. They also spurred the growth of other industries. The railroad companies' demands for locomotives, rails, and railcars poured money into the steel and railroad-car construction industries. Innovations like refrigerated freight cars helped the development of the meatpacking industry. In addition, the network of railroad lines allowed companies to sell their products nationally. A Pennsylvania steel foundry could obtain iron ore from the Great Lakes region, and a Philadelphia furniture company could sell its products in small midwestern towns.

Railroads also shaped American popular culture and folk music. One ballad immortalized Casey Jones, the Illinois Central engineer killed in a crash with a freight train in 1900. Other songs celebrated famous trains like the Wabash Cannonball.

INTERPRETING THE VISUAL RECORD

Railroads. The Illinois Central Railroad connected rural Americans with the rest of the world. ***What do the various images in this poster represent?***

The horseless carriage. The innovations in oil refining in the late 1800s led to advances in the development of motors and the creation of a new mode of transportation. The horseless carriage, a self-propelled vehicle and forerunner to the automobile, had originally been developed about 1770. A French artillery officer named Nicolas-Joseph Cugnot had mounted a steam engine to a three-wheeled carriage. The use of steam power for these early automobiles was expensive and inefficient for the small amount of power needed for these carriages.

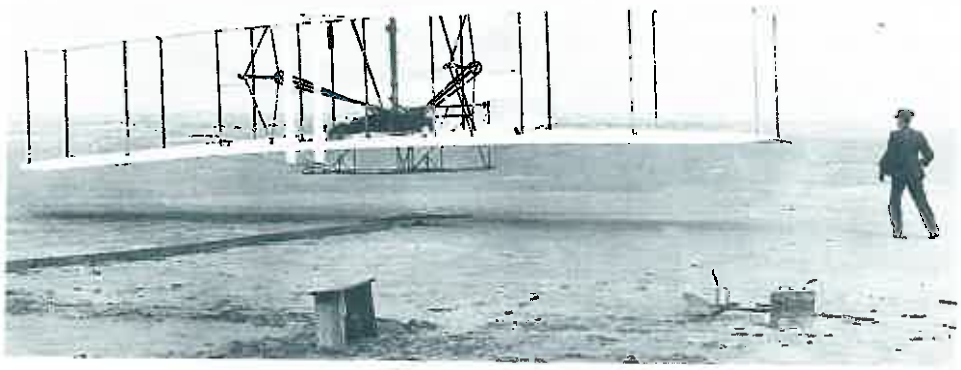
Efforts to develop a gasoline-powered engine led to the creation of a more practical self-propelled vehicle. Innovations in oil refining led Nikolaus A. Otto to invent the first internal combustion engine powered by gasoline in 1876. In the 1880s ambitious designers in Europe and the United States attempted to use this gasoline engine to power horseless carriages. In 1893 Charles and J. Frank Duryea built the first practical motorcar in the United States.

The 1890s brought further innovations to the horseless carriage. By the turn of the century, more Americans had begun to use the carriages in their daily lives. The use of this new mode of transportation was limited, however, since only wealthy citizens could afford it. Nevertheless, automobile production rapidly became a substantial commercial industry.

Airplanes. The internal combustion engine also led to advances in flight. Using small gasoline engines, Orville and Wilbur Wright of Dayton, Ohio, developed one of the first working airplanes.

The Wright brothers had experimented with glider designs. They also experimented with engines based on European designs in the mid-1890s. On

With experience gained from operating a bicycle shop and experimenting with small engines and gliders, the Wright brothers developed a plane and made the first piloted flight in December 1903.



December 17, 1903, near Kitty Hawk, North Carolina, Orville Wright made the first piloted flight—12 seconds and 120 feet—in a powered plane. He made a statement summing up the significance of the achievement.

History Makers Speak

"This flight lasted only twelve seconds, but it was, nevertheless, the first in the history of the world in which a machine carrying a man had raised itself by its own power into the air in full flight, had sailed forward without reduction of speed, and had finally landed at a point as high as that from which it started."

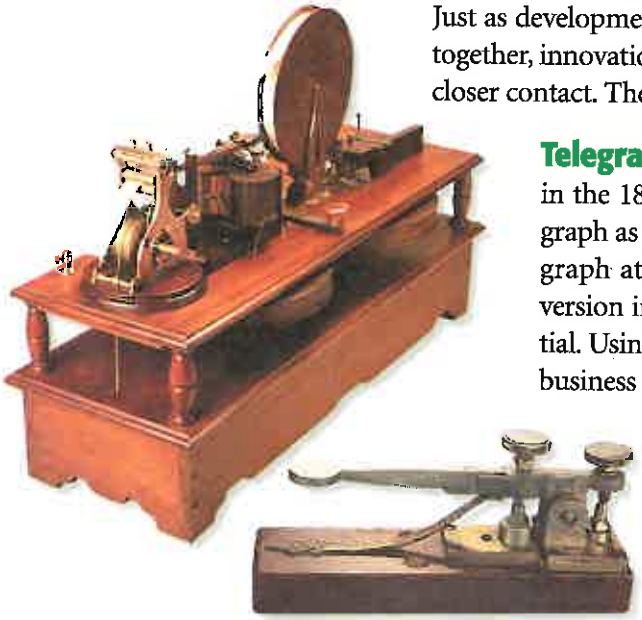
—Orville Wright, quoted in *A History of Flying*, by C.H. Gibbs-Smith

The Wright brothers' first flight received little public attention or press coverage. However, as word of their achievement spread, a surge of related inventions and patents by other engineers dramatically demonstrated the importance of this new form of transportation.

✔ **READING CHECK: Finding the Main Idea** Describe the innovations that were made in transportation in the late 1800s.

INTERPRETING THE VISUAL RECORD

Telegraph. Developed by Samuel F. B. Morse, this telegraph and receiver allowed for communication over long distances with electricity. ***Based on these images, how do you think a telegraph would be operated?***



Communications

Just as developments in transportation made traveling easier and brought people together, innovations in communications technology also brought Americans into closer contact. These advances also furthered the growth of American industry.

Telegraph. One of the most significant advances in communications in the 1800s was the **telegraph**. Samuel F. B. Morse developed the telegraph as a means of communicating over wires with electricity. The telegraph attracted little attention when Morse filed for a patent on his version in 1837. In time, however, people recognized its business potential. Using Morse's dot-and-dash code, a telegraph operator could send a business order to a distant location in minutes.

By 1866 Western Union, the leading telegraph company, had more than 2,000 telegraph offices. The telegraph grew along with the railroad. Telegraph companies established offices in train stations and strung telegraph wire on poles alongside the railroad lines. Telegraphs sent information for businesses, the government, newspapers, and private citizens.

Telephone. Patented by **Alexander Graham Bell** in March 1876, the "talking telegraph," or telephone, had an even greater impact. Bell demonstrated his invention at the Philadelphia Centennial Exposition in June 1876. Judges there pronounced it "perhaps the greatest marvel hitherto [thus far] achieved by the electric telegraph." Businesses quickly found the telephone indispensable. By the end of the 1800s more than a million telephones had been installed in American offices and homes. Bell Telephone Company eventually became American Telephone and Telegraph, one of the nation's largest and longest lasting monopolies.

Early telephones required operators to connect callers. Many women filled these new jobs. A former telephone operator described the fast-paced work.

Alexander Graham Bell's invention of the telephone allowed Americans to stay in greater contact.

History Makers Speak

"On the second floor where the switchboards were located there arose a dull roar like that of locusts on a sunburnt prairie, a sense of many voices without any one being distinguishable. . . . I could see their hands working swiftly, pulling cords out of the holes, jabbing others in. Serving the Thing that signaled them with little flashing lights, making them hurry, hurry."

— "Pilgrim's Progress in a Telephone Exchange," quoted in *Life and Labor*, 1921

Analyzing Primary Sources

Drawing Conclusions What is the "Thing" referred to in the quotation?

Changing Ways Technology in Daily Life

Understanding Change The "age of invention" transformed American life. Much of the technology developed in the late 1800s remains important today. Examine the chart, which compares items used in the mid-1800s and items used today. *What items used in the mid-1800s are still used by some people today? How have their uses changed? How would life today be different without the items in the right column?*

Technology	Then	Now
Energy	firewood	oil, natural gas, nuclear power
Transportation	horse and carriage	automobile
Communication	handwritten letters	Internet
Popular Entertainment	live theater	television, films
Household Appliances	washboard hammer fireplace livestock underground icehouse	washing machine electric drill microwave oven lawnmower refrigerator

Data reflects mid-1800s and 2000.

Then

Now

Christopher Sholes's typewriter revolutionized business communication.

Typewriter. Christopher Sholes developed the typewriter in 1867. By allowing users to quickly produce easily legible documents, the typewriter revolutionized communications. Sholes sold his typewriter patent in 1873 to E. Remington & Sons. Although other typewriter designs had preceded Sholes's design, his was the first to be marketed. Sholes's keyboard design, with only a few changes, is still used today in typewriters and computers. Carbon paper, also introduced during this period, allowed users of typewriters to produce multiple copies of a document at the same time.

The invention of the typewriter soon gave rise to the use of typing pools. These business departments were made up of many clerical workers whose main task was to type. Women made up the majority of workers in the typing pools. The pools offered many working-class women the opportunity to move into a skilled profession for the first time. Lillian Sholes, Christopher Sholes's daughter, was probably the first professional female typist. Christopher Sholes was aware of the impact of the typewriter on communications and on the expansion of job opportunities for women. He later wrote, "I feel that I have done something for the women who have always had to work so hard."

✔ **READING CHECK: Identifying Cause and Effect** How did innovations in communications technology affect American women?

Science & Technology

Electricity

The late 1800s brought significant advances in the uses of electricity. One such advance was the lightbulb. In simple terms, the lightbulb produces light when electricity flows through a filament that resists that flow. This resistance gives off energy in the form of heat—so much heat that the filament glows, producing light. To prevent the filament from being consumed by the heat, inventors created a vacuum through the use of a glass bulb. This reduces the oxygen around the filament. The bulb was filled with inert gas.

While many inventors experimented with the incandescent lightbulb, Thomas Edison and his team at Menlo Park, New Jersey, made the most significant contributions by finding a filament that would light up without burning up. Edison and his associates discovered in 1880 that carbonized bamboo fiber could last an average of 600 hours. Eventually filaments made of the element tungsten were used.

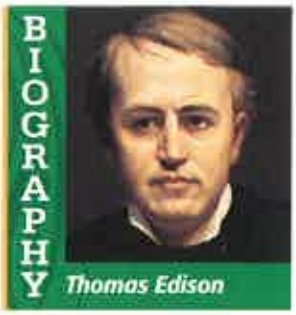
Power plants soon arose to supply electricity for lightbulbs in homes and industries. However, electricity could not be transmitted over long distances with direct current (DC) because too much energy was lost in transportation over power lines. Inventor Nikola Tesla patented an alternating current (AC) generator that could produce electricity for transmission over longer distance with less loss of energy. With this advance, the use of electricity spread rapidly.

Understanding Science and History

1. What purposes does the glass bulb serve?
2. How did advances made with electricity affect the development of the United States?

Edison and Menlo Park

Thomas Alva Edison was another pioneer of communications technology. His first major invention was a telegraph that could send up to four messages over the same wire simultaneously. Edison's early inventions had a significant impact on telegraphic communications. However, his influence on American life extends well beyond the history of the telegraph. An active innovator, Edison and his fellow researchers made significant discoveries and advances in electricity, lightbulbs, phonographs, and early motion-picture cameras.



Born in a small Ohio town in 1847, Edison received the majority of his schooling at home. He became a newsboy at age 12 and later worked as a telegraph operator. An eager amateur scientist, Edison conducted experiments and read widely in his spare time. In 1869 he patented an electric vote recorder. That year he also received his second patent, for a telegraphic stock ticker. Other inventions followed. In 1876 he went into the "invention business" full-time. He opened a workshop in Menlo Park, New Jersey, where he assembled a team of researchers.

Edison promised that he and his fellow researchers would deliver "a minor invention every ten days and a big thing every six months or so." He kept his word. His researchers invented the phonograph in 1877 and the lightbulb in 1879. Edison also improved Alexander Graham Bell's original design for a telephone transmitter. Edison's design made it possible to send stronger telephone signals, which greatly improved the sound quality. When he died in 1931, the "Wizard of Menlo Park" held more than 1,000 patents. Describing his process of invention to a colleague, Edison explained the secret to his success.

History Makers Speak

"I have the right principle and am on the right track, but time, hard work and some good luck are necessary too. It has been just so in all of my inventions. The first step is an intuition, and [it] comes with a burst, then difficulties arise. . . . Months of intense watching, study and labor are requisite [required] before commercial success or failure is certainly reached."

—Thomas Edison, letter to colleague, November 13, 1878

Edison's work at Menlo Park was a team effort. Some of the most significant contributions to the development of the lightbulb were made not by Edison but by his assistant **Lewis Latimer**. Latimer was also a skilled draftsman. As an expert in patent law, Latimer testified in several court cases to support Edison's patents.

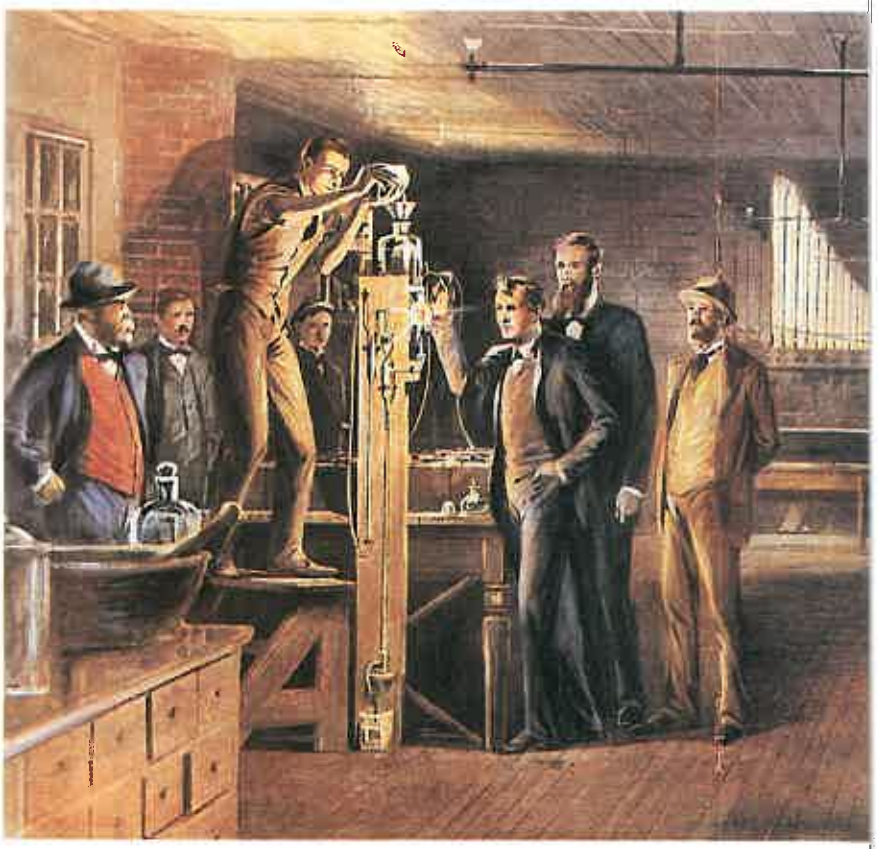
Research on the ROM

Free Find: Thomas Edison

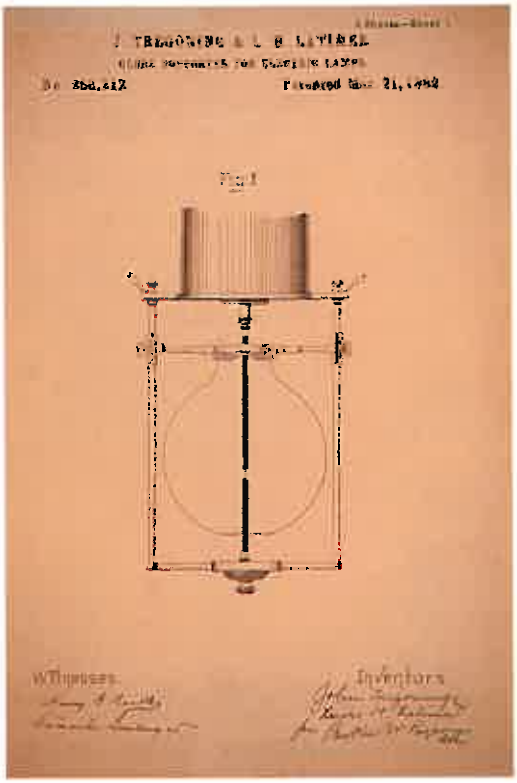
After reading about Thomas Edison on the **Holt Researcher CD-ROM**, create a list of the most important of Edison's inventions and explain why each was significant.

INTERPRETING THE VISUAL RECORD

Menlo Park. Thomas Edison's team at Menlo Park developed more than 1,000 patented inventions. ***What conclusions can be drawn from this image about the working environment at Menlo Park?***



THE GRANGER COLLECTION, NEW YORK



Lewis Latimer developed a globe supporter for the electric lightbulb in 1882.

In 1882 Edison opened one of the world's first electric power plants in New York City. Edison's New York plant used direct current (DC) electricity. This meant that the plant could only deliver electricity to the homes and offices in a very small area surrounding the plant. Despite the initial limitations, New Yorkers marveled at the new advances. One reporter from the *New York Times* explained that with electric lighting in the newspaper's offices, "it seemed almost like writing by daylight."

George Westinghouse and Nikola Tesla made additional advances beginning in the late 1880s. They developed a transformer that could transmit a high-voltage alternating current (AC) over long distances. The development of the alternating current allowed continued expansion of the use of electricity in urban households and industry.

At the 1893 World's Columbian Exposition in Chicago, Illinois, a Westinghouse-Tesla generator powered the twinkling lights outlining the major buildings at night. The electric lights enchanted visitors. They marveled at the "fairyland" and frequently referred to the illuminated exposition as the White City. To many witnesses, it symbolized a transformation of American life. Indeed, by the end of the century, electric lights had begun to replace gaslights. The availability of electrical power also made possible another major change. In many cities, horse-drawn vehicles gave way to electric streetcars.

✔ **READING CHECK: Evaluating** How did the inventions created by Thomas Edison's research laboratory affect daily life?

SECTION 1 REVIEW

1. Define and explain:
patent
transcontinental railroad
trunk lines
telegraph

2. Identify and explain:
Bessemer process
Edwin L. Drake
Elijah McCoy
George Westinghouse
Alexander Graham Bell
Thomas Alva Edison
Lewis Latimer

3. Categorizing Copy the graphic organizer below. Use it to list and describe the various innovations that affected industry, transportation, and communications in the late 1800s.

Industry		
Inventions	**Inventors**	**Effects**

Transportation		
Inventions	**Inventors**	**Effects**

Communications		
Inventions	**Inventors**	**Effects**

4. Finding the Main Idea

a. How did American daily life change after the Second Industrial Revolution?

b. Why might important breakthroughs such as the telegraph or the Wright brothers' flight have attracted so little attention or recognition at the time they occurred?

c. How did innovations in industry, transportation, and communications affect the nature of work in American society?

5. Writing and Critical Thinking

Drawing Conclusions Imagine that you are an inventor working in Edison's Menlo Park laboratory. Write a letter to your family describing your job.

Consider:
- aspects of working on your own
- an invention you might have helped create
- how your work builds on earlier innovations

Homework Practice Online
keyword: SE3 HP6