

# Technology in the Industrial Age

*Railroad iron is a magician's rod, in its power to evoke the sleeping energies of land and water.*

—Ralph Waldo Emerson (1803-1882)

**Essential Question:** How did technology shape economic production during the period from 1750 to 1900?

**A**s the Industrial Revolution spread, it became increasingly important economically. Although he later came to be troubled by the role of technology, Ralph Waldo Emerson initially saw the innovations of the industrial age as a delightful way to mold nature in the service of humankind. The steam engine and then the internal combustion engine, powering railroads, ships, and factories, increased access to resources and increased the distribution of goods those resources helped produce.

The next technological wave, known as the second industrial revolution, came in the late 19th and early 20th centuries and involved chemicals, steel, precision machinery, and electronics. Electrification lit the streets, and the telephone and radio made world-wide, instantaneous communication a reality.

## The Coal Revolution

The new machinery of the Industrial Revolution benefitted from a new power source, one more mobile than the streams that had powered the first factories with their water power. The version of the **steam engine** made by **James Watt** in 1765 provided an inexpensive way to harness **coal** power to create steam, which in turn generated energy for machinery in textile factories. Within 50 years, steam was producing power for steam powered trains.

**Water Transportation** Steamships revolutionized sailing. The use of coal made energy production mobile and dependable. Instead of being fixed in one place as a river was, coal-powered steam engines could be built anywhere and could be used on ships and trains. Further, unlike the wind, engines could be turned on by people when needed and turned off when not. As a result, ocean-going ships and boats on lakes were no longer dependent on winds for power. On rivers, steam-powered ships were able to travel quickly upstream on rivers, up to five miles per hour, instead of having to sail up or be towed by

people and animals along the shore. Over time, steam-powered ships replaced sailing ships in worldwide travel. As a result, **coaling stations**, especially at critical points on trade routes, such as Cape Colony in South Africa and various islands in the Pacific, became important refueling points.



Source: Hunter Wood, 1819. Wikimedia Commons.

The *SS Savannah* (upper) was the first steam-powered ship to cross the Atlantic Ocean (1819)



Source: U.S. Post Office.

The first transcontinental railroad (lower) was completed in 1869 in Utah.



**Iron** In addition to powering steam engines, coal made possible the mass production of iron. Throughout the 1700s and into the early 1800s, improved processes helped iron producers increase outputs. One of these was the introduction of coke, a refined form of coal that made possible the use of much larger iron producing furnaces. Cast iron was strong but brittle, making it difficult to stretch and shape. But in 1794, Englishman Henry Cort patented the process for making the less strong but much more workable wrought iron. Each was a valuable component in transportation and industry, but greater improvements were still to come.

## A Second Industrial Revolution

The United States, Great Britain, and Germany were key players in what is known as the **second industrial revolution**, which occurred in the late 19th and early 20th centuries. The innovations of the first industrial revolution were in textiles, steam power, and iron. The developments of the second industrial revolution were in **steel**, chemicals, precision machinery, and electronics.

**Steel Production** The mass production of steel, an alloy of iron and carbon, became possible with the introduction of the Bessemer Process in 1856. This process involved blasting the molten metal with air as a means of removing impurities as well as helping keep the metal from solidifying. Over the years, Bessemer's innovation was refined and improved, allowing steel to become the strong and versatile backbone of the industrial society.

**Oil** In the mid-1800s, the first commercial oil wells were drilled, tapping into a vast new resource of energy. Petroleum, like coal, is a fossil fuel, an energy source derived from plant and animal remains. At first, the most important product from petroleum was kerosene, which was used for lighting and heaters. In 1847, inventors developed chemical techniques to extract kerosene from petroleum.

These techniques led to other developments, such as precision machinery and the internal combustion engine, which in turn led to automobile and airplane technologies. When automobiles were introduced in the early 1900s, gasoline as fuel became a more important product from petroleum than kerosene.

**Electricity** The harnessing of electrical power had to wait for the development of an effective electrical generator. In 1882 in London, the first public power station began production. Electrification led to street lighting and electric street trains in the 1890s.

**Communications** The development of electricity and electronics over the years helped lead to important developments in communication technology. Inventors had been working with the idea of transmitting sound by electrical means since the early 19th century. Finally, a patent for the telephone was issued to **Alexander Graham Bell** in 1876. Early phone systems were notoriously low in quality, but Thomas Edison's 1886 design of a refined voice transmitter made telephone use more practical.



Radio developed after the experiments of Italian physicist **Guglielmo Marconi**. In 1901, he was able to send and receive a radio signal across the Atlantic Ocean. After further refinements and inventions, radio became a form of popular mass media with an impact unlike any previously seen.

## Global Trade and Migration

Railroads, steamships, and a new invention called the telegraph made exploration, development, and communication possible. The telegraph allowed immediate communication. The construction of railroads, including the **Transcontinental Railroad** that connected the Atlantic and Pacific oceans when it was completed in 1869, facilitated U.S. industrial growth. Like the canals, the railroads were heavily subsidized by public funds. The vast natural resources of the United States (timber, coal, iron, and **oil**, for example) and the ability to transport them efficiently contributed to the development of the United States as an industrial nation.

The desire for **capital**, money available to invest in a business, was a driving force domestically and abroad. Products of industrialization, such as the railroad, steamship, and the telegraph, directly linked farmers, miners, manufacturers, customers, and investors globally for the first time in history.

With the development of the railroad and steamships, such countries as Great Britain, Germany, and the United States intensified industrialization, increasing the need for resources. Industrialized countries sought to protect their access to resources and markets by establishing colonies.

Whereas earlier trade and migration often centered on coastal cities, railroads, steamships, and the telegraph also opened up to exploration and development the interior regions around the globe. Access to these areas increased trade and migration. (Connect: Write a paragraph describing how the Silk Roads set the stage for the industrial developments of the 1800s. See Topic 2.1.)

KEY TERMS BY THEME		
<p><b>ENVIRONMENT:</b> Resources coal coaling stations</p> <p><b>TECHNOLOGY:</b> Transportation and Communication Alexander Graham Bell Guglielmo Marconi Transcontinental Railroad</p>	<p><b>ECONOMY:</b> Industry steam engine James Watt steel oil capital</p>	<p><b>SOCIETY:</b> second industrial revolution</p>