

## 3.1 Invention and Mechanization

How did the development of new technologies change life in the United States?

### Explore

## The Driving Force of Transportation

What inventions helped to expand the railroad system?

As companies gathered more raw materials and produced more products, they needed better transportation networks to move raw materials to factories and to move products from factories to stores. Railroads solved this problem.

In 1829, George Stephenson, an English engineer, developed the first public railroad, which used a steam locomotive for power. A steam locomotive pulls the weight of the train cars using the power generated by a water boiler and a system of exhausting the steam to create a draft in its firebox. The firebox is the area of the engine where fuel, such as wood or coal, is burned, producing heat to boil the water and create steam. The draft mechanism draws huge amounts of air through the firebox, allowing fuel to be burned rapidly. Stephenson also developed a standard gauge for all railroads—4 feet, 8.5 inches. The gauge is the width between the inside sections of running railroad tracks. The cost of constructing and operating a rail line depends on the gauge size, and numerous gauges were used in early rail systems to save money or improve stability. Soon, railroads throughout Europe and the United States adopted Stephenson's gauge as the standard size.

A number of technological changes helped railways provide safer and more efficient transportation. In 1869, a U.S. inventor, George Westinghouse, developed an air brake that could automatically stop a train. Before air brakes, the early brake system on trains required that an operator, or brakeman, physically apply a hand brake in each car, signaled by the train engineer. Air brakes significantly enhanced the safety of speeding locomotives. In addition, by the 1870s, railroad companies began to use steel for rails, which were much more durable than iron rails. Steel rails broke less often and could carry heavier loads of cargo. The development of the refrigerated railroad car enabled companies to transport fresh meat to markets far away. The demand for fresh meat in these markets was high, and meatpacking became a profitable industry.

As these new developments helped to expand the railroad industry, several companies rushed to build and complete rail lines after the Civil War, which created competition in the railroad industry. The competition between these businesses helped keep fare costs lower for riders. No single company could charge too much because customers were able to find a competing railway line with less expensive fare.

Soon, railroads expanded into a nationwide network. The Union Pacific and Central Pacific railroads completed

a **transcontinental railroad** in 1869. The success of new rail lines in the West was partially due to the consolidation, or combination, of older railroad companies in the east during the late 1800s. Through the consolidation of several networks, passengers were able to travel on many of one company's lines at a low cost. Now, many more raw materials, goods, and people could be transported coast-to-coast in a week instead of months. Before long, other railroad lines crossed the country. In addition to goods, the railcars brought people in search of new opportunities.