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Industrial Revolution, 1750–1900

> *One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; . . . and the important business of making a pin is, in this manner, divided into about eighteen distinct operations.*
>
> —Adam Smith, *Wealth of Nations* (1776)

The quote above describes the rigid structure of early factory work, one of the most enduring images of the *Industrial Revolution.* The term *industrialization* refers not only to the increased mechanization of production, but also to the social changes that accompanied this shift. The Industrial Revolution began in Britain in the eighteenth century, and then it spread to other countries in northwest Europe and North America in the nineteenth century. Still later in the nineteenth century, it spread to Japan and Russia. In order to appreciate the impact of industrialization, it is important to understand its causes as well as what life was like prior to industrialization.

Preindustrial Societies

During the early eighteenth century, most families in Britain lived in rural areas, grew most of their own food, and made most of their own clothes. For centuries, wool and flax had been raised domestically, and people spun fabrics in their own homes.

However, one result of the East India Company's dealings with South Asia was that Indian cotton became available in Britain and before long it was in high demand. Wool and flax could not be produced as quickly or in as much quantity to compete with cotton imports. To compete with Indian cotton, investors in Britain began to build their nation's own cotton cloth industry. Using imported raw cotton produced by slave labor in the Americas, the British developed the *cottage industry* system, in which merchants provided raw cotton to women who spun it into finished cloth in their own homes.

Home spinning was hard work and did not pay well, but cottage industries gave women weavers a degree of independence. While working in their own homes, they were also within close proximity of their children. But this cottage industry, or *putting-out system* as it was called, was slow. Inventors demanded faster production, spurring the development of technologies that turned out cloth in more efficient ways.

Causes of Industrialization

The most obvious cause of industrialization was the development of technology. However, technological advances were not the only cause. Population growth and access to resources were other major contributors to Britain's industrialization. Yet analyzing historical causation is a complex process. Saying "A caused B" is often an oversimplification. Usually, historical causation is an expanding chain of causes and effects. For example, while the development of technology was one cause of industrialization, the growth of industrialization then spurred further advances in technology.

Growth of Technology By the mid-eighteenth century, the *spinning jenny* and the *water frame* reduced the time needed to spin yarn and weave cloth. The spinning jenny, invented by *James Hargreaves* in the 1760s, allowed a weaver to spin more than one thread at a time. The water frame, patented by *Richard Arkwright* in 1769, used waterpower to drive the spinning wheel. The water frame was more efficient than a single person's labor, and this mechanization doomed the household textile cottage industry, as textile production was moved to factories big enough to house these bulky machines. Arkwright was thus considered the father of the *factory system.*

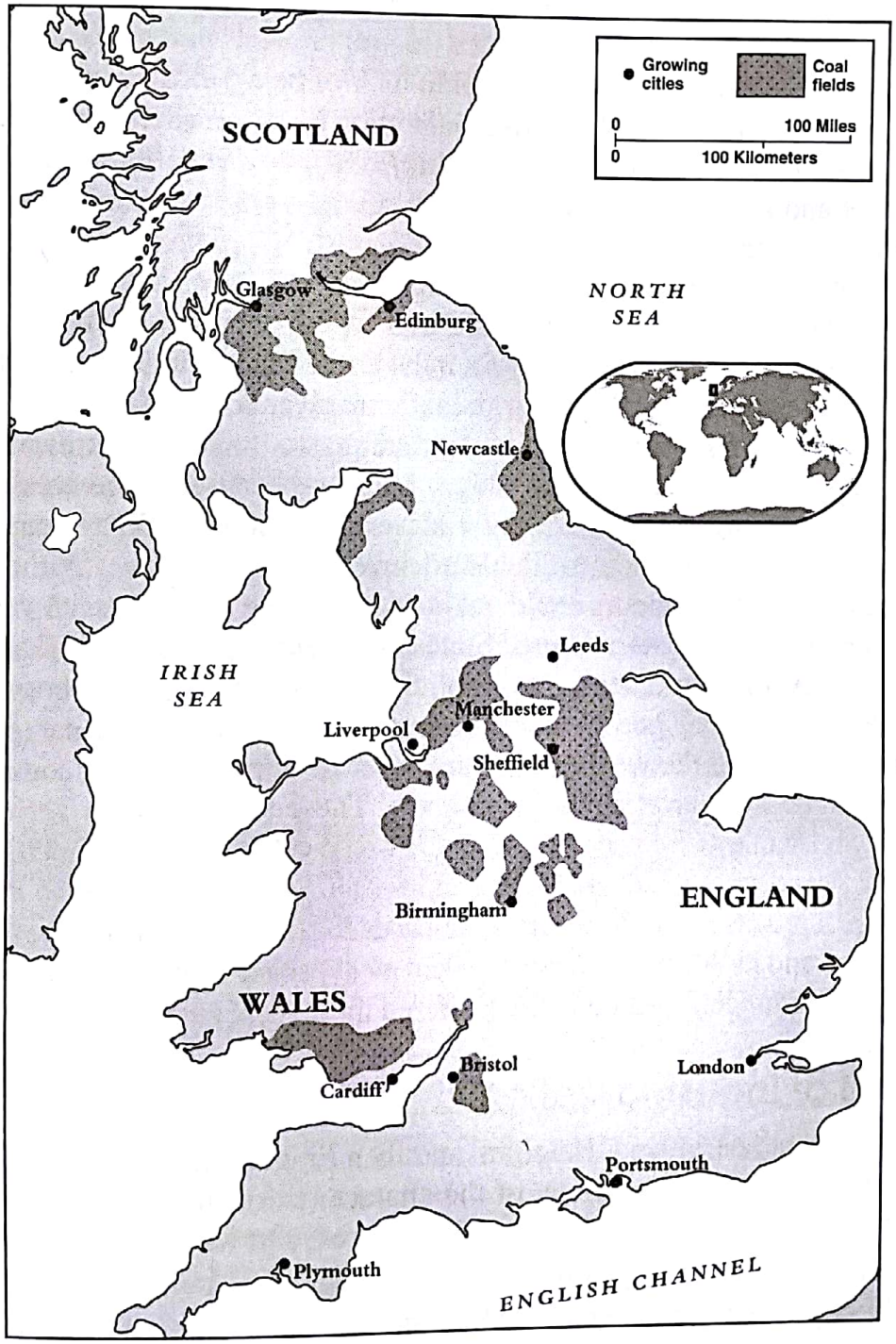
Interchangeable Parts In 1798, *Eli Whitney*, best known for developing the cotton gin, created a system of *interchangeable parts* for manufacturing firearms for the U.S. military. In Whitney's system, if a particular component of a machine were to break, the broken component could easily be replaced with a new, identical part. Entrepreneurs adapted this method of making firearms to the manufacture of other products. The system of interchangeable parts was a pivotal contribution to industrial technology. Instead of relying on skilled workers to craft every component of a product, Whitney's standardized tools allowed unskilled workers to attach a particular piece to a product. This led directly to a *division of labor* among workers. In this system, each worker specializes in a specific task. For example, one worker might a cast a part. Once cast, the part is given to another worker, whose specific job it is to install the part on the finished product, and so on. In the early twentieth century, Henry Ford expanded the concept of the division of labor, developing the moving *assembly line* to manufacture his Model T automobiles.

Steam Engine The new machinery benefitted from a new power source, one more mobile than streams. The version of *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. A steam-powered locomotive came almost 50 years later and produced power for railway trains.

Just as important was the development of the *steamship* in the late eighteenth century. Steam-powered ships were able to travel quickly upstream on rivers instead of having to sail up or be towed by people and animals along the shore. Steamships revolutionized transportation on lakes and the oceans as well, because ship captains were no longer dependent on winds for power. The need to travel long distances along ocean coasts led to the creation of coaling stations at critical points, such as in Cape Colony in South Africa and various islands in the Pacific.

Population Growth Slightly predating the Industrial Revolution during the early 1700s was an *agricultural revolution* resulting in increased productivity. *Crop rotation* (rotating different crops in and out of a field each year) and the *seed drill* (a device that efficiently places seeds in a designated spot in the ground) both increased food production. Additionally, the introduction of the potato from South America contributed more calories to people's diets. As nations industrialized, their populations grew because more food was available to more people. And because of improved medical care, infant mortality rates declined and people lived longer. With these demographic changes, more people were available to work in factories and to provide a market for manufactured goods.

THE GROWTH OF BRITISH CITIES, C. 1800



Urbanization However, the growing population would not remain in rural areas. Migration was sometimes the best of bad options. English towns had traditionally allowed farmers to cultivate land or tend sheep on government property known as "the commons." However, this custom ended with the *enclosure movement* as the government fenced off the commons in order to give exclusive use of it to people who paid for the privilege or who purchased the land. Many farmers became landless and destitute. The enclosure movement was thus instrumental in another wave of demographic change—forcing small farmers to move from rural areas to urban areas such as *Manchester* and *Liverpool,* and become the new industrial workforce.

Britain's Advantages Britain had many geographical advantages in the process of industrialization. Located on the Atlantic Ocean with its many *seaways,* the country was well placed to import *raw materials* and export finished goods. It also had the geographic luck of being located atop immense coal deposits. Coal was vital to industrialization because when burned it could power the steam engine. The burning of this *fossil fuel*, an energy source derived from plant and animal remains, was also essential in the process of separating iron from its ore. Iron production (and later steel production) allowed the building of larger bridges, taller buildings, and stronger ships. Coal mining became the major industry of northern and western Britain, including South Wales, Yorkshire, and Lancashire. When the United States industrialized, coal-mining areas developed in West Virginia, Pennsylvania, and Kentucky.

As a colonizing power, Britain also had access to resources available in its colonies, including timber for ships. Largely because of the wealth they accumulated during the trans-Atlantic slave trade, enough British capitalists had excess *capital* (money available to invest in businesses). Without this capital, private entrepreneurs could not have created new commercial ventures.

Britain, the northeastern United States, and other regions also had a natural network of rivers supplemented by publicly funded canals and harbors. These water routes made transport of raw materials and finished products inexpensive.

Britain also had the world's strongest fleet of ships, including commercial ships for trade and naval ships for defense. These ships brought agricultural products to Britain to be used to make finished products for consumers.

A final and vital factor that aided industrialization in Britain was the legal protection of private property. Entrepreneurs needed the assurance that the business they created and built up would not be taken away, either by other businesspeople or by the government. Not all nations offered these legal guarantees.

Spread of Industrialization

After Britain industrialized, Belgium, and then France and Germany followed. These countries possessed many of the characteristics that allowed Britain to industrialize, including capital, natural resources, and water transportation.

France and Germany One factor that was not in France's favor was its sparsely populated urban centers, which limited the amount of labor available

for factories. Another factor was the French Revolution (1789–1799) and subsequent wars involving France and its neighbors, which consumed both the attention and the capital of France's elites. These factors delayed the Industrial Revolution for France.

Germany was politically fragmented into numerous small states, which delayed its industrialization. However, once Germany unified in 1871, it quickly became a leading producer of steel and coal.

The United States The United States began its industrial revolution in the nineteenth century. By 1900, the United States was a leading industrial force in the world. 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 nation's vast natural resources, including timber, coal, and oil, contributed to its development as an industrial nation.

Human capital (the workforce) was also a key factor in America's success. Political upheaval and widespread poverty brought a large number of immigrants to the United States from Europe and East Asia. These immigrants, as well as migrants from rural areas in the United States, provided the labor force to work in the factories. The development of the telegraph in the 1830s made long-distance communication easy for the first time in history.

A Second 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 nineteenth and early twentieth 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. The development of chemical techniques to extract kerosene from petroleum in 1847 led to other developments such as the internal combustion engine, which in turn led to automobile and airplane technologies. Similarly, the harnessing of electrical power led to electrification—street lighting and electric street trains in the 1890s. Other technologies followed as well, such as the telephone (1876) and wireless communication and radio (1901).

Agricultural Products for Trade in the Nineteenth Century

Product	Producers	Users (Finished Products)
Wheat	Russia, Britain	Britain (food)
Rubber	Brazilian Amazon	Britain (tires, footwear, fabrics)
Palm Oil	West Africa, Indonesia	Britain (cooking oil, soap)
Sugar	Caribbean Islands, Brazil	Britain (refined sugar)
Cattle and Hogs	United States, Ireland, Argentina	Britain, United States (meat)
Cotton	United States	Britain (textiles)

Japan By the end of the nineteenth century, Japan also began the process of industrialization. Under the *Meiji* (1868–1912), Japan ended its self-imposed isolation from the rest of the world. It had been alarmed by the advanced navy and armaments produced by the industrial systems of the West—particularly those of Britain and the United States—and how they had humiliated China. Japan's leaders realized that their country needed to industrialize to protect itself. The leaders hired foreign experts to instruct their workers and business managers about modern industry. However, in replicating the "progress" made by Western countries, the Japanese also replicated some of industrial society's problems. For example, accounts of abuse and exploitation of female Japanese mill workers are similar to the experiences that British female mill workers had recorded decades earlier. (Test Prep: Write a brief paragraph comparing Japan's industrialization with developments in the West. See pages 456–457.)

Russia Russia also began to industrialize, focusing particularly on railroads and exports. By 1900, Russia had more than 36,000 miles of railroad, connecting its commercial and industrial areas. The *Trans-Siberian Railroad* stretched from Moscow to the Pacific Ocean, allowing Russia to trade more easily with countries in East Asia, such as China and Japan. The Russian coal, iron, and steel industries developed with the railroad, mostly in the 1890s. By 1900 Russia had become the fourth largest producer of steel in the world. However, the economy remained overwhelmingly agricultural until after the Communists seized power in 1917.

Effects of the Industrial Revolution

The Industrial Revolution affected every aspect of society, transforming not only the way products were manufactured, but also the nature of work itself. Because of industrialization, people began to move from rural to urban areas, a trend that continued through the twentieth century. By the beginning of the 1900s, British society was more urban than rural. The new workplace and the growth of business created an entirely new class hierarchy. Women and children at every rung of society saw their roles in the family change dramatically.

Effects on Families Prior to industrialization, family members worked in close proximity to one another. Whether women spun fabric in their own homes or landless workers farmed the fields of a landlord, parents and children usually spent their working hours together. Industrialization disrupted this pattern. Industrial machinery was used in large factories, making it impossible to work from home. Thus, family members had to leave their homes and neighborhoods for a long workday in order to earn enough money to survive.

In a factory, work schedules were nothing like they were on a farm or in a cottage industry. The shrill sounds of the factory whistle told workers when they could take a break, obviously a culture shock to ex-farmers who had previously completed tasks according to their own needs and schedules. Considering that workers commonly spent 14 hours a day, six days a week in a factory, exhaustion was common. Some of these exhausted workers operated dangerous heavy machinery. Injuries and death were common.