

Topic Page: [Industrial Revolution](#)

Definition: **Industrial Revolution** from *Dictionary of Energy*

History. the name for a process of technological innovation, mechanized development, and agricultural improvements that first gathered momentum in Great Britain in the late 18th century and then extended to continental Europe, North America, and other areas in the early 19th century and thereafter. See next page.



Image from: [in 1763 James Watt designed his steam engine.... in Encyclopedia of Environment and Society](#)

Summary Article: **Industrial Revolution**
from *Encyclopedia of Geography*

Although capitalism has been a dynamic socioeconomic system since its inception, the pace of technological and social change accelerated exponentially in the 18th and 19th centuries with the Industrial Revolution. It is important not to equate capitalism and industrialization, for they are not synonymous. Historically, the Industrial Revolution occurred long after capitalism began; indeed, for most of capitalism's history, it involved preindustrial forms of production, including artisanal and household types. However, starting in the mid 1800s, an explosive increase in the speed and productivity of capitalist production occurred that transformed the worlds of work, everyday life, and the global economy. Industrialization is a complex process that involves multiple transformations in inputs, outputs, and technologies. Three dimensions are particularly important here: (1) the use of inanimate energy, (2) technological innovation, and (3) increased productivity. This entry first describes these aspects of the Industrial Revolution and then examines its geographical development, cyclical nature, and global impact.

Inanimate Energy

If preindustrial societies relied and continue to rely on animate sources of energy (i.e., human and animal muscle power), industrialization can be defined loosely as the harnessing of inanimate sources of energy. The first of this type was running water in waterwheels, a source used since the late feudal era to grind corn and flour and to saw wood. Running water was a major source of energy in the earliest stages of the Industrial Revolution, but it constrained firms to locating near streams and rivers; moreover, most streams are ephemeral, that is, they do not flow all year long.

A more efficient source of inanimate energy involves the steam engine, originally designed by Thomas Newcomen in 1712; the first prototype, however, was built by the Scottish engineer James Watt in 1769 as part of an effort to expunge seawater from coal mines that reached under the ocean. The steam engine marked a decisive turning point in the process of industrialization, with widespread applications in several areas of production and transportation. Wood provided the first major source of fuel for this invention, which required heating water into steam to drive the engine's pistons. As producers began to cut down forests in Britain in large numbers, deforesting much of the country, wood supplies began to dwindle, and the rising cost eroded profits. As wood became scarce, producers switched to coal. Thus, as Britain industrialized, several areas became major coal-producing centers, including Southern Wales and Newcastle. As the Industrial Revolution spread across the face of Europe in the 19th century, the large coal deposits of the Northern European lowlands became increasingly important, fueling the growth of manufacturing complexes in Belgium, Northern France,

Northern Italy, Germany, Poland, and the Ukraine. In the United States as well, Appalachian coal played a key role in the nation's industrialization, and that industry flourished hand in hand with the rise of the Manufacturing Belt. In the late 19th and 20th centuries, coal was joined by other fossil fuels, particularly petroleum and natural gas. The abundance of cheap energy was the lifeblood of industrialization, and production became increasingly energy intensive as a result.

Technological Innovation

The Industrial Revolution witnessed an explosive jump in the number, diversity, and applications of new technologies. A technology can be defined simply as a means of converting inputs to outputs. These can range from extremely simple to very sophisticated. As industrialization produced an increasingly complex division of labor, as noted by Adam Smith, opportunities for new inventions rose rapidly. These innovations were employed in agriculture, in manufacturing, in transportation and communications, and in services.

In the Industrial Revolution, a major reorganization in the nature of work occurred with the development of the factory system and a far more detailed division of labor both within and among firms. Prior to this era, industrial work was organized on a small-scale artisanal basis, including home-based work. By the late 18th century, firms in different industries were grouping large numbers of workers together under one roof, a process that effectively created the industrial working class. Inside factories, workers used vast amounts of capital, that is, many types of machines. The introduction of interchangeable parts, invented by the American gun maker Eli Whitney, made the production and operation of machines much cheaper and more reliable. By the early 20th century, Henry Ford introduced the moving assembly line, which further accelerated the tempo of work and the ability of workers to produce.

Productivity Increases

As a consequence of the technological changes of the Industrial Revolution, productivity levels surged. Productivity refers to the level of output generated by a given volume of inputs; productivity increases refer to higher levels of efficiency—that is, greater levels of output per unit of input (e.g., labor hour or unit of land) or, conversely, fewer inputs per unit of output.

Productivity levels rose exponentially in the 19th century throughout the industrializing world. As the cost of producing goods declined, standards of living rose correspondingly. Most workers labored long hours under notoriously exploitative conditions and endured a standard of living quite low compared with those we enjoy today. But nonetheless, over several decades, industrialization saw many kinds of goods become increasingly affordable to the growing middle class. Because wage rates have been linked historically to the marginal productivity of labor, the working class became significantly better off. Most important in this regard concerns the industrialization of agriculture. As food became progressively cheaper, diets improved as more people ate more and better food than ever before, with corresponding improvements in infant mortality rates and life expectancy. With the notorious exception of the Irish Potato Famine of the 1840s, hunger and malnutrition gradually declined throughout Europe.

The Geography of the Industrial Revolution

The Industrial Revolution unfolded very unevenly over time and space. Whereas capitalism had its origins in Northern Italy, industrialization was very much a product of northwestern Europe. Some observers put the first textile factories in Belgium, in cities such as Liège and Flanders, with a tradition that dated to late medieval times. However, it was Britain that became the world's first industrialized

nation, a status that likely reflected, among other things, its extensive network of trading ties and prior commercialization of agricultural land through the Enclosures. By the end of the 18th century, Britain stood virtually alone as the world's only industrial economy, a fact that gave it an enormous advantage over its rivals and propelled it to the status of world hegemon. Cities in the Midlands of Britain, such as Leeds and Manchester, were known as the “workhouses of the world” for their high concentrations of workers, capital, and output. Others, such as London, Glasgow, and Liverpool, became shipbuilding centers. In many cities, networks of producers in guns, watches, and light industry formed dense industrial districts.

A half-century after it began in Britain, the Industrial Revolution diffused to the European Continent, North America, and Japan. In France, this process saw the formation of industrial complexes in the lower Seine River, Lille, and Paris. In Italy, Milan and the Po River valley became a major producer of textiles and shoes. In Northern Spain, Barcelona became an important center. In Scandinavia, cities such as Stockholm became major ship producers. In Germany, which was late to industrialize, the Ruhr region became a global center of steel, automobile, and petrochemical firms in the late 19th century, propelling that newly unified nation to global prominence.

By the early 19th century, the revolution leapfrogged across the Atlantic, igniting the industrialization of Southern New England with the growth of the textile industry there. In New York City, a huge complex of light manufacturing arose, centered on garments but including many other small firms. Philadelphia became a large center of ship construction. Stretching across the southern shores of the Great Lakes, the Manufacturing Belt became the second largest industrial region in the late 19th century, following Britain, largely on the basis of the steel, rubber, tool and die, agricultural implements, and automobile industries. However, industrialization also dramatically affected agriculture and meat packing.

Russia did not become industrialized until the 1920s and 1930s, when the Soviet Union under Stalin leaped to become the world's second largest economy in the span of a decade. Under the Soviet system, heavy manufacturing, particularly steel and armaments, was emphasized over sectors producing consumer goods. Starting in the 1870s, Japan became the first non-Western country to join the industrialized nations, developing a formidable industrial base in steel, railroads, armaments, textiles, and ship building that fueled its expansionary growth and militarism.

In the late 20th century, the process of industrialization diffused to many developing countries, particularly the East Asian Newly Industrialized Countries (NICs) such as South Korea, Hong Kong, Taiwan, and Singapore, many of which borrowed liberally from the Japanese model. More recently, Thailand, Indonesia, and Malaysia have moved down this path. Rapid economic growth in China today represents another stage in the industrialization of Asia, including the production of textiles, toys, and electronics. Similar events occurred in Mexico and Brazil, including the maquiladores in the former and an electronics and aerospace industry in the latter. In a sense, the industrialization of the developing world, which is still very partial and incomplete, is a continuation of a long-standing historical process.

Cycles of Industrialization

The nature and form of industrialization varied in successive historical periods. Capitalism is prone to long-term cyclical shifts in its composition, often in waves of roughly 50 to 75 yrs.' (years') duration, often known as Kondratief waves. This process saw the rise of different industries at different times. Industrialization was thus not one process but a series of them that varied over time and space.

The first wave of the Industrial Revolution (1770s-1820s) centered on the textile industry. In Britain, as in the rest of Europe, North America, Japan, and the developing world today, textiles have *always* led industrialization. Easy to set up, with few requirements of capital or labor skills, this sector initiated the industrial landscapes of most of the world. Because this early wave of industrialization was centered in Britain, it witnessed that nation become the leading economic power in the world, initiating the period of the Pax Britannica.

The second wave, from the 1820s to the 1880s, was a period dominated by heavy industry. In the 19th century, sectors such as shipbuilding, railroads, and iron and steel plants were critical. Large scale and capital intensive, these types of firms differed markedly from the light industry of textiles. They required massive capital investments, an infrastructure often built by the state, were difficult to enter, and moved toward an oligopoly rather than a competitive market structure. This was the period in which the U.S. Manufacturing Belt began to form, although most of its growth was after the Civil War of the 1860s.

The third wave of industrialization, from the 1880s to the 1930s, saw numerous heavy industries appear, including steel, rubber, glass, and automobiles. This was a period of massive technological change, including capital intensification and automation of work, as well as economic changes. As local markets gave way to national markets, most sectors experienced a steady oligopolization, or concentration of output and ownership in the hands of a few large firms led by robber barons.

In the fourth wave of industrialization, which started during or immediately after the Depression of the 1930s and lasted until the oil shocks of the 1970s, the primary growth sectors were petrochemicals and automobiles. It is often associated with Fordist systems of mass production. With a relatively stable global economy, this era saw the domination of the world system by the United States, which produced a huge share of the planet's industrial output, including, in the 1950s, two thirds of its steel and 60% of its automobiles.

The fifth wave of industrialization, often held to begin after the oil shocks of the 1970s that ended the post-World War II boom, has been led by the electronics industry, which was powered by the microelectronics revolution and by the explosive growth of producer services.

During each era, the major propulsive industry was commonly featured as the “high-tech” sector of its day. Thus, just as electronics is often celebrated at this historical moment for its innovativeness and ability to sustain national competitiveness, so too were the textile industry in the 18th century and the steel industry in the 19th century associated with high levels of productivity and wages.

Consequences of the Industrial Revolution

The Industrial Revolution permanently changed the social and spatial fabric of the world, particularly in the societies that now comprise the economically developed countries. Within a century of its inception, industrialization transformed a series of rural, poverty-stricken societies into relatively prosperous, urbanized ones. It is no exaggeration to credit industrialization with the rise of modernity in all its complex forms.

The Industrial Revolution essentially created the modern working class. For the first time in human history, large numbers of workers labored together using machines. These conditions were markedly different from those facing agricultural or artisanal workers, who were dispersed over large spaces and relied on animate sources of energy. Industrialization gave rise to organized labor markets in which

workers were paid by the hour, day, or week. This process was not easy, given how brutally exploitative working conditions were during this time. Workers typically labored for 10, 12, even 14 hours per day, 6 days per week for relatively low wages. Often the work was unsanitary and dangerous, even lethal, as workers were subjected to abusive employers, accidents, poor lighting, and poor air quality. Child labor was also common, subjecting those as young as 4 or 5 yrs. of age to horrendous conditions.

As the result of this process, time—like space and so much else—became a commodity, something bought and sold. The transition from agricultural time to industrial time was important. Prior to the Industrial Revolution, people experienced time seasonally, with different tasks at different times of the year, and rarely felt the need to be conscious of it, for precision was unnecessary. With industrialization, however, time was measured and divided into discrete units, as signaled by the factory whistle, clock, bell, and stopwatch. This change marked the commodification of time through the labor market.



Spinners at Cherryville Mfg. Co., North Carolina, 1908. During the Industrial Revolution, child labor was common, subjecting those as young as 4 or 5 yrs. of age to horrendous conditions.

Source: Library of Congress Prints and Photographs Division, LC-USZ62-65667.

Industrialization also produced labor unions. The first resistance to employers included the British Luddites in the late 18th and early 19th centuries, who blamed their miserable working conditions on the machines they used and often destroyed them in attempts to halt their exploitation. By the late 19th century, organized labor had created a number of unions, which in the United States included the Knights of Labor, the American Federation of Labor (AFL), and in the 20th century, the Industrial Workers of the World and the Congress of Industrial Organizations (CIO, which later merged with the AFL to form the AFL-CIO). Industrialization was thus often a period of considerable class conflict.

Geographically, the Industrial Revolution was closely associated with the growth of cities. Almost everywhere, industrialization and urbanization have been virtually simultaneous processes. The reasons why firms concentrated in cities are important. Cities were clearly centers of capital as much as they

were centers of labor. There are powerful reasons for firms to concentrate, or agglomerate, in cities. Most firms benefit by having close proximity to other firms, including lower transport costs to suppliers of parts and ancillary services, and access to an infrastructure, specialized information, and the labor force. As complexes of firms sprouted in cities, industrialization changed the character of societies from predominantly rural to predominantly urban. In Western Europe, North America, and Japan, for the first time in history, the majority of people lived in cities. In the United States, for example, the first national census of 1790 showed that 95% of Americans lived in rural areas. This proportion decreased throughout the 19th century, and by 1920, 50% of the nation's population lived in cities. Today, it is roughly 85%, a proportion that is found in most economically developed countries.

Industrialization also shaped the population growth rates and demographic composition. On the eve of the Industrial Revolution, the famous theorist Thomas Malthus predicted that rapid population growth would create widespread famine. Yet Malthus was soon proven to be wrong, at least in the short run. The industrialization of agriculture generated productivity increases greater than the rate of population growth, and the creation of a stable food supply improved most people's diets. As a result, life expectancy rose. Industrialization also lowered death rates, particularly as malnutrition declined and infant mortality rates dropped. Eventually, public health measures and cleaner water helped control the spread of most infectious diseases. As death rates dropped, the populations of industrializing countries increased dramatically. This change was also accompanied by a shift from the extended to the nuclear family. Eventually, industrialization also led to a decline in the birth rate; families had fewer children, and population growth rates declined.

Yet another impact of the Industrial Revolution concerned the global economy. Capitalism had formed a loose network of international trade well before the 18th century. The harnessing of inanimate energy for transportation dramatically accelerated the speed of both land and water transportation, notably through the railroad and steamship, forming a significant round of time-space compression. New, industrialized forms of transportation were not only faster but also cheaper, resulting in cost-space convergence or compression as well. These changes dramatically lowered the barriers to trade, and the volume of imports and exports began to soar. Europe, starting with Britain, could import unprocessed raw materials, including cotton, timber, sugar, wheat, and mineral ores, and export high-value-added finished goods, a process that generated large numbers of jobs in Europe and contributed to a steady rise in the standard of living.

Finally, the industrial world economy saw an explosion of international finance. British banks, largely concentrated in London, for example, began to extend their activities on an international basis, lending to clients and investing in markets overseas. Much of the capital that financed the American railroad network was from Britain. The globalization of production was thus accompanied by the steady globalization of money and credit.

See also

Agglomeration Economies, Agriculture, Industrialized, Automobile Industry, Business Cycles and Geography, Demographic Transition, Economic Geography, Fordism, Industrialization, Malthusianism, Manufacturing Belt, Textile Industry, Time-Space Compression, Urbanization

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