**Industrial Revolution**

**Industrial Revolution**, in modern history, is the [process](https://www.britannica.com/topic/industrialization) of change from an agrarian and handicraft economy to one dominated by [industry](https://www.britannica.com/technology/industry) and [machine](https://www.britannica.com/technology/machine) [manufacturing](https://www.britannica.com/technology/manufacturing). This process began in [Britain](https://www.britannica.com/place/United-Kingdom) in the 18th century and from there spread to other parts of the world. Although used earlier by French writers, the term *Industrial Revolution* was first popularized by the English economic historian [Arnold Toynbee](https://www.britannica.com/biography/Arnold-Toynbee) (1852–83) to describe Britain’s economic development from 1760 to 1840. Since Toynbee’s time the term has been more broadly applied.

The main features involved in the Industrial Revolution were technological, socioeconomic, and cultural. The [technological](https://www.britannica.com/technology/history-of-technology) changes included the following: (1) the use of new basic materials, chiefly [iron](https://www.britannica.com/science/iron-chemical-element) and [steel](https://www.britannica.com/technology/steel), (2) the use of new [energy](https://www.britannica.com/science/energy) sources, including both fuels and motive power, such as [coal](https://www.britannica.com/science/coal-fossil-fuel), the [steam engine](https://www.britannica.com/technology/steam-engine), [electricity](https://www.britannica.com/science/electricity), [petroleum](https://www.britannica.com/science/petroleum), and the [internal-combustion engine](https://www.britannica.com/technology/internal-combustion-engine), (3) the [invention](https://www.britannica.com/technology/invention-technology) of new machines, such as the [spinning jenny](https://www.britannica.com/technology/spinning-jenny) and the power [loom](https://www.britannica.com/technology/loom) that permitted increased production with a smaller expenditure of human energy, (4) a new organization of work known as the [factory system](https://www.britannica.com/topic/factory-system), which entailed increased [division of labour](https://www.britannica.com/topic/division-of-labour) and specialization of function, (5) important developments in [transportation](https://www.britannica.com/technology/transportation-technology) and [communication](https://www.britannica.com/topic/communication), including the steam [locomotive](https://www.britannica.com/technology/locomotive-vehicle), steamship, [automobile](https://www.britannica.com/technology/automobile), [airplane](https://www.britannica.com/technology/airplane), [telegraph](https://www.britannica.com/technology/telegraph), and [radio](https://www.britannica.com/topic/radio), and (6) the increasing application of [science](https://www.britannica.com/science/science) to industry. These technological changes made possible a tremendously increased use of natural resources and the [mass production](https://www.britannica.com/technology/mass-production) of manufactured goods.

There were also many new developments in nonindustrial spheres, including the following: (1) agricultural improvements that made possible the provision of [food](https://www.britannica.com/topic/food) for a larger nonagricultural population, (2) economic changes that resulted in a wider distribution of wealth, the decline of [land](https://www.britannica.com/topic/land-economics) as a source of wealth in the face of rising industrial production, and increased [international trade](https://www.britannica.com/topic/international-trade), (3) political changes reflecting the shift in economic power, as well as new state policies corresponding to the needs of an industrialized society, (4) sweeping social changes, including the growth of [cities](https://www.britannica.com/topic/city), the development of working-class movements, and the emergence of new patterns of authority, and (5) cultural transformations of a broad order. Workers acquired new and distinctive skills, and their relation to their tasks shifted; instead of being craftsmen working with [hand tools](https://www.britannica.com/technology/hand-tool), they became machine operators, subject to factory [discipline](https://www.merriam-webster.com/dictionary/discipline). Finally, there was a psychological change: confidence in the ability to use resources and to master nature was heightened.

**The first Industrial Revolution**

In the period 1760 to 1830 the Industrial Revolution was largely confined to [Britain](https://www.britannica.com/topic/history-of-United-Kingdom). Aware of their head start, the British forbade the export of machinery, skilled workers, and manufacturing techniques. The British [monopoly](https://www.britannica.com/topic/monopoly-economics) could not last forever, especially since some Britons saw profitable industrial opportunities abroad, while continental European businessmen sought to lure British know-how to their countries. Two Englishmen, [William](https://www.britannica.com/biography/William-Cockerill) and [John Cockerill](https://www.britannica.com/biography/John-Cockerill), brought the Industrial Revolution to [Belgium](https://www.britannica.com/place/Belgium) by developing machine shops at [Liège](https://www.britannica.com/place/Liege-Belgium) (c. 1807), and Belgium became the first country in continental Europe to be transformed economically. Like its British progenitor, the Belgian Industrial Revolution centred in iron, coal, and [textiles](https://www.britannica.com/topic/textile).

[**Industrial Revolution**](https://cdn.britannica.com/90/198190-050-97332EE2/map-spread-Industrial-Revolution-Europe.jpg): [France](https://www.britannica.com/place/France) was more slowly and less thoroughly industrialized than either Britain or Belgium. While Britain was establishing its industrial leadership, France was immersed in its [Revolution](https://www.britannica.com/event/French-Revolution), and the uncertain political situation discouraged large investments in industrial [innovations](https://www.merriam-webster.com/dictionary/innovations). By 1848 France had become an industrial power, but, despite great growth under the [Second Empire](https://www.britannica.com/topic/Second-Empire), it remained behind Britain.

Other European countries lagged far behind. Their [bourgeoisie](https://www.britannica.com/topic/bourgeoisie) lacked the wealth, power, and opportunities of their British, French, and Belgian counterparts. Political conditions in the other nations also hindered industrial expansion. [Germany](https://www.britannica.com/place/Germany), for example, despite vast resources of coal and iron, did not begin its industrial expansion until after national unity was achieved in 1870. Once begun, Germany’s industrial production grew so rapidly that by the turn of the century that nation was outproducing Britain in steel and had become the world leader in the chemical industries. The rise of [U.S.](https://www.britannica.com/place/United-States) industrial power in the 19th and 20th centuries also far outstripped European efforts. And [Japan](https://www.britannica.com/place/Japan) too joined the Industrial Revolution with striking success.

The eastern European countries were behind early in the 20th century. It was not until the five-year plans that the [Soviet Union](https://www.britannica.com/place/Soviet-Union) became a major industrial power, telescoping into a few decades the industrialization that had taken a century and a half in Britain. The mid-20th century witnessed the spread of the Industrial Revolution into hitherto nonindustrialized areas such as [China](https://www.britannica.com/place/China) and [India](https://www.britannica.com/place/India).

**The**[**second Industrial Revolution**](https://www.britannica.com/topic/Second-Industrial-Revolution)

Despite considerable overlapping with the “old,” there was mounting evidence for a “new” Industrial Revolution in the late 19th and 20th centuries. In terms of basic materials, modern industry began to exploit many natural and [synthetic](https://www.merriam-webster.com/dictionary/synthetic) resources not hitherto utilized: lighter [metals](https://www.britannica.com/science/metal-chemistry), new [alloys](https://www.britannica.com/technology/alloy), and synthetic products such as [plastics](https://www.britannica.com/science/plastic), as well as new [energy](https://www.britannica.com/science/energy) sources. Combined with these were developments in [machines](https://www.britannica.com/technology/machine), [tools](https://www.britannica.com/technology/tool), and [computers](https://www.britannica.com/technology/computer) that gave rise to the automatic factory. Although some segments of industry were almost completely mechanized in the early to mid-19th century, automatic operation, as distinct from the [assembly line](https://www.britannica.com/technology/assembly-line), first achieved major significance in the second half of the 20th century.

Ownership of the means of production also underwent changes. The oligarchical ownership of the means of production that characterized the Industrial Revolution in the early to mid-19th century gave way to a wider distribution of ownership through purchase of common [stocks](https://www.britannica.com/topic/stock-finance) by individuals and by institutions such as insurance companies. In the first half of the 20th century, many countries of Europe socialized basic sectors of their economies. There was also during that period a change in political theories: instead of the [laissez-faire](https://www.britannica.com/topic/laissez-faire) ideas that dominated the economic and social thought of the classical Industrial Revolution, governments generally moved into the social and economic realm to meet the needs of their more complex industrial societies. That trend was reversed in the United States and the United Kingdom beginning in the 1980s.

**Industry**

**Industry**, group of productive enterprises or organizations that produce or supply goods, services, or sources of income. In [economics](https://www.britannica.com/topic/economics), industries are generally classified as primary, secondary, tertiary, and quaternary; secondary industries are further classified as heavy and light.

**Primary industry**

This sector of a nation’s economy includes [agriculture](https://www.britannica.com/topic/agriculture), [forestry](https://www.britannica.com/science/forestry), [fishing](https://www.britannica.com/technology/commercial-fishing), [mining](https://www.britannica.com/technology/mining), [quarrying](https://www.britannica.com/technology/quarry-mining), and the extraction of [minerals](https://www.britannica.com/technology/mineral-processing). It may be divided into two categories: genetic industry, including the production of raw materials that may be increased by human intervention in the production process; and extractive industry, including the production of exhaustible raw materials that cannot be augmented through cultivation.

The genetic industries include agriculture, forestry, and [livestock](https://www.britannica.com/topic/livestock-farming) management and fishing—all of which are subject to scientific and technological improvement of renewable resources. The extractive industries include the mining of mineral ores, the quarrying of stone, and the extraction of mineral fuels.

Primary industry tends to dominate the economies of undeveloped and developing nations, but as secondary and tertiary industries are developed, its share of the economic output tends to decrease.

**Secondary industry**

This sector, also called [manufacturing](https://www.britannica.com/technology/manufacturing) industry, (1) takes the raw materials supplied by primary industries and processes them into consumer goods, or (2) further processes goods that other secondary industries have transformed into products, or (3) builds capital goods used to manufacture consumer and nonconsumer goods. Secondary industry also includes energy-producing industries (e.g., [hydroelectric](https://www.britannica.com/science/hydroelectric-power) industries) as well as the [construction](https://www.britannica.com/technology/construction) industry.

Secondary industry may be divided into heavy, or large-scale, and light, or small-scale, industry. [Large-scale industry](https://www.britannica.com/topic/heavy-industry) generally requires heavy capital investment in plants and [machinery](https://www.britannica.com/technology/machine), serves a large and [diverse](https://www.merriam-webster.com/dictionary/diverse) market including other manufacturing industries, has a complex industrial organization and frequently a skilled specialized [labour force](https://www.britannica.com/topic/labor-in-economics), and generates a large volume of output. Examples would include [petroleum refining](https://www.britannica.com/technology/petroleum-refining), [steel](https://www.britannica.com/technology/steel) and iron manufacturing (*see* [metalwork](https://www.britannica.com/topic/metalwork)), [motor vehicle](https://www.britannica.com/technology/automobile) and heavy machinery manufacture, [cement](https://www.britannica.com/technology/cement-building-material) production, nonferrous metal refining, [meat-packing](https://www.britannica.com/technology/meat-processing), and [hydroelectric power](https://www.britannica.com/science/hydroelectric-power) generation.

Light, or small-scale, industry may be characterized by the nondurability of manufactured products and a smaller capital investment in plants and equipment, and it may involve nonstandard products, such as customized or craft work. The labour force may be either low skilled, as in [textile](https://www.britannica.com/topic/textile) work and [clothing](https://www.britannica.com/topic/dress-clothing) manufacture, [food processing](https://www.britannica.com/technology/food-processing), and [plastics](https://www.britannica.com/science/plastic) manufacture, or highly skilled, as in [electronics](https://www.britannica.com/technology/electronics) and [computer](https://www.britannica.com/technology/computer) hardware manufacture, precision instrument manufacture, gemstone cutting, and craft work.

**Tertiary industry**

This broad sector, also called the [service industry](https://www.britannica.com/topic/service-industry), includes industries that, while producing no [tangible](https://www.merriam-webster.com/dictionary/tangible) goods, provide services or intangible gains or generate wealth. This sector generally includes both private and government enterprises.

The industries of this sector include, among others, [banking](https://www.britannica.com/topic/bank), [finance](https://www.britannica.com/topic/finance), [insurance](https://www.britannica.com/topic/insurance), [investment](https://www.britannica.com/topic/investment), and real estate services; wholesale, retail, and resale trade; [transportation](https://www.britannica.com/technology/transportation-technology); professional, consulting, legal, and personal services; [tourism](https://www.britannica.com/topic/tourism), [hotels](https://www.britannica.com/topic/hotel), [restaurants](https://www.britannica.com/topic/restaurant), and entertainment; repair and maintenance services; and health, [social welfare](https://www.britannica.com/topic/social-welfare-program), administrative, [police](https://www.britannica.com/topic/police), security, and defense services.

**Quaternary industry**

An extension of tertiary industry that is often recognized as its own sector, quaternary industry, is concerned with information-based or knowledge-oriented products and services. Like the tertiary sector, it [comprises](https://www.merriam-webster.com/dictionary/comprises) a mixture of private and government endeavours. Industries and activities in this sector include [information systems](https://www.britannica.com/topic/information-system) and information [technology](https://www.britannica.com/technology/technology) (IT); [research and development](https://www.britannica.com/topic/research-and-development), including technological development and scientific research; financial and strategic analysis and consulting; media and [communications](https://www.britannica.com/topic/communication) technologies and services; and [education](https://www.britannica.com/topic/education), including [teaching](https://www.britannica.com/topic/teaching) and educational technologies and services.

**Steam engine**

**Steam engine**, [machine](https://www.britannica.com/technology/machine) using steam power to perform mechanical [work](https://www.britannica.com/science/work-physics) through the agency of heat.

In a steam engine, hot steam, usually supplied by a [boiler](https://www.britannica.com/technology/boiler), expands under [pressure](https://www.britannica.com/science/pressure), and part of the heat energy is converted into work. The remainder of the heat may be allowed to escape, or, for maximum engine [efficiency](https://www.merriam-webster.com/dictionary/efficiency), the steam may be condensed in a separate apparatus, a [condenser](https://www.britannica.com/technology/condenser-cooling-device), at comparatively low [temperature](https://www.britannica.com/science/temperature) and pressure. For high efficiency, the steam must fall through a wide temperature range as a consequence of its expansion within the engine. The most efficient performance—that is, the greatest output of work in relation to the heat supplied—is secured by using a low condenser temperature and a high boiler pressure. The steam may be further heated by passing it through a superheater on its way from the boiler to the engine. A common superheater is a group of parallel pipes with their surfaces exposed to the hot gases in the boiler furnace. By means of superheaters, the steam may be heated beyond the temperature at which it is produced by boiling water.

In a [reciprocating](https://www.merriam-webster.com/dictionary/reciprocating) engine, the [piston and cylinder](https://www.britannica.com/technology/piston-and-cylinder) type of steam engine, steam under pressure is admitted into the cylinder by a [valve](https://www.britannica.com/technology/valve-mechanics) [mechanism](https://www.britannica.com/technology/mechanism-machinery). As the steam expands, it pushes the piston, which is usually connected to a [crank](https://www.britannica.com/technology/crank) on a [flywheel](https://www.britannica.com/technology/flywheel) to produce rotary motion. In the double-acting engine, steam from the boiler is admitted alternately to each side of the piston. In a simple steam engine, expansion of the steam takes place in only one cylinder, whereas in the [compound](https://www.merriam-webster.com/dictionary/compound) engine there are two or more cylinders of increasing size for greater expansion of the steam and higher efficiency; the first and smallest piston is operated by the initial high-pressure steam and the second by the lower-pressure steam exhausted from the first.

In the [steam turbine](https://www.britannica.com/technology/steam-turbine), steam is discharged at high velocity through nozzles and then flows through a series of stationary and moving blades, causing a rotor to move at high speeds. Steam turbines are more compact and usually permit higher temperatures and greater expansion ratios than reciprocating steam engines. The turbine is the universal means used to generate large quantities of [electric power](https://www.britannica.com/technology/electric-power) with steam.

The earliest steam engines were the scientific novelties of [Hero of Alexandria](https://www.britannica.com/biography/Heron-of-Alexandria) in the 1st century CE, such as the [aeolipile](https://www.britannica.com/technology/aeolipile), but not until the 17th century were attempts made to harness steam for practical purposes. In 1698 [Thomas Savery](https://www.britannica.com/biography/Thomas-Savery) patented a pump with hand-operated valves to raise water from mines by suction produced by condensing steam. In about 1712 another Englishman, [Thomas Newcomen](https://www.britannica.com/biography/Thomas-Newcomen), developed a more efficient steam engine with a piston separating the condensing steam from the water. In 1765 [James Watt](https://www.britannica.com/biography/James-Watt) greatly improved the Newcomen engine by adding a separate condenser to avoid heating and cooling the cylinder with each stroke. Watt then developed a new engine that rotated a shaft instead of providing the simple up-and-down motion of the pump, and he added many other improvements to produce a practical power plant.

A cumbersome steam carriage for roads was built in France by Nicholas-Joseph [Cugnot](https://www.britannica.com/biography/Nicolas-Joseph-Cugnot) as early as 1769. [Richard Trevithick](https://www.britannica.com/biography/Richard-Trevithick) in England was the first to use a steam carriage on a railway; in 1803 he built a steam locomotive that in February 1804 made a successful run on a horsecar route in [Wales](https://www.britannica.com/place/Wales). The [adaptation](https://www.merriam-webster.com/dictionary/adaptation) of the steam engine to railways became a commercial success with the *Rocket* of English engineer [George Stephenson](https://www.britannica.com/biography/George-Stephenson) in 1829. The first practical [steamboat](https://www.britannica.com/technology/steamboat) was the tug [*Charlotte Dundas*](https://www.britannica.com/topic/Charlotte-Dundas)*,* built by [William Symington](https://www.britannica.com/biography/William-Symington) and tried in the Forth and Clyde Canal, [Scotland](https://www.britannica.com/place/Scotland), in 1802. [Robert Fulton](https://www.britannica.com/biography/Robert-Fulton-American-inventor) applied the steam engine to a passenger boat in the United States in 1807.

Though the steam engine gave way to the [internal-combustion engine](https://www.britannica.com/technology/internal-combustion-engine) as a means of vehicle propulsion, interest in it revived in the second half of the 20th century because of increasing air-pollution problems caused by the burning of fossil fuels in internal-combustion engines.

**Agricultural revolution**

**Agricultural revolution**, gradual transformation of the traditional agricultural system that began in [Britain](https://www.britannica.com/place/United-Kingdom) in the 18th century. Aspects of this complex transformation, which was not completed until the 19th century, included the reallocation of land ownership to make farms more compact and an increased investment in technical improvements, such as new machinery, better drainage, scientific methods of [breeding](https://www.britannica.com/science/breeding), and experimentation with new crops and systems of [crop rotation](https://www.britannica.com/topic/crop-rotation).

Among those new crop-rotation methods was the [Norfolk four-course system](https://www.britannica.com/topic/Norfolk-four-course-system), established in [Norfolk county](https://www.britannica.com/place/Norfolk-county-England), [England](https://www.britannica.com/place/England), which emphasized fodder crops and the absence of the theretofore conventionally employed fallow year. [Wheat](https://www.britannica.com/plant/wheat) was grown in the first year and [turnips](https://www.britannica.com/plant/turnip) in the second, followed by [barley](https://www.britannica.com/plant/barley-cereal), with [clover](https://www.britannica.com/plant/clover-plant) and [ryegrass](https://www.britannica.com/plant/ryegrass) undersown in the third. The clover and ryegrass were cut for feed or grazed in the fourth year. In the winter, cattle and sheep were fed the turnips. The development of [Shorthorn](https://www.britannica.com/animal/Shorthorn) beef cattle through selective breeding of local cattle of the Teeswater district, [Durham county](https://www.britannica.com/place/Durham-unitary-authority-England), typified the advances brought about by scientific breeding.

The historiography of the period that emphasized the contributions of “great men” has lost much of its influence, but the names [Jethro Tull](https://www.britannica.com/biography/Jethro-Tull) and [Arthur Young](https://www.britannica.com/biography/Arthur-Young) are still frequently [invoked](https://www.merriam-webster.com/dictionary/invoked) by those seeking to understand the significance of the agricultural revolution, which was an essential prelude to the [Industrial Revolution](https://www.britannica.com/event/Industrial-Revolution).

**William Cobbett**

**William Cobbett**, pseudonym **Peter Porcupine**, (born March 9, 1763, Farnham, [Surrey](https://www.britannica.com/place/Surrey-county-England), England—died June 18, 1835, Normandy, Surrey), English popular [journalist](https://www.britannica.com/topic/journalism) who played an important political role as a champion of traditional rural [England](https://www.britannica.com/place/England) against the changes wrought by the [Industrial Revolution](https://www.britannica.com/event/Industrial-Revolution).

His father was a small farmer and innkeeper. Cobbett’s memories of his early life were pleasant, and, although he moved to London when he was 19, his experiences on the land left their impressions on his life. Cobbett’s careers as a journalist and, for the last three years of his life, as a member of the [House of Commons](https://www.britannica.com/topic/House-of-Commons-British-government) were devoted to restoring his ideal of rural England in a [country](https://www.britannica.com/topic/nation-state) rapidly being transformed by the Industrial Revolution into the world’s foremost manufacturing nation.

Although he embraced advanced political ideas, Cobbett was at heart not a radical but instead deeply [conservative](https://www.merriam-webster.com/dictionary/conservative), even reactionary. His object was to use radical means to break the power of what he regarded as a selfish [oligarchy](https://www.merriam-webster.com/dictionary/oligarchy) and thus establish the earlier England of his imagination. In his England, political parties, the national debt, and the [factory system](https://www.britannica.com/topic/factory-system) would not exist. Instead, all classes would live in harmony on the land. Despite this seemingly backward-looking viewpoint, Cobbett’s writings were widely read, in part because of his lucid, racy style but mainly because he struck a powerful chord of [nostalgia](https://www.merriam-webster.com/dictionary/nostalgia) at a time when rapid economic changes and war with France had produced widespread anxiety.

At the age of 21, Cobbett joined the army, in which he eventually rose to the rank of sergeant major. He taught himself English [grammar](https://www.britannica.com/topic/grammar) and thus laid the foundation of his future career as a journalist. After serving in Canada, he returned to England in 1791 and charged certain of his former officers with corruption. Although venality was all but general in the army, indeed in the whole of public life, his charges boomeranged when the officers sought to bring countercharges against him. Rather than appear at a court-martial, Cobbett fled to France. Quickly realizing that France in the throes of revolution was no place for an Englishman, he sailed for America, settling in [Philadelphia](https://www.britannica.com/place/Philadelphia), where he supported himself and his family by teaching English to French émigrés.

An effusive welcome accorded [Joseph Priestley](https://www.britannica.com/biography/Joseph-Priestley) by radical republican groups in the United States after the radical scientist had left England in 1794 drew Cobbett into controversy. Convinced that Priestley was a traitor, Cobbett wrote a pamphlet, *Observations on the Emigration of Joseph Priestley*. It launched his career as a journalist. For the next six years he published enough writings against the spirit and practice of American [democracy](https://www.merriam-webster.com/dictionary/democracy) to fill 12 volumes. His violent [journalism](https://www.britannica.com/topic/journalism) won him many enemies and the nickname “Peter Porcupine.” After paying a heavy fine in a libel judgment, Cobbett returned to England in 1800.

The [Tory](https://www.britannica.com/topic/Whig-Party-England) government of [William Pitt](https://www.britannica.com/biography/William-Pitt-the-Younger) welcomed Cobbett and offered to subsidize his powerful pen in further publishing ventures. But Cobbett, whose journalism was entirely personal and always incorruptible, rejected the offer and in 1802 started a weekly, *Political Register*, which he published until his death in 1835. Though the *Register* at first supported the government, the [Treaty of Amiens](https://www.britannica.com/event/Treaty-of-Amiens-1802) (1802) with France disgusted him, and he promptly called for a renewal of the war. Cobbett believed that commercial interests were dictating English [foreign policy](https://www.britannica.com/topic/foreign-policy) and were responsible for all that was wrong with the country. In 1805 he announced that England was the victim of a “System,” which debauched liberty, undermined the [aristocracy](https://www.merriam-webster.com/dictionary/aristocracy) and the [Church of England](https://www.britannica.com/topic/Church-of-England), and almost extinguished the gentry. His [conviction](https://www.merriam-webster.com/dictionary/conviction) grew in the following year after he witnessed the widely accepted corruption in parliamentary elections. Cobbett’s career as an orthodox Tory was over. [Advocacy](https://www.merriam-webster.com/dictionary/Advocacy) of radical measures brought him into an uneasy association with reformers. Cobbett and the radicals could never be close, however, since his goals were so different from theirs.

Cobbett was at his best when condemning specific abuses. He spent two years in jail (1810–12) and paid a fine of £1,000 after denouncing the flogging of militiamen who had protested against unfair deductions from their pay. He also recognized that unrest among the poor was caused by unemployment and hunger and not, as the government had [alleged](https://www.merriam-webster.com/dictionary/alleged), by a desire to overthrow English society. Cobbett could see no solution to economic distress without a reform of Parliament and reduction of interest on the national debt. In 1816, at the height of his influence, he was able to reach the common man by putting out the *Political Register* (denounced as Cobbett’s “two-penny trash”) in a cheap edition that avoided the heavy taxes on ordinary newspapers. The government, seeing [sedition](https://www.britannica.com/topic/sedition) in even the most moderate proposals for change, repressed dissent, and the following year Cobbett was forced to flee to the United States to avoid arrest.

Renting a farm on [Long Island](https://www.britannica.com/place/Long-Island-New-York), New York, Cobbett continued to edit and write for the *Political Register*, which was published by his agents in England. When he returned to England at the end of 1819, his influence had waned and he was insolvent. During the 1820s he supported many causes in an attempt to regain his standing and in the hope that they would lead to the changes in England’s political and [economic system](https://www.britannica.com/topic/economic-system) that he desired. He unsuccessfully tried to be elected to the House of Commons in 1820 from [Coventry](https://www.britannica.com/place/Coventry-England) and in 1826 from [Preston](https://www.britannica.com/place/Preston-England). His famous tours of the countryside began in 1821 and were to lead to his greatest book, *Rural Rides*, which was an unrivalled picture of the land.

Although he had no love for the Whigs, Cobbett supported the parliamentary [Reform Bill](https://www.britannica.com/event/Reform-Bill) of 1832, which, despite its limited nature, he sensed was the best that could be had. In 1830 agricultural labourers in his beloved southern England had rioted in protest against their low wages. Cobbett defended them and as a result was prosecuted in 1831 by a Whig government that was anxious to prove its zeal in moving against “sedition.” Acting as his own [counsel](https://www.merriam-webster.com/dictionary/counsel), Cobbett confounded his opponents and was set free. Yet, despite this threat of another jail term, he supported his persecutors on the issue of parliamentary reform.

In 1832 Cobbett was elected to Parliament as a member from [Oldham](https://www.britannica.com/place/Oldham-England). At 69 years of age he found the nocturnal schedule of Parliament an unpleasant contrast to his lifelong preference for early rising and working in the morning. Essentially an individualist and a man of action, he chafed at parliamentary routine. Most members of the House of Commons did not respect him, and Cobbett’s parliamentary career was a failure. The unnatural hours hastened his death, from influenza, in 1835.

Passionate and [prejudiced](https://www.merriam-webster.com/dictionary/prejudiced), Cobbett’s prose, full of telling phrases and inspired ridicule, was completely personal. He had no theoretical understanding of the complicated issues about which he wrote. While his views of the ideal society were retrograde, no one could excel him in specific [criticisms](https://www.merriam-webster.com/dictionary/criticisms) of corruption and extravagance, harsh laws, low wages, absentee clergymen—indeed, nearly everything that was wrong with England.

**Fernand Braudel**

**Fernand Braudel**, in full **Fernand Paul Braudel**, (born Aug. 24, 1902, Luméville, France—died Nov. 28, 1985, Haute-Savoie), was a French historian and author of several major works that [traversed](https://www.merriam-webster.com/dictionary/traversed) borders and centuries and introduced a new [conception](https://www.merriam-webster.com/dictionary/conception) of historical time. As leader of the post-World War II [Annales school](https://www.britannica.com/topic/Annales-school), Braudel became one of the most important historians of the 20th century.

Braudel’s family was descended from Lorraine peasants. The son of a schoolteacher who later became a headmaster, Braudel acquired a cosmopolitanism unusual for his generation. After studying in Paris at the Lycée Voltaire and the Sorbonne (now part of the [Universities of Paris I–XIII](https://www.britannica.com/topic/Universities-of-Paris-I-XIII)), he taught for nine years at secondary schools in Constantine and Algiers, in Algeria (1923–32), where he developed his fascination with the Mediterranean as a prime subject of [history](https://www.britannica.com/topic/history). He returned to France to teach at secondary schools in Paris (1932–35) and afterward taught at the University of São Paolo in Brazil (1935–37) before joining the École Pratique des Hautes Études in Paris in 1937. His mentor was the noted early modern historian [Lucien Febvre](https://www.britannica.com/biography/Lucien-Paul-Victor-Febvre), under whose influence Braudel shifted his dissertation from a conventional study of Philip II’s Mediterranean diplomacy to a grand examination of the “complex totality” of the Mediterranean region in the late 16th century.

While serving as a lieutenant in the French army in 1940, Braudel was captured by the Germans. During his next five years in prisoner-of-war camps in Mainz and [Lübeck](https://www.britannica.com/place/Lubeck), with his phenomenal memory his main resource, Braudel produced drafts of the massive work that established his international reputation, *La Méditerranée et le monde méditerranéen à l’époque de Philippe II* (1949; [*The Mediterranean and the Mediterranean World in the Age of Philip II*](https://www.britannica.com/topic/The-Mediterranean-and-the-Mediterranean-World-in-the-Age-of-Philip-II)). First submitted as a doctoral thesis to the Sorbonne in 1947 and subsequently published as a two-volume book, this geohistorical study centred not only on the conflict between [Spain](https://www.britannica.com/place/Spain) and the [Ottoman Empire](https://www.britannica.com/place/Ottoman-Empire) in the 16th century but also on the region’s history, geography, religion, agriculture, technology, and [intellectual](https://www.merriam-webster.com/dictionary/intellectual) climate.

After [World War II](https://www.britannica.com/event/World-War-II) Braudel emerged as Febvre’s protégé and heir. He became codirector (with Febvre), then director of the journal *[Annales: économies, sociétés, civilisations](https://www.britannica.com/topic/Annales-Histoire-Sciences-Sociales)* (1946–85) and was elected professor at the [Collège de France](https://www.britannica.com/topic/College-de-France) in 1950 (a position he held until 1972). In 1956 he succeeded Febvre as president of the Sixth Section of the École Pratique des Hautes Études; under his direction it became a leading centre for [social science](https://www.britannica.com/topic/social-science) and historical research. In 1962 he founded and administered the Maison des Sciences de l’Homme. Thanks to the centralized character of French [higher education](https://www.britannica.com/topic/higher-education), Braudel’s [dynamic](https://www.merriam-webster.com/dictionary/dynamic) figure dominated historical scholarship in postwar France. A generous mentor, he also aided numerous historians from southern and eastern [Europe](https://www.britannica.com/place/Europe), [South America](https://www.britannica.com/place/South-America), and Africa, further extending his influence over international scholarship. He received more than 20 honorary foreign doctorates, gave his name to an international research centre at the [State University of New York](https://www.britannica.com/topic/State-University-of-New-York) at Binghamton (opened 1976) in the United States, and was admitted to the prestigious [French Academy](https://www.britannica.com/topic/French-Academy) in 1984.

Under Braudel’s direction the Annales school acquired a global reputation for promoting a new form of history. It replaced the study of leaders with the lives of ordinary people and supplanted the hallowed trio of politics, diplomacy, and wars with inquiries into climate, demography, agriculture, commerce, technology, transportation, and communication, as well as social groups and mentalities. Annales history further challenged the reductionism of the Marxists and the [structuralism](https://www.britannica.com/science/structuralism-anthropology) of the social sciences, its main competitors at the vanguard of postwar [historiography](https://www.britannica.com/topic/historiography). It aimed at a “total history” that relied heavily on quantification and also yielded dazzling microstudies of villages and regions. Braudel’s most significant contribution was his three-tiered view of historical time. Conceived while he was in captivity in 1944, it consisted of very long, practically immobile environmental time (the *longue durée*); the medium time of economies, societies, and cultures; and the short time of discrete events (the subject of *histoire événementielle*). Far from a simple flow, human experience was registered on all three clocks, operated with speed-ups and delays, and left a vast range of physical as well as mental traces.

Testing his concepts, Braudel produced a giant, three-volume study of the world between the Middle Ages and the [Industrial Revolution](https://www.britannica.com/event/Industrial-Revolution), based on a three-tiered arrangement of its material foundations, economic functioning, and capitalist developments, *Civilisation matérielle et capitalisme, XVe-XVIIIe siècle* (vol. 1, 1967; vol. 2–3, 1979; [Civilization and Capitalism, 15th–18th Century)](https://www.britannica.com/topic/Civilization-and-Capitalism-15th-18th-Century). (The titles of the three individual volumes are *Les Structures du quotidien: le possible et l’impossible* [*The Structures of Everyday Life: The Limits of the Possible*], *Les Jeux de l’échange* [*The Wheels of Commerce*], and *Le Temps du monde* [*The Perspective of the World*].) Incorporating geography, sociology, and economics, Braudel produced a sweeping study of the evolution of the European and world economy, [encompassing](https://www.merriam-webster.com/dictionary/encompassing) an immense span of human activity and development. A nonrigid structuralist, Braudel acknowledged variations in the systems he constructed and admitted complexities that belied the most rigorous analysis. Despite the mass of detail, his was a unified vision, and he wrote in elegant prose. In his final, unfinished, three-volume work, *L’Identité de la France* (1986; *The Identity of France*), he applied the geohistorical method to his homeland, presenting a history that favoured the physical mutations of its [diverse](https://www.merriam-webster.com/dictionary/diverse) regions over the unruly lives and thoughts of their inhabitants.

Like all who treat huge subjects and periods, Braudel often relied on others’ scholarship; his zeal for detail revealed occasional gaps and misinterpretation. Because he minimized the importance of political and military power in human affairs, Braudel was blamed for the apolitical stance of the postwar Annales school and its members’ reluctance to study contemporary history or engage in the [moral](https://www.merriam-webster.com/dictionary/moral) and ideological issues of the [Cold War](https://www.britannica.com/event/Cold-War) era. Nevertheless, his reputation as a prodigious scholar and [discipline](https://www.merriam-webster.com/dictionary/discipline) builder remains secure.

**Factory**

**Factory**, Structure in which work is organized to meet the need for production on a large scale usually with power-driven [machinery](https://www.britannica.com/technology/machine). In the 17th–18th century, the [domestic system](https://www.britannica.com/topic/domestic-system) of work in Europe began giving way to larger units of production, and [capital](https://www.britannica.com/technology/capital-architecture) became available for investment in industrial enterprises. The movement of population from country to city also contributed to change in work methods. [Mass production](https://www.britannica.com/technology/mass-production), which transformed the organization of work, came about by the development of the [machine-tool](https://www.britannica.com/technology/machine-tool) [industry](https://www.britannica.com/technology/industry). With precision equipment, large numbers of identical parts could be produced at low cost and with a small workforce. The [assembly line](https://www.britannica.com/technology/assembly-line) was first widely used in the U.S. meat-packing industry; [Henry Ford](https://www.britannica.com/biography/Henry-Ford) designed an automobile assembly line in 1913. By mid-1914, chassis assembly time had fallen from 121/2 man-hours to 93 man-minutes. Some countries, particularly in Asia and [South America](https://www.britannica.com/place/South-America), began industrializing in the 1970s and later. *See also* [American System of manufacture](https://www.britannica.com/technology/American-System-industry).

**Lowell**

**Lowell**, [city](https://www.britannica.com/topic/city), [Middlesex](https://www.britannica.com/place/Middlesex-county-Massachusetts) county, northeastern [Massachusetts](https://www.britannica.com/place/Massachusetts), U.S. It lies at the junction of the [Concord](https://www.britannica.com/place/Concord-Massachusetts) and [Merrimack](https://www.britannica.com/place/Merrimack-River) rivers, 25 miles (40 km) northwest of [Boston](https://www.britannica.com/place/Boston). It was the country’s first planned industrial town.

The site was originally settled in 1653 as a farming [community](https://www.merriam-webster.com/dictionary/community) known as East [Chelmsford](https://www.britannica.com/place/Chelmsford-Massachusetts). Beginning in the early 19th century, the village grew to become a major centre of cotton [textile](https://www.britannica.com/topic/textile) [manufacturing](https://www.britannica.com/technology/manufacturing), with an abundance of waterpower from the Merrimack’s [Pawtucket](https://www.britannica.com/place/Pawtucket) Falls (32 feet [10 metres]) and the completion of the Middlesex Canal link to Boston in 1803. By 1824 the locality was crisscrossed by a canal system that served numerous cotton textile mills along the [Merrimack River](https://www.britannica.com/place/Merrimack-River). The community was incorporated as a town in 1826 and was named for [Francis Cabot Lowell](https://www.britannica.com/biography/Francis-Cabot-Lowell), a pioneer textile industrialist who was influenced by the organizational [reforms of Robert Owen](https://www.britannica.com/topic/industrial-relations/Responsibility-to-the-worker#ref66856). Lowell’s mills gained attention and renown for being staffed by the so-called “mill girls,” young women predominantly from neighbouring rural [communities](https://www.merriam-webster.com/dictionary/communities) who were given the opportunity to pursue gainful employment. The town’s growth was further sustained by the completion of the Boston and Lowell Railroad in 1835.

By the mid-19th century Lowell had become one of the country’s major industrial cities; it was called the “spindle city” and the “[Manchester](https://www.britannica.com/place/Manchester-England) of America” because of its large textile industries. As such it aroused the interest of European writers such as [Charles Dickens](https://www.britannica.com/biography/Charles-Dickens-British-novelist) and [Anthony Trollope](https://www.britannica.com/biography/Anthony-Trollope), who recorded their impressions of it. By mid-century the mill girls had begun to be replaced by successive immigrant groups. The Irish came first and then French Canadians in the 1860s and ’70s, followed by eastern and southern European immigrants—including Greeks, Poles, and Lithuanians—by the century’s end. The city’s peak as a textile centre was reached about 1924.

Following a period of decline and eventual relocation of the textile mills to Southern states, Lowell’s economy stagnated through the middle of the 20th century. However, the city’s fortunes began to change with the establishment of Lowell National Historical Park in 1978, [commemorating](https://www.merriam-webster.com/dictionary/commemorating) the first American textile mills and saving much of the historic downtown, which included the majority of the vacant mills, from demolition. An influx of immigrants from [Southeast Asia](https://www.britannica.com/place/Southeast-Asia), primarily refugees from [Cambodia](https://www.britannica.com/place/Cambodia), that began in the late 1970s contributed to making Lowell one of the most ethnically [diverse](https://www.merriam-webster.com/dictionary/diverse) cities in the [United States](https://www.britannica.com/place/United-States) by the end of the 20th century. Many of the former mills have been converted either to museums or to residential and artist space. By the early 21st century, technology, health care, [higher education](https://www.britannica.com/topic/higher-education), tourism, and the arts had become the city’s main economic activities.

Lowell is the birthplace of the artist [James Abbott McNeill Whistler](https://www.britannica.com/biography/James-McNeill-Whistler), author and poet [Jack Kerouac](https://www.britannica.com/biography/Jack-Kerouac), actor Michael Chiklis, and professional boxer Micky Ward. There are two prominent institutions of higher education there: the [University of Massachusetts](https://www.britannica.com/topic/University-of-Massachusetts) Lowell (1991; formerly the University of Lowell, which emerged in 1975 from the amalgamation of Lowell State College and the Lowell Technological Institute, each of which had origins in the 1890s) and a campus of Middlesex Community College (1970; Lowell campus established 1991). Two festivals honouring Kerouac are held annually, one in March to [commemorate](https://www.merriam-webster.com/dictionary/commemorate) his birthday and another in October. The Lowell Folk Festival, which began in 1990, features traditional music along with arts and crafts. Inc. city, 1836. Pop. (2000) 105,167; (2010) 106,519.

**Assembly line**

**Assembly line**, industrial arrangement of machines, equipment, and workers for continuous flow of workpieces in [mass-production](https://www.britannica.com/technology/mass-production) operations.

The design for an assembly line is determined by analyzing the steps necessary to manufacture each product component as well as the final product. All movement of material is simplified, with no cross flow, backtracking, or repetitious procedure. Work assignments, numbers of machines, and production rates are programmed so that all operations along the line are compatible.

An [automotive](https://www.britannica.com/technology/automotive-industry) assembly line starts with a bare chassis. Components are attached successively as the growing assemblage moves along a conveyor. Parts are matched into subassemblies on feeder lines that intersect the main line to deliver exterior and interior parts, engines, and other assemblies. As the units move by, each worker along the line performs a specific task, and every part and [tool](https://www.britannica.com/technology/tool) is delivered to its point of use in synchronization with the line. A number of different assemblies are on the line simultaneously, but an intricate system of scheduling and control ensures that the appropriate body type and colour, trim, engine, and optional equipment arrive together to make the desired combinations.

[Automated](https://www.britannica.com/technology/automation) assembly lines consist entirely of machines run by machines, with little or no human supervision. In such continuous-process industries as [petroleum refining](https://www.britannica.com/technology/petroleum-refining) and chemical manufacture and in many modern automobile-engine plants, assembly lines are completely mechanized and consist almost entirely of automatic, self-regulating equipment.

Many products, however, are still assembled by hand because many component parts are not easily handled by machines. Expensive and somewhat inflexible, automatic assembly machines are economical only if they produce a high level of output. However, the development of versatile [machinery](https://www.britannica.com/technology/machine) and the increased use of industrial [robots](https://www.britannica.com/technology/robot-technology) have improved the [efficiency](https://www.merriam-webster.com/dictionary/efficiency) of fully automated assembly operations.

**Anthony F.C. Wallace**

**Anthony F.C. Wallace**, in full**Anthony Francis Clarke Wallace**, (born April 15, 1923, [Toronto](https://www.britannica.com/place/Toronto), [Ontario](https://www.britannica.com/place/Ontario-province), Canada—died October 5, 2015, [Pennsylvania](https://www.britannica.com/place/Pennsylvania-state), U.S.), Canadian-born American psychological anthropologist and historian known for his analysis of [acculturation](https://www.britannica.com/topic/acculturation) under the influence of technological change.

Wallace received his Ph.D. in 1950 from the [University of Pennsylvania](https://www.britannica.com/topic/University-of-Pennsylvania) in Philadelphia and taught there from 1951 to 1988. His most important work, *Rockdale: The Growth of an American Village in the Early Industrial Revolution* (1978), is a psychoanthropological [history](https://www.britannica.com/topic/history) of the [Industrial Revolution](https://www.britannica.com/event/Industrial-Revolution). Wallace studied the cultural aspects of the [cognitive](https://www.merriam-webster.com/dictionary/cognitive) process, especially when it involves the transfer of information during periods of technological expansion. In other books he compares [religion](https://www.britannica.com/topic/religion) as a movement of “social revitalization” among the American Indians and in modern times. His books include *King of the Delawares: Teedyuscung, 1700–1763* (1949), *Culture and Personality* (1961, rev. ed. 1970), *Religion: An Anthropological View* (1966), *Death and Rebirth of the Seneca* (1970), *The Social Context of Innovation* (1982), *St. Clair: A Nineteenth-Century Coal Town’s Experience with a Disaster-Prone Industry* (1987), and *The Long, Bitter Trail: Andrew Jackson and the Indians* (1993).

TOP QUESTIONS

Where and when did the Industrial Revolution take place?

How did the Industrial Revolution change economies?

How did the Industrial Revolution change society?

What were some important inventions of the Industrial Revolution?

Who were some important inventors of the Industrial Revolution?