

Cynthia Stokes Brown, *Big History: From the Big Bang to the Present* (New York: New Press Distributed by W.W. Norton, 2007), 214-19.

BIG HISTORY

From the Big Bang to the Present

CYNTHIA STOKES BROWN



THE NEW PRESS

NEW YORK
LONDON

2007

Industrial Revolution

The change to industrialization is now being seen as a global phenomenon, created not by European society but by the forces at work in the whole global network, the interaction of people in Afro-Eurasia with the people of the Americas. After the connection of the two hemispheres, a sharp acceleration occurred in rates of innovation, levels of productivity, and the pace of collective learning around the globe. The Atlantic seacoast of Europe benefited from its location as the first hub of the first world system; Europeans were exceptional by their strategic location and by being young and flexible, ready for change.

The process of industrialization began specifically in Britain, the damp little island off northwest Europe. One major reason lay in the fact that Britain had large deposits of coal. As the island began running out of

forests to convert into charcoal for smelting, iron production began to slump. Burning regular coal for smelting iron did not work, since the impurities in the coal made the iron brittle. In 1709 the Darby family in Shropshire discovered that when coal is first converted into coke, smelting could be done successfully.

Coal deposits, however, were deep and were impeded by water filling the shafts. Some kind of pump was needed. In the 1770s a Scotsman, James Watt, improved the design of the steam engine, and by 1800 Britain had about 2,000 steam engines—still only about 5 percent efficient but each equal to some 200 men pumping water out of coal mines. (Coal output grew almost 500 percent from 1780 to 1830.) Improvements had to be made in the steam engine; for this, the English used all their gun-making and clock-making skills. Costs of energy for steam-run equipment went down precipitously after 1830.⁸

Steam engines as curiosities had developed in other societies before the eighteenth century. The Chinese had various systems, but they used the engine as a bellows in which the wheel turned the piston rather than the piston turning the wheel, as in Watt's design. The Chinese also used coal to produce iron; in 1080 their iron production exceeded that of non-Russian Europe in 1700. But northern China, where the coal deposits lay, suffered Mongol invasions, civil war, floods, and plague. Population shifted to the south, and iron production, when it recovered, used charcoal instead of coal.⁹

In the 1700s the world's only large exporter of cotton fabric was India. In 1721 wealthy merchants in England, through Parliament, prohibited the import of Indian cloth, in order to increase their own income from local production. They procured the raw cotton from American colonies, produced by slaves, and took it to rural areas of England, where whole families of artisans used hand tools—the spinning wheel and the home loom—to produce cloth, which the merchants marketed. The spinners and weavers worked at home, or in small groups like protofactories.

In 1764 a society in London offered a prize for the best improvement of the spinning process; James Hargreaves won it with his "spinning jenny," a wood frame with a series of spinning wheels geared together to produce eight threads simultaneously, or 100 threads when adapted to water power. By the early 1800s the English had figured out a loom powered by steam engine; the invention of the cotton gin in Georgia (United States), increased the output of cotton. By the 1860s India could not match British competition in cotton textiles.

The process of industrialization in England required many simultane-

ous changes. Inventions, as described, were necessary. The American colonies provided raw materials and markets. Canals and roads provided a basic transportation system; later, steamships and railroads speeded up transportation. Financial systems to support the accumulation of capital had started to develop in the seventeenth and early eighteenth centuries. Attitudes about usury had to change. Finally, increased agricultural production released workers from the fields to the factories.

English farmers made significant increases in their production by selective breeding of sheep to double their size, by planting seeds in rows instead of by sowing, by using horse-drawn drilling machines, and by figuring out a four-year crop rotation (turnips, barley, clover, wheat) that did not require leaving fields fallow. By feeding turnips to their cattle over the winter, farmers did not have to slaughter in the fall and had milk and butter year round. These changes required larger fields to be effective; the wealthiest farmers demanded enclosure of formerly common areas where poorer farmers grazed their animals. The enclosure movement peaked in the last decades of the 1700s and the early decades of the 1800s, as small farmers became hired hands or left farming for the city. Even though food production increased, so did population, and England by the mid-1800s needed to trade manufactured goods for foods. The last surplus of English wheat for export occurred in 1792.¹⁰

All these changes proved difficult, if not catastrophic, for the poor people of England. Thousands of hand weavers were thrown on the streets by the use of power looms. Wages fell from 1760 to 1815. Historians do not agree on whether conditions for the poor were worse than earlier or, if so, how much worse. Some say that two generations were sacrificed to create Britain's industrial base, but most agree that after 1850, when industrialization is considered mature in Britain, the people as a whole shared in Britain's success on the world stage. Meanwhile, a massive migration took place; from 1815 to 1914 20 million Brits left their island. In 1900 the British population was 41 million, but it would have been 70 million without the exodus.¹¹

It is no coincidence that tobacco, cocoa, tea, and coffee became features of everyday life during the process of industrialization. Tobacco from the Americas was cultivated in England by 1565, coffee reached London in 1651, chocolate in 1657, and tea in 1660. All were addictive, quick to prepare and consume, and provided short bursts of energy—perfect for long days away from home. By adding sugar to the drinks, the poor were able to prevent the scarce protein in their diets being burned for energy. An acre of tropical sugar land yielded as many calories as four acres of potatoes or

nine to twelve acres of wheat. By 1900 sugar imports had increased eleven times since 1815, and Brits averaged 15 to 25 percent of their daily calories in sugar.¹²

Since industrialization removed work from the family setting, it impacted women and children in a major way. They became a flexible workforce, entering the labor market as needed to supplement men's labor, holding jobs that men didn't want, that held little authority or required minimal training. In this way inequality was built into the process. Yet some children had the advantage of being released from productive/grinding labor to pursue education as their primary task, and some women in urban households and service industries (excluding domestic service) were better off than male day-laborers in agriculture.¹³

Why did industrialization begin in England when it did? Historians have come up with various answers. The short one seems to be a combination of unique factors: location on the sea, overclearing of forests, coal deposits, the social and political consequences of the Glorious Revolution, commercial and agricultural development based on land and wealth in the Americas, transportation, instrumentation skills, population growth, printing presses, plus the freedom and incentive to innovate.

After 1815 other parts of Europe and the United States began the process of industrialization. Belgium and Switzerland industrialized early; they had deposits of coal. Germany had the coal-rich Ruhr region, and its industry outstripped the British by the 1880s. France had too little coal to be a leader and had to import it after 1848. The United States pioneered factory management, first using interchangeable parts in weapon production, and by the 1890s its industry outpaced that of Germany to be the world's leader. The only non-Western societies that began to industrialize before 1900 were Russia and Japan. Russia began in the 1860s and by 1910 had the world's fourth or fifth largest heavy industry complex, fully mature by 1950. Japan also began in the 1860s and by 1914 had become a first-rank military and industrial power. The great powers of the twentieth century proved to be those who had managed to industrialize in the nineteenth century—Britain, Germany, Russia, the United States, and Japan.¹⁴

With the harnessing of coal, which made labor less scarce, slavery and forced labor gradually became less attractive or economical. Right at the height of slavery and serfdom in the world, these two ancient arrangements were, rather rapidly, mostly abolished worldwide.

The peak of slavery and serfdom came in the first half of the nineteenth century. Slavery quintupled between 1800 and 1860 in the U.S. South to produce cotton. It expanded in the Caribbean and Brazil to produce more

sugar. In southeast Asia slaves on plantations produced sugar and peppers. In Russia millions of serfs raised wheat; in Egypt they formed the army and raised cotton; in North Africa slavery increased during this time, especially to raise palm oil, used as an industrial lubricant.

Agitation to abolish slavery began with the Quakers in England and with the enlightenment philosophers in France in the late eighteenth century. Printing and travel circulated the idea. By 1807 in England and 1808 to 1830 in France the selling of slaves was abolished. In the 1820s Chile and Mexico abolished slavery itself; England did so in 1833. Other Atlantic countries followed: the United States in 1865, Spain in 1886, Brazil in 1888. In 1861 Russia abolished private serfs, who had to work at least nine more years to own their land communally; government serfs were freed in 1866. The Ottomans succumbed to European pressure and banned slave trading but never slavery itself, since it was recognized in Muslim law. In Africa trading ceased by 1914, and abolition came in the first third of the twentieth century. On the whole, the abolition of slavery and serfdom represented a historic liberation for humanity; 50 million serfs in Russia alone gained their freedom. The use of fossil fuels helps explain why slavery has officially if not completely vanished.¹⁵

Inventions in transportation and telecommunication continued to transform world trade. In 1801 the United States and Scotland produced early steamships; by 1860 they left sailing vessels in their wake on the high seas. It took one year in 1650 to sail from Holland to Java; it took three months in 1850, and three weeks in 1920. World shipping increased four-fold from 1850 to 1910.

Britain had the world's first public railroad in 1830, but by 1845 the United States had twice as much track as Britain, and by 1914 the United States had half the world's railroad track. The first telegraph messages were sent between Baltimore and Washington in 1844. By 1866 a trans-Atlantic cable was laid down, and in 1870 a line from Britain to India reduced the time of conveying messages from eight months to five hours. By 1902 the British had cables worldwide. In 1860 telegraphs could send ten words a minute in Morse code; sixty years later they could send 400 words a minute. Electrification of the globe began around 1890.¹⁶

At the end of the nineteenth century another invention appeared to transform the world—the use of oil, a fossil fuel like coal laid down millions of years ago, to fuel internal combustion engines. A Scot, James Young, figured out how to refine crude oil in 1850, while Edwin Drake in Pennsylvania proved in 1859 that oil could be obtained by drilling through deep rock. Germans began to develop engines using oil in the 1880s. World produc-

tion of oil rose from zero in 1800, to 20 million metric tons in 1900, to 3 billion metric tons in 1990, when people in the United States (4 percent of the world's population) were using 25 percent of the world's production. Oil would become a major strand, perhaps the major strand, of the story of the twentieth century.¹⁷

12. Industrialization

1. Peter N. Stearns, 1993, *The Industrial Revolution in World History*, Boulder, CO: Westview Press. For example, Fred Spier, 1996, *The Structure of Big History: From the Big Bang Until Today*, Amsterdam: Amsterdam University Press, 38.
2. J.R. McNeill and William H. McNeill, 2003, *The Human Web: A Bird's-Eye View of World History*, New York: W. W. Norton, 222; Donella Meadows, et al., 2004, *Limits to Growth: The Thirty-Year Update*, White River Junction, VT: Chelsea Green Publishing, 28.
3. Robert Skidelsky, "The Mystery of Growth," *New York Review of Books*, March 13, 2003, 28–31.
4. Fernand Braudel, 1985, *Civilizations and Capitalism, Fifteenth–Eighteenth Century*, vol. II, London: Fontana Press, 245, 525–574.
5. Mark Van Doren, 1991, *A History of Knowledge: Past, Present and Future*, New York: Ballantine, 227.
6. Howard Zinn, 1980, *A People's History of the United States*, New York: Harper and Row, 82–95.
7. George M. Frederickson, 2002, *Racism: A Short History*, Princeton: Princeton University Press, 56–57; Ivan Hannaford, 1996, *Race: The History of an Idea in the West*, Washington, DC: Woodrow Wilson Center Press, 206–208.
8. Kenneth Pomeranz, 2001, *The Great Divergence: China, Europe, and the Making of the Modern World Economy*, Princeton: Princeton University Press, 61; J.R. McNeill, 2000, *Something New Under the Sun: An Environmental History of the Twentieth-Century World*, New York: W. W. Norton, 13; McNeill and McNeill, 2003, 230–232.
9. Pomeranz, 2001, 61–66.
10. Crane Brinton, John B. Christopher, and Robert Lee Wolff, 1960, *A History of Civilization*, vol. II, Englewood Cliffs, NJ: Prentice-Hall, 11–12; I.A. Ritchie Carson, 1981, *Food in Civilization: How History Has Been Affected by Human Tastes*, New York and Toronto: Beaufort Books, 135–136.
11. Braudel, 1985, vol. III, 595–615; Paul Kennedy, 1991, *Preparing for the Twenty-First Century*, New York: Ballantine, 6–7.
12. Braudel, 1985, vol. I, 249–261; Pomeranz, 2001, 275–281.
13. Louise A. Tilly, 1993, *Industrialization and Gender Inequality*, Washington, DC: American Historical Association, 14, 48; Stearns, 1991, 14–15.
14. McNeill and McNeill, 2003, 241–245; Stearns, 1991, 35–40.
15. David Christian, 1997, *Imperial and Soviet Russia: Power, Privilege and the Chal-*

16. This paragraph and the previous one are based on McNeill and McNeill, 2003, 217–221.
17. J.R. McNeill, 2000, 14; Kennedy, 1991, 32.
18. Philip Curtin, 1984, *Cross-Cultural Trade in World History*, Cambridge: Cambridge University Press, 251; Peter Jay, 2000, *The Wealth of Man*, New York: Public Affairs, 186–208.
19. Frederickson, 2000, 170.
20. Paul E. Lovejoy, 2000, *Transformations in Slavery: A History of Slavery in Africa*, 2nd ed., Cambridge: Cambridge University Press, 252, 288; McNeill and McNeill, 2003, 216; John Iliffe, 1995, *Africans: The History of a Continent*, New York: Cambridge University Press, 3.
21. See Mike Davis, 2001, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World*, London and New York: Verso. Also John Richards, 2003, *The Unending Frontier: An Environmental History of the Early Modern World*, Berkeley: University of California Press, 82.
22. McNeill and McNeill, 2003, 291–292; Paul Bairoch, 1993, *Economics and World History: Myths and Paradoxes*, Chicago: University of Chicago Press, 9.
23. McNeill and McNeill, 2003, 280.
24. Lester Kurtz, 1995, *Gods in the Global Village: The World's Religions in Sociological Perspective*, Thousand Oaks, CA: Pine Forge Press, 21.
25. J.R. McNeill, 2000, 15–16; McNeill and McNeill, 2003, 290–316.
26. Kennedy, 1991, 45–46; Donella Meadows, Jorgen Randers, and Dennis Meadows, 2004, *Limits to Growth: The 30-Year Update*, White River Junction, VT: Chelsea Green, 42–43.
27. David Christian, 2004, *Maps of Time: An Introduction to Big History*, Berkeley: University of California Press, 444–445; Paul Kivel, 2004, *You Call This a Democracy? Who Benefits, Who Pays and Who Really Decides*, New York: Apex Press, 25.
28. J.R. McNeill, 2000, 16.
29. Braudel, 1985, vol. III, 620–623.
30. Allen K. Smith, 1991, *Creating a World Economy: Merchant Capital, Colonialism and World Trade, 1400–1825*, Boulder, CO: Westview Press, 116.
31. Elizabeth Kolbert, "Why Work?" *New Yorker*, November 29, 2004, 154.