2 Industrial Britain, 1850

Industrial Revolution

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The Industrial Revolution

- We devoted our last unit to the French Revolution. We will discuss three different kinds of Revolutions this unit.
- We will begin today with the Industrial Revolution.
- Next week, we will discuss the Emancipation and the end of the Atlantic Slave Trade.
- In the third week, we will focus on the 1848 Revolutions.
- In the last week of the unit, we will revert to the French Revolution to see what happened in Europe post-Waterloo.

References

- R. C. Allen and J. L. Weisdorf, “Was There an ‘Industrious Revolution’ before the Industrial Revolution? An Empirical Exercise for England, c. 1300–1830,” *Economic History Review* 64, no. 3 (August 2011): 715–29.
- Gregory Clark, *A Farewell to Alms: A Brief Economic History of the World* (Princeton, NJ: Princeton University Press, 2007).
- Priya Satia, *Empire of Guns: The Violent Making of the Industrial Revolution* (New York: Penguin Press, 2018).

The Industrial Revolution

- Two scholars help us understand the Industrial Revolution.
  - The British Reverend Thomas Robert Malthus (1766-1834) made a determined effort to understand the factors that influenced human happiness and progress, looking at the economic conditions prevailing up to the end of the 18th century, until exactly 1798.
  - Another scholar is UC Davis historian Gregory Clark, who wrote a book about the Industrial Revolution, A Farewell to Alms: A Brief Economic History of the World, published it in 2007, and taught a course on the Industrial Revolution, which is now available on YouTube.

The Industrial Revolution: The Crux

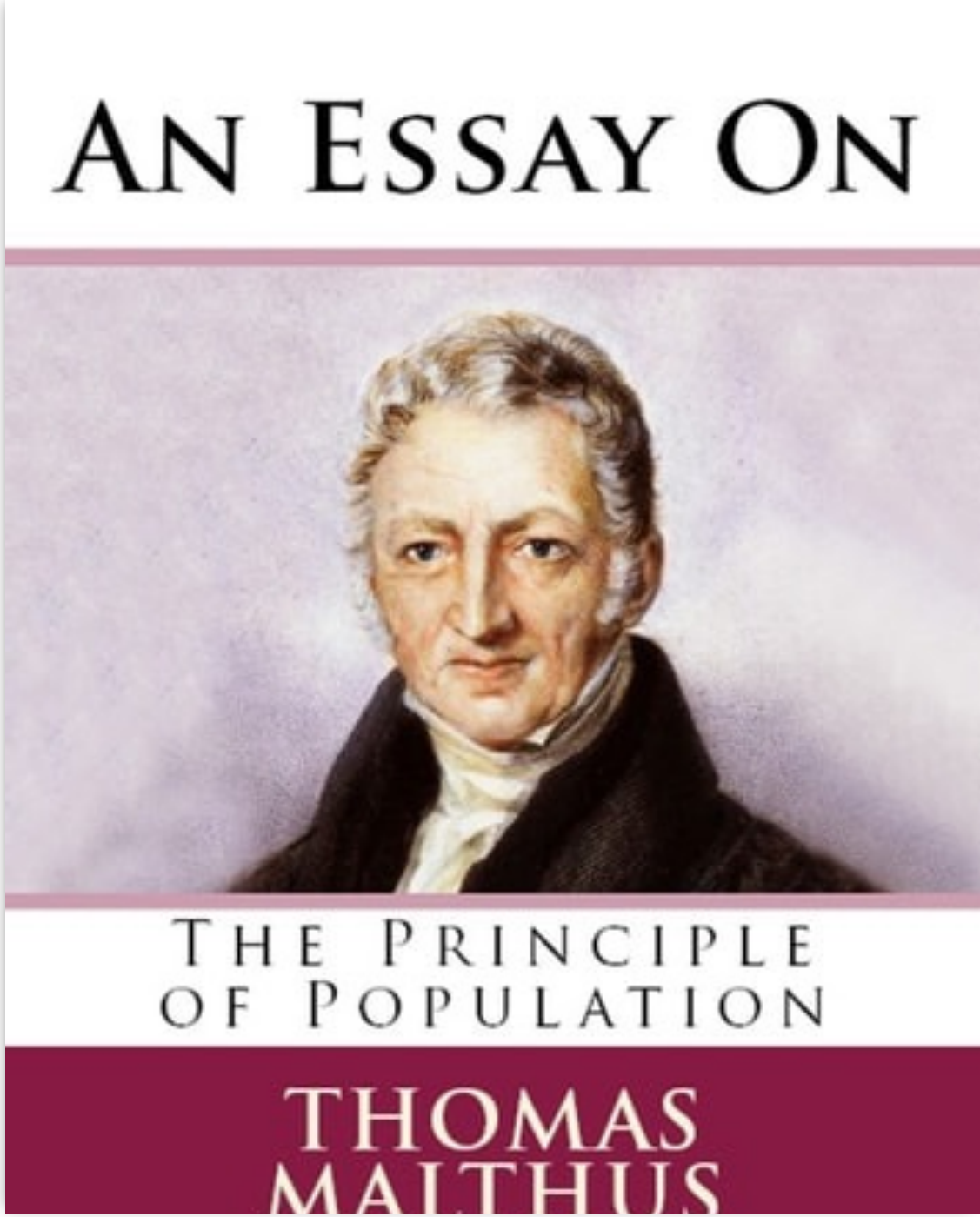
- Gregory Clark seeks to explain the significance of the Industrial Revolution through a simple economic model that relates to the factors of production. In his view, this model reveals a single decisive factor driving modern growth. Growth is generated overwhelmingly by investments in the stock of production knowledge in societies (197).
- Clark emphasizes, "…the efficiency growth from innovation is actually the true source of all growth," (204).
- Economics counts four factors of production—land, labor, capital, and entrepreneurship that combine to create goods and services. Clark's emphasis on efficiency growth will be part of entrepreneurship. The Industrial Revolution enhanced this activity, which became omnipresent after 1800.

The Industrious Revolution Before the Industrial Revolution

- Allen and J. L. Weisdorf highlight how diligently people tried to enhance productivity over the long run between 1540 and 1818. They located two episodes of steep increase in work requirements: one between 1540 and 1616, and another between 1750 and 18 18.
  - First upsurge in labor input coincides with the removal of 49 holy days in England, conducted in 1536 as part of the Protestant Reformation.
  - Second, starting at the eve of the industrial revolution, the working year increased between 1750 and 1800.

Malthusian Model

- Reverent Thomas Malthus An Essay on the Principle of Population (1798).



Clark's Research

- Only efficiency growth broke through what the economist came to call the Malthusian Trap.
- Gregory Clark defined the Malthusian thought as enunciating that before 1800, economic policy was turned on its head: vice was a virtue, and virtue a vice. What he meant was that before 1800, all those elements that characterize failed modern states, such as "war, violence, disorder, harvest failure, collapsed public infrastructures, bad sanitation- were the friends of mankind. They reduced population pressures and increased material living standards. In contrast, policies beloved of the World Bank and the United Nations today- peace, stability, order, public health, transfer to the poor- were the enemies of prosperity. They generated the population growth that impoverished societies (Clark, P5).
- Let us see why Clark reached that conclusion.

Malthusian Model

- In 1798 which means technically by the fourth decade of the period we broadly label as the Industrial Revolution; Malthus had no idea that he was living through a momentous period. He determined, taking a long view of the world economy, that the economy of humans in the years up to 1798 turned out to be just the natural economy of all animal species, with the same kind of factors determining the living conditions of animals and humans.
- The scholars later labeled that situation as the Malthusian Trap.

Malthusian Trap

- Reverend Malthus wrote his essay in search of “truth,” and for “the future improvement of society.” His understanding was that to attain that objective, the population must always be kept down to the level of the means of subsistence. He thought, “the biggest obstacle in the way to any very great improvement of society,” had to be removed to attain human welfare.
- In Chapter One, he admits that the 18th century, was “a period big with the most important changes.” These changes, he thought, could in some years be decisive for the future of mankind. His concern was “whether man shall henceforth start forwards with accelerated velocity towards illimitable, and hitherto unconceived improvement, or be condemned to a perpetual oscillation between happiness and misery from and after every effort remains still at an immeasurable distance from the wished-for all goal.”

Malthusian Trap

- Malthus postulated his realistic diagnosis of the absence of “perfectibility of society” and formed, in his words, “two postulata,”
  - “First, that food is necessary to the existence of man.
  - Second, that the passion between the sexes is necessary and will remain nearly in its present state.”
- These were, he argued, fixed laws of human nature and implied that “the power of population is indefinitely greater than the power in the earth to produce subsistence for man. A population, when unchecked, increases in a geometrical ratio. Subsistence increases in an arithmetical ratio.”

Malthusian Trap

Malthus believed that the effects of these two unequal powers, population and production, must be kept equal, which required a strong and constantly operating check on the population. He explained, “This natural inequality of the two powers of population and production in the earth, and that great law of our nature which must constantly keep their effects equal, form the great difficulty that to me appears insurmountable in the way to the perfectibility of society.”

Malthus believed that the superior power of the population “cannot be checked without producing misery or vice, the ample portion of these two bitter ingredients in the cup of human life in the continuance of the physical causes that seemed to have produced them bear too convincing a testimony,” (Chapter 2).

What did the Industrial Revolution Achieve?

Clark argues that “the logic of the Malthusian model matches the empirical evidence for the pre-industrial world. While even long before the Industrial Revolution small elites had an opulent lifestyle, the average person in 1800 was no better off than his or her ancestors of the Paleolithic or Neolithic,” (P 5).

Clark postulated that the Industrial Revolution shattered the statis of the preindustrial, Malthusian world. It produced for the first time “economic growth fueled by increasing production efficiency made possible by advances in knowledge.” The Industrial Revolution secured efficiency advances which translated into “the astonishing rise of income per person that we have seen since 1800,” (P 8). Essentially, England experienced accelerated growth of per capita output and labor productivity from 1763 to 1860.

How did the Industrial Revolution Happen?

- A Revolution means a sudden, radical, and complete change.
- Clark believes that the Industrial Revolution was not “a sudden fissure in economic life.” In his view, “the classic Industrial Revolution in England in 1760-1860 was a blip, an accident, superimposed on a longer-running upward sweep in the rate of knowledge accumulation that had its origins in the Middle Ages or even earlier,” (P. 10).
- He considers that an evolutionary account of gradual changes spread over the period between 1200 and 1860 in Europe, is a more plausible explanation, (P 10).
- The Industrial Revolution had as its components the Agricultural Revolution, Transport Revolution, and Technological Revolution.

What Does the Industrial Revolution Mean?

- Patrick K. O' Brien, in an article published by MIT Press in 2010, titled Deconstructing the British Industrial Revolution as a Conjuncture and Paradigm for Global Economic History distilled the following features of the First Industrial Revolution:

A range of innovations of world significance

The steam engines of Newcomen and Watt,

Henry Cort's path-breaking technique for puddling iron,

The weaving machines of Kay and Cartwright.

He categorized them as novel and indigenous to the British Isles.

- O'Brien also looked at the international dimension of the innovation and pointed out that Wedgwood's "China," or the techniques used to manufacture, bleach, dye, and print cotton cloth, were no longer acclaimed as peculiarly "English" (P. 15).

What Led to the Industrial Revolution?

- Patrick O'Brien includes the following as the significant causes or origins of the First Industrial Revolution:
  - The kingdom's highly productive and responsive agriculture;
  - It's abundant and accessible supplies of minerals, particularly coal;
- Foreign trade was sustained by massive and cost-effective state investment in naval power. He emphasizes, "It occurred largely because of the Island state's favorable national endowments and massive investments in naval power" and,
- Technological discovery and innovation (P 24). Textile, mining, and smelting sectors benefited enormously.

Great Inventors

- The following is a timeline and list of important dates of the Industrial Revolution:
- 1712:
  Thomas Newcomen invented the first productive steam engine.
- 1719:
  John Lombe opens the first silk-throwing factory in Great Britain in Derby.
- 1733:
  James Kay invented a simple weaving machine called the Flying Shuttle. **The textile industry thrives because of innovations like this and others that followed.**
- 1755:
  Professor William Cullen designed a small refrigerator at the University of Glasgow.
- 1764:
  James Hargreaves invented the Spinning Jenny, which allowed workers to produce multiple spools of thread at the same time.
- 1769:
  James Watt patents his revision of the steam engine, which features a separate condenser.

Great Inventors

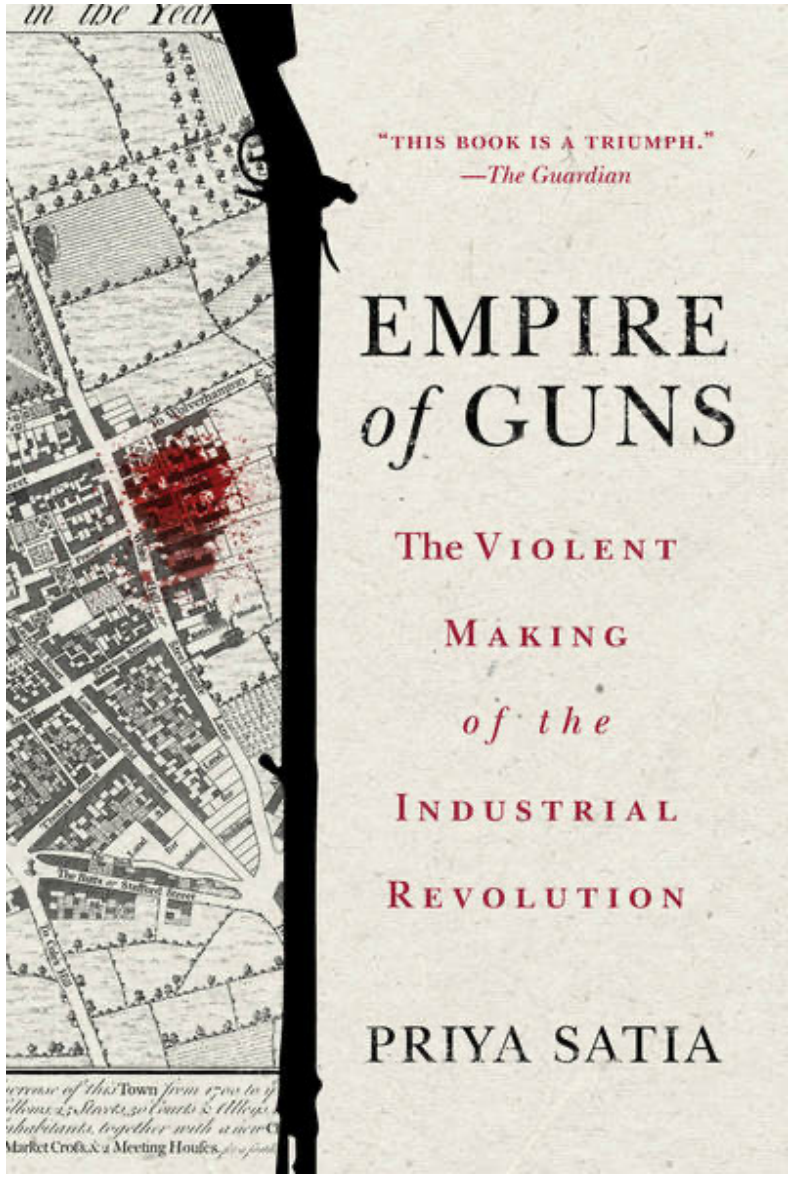
- 1779:
  Samuel Crompton invented the spinning mule, which combines spinning and weaving into one machine.
- 1785:
  Edmund Cartwright invented the power loom, which replaced the flying shuttle.
  Henry Cort invented iron refining techniques.
- 1787:
- Beverly Cotton Manufactory, the first cotton mill in America, opens in Beverly, Massachusetts, and is powered by horses.
- 1790:
  On December 20, 1790, Samuel Slater opened his first textile mill in Rhode Island, which was the first American factory to successfully produce cotton yarn using water-powered machines.
- 1793:
  Eli Whitney, an American, invented the cotton gin, which greatly increased the production of cotton.

Great Inventors

- 1801: On December 24, Richard Trevithick test drives the world's first steam-powered locomotive, called the "Puffing Devil" or "Puffer" on the streets of Camborne, England.
- 1802: An American farmer, Thomas Moore, invented the first wooden ice box.
- On March 24, Richard Trevithick patented his steam-powered locomotive called the "Puffer Devil."

How Did the Innovations Have an Impact?

- International trade, interlinked with the British Naval power, was a major contributor to the Industrial Revolution.
- O'Brien points out that over the eighteenth century, the volume of goods sold overseas multiplied four times compared to a multiplier of over just two from 1500 to 1700.
- Ratios of exports to gross national product kept increasing, from a little over 4 percent in the reign of Elizabeth (1558-1603), to 6 percent after the Restoration, beginning 1660, to 8 percent at the Glorious Revolution (1688), and reached 12 percent under George III (1760-1820).
- At least half of the increase in industrial production during the long eighteenth century (1688 – 1815) was sold overseas.
- Increasingly urban, British industrial labor provided manpower while facing challenging working and living conditions, and yet held on to the prospects of a rising middle class and prosperous family structures.


"THIS BOOK IS A TRIUMPH."
—The Guardian
EMPIRE
of GUNS
The VIOLENT
MAKING
of the
INDUSTRIAL
REVOLUTION
PRIYA SATIA

How Did the Innovations Have an Impact?

- International trade, interlinked with the British Naval power, was a major contributor to the Industrial Revolution.
- A Stanford Professor of International History, Priya Satia, published Empire of Guns: The Violent Making of the Industrial Revolution in 2019, exploring the reasons and the scale that crucial inventions like the steam engine, puddling, iron smelting, and weaving had achieved.
- Stanford Press introduces her book as exploring, “the true root of economic and industrial expansion: the lucrative military contracting that enabled the country's near-constant state of war in the eighteenth century. Demand for the guns and other war materials that allowed British armies, navies, mercenaries, traders, settlers, and adventurers to conquer an immense share of the globe, in turn, drove the rise of innumerable associated industries, from metalworking to banking.”

How Did the Innovations Have an Impact?

- Contrary to the classical view, Satia believes that instead of steam engines assisting the war effort, “war had assisted the spread of steam engine. These inventions- steam engines, lathes, and the puddling process, facilitated the rise of large-scale industry. They were interdependent and mutually reinforcing, and the state stood at the center of the networks around them. Major turning points of the Industrial Revolution steam engine, puddling, and copper sheeting- were triggered by war and produced by networks of contractor-industrialists, (P 161).

War and the Industrial Revolution

- Satia argued that war was foundational to modern industrial life. Britain, she pointed out, was involved in major military operations 87 of the years between 1688 and 1815, declaring war against foreign powers no fewer than eight times…"
- Because the war was the norm in this period, "… and it shaped the economy…." The British state, being the single most important factor in the economy, the largest borrower and spender, and employer, played a crucial part in it. The state, she emphasizes, was a consuming entity, supporting private industry through bulk purchases at critical times. It cut a wide swath as a consumer, literally investing Britons in its war-making (P2).
- In this environment, the arms maker morphed from a morally unremarkable participant in industrialization to a uniquely villainous merchant of death (P3).

Military-Industrial Complex

- The military-industry society, a collective of interdependent economic actors tied in varying ways to the state, in which there was no economic space not in some way connected to war (P 7).
- The diverse gun makers needed the authorities to “ensure their interest in businesses bearing on supply and carriage-canal construction, banking, trade to Africa in the New World, and so on. Likewise, businessmen from those worlds became invested and involved in the gun trade” (P 100).
- The nation stood for the gun industry, and the gun industry stood for the nation. In the wars of the second half of the century, in fits and starts, the Ordnance Office shaped revolutionary change in an industry central to the making of the state, the nation, and the empire (P 101).

Military-Industrial Complex

- The way gun makers operated was “a kind of virtual factory: a highly subdivided and efficient system of mass production, but too inclusive to house under a single roof. Well before the era of machine production, these factories together produced the standard British military arm in millions” (P 100).
- The government enabled this development of the scale of production throughout the three major wars Britain fought in the second half of the 18th century: the Seven Years’ War, the American War, and the French Revolutionary and Napoleonic Wars (P.101).

Military-Industrial Complex

- The British denied similar growth in their colonies if possibilities existed there. East India Company, for example, understood that arms manufacture was triggering revolutionary change at home, and refused to encourage the local industry which had been one of its suppliers, (P7).

- “While military purchasing driven by Britain’s aggressive colonial expansion incited industrial revolution at home, British officials abroad intentionally stymied similar transformation in the colonies,” (P 176).

Military-Industrial Complex: the Ordnance Office

- The Ordnance Office worked towards dramatically expanding the trade's productive capacity to secure the arms the Kingdom needed in its ever-larger conflicts and produce mass quantities (P 102).

- The dialogue between contractors and the state on prices and patterns improved the efficiency of mass production. Government offices led the way in many key innovations in key industries. Association with government contracts and innovations is a "common factor behind the pivotal organizational and technological breakthroughs of the time. War demand for mass quantities on standard patterns stimulated forms of production larger in scale, more complex, and more administratively demanding than those in civilian life. It posed organizational challenges that these industries would not otherwise have faced, fueling experimentation and change" (P 180).

War Needs and the Industrial Revolution

- During the Seven Years' War, Britain provisioned 96% of the combined army of British, Prussians, and other allied forces, numbering more than 100,000, plus 70,000 British sailors and soldiers at sea and in the Americas. No previous 18th-century army had exceeded 80,000 (P 108).

- Stores were constantly being depleted because the post-seventeen-sixty-three peace was purely notional. The Seven Years' War flipped the British state into a condition of almost permanent warfare for half a century (P 110).

War Needs and the Industrial Revolution

- From 1688 to 1815, roughly 80% of public expenditure was for military purchasing. Arms and ammunition accounted for only four to 5% of that.
- This means that whatever 18th-century industrial business you were in, you probably made something the government needed for war. We know the broad array of businesspeople with a stake in the gun trade, imagine a similarly wide net for each of these businesses with significant shares of military demand.
- British military expenditures headed the European league tables on a per capita basis, and Britain was the site of the Industrial Revolution. These were not coincidental but deeply interconnected developments," (P 167).

War Needs and the Industrial Revolution

- O’Brien’s research reinforces Satia’s argument. He points out that by the close of the Seven Years' War, something like half of the nation’s nonagricultural workforce depended directly or indirectly on markets overseas for its livelihood. As centers of growth, London, Bristol, Hull, Glasgow, Newcastle, Liverpool, and other maritime cities provided infrastructures, skilled workforces, and transportation and distribution networks to service internally as well as overseas trade.
- The country’s geographically conditioned but sustained commitment to a naval strategy for the defense of the realm carried unintended but important consequences for the development of a leading maritime public-cum-private sector of the British economy over time (P 35).

War Needs and the Industrial Revolution

- O’Brien also emphasizes that not long after the Hundred Years War (1337–1453), England’s kings, aristocrats, and merchants began to conceive of naval power, funded and sustained by the state, as the first line of defense against external threats and as the force required to back conquest and commerce with continents outside Europe (P 36).
- After the restoration of the monarchy and aristocracy in 1660, Britain’s elite sustained the political consensus required to form a highly effective fiscal naval state.

War and the Industrial Revolution

- Satia affirms that the government war demand built up the economic sectors that we know as “private” industry and finance.
- Contracting was foundational to the first industrial economy. Government-induced investment was critical to the rapid application and development of ideas that had been the subject of experimental interest; it drove substantive progress in heavy metal industries, steam power, and textiles. British merchants and manufacturers’ ability to provide the ships, cannons, guns, food, transport, and finance that the state needed depended on the Industrial Revolution.
- The Industrial Revolution was about reorganization and expansion of industry as much as it was about technological change, often driven by the state” (P 176).

https://time.com/7339621/person-of-the-year-2025-ai-architects-choice/

The Industrial Revolution and After

- Satia and O'Brien traced the state's role in driving industrial expansion and technological change.
- We can make a similar argument about what the historians called the Second Industrial Revolution, which spanned from 1870 to 1914. Similar factors drove it. The Great War triggered greater demand for energy, transportation, and raw materials, including coal, and pulled in a larger globalized base of production, industrialized states in the Americas, a Europe revitalized by the creation of a German Empire (1871) and the Kingdom of Italy (1861), as well as imperial colonies in Asia and Africa.
- Demand and supply aligned, the United States' growth in industry and finance led the second industrial revolution, with the world joining it at a differentiated scale.

The Industrial Revolution and After

- Human progress did not stop there.
- The first two Industrial Revolutions had something to do with the state and war. In the third, the state had a crucial and yet smaller role, while a non-state actor, a multinational company, took center stage.
- Mark III, a giant-sized IBM computer built for the Navy for $ 500,000, became Time's Person of the Year in January 1950. This was the third Industrial Revolution, the beginning of the digital age.
- We have since seen miniaturization and aggregation of digital tech and an abundance of ways in which it seeks to integrate with human life and needs.

https://time.com/7339621/person-of-the-year-2025-ai-architects-choice/

The Industrial Revolution and After

- Where are we now? Although we all know why the eight tech billionaires are Time's Person of the Year, the academic community seems divided on how to label our epoch.
- A South African researcher, Ian Moll, explored the differences that emerged at the Davos Economic Forum, January 2016, over the term Fourth Industrial Revolution. While there is consensus on how AI disrupts or changes our lives, some scholars prefer to see it as a continuation of the third Industrial Revolution.
- Third or Fourth, we are living through a revolution, which, like the first, is equally promising and life-changing as well as scary. A group of apprehensive workers strived to smash the machines that took away their jobs because of the first Industrial Revolution. We remember them as Luddites. Indestructible, the machines outlived them, and the technology created more jobs.

The Industrial Revolution and After

- Allen and Weisdorf have empirically shown that during a long period between 1300 and 1830, both the work hours and the real incomes increased twice. First time because the Black Death strained the labor market and thus increased the value of labor and the wages offered for it. Second, during the Industrial Revolution, the surplus rural populations found jobs in the rapidly growing and industrializing urban centers. We know from Karl Marx and Engels the price they paid in terms of worsening working and living conditions.
- Labor shortage also bedeviled the second Industrial Revolution, as the war drained the able-bodied cross sections of various protagonists. Simultaneously, it offered new avenues of labor and civic participation.
- The Third/Fourth Industrial Revolution would not be possible without the first and second, but it is different in multiple ways.

The Industrial Revolution and After

- The Third/Fourth Industrial Revolutions share a fundamental characteristic with the first two, which is that, as part of the factors of production, technology enhances productivity. This is how humans broke the Malthusian Trap.
- The AI Revolution promises to enhance productivity in unprecedented multiples. Jensen Huang tells Time, “There’s a belief that the world’s GDP is somehow limited at $100 trillion, AI is going to cause that $100 trillion to become $500 trillion.” We see similarly ensuring estimates about the value of the AI companies and the economic sectors that will competitively and more efficiently integrate AI. NVIDIA is the first-ever $5 trillion value company in the world.
- One major difference about the enhanced productivity this time would be that it might not need the manpower at the current levels. The AI enhancement of productivity and modes of getting there would eliminate thousands of jobs. While the previous revolutions replaced the old jobs with new ones, the AI Revolution, for the moment, does not indicate how and if that process will happen this time as well.

The Industrial Revolution and After

- The apprehensions about the AI Revolution are numerous. All Industrial Revolutions have been human creations. So is the case with this one. The difference, however, is that this Revolution, at minimum, aims at replicating and ultimately replacing the human mind.
- Time's lead author, Sam Jacobs, says, "These systems are improving at a blistering pace, taking seconds to perform work that once took people hours. AI's capabilities double nearly twice a year now, according to one study. The speed of adoption has been without precedent…"
- In a related article based on an interview with Jansen Huang, Campbell, Chow, and Perrigo observe, "AI systems may eventually outcompete humans—as if an advanced species were on the cusp of colonizing the earth." OpenAI's ChatGPT, they say, has surpassed 800 million weekly users, and "AI wrote millions of lines of code, aided lab scientists, generated viral songs, and spurred companies to re-examine their strategies or risk obsolescence."

Conclusion

- The Industrial Revolution was a watershed moment in British and World history. We are living through another Revolution seeking to model the machines on the functioning of the human mind.
- The first Industrial Revolution shattered the Malthusian Trap and enabled British industry to attain a worldwide reach because the British Naval power created demand, and colonialism ensured supplies of raw materials and markets for manufactured goods, including textiles and guns.
- The AI Revolution aims at exponentially enhancing productivity while raising serious ethical, social, and intellectual concerns as it unfolds.