

# Industry 4.0: The lead upto the future of Humanity

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*“After supervised learning — Transfer Learning will be the next driver of ML commercial success.”*

- Andrew Ng

## Introduction

There has been a lot of talk about the Fourth Industrial Revolution, a term first introduced by Klaus Schwab, the executive chairman of the World Economic Forum. Also called Industry 4.0, this new era of technology is poised to combine all the latest advancements in Robotics, Artificial Intelligence, Nanotechnology, Biotechnology, and the improvements made in wireless communication systems. Schwab describes an industrial revolution as “the appearance of new technologies and novel ways of perceiving the world that trigger a profound change in economic and social structures.” For us to try and realize where we are headed, we need to first understand what got us here.

## The First Revolution

The First Industrial Revolution began in England in the late 18th century. The success of this revolution later spread to

other countries in Western Europe and North America, which adopted and later improvised these technologies. The first advances came with a revolution in the production of cotton cloth using new machines powered by water wheels and then later by steam engines. These changes massively increased the productivity of workers, first in the textile, and then later in other industries. This revolution is what led the way for our lifestyles to move from an agrarian and handicraft economy to one dominated by industry and machine manufacturing, with factories like the one shown in Fig. 1.

## The Second Revolution

The Second Industrial Revolution, also known as the Technological Revolution, usually dated from 1870 to 1914, was where ideas and production really started to pick up the pace. This era saw the electrification of

cities, expansion of railways, production of automobiles, and exploitation of petroleum resources to be used as fuel. Modern management methods were conceptualized to help run massive private enterprises that were starting to form during this time. However, the rapid increase in technology also meant improvements in military technology and coupled with a massive increase in Iron and Steel production, inevitably lead to the First World War.

## The Third Revolution

The conclusion of the Second World War gave rise to the Atomic age and subsequently, the Space age. This era also brought us the Digital Revolution, which is what is usually associated with the Third Industrial Revolution. The advances in Semiconductor technology, improvements in Computers and the rise of the Internet and the Information age is what makes the modern world.

## Significance of the Industrial Revolution

Before the Industrial Revolution, people lived in agrarian societies across rural areas where farming was the leading occupation for most of the population. Life was relatively hard, and skeletal remains show that humans actually decreased in size after the Agricultural Revolution, indicating a more nutritious hunter-gatherer lifestyle. This goes contrary to the popular notion that the standard of living had got progressively better as humans started to evolve socially and politically.

However, the agricultural revolution gave way to the formation of large complex systems of organization like political entities and standardized systems of currency,

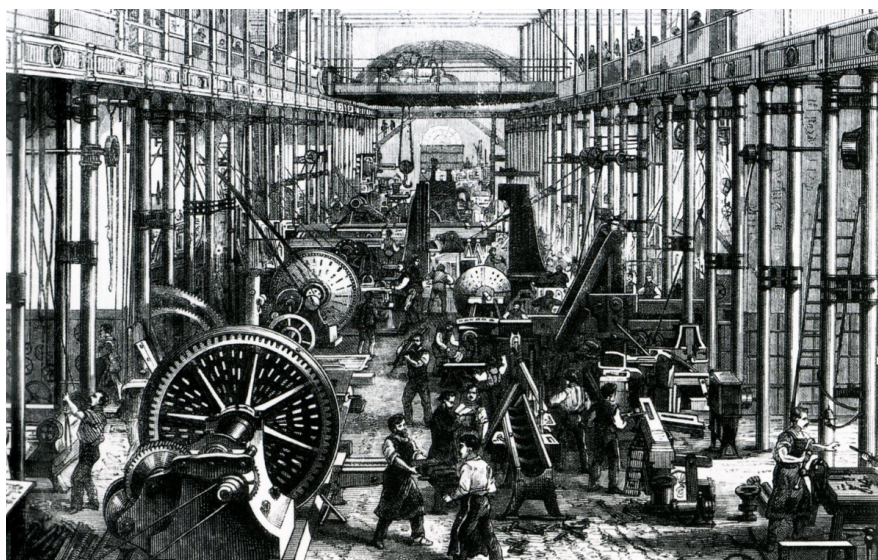


Fig. 1: A typical factory during the first industrial revolution

which ultimately led to the First Industrial Revolution.

There were many societies in the past that came close to industrialization, notably, the Song Dynasty in China and the Mughal Empire in India, particularly in the province of Bengal. In fact, the Industrialization of Britain in the 18th century was significantly boosted by its colonization and exploitation of resources from India.

The origin of much of our lifestyle and social norms can be traced back to the Industrial Revolution. Sustained economic growth was achieved for the first time, and it was the beginning of mass urbanization, literacy, and education, the latter of which was necessary to fill all the new engineering and technical jobs that were being created. This paved the way for improvements in sanitation and public health, and, due to decreased child mortality, led to a surge in population growth.

As we discussed earlier, before the Industrial Revolution, almost all of the economy was agriculture-based. This meant that resources were scarce and the only way to increase economic output for countries was to conquer new territories and exploit those resources. The Industrial Revolution changed this whole game completely. Agricultural productivity surged with the use of fertilizers and improved farming techniques, which allowed much of the workforce to be employed in factories and increase the production of goods. This movement led to urbanization which concentrated intellectual capital and led to an increase in innovation and productivity. Enormous amount of new wealth was being created for the first time, paving the way for the emergence of the Middle Class. Since its inception, this cycle of wealth creation has continued to this day, bringing people closer and generating greater prosperity for everyone. The Industrial Revolution also brought an end to Mercantilism and started a new era of free trade based on the principles laid out in Adam Smith's book, 'The Wealth of Nations', published in 1776.

However, this begs the question- what makes some countries wealthy and others poor? What leads to so much disparity in wealth distribution among individuals and nations as a whole? The answer to this question can be found in the difference in the nature of economic institutions in a society, which in turn are dictated by the political

## 2,000 YEARS OF ECONOMIC HISTORY IN ONE CHART

All major powers compared by GDP from the year 1 AD

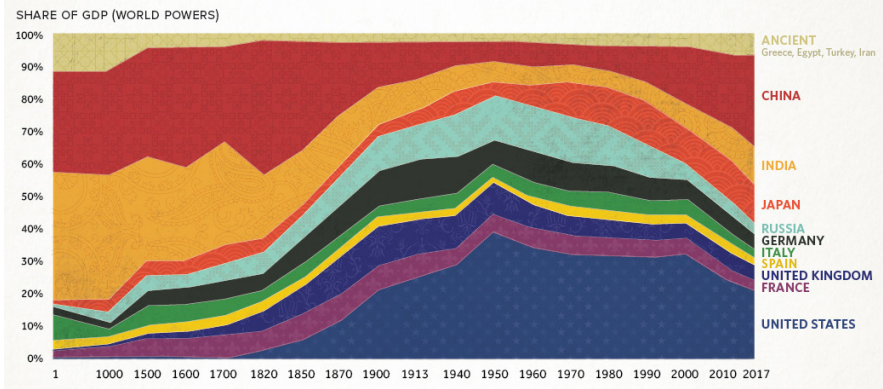


Fig. 2: History of annual economic output by nation

institutions that took shape in the land. Inclusive economic institutions encourage innovation, while extractive institutions do not. This is discussed in detail in the book-'Why Nations Fail' by Daron Acemoglu and James Robinson.

We have to realize, though, that wealth inequality is a real problem and should be addressed seriously. The income of most people in the world was similar until the Industrial Revolution, with the people in the wealthiest country on an average being four times richer than the poorest country. After the Industrial Revolution, this difference became huge, and today, that number is almost 177-fold. Fig. 2 illustrates this phenomenon, where we can see how

the European nations disproportionately contributed to the world economy starting from the 19th century.

Countries that later adopted the technologies pioneered in the early Industrial economies were able to transition much quicker than their predecessors and became Industrialized in a very short amount of time. An example of this is Germany which started to industrialize in the late 19th century and Russia in the early 20th century. Since the work on designing machines, optimizing production, and the methods of operation had already been developed, the only task for these countries was to adopt and implement them. The latest example is China, which started to industrialize rapidly from the

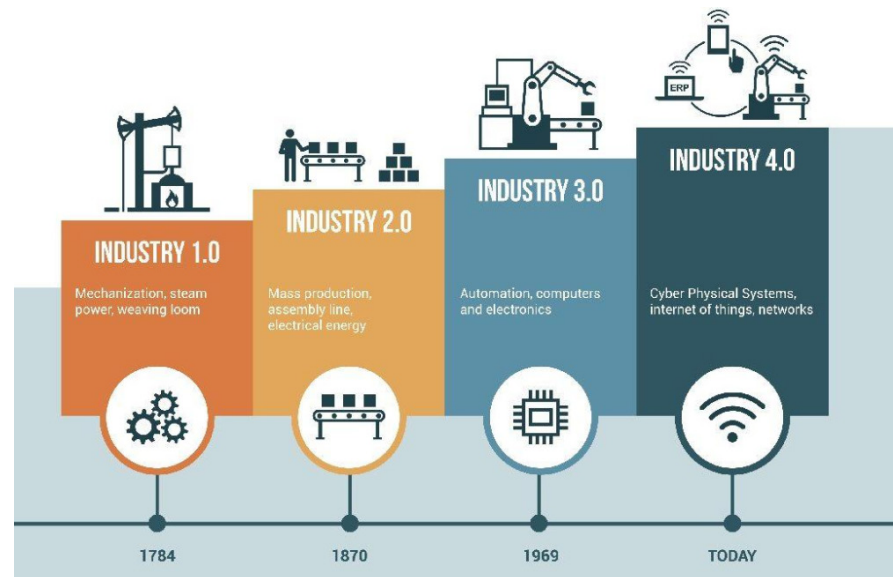


Fig. 3: An overview of the four industrial revolutions

1980s and came to be popularly known as the factory of the world. This industrialization transformed the country from being one of the most impoverished nations that were ravaged by famine and disease to becoming the hub of manufacturing for smartphones and advanced robots.

This brings us to the present day, where we are quickly transitioning into an exciting world where the physical, digital, and biological spheres merge. We have focused on the social aspects more than the technical details so far, and this will continue in the next section, where we will speculate on how the changes of today might impact us in the days to come.

## The Fourth Revolution

The advances in Artificial Intelligence and Robotics has already brought a lot of changes to our daily lives. Machines are poised to become far more capable than humans and will replace us in almost every field of work. It is only a question of when this transition is going to occur.

This is a phenomenon that is already felt by the chess community. On 7 December 2017, Google's AlphaZero program defeated the Stockfish 8 program. Stockfish 8 had centuries of accumulated human experience in chess, added with decades of computer experience. AlphaZero, on the other hand, was not taught anything-it only used the latest machine-learning principles to self-learn chess by playing against itself, which took a time of four hours, before the scheduled match against Stockfish. Out of a hundred games, AlphaZero won 28 games and tied 72 times. It did not lose a single game! Many of the winning moves played by AlphaZero looked very unconventional to human eyes, and the creative genius was outright inhuman, as one would expect. Today, one of the ways to catch cheaters in chess tournaments is to monitor the level of originality displayed by the players. If a move is unusually

creative, then the judges have a good reason to suspect chess programs aided their cause. At least in the chess industry, creativity is a trademark of machines, not humans! We can expect the same situation in all the fields and industries as time goes on.

Another example of machines venturing into traditionally human tasks is music composition. Music is an art adored by all as a way of expressing human emotion. However, at the end of the day, music consists of mathematical patterns that can be learned and replicated by machines. At the forefront of this movement to automate music is David Cope, a musicology professor at UC Santa Cruz and a very controversial figure in the world of Classical Music. Cope has written programs that compose chorales, symphonies, and operas, and his first creation was named Experiments in Musical Intelligence(EMI), which specialized in imitating the style of Johann Sebastian Bach, one of the greatest composers of all time. EMI took seven years to build, but once finished, it could compose 5000 chorales in a day! When played at a Music festival, people could not differentiate between Bach's original pieces and the ones composed by EMI. EMI continued to improve and learned to imitate Beethoven, Chopin, Rachmaninov, and Stravinsky. Critics argued that EMI's music is technically excellent, but that it lacks something- it is too accurate, it has no depth. However, when people heard EMI's compositions without being informed of their provenance, they frequently praised them precisely for their soulfulness and emotional resonance.

What I want to convey here is that machines have the ability to do everything humans can and one day will be better than us in every field of work. It is only a matter of economic incentive and political will, that will decide which jobs the machines will replace. If we look at the factory environment, advances in IoT and machine-to-machine

communication reduces human involvement and is giving rise to smart factories. Jobs are shifting to the service sector with a lot of focus on specialization. Yuval Harari, a historian and the author of Sapiens, foresees a world where we have to update our skills every few years if we expect to be a part of the job market. The situation will resemble Europe today, the continent with the most automated jobs in the world, where people enjoy more leisure time and prosperity than any other continent. We can expect our productivity to skyrocket in the coming decades, which will be beneficial to the species as a whole.

What we can also look forward to are mini-robots that function in the bloodstream, and robotic limbs for amputees. Medical technology is going to accelerate, improving our lives significantly. Additionally, this era also seeks to undo the damage done in the previous Industrial Revolutions. Climate change has become a significant global issue which demands a great deal of co-operation from all the players involved.

The era coming along with this latest revolution has the potential to impact our lives at a rapid pace, unlike anything we have seen before. However, we have good reason to be optimistic about our future, despite all the challenges we face ahead of us.

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