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Rise of the Robots

Technology and the Threat of a Jobless Future

Martin Ford

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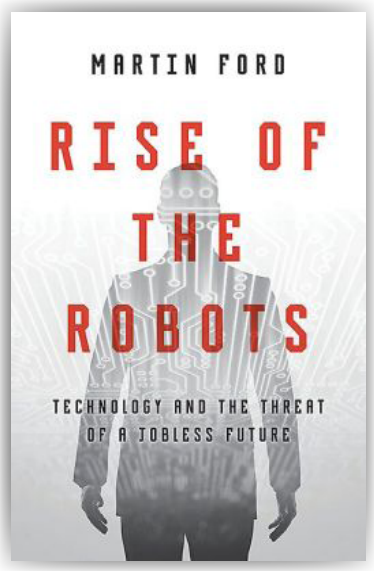

Key Concepts

- *A surge in robotic technology is imminent*. With increasingly affordable hardware, a standard robot operating system, and cloud computing to share new developments with others, the stage is set for an explosion in robotics.
- *Automation poses a serious threat to blue-collar professions*. Automated machines will eliminate manufacturing, agricultural, and service industry jobs by providing businesses with faster, more accurate performances for significantly less money.
- *Artificial intelligence puts white-collar professions at risk*. By harnessing the insights provided by big data, artificial intelligence is beginning to replace the jobs of knowledge workers in fields that include reporting, finance, law, and medicine.
- *The threat of an economic crisis is on the horizon*. Advancing technology will drive inequality in both income and consumption. As a result, it will undermine the vibrant and broad-based market demand necessary for economic prosperity.
- *A new economic paradigm will soon be essential*. In order to sustain economic growth in the future, new government policies must be enacted to provide citizens with a basic safety net against joblessness.

Summary

Introduction

In **Rise of the Robots**, author Martin Ford taps into his years of experience in software development to discuss the dangerous impact robotics may soon have on the economy. According to Ford, accelerating technology not only has the power to eliminate blue- and white-collar jobs, but may derail the economic system altogether.

In order to prevent this bleak future, leaders must learn about the fundamentals of both accelerating technology and the economy. Only with an understanding of these two forces can leaders begin shaping the policies necessary to prevent a future of economic despair.

The Automation Wave

Despite their superiority in strength and speed, robots historically have not truly threatened people's jobs because they lacked two priceless human abilities: sight and decision making. This all changed in 2006 when Nintendo introduced the Wii video game console, arguably the first robot with "eyes." Competitor Microsoft responded to Wii with Kinect, an Xbox 360 game console add-on with three-dimensional machine vision capability. Kinect has since paved the way for affordable machines with near human-level abilities to perceive and interact with their environments.

We are, in all likelihood, at the leading edge of an explosive wave of innovation that will ultimately produce robots geared toward nearly every conceivable commercial, industrial, and consumer task.

The coming explosion in robotics is illustrated well by Rethink Robotics' development of Baxter—a humanoid manufacturing robot that can learn and perform a number of repetitive tasks. The imminent surge in automated machines akin to Baxter can be attributed to a number of factors, including the increasing number of affordable hardware components (like the inexpensive "eyes" that Kinect introduced to the industry), as well as the development of the Robot Operating System, a free, open-source software platform that has made robots easy to program and control. As these automated machines become increasingly ubiquitous, they will greatly impact employment in America.

According to Ford, automation will cause a major disruption in the following sectors:

- *Service*. As company Momentum Machines, Inc. demonstrates with their machine that shapes and grills fresh burgers to order, the majority of fast-food workers can easily be replaced by more efficient, sanitary robotic devices.
- *General retail*. Three technological forces that will affect retail employment include:
    1. The ongoing disruption from online retailers like Amazon, eBay, and Netflix.
    2. The development of fully automated self-service retailers like intelligent vending machines and kiosks, which will eliminate the salesperson job.
    3. The introduction of automation and robotics in stores for tasks like stocking shelves and doing inventory.
- *Agriculture*. Robotics can improve farming efficiency by both picking crops and using fewer natural resources.

Is This Time Different?

In 1964, a group of academics, journalists, and technologists came together to publish a report citing three forces they believed could greatly impact the country. One of these was automation, which they believed would not only cause massive unemployment and income inequality, but would result in American consumers losing their buying power, which in turn would cause economic stagnation. Ford argues that their concerns regarding the economic effects of automation were premature; *now* is the time to assess the impact of technology.

Combined with globalization, financialization, and politics, technology has driven the following seven "deadly" economic trends:

1. *Stagnant wages*. Since 1980, productivity has grown steadily in America, while workers' compensation has stagnated.

2. *A bear market for workers, and a raging bull for corporations*. For over three decades, labor's share of income has been declining, while corporate profits have skyrocketed.
3. *A dwindling workforce*. The number of people in the workforce is dwindling, since many workers gave up looking for jobs altogether during the Great Recession.
4. *Weak job creation, long jobless recoveries, and persistent unemployment*. The 2000s ended in a deficit of 9 million jobs. Meanwhile, research shows that the economy is taking longer than ever to bounce back.
5. *Inequality*. American income inequality today is on par with the Philippines. The better people at the top do, the worse the prospects for the people at the bottom.
6. *Declining incomes and underemployment for recent graduates*. Recent college graduates are unable to find jobs or are stuck with jobs for which they are overeducated.
7. *Polarization and part-time jobs*. Solid, middle-class jobs were destroyed during the recession and replaced with low-paying retail and hospitality jobs or high-skill jobs that require extensive training.

Information Technology: An Unprecedented Force for Disruption

Information technology (IT) is a highly disruptive force for a number of reasons. For one, IT has evolved into a general-purpose technology that has infiltrated every part of society, including economic, social, and financial systems. It provides humans with more cognitive capability. Also, IT's disruptive power can be attributed to its exponential acceleration. For other technologies like cars and aircrafts, the pace of innovation typically is described as an S-curve: innovation grows slowly, balloons out, dips before growing again, and then eventually matures into a plateau. Meanwhile, IT has not matured into a plateau but has successfully climbed a staircase of cascading S-curves. According to Moore's Law, the speed at which new computing technologies are developed continues to get faster and faster because each new innovation is able to leverage the accumulated progress of the innovations that precede it.

As information technology marches forward, its tentacles reach ever deeper into organizations and the overall economy . . .

Economists that deny the threat of machines taking over the workforce often base their claims on the theory of *comparative advantage*, which argues that productivity is achieved when everyone specializes in a task that they are "least bad" at compared to others. Advocates of this idea assert that machines will specialize in certain areas and allow humans to specialize in others; however, it is more likely that companies will train a single robot to do all tasks and then clone it into an army of workers. In this scenario, robots will not work alongside people—they will simply replace them.

White-Collar Jobs at Risk

Just as automation increasingly encroaches on manufacturing and service industry jobs, *artificial intelligence* (AI) is starting to take jobs away from knowledge workers. AI engine Quill, for example, is able to write both news stories and business reports. Described as a general-purpose, analytical, and narrative-writing engine, Quill collects data from a variety of sources, performs an analysis to discern the most interesting facts, and then puts the information together into a coherent story. Some experts predict that in the next 15 years, over 90 percent of news articles will be written algorithmically with programs like Quill.

Quill exemplifies the sea of new applications that are being developed in an effort to leverage the thousands of exabytes of data collected by businesses, organizations, and governments. Known as *big data*, this unstructured, valuable information is mined from countless digital sources, including search queries, emails, and social media interactions. It is big data that fuels machine learning, a process that typically comprises two steps. First, an algorithm gets trained on a type of data. Then, the algorithm then tries to find solutions for similar problems

with new data. Examples of machine-learning algorithms include spam filters and Netflix movie recommendations.

The big data revolution is likely to have two implications for knowledge-based occupations:

1. *Big data will lead to the direct automation of specific tasks and occupations*. By analyzing patterns of past behavior and implementing self-learning systems that can adapt to unpredictable situations, machines can begin to act independently.
2. *Big data and algorithms will impact the way organizations are managed*. As the predictions generated by big data replace human judgment, the need for knowledge workers to collect and analyze information will disappear. Consequently, organizations' structures will flatten, and clerical, analyst, and middle-management jobs will disappear.

. . . If automation eliminates a substantial fraction of the jobs that consumers rely on . . . then it is difficult to see how a modern mass-market economy could continue to thrive.

The effects of white-collar automation will be comparable to the recent increase in *offshoring*, where lawyers, computer programmers, and even tax preparers in India have been conducting more American work for a fraction of the price. White-collar automation will be especially hard on recent college graduates, as entry-level positions are particularly vulnerable to being performed by AI. Even young lawyers are facing a threat as programs like e-Discovery make it possible to analyze millions of electronic documents and identify the ones most relevant to a case. While there will be some human-machine collaboration jobs in the future, this period will be short-lived. Eventually the machines will learn the humans' tasks and perform them better, for less money.

Transforming Higher Education

At first glance, higher education seems like an industry that would be unaffected by accelerating technology. However, the recent development of the following innovations prove that higher education jobs may also be at risk:

- *Automated grading algorithms*. While teachers may protest that machines cannot read, algorithmic grading is in fact more objective, consistent, and efficient. Research shows that when it comes to essays, the analysis of statistical correlations allows machines to match or even outperform human graders.
- *Massive open online courses (MOOCs)*. A mass education mechanism that has been proven effective for students with motivation and self-discipline, MOOCs have the potential to disrupt a half a trillion-dollar industry with more than three million employees by providing education from elite institutions like Stanford online for free. While course completion of MOOCs is low, cheating is common, and institutions are reluctant to give out college credit for free, the heyday of MOOCs may not be over. American higher education has never been more expensive and students, drowning in debt, are looking for alternatives. Eventually employers may start accepting the competency credit students receive for passing MOOCs.
- *Adaptive learning systems*. These new educational technologies act as robotic tutors by following students' individual progress and offering personalized pace of learning, instruction, and general assistance.

The Health Care Challenge

Artificial intelligence and big data have the potential to transform the health care industry. By collecting all of the medical knowledge and diagnostic skills from individual physicians and making it available to others, new technologies will improve the accuracy and efficiency of medical treatment strategies. This is the goal behind Watson, IBM's AI computer system, and its collaboration with the world-renowned MD Anderson Cancer Center in Texas. By gathering data from MD Anderson's physicians, Watson is creating an interactive advisor capable of

recommending the best evidence-based treatment options for cancer patients. Once the advisory system is up and running, it will be made available as a resource for doctors everywhere, thereby democratizing cancer care.

In addition to quicker, better treatments, robotics and AI may improve the health care industry by:

- Acting as a valid second opinions source, thereby cutting malpractice costs.
- Providing patients with accurate diagnoses and effective treatment, potentially eliminating the need for doctors to oversee every patient visit.
- Giving way to a new class of medical professionals who are trained predominantly to interact and examine patients and let the machines do the rest.
- Providing eldercare to an aging population.
- Diagnosing and managing chronic illnesses like diabetes by collecting patient data with biometric sensors.

Despite all these potential benefits, IT has made relatively few inroads into the health care industry—perhaps because of the dysfunctional market that health care operates within. Because the health care market exists between providers and insurers and not providers and patients, providers tend to inflate the price of medical tests and treatments. Without market pressure, or the need to win the business of their customers through quality and affordable services, providers tend to invest in the technologies that will make them more money—not those poised to increase efficiency.

One of the most important benefits of artificial intelligence in medicine is likely to be the avoidance of potentially fatal errors in both diagnosis and treatment.

In order for new technologies to improve the quality of health care in America, the industry must either consolidate and treat health insurance as a utility or set all-payer rates.

Technologies and Industries of the Future

The concept of *creative destruction* argues that while technology may eliminate some jobs and businesses, it will also create entirely new industries and occupations. Throughout history, creative destruction has been a reoccurring force because there has always been a need for human labor and intelligence. Thanks to the rise of automated manufacturing and AI, however, this is no longer the case. As old companies fade into obsolescence, the new businesses that are taking their place are like YouTube—tiny workforces with huge valuations. The following future industries illustrate how creative destruction may no longer be a reality:

- *3-D printing*. 3-D printers can be used with any type of material, from artisan cookie ingredients to the human cells necessary to create a liver. Because it is automating the creation of new products, this industry is likely to eliminate rather than create jobs.
- *Autonomous cars*. People will most likely hire autonomous cars rather than own them. If the individual-ownership model for cars falls, it will have an enormous impact on the economy and job market by eliminating car dealerships, repair shops, and gas stations. The manufacturing, insuring, and maintenance of autonomous cars is likely to be centralized by companies like Google.

Consumers, Limits to Growth … and Crisis?

The economic effects of accelerating technology have the potential to be catastrophic. By eliminating jobs, machines are taking away people's income, thereby prohibiting their ability to participate in the economy as consumers. As machines are not consumers, they cannot provide the broad-based market demand necessary for economic growth.

In America's mass-market economy, industries like consumer electronics, health care, and automotives can only thrive if there is a high unit demand. Consequently, income inequality poses a serious problem; a handful of wealthy customers cannot buy the thousands of mobile phones or cars necessary to keep the economy afloat. According to Ford, the surge of robotics and self-service technology in the near future will not only exacerbate the existing income inequality that plagues America today, but will also cause economic stagnation.

Some people argue that robotics will increase the efficiency of production, which in return will cause product prices to drop. Their logic is that lower incomes will not be a problem if there are lower prices to match them. However, lower product prices can cause another dangerous outcome: a deflationary economy accompanied by soaring unemployment and unmanageable debt.

Super-Intelligence and the Singularity

According to some of the world's top scientific minds, the threat of robotics could hypothetically go beyond job elimination and economic catastrophe. If artificial intelligence evolves into Artificial General Intelligence (AGI), which is comparable to human thought, machines would be able to conceive new ideas, demonstrate awareness of their own existence, and carry on coherent conversations. Thanks to Moore's Law, machines with AGI would quickly outpace humans in intelligence—a fact that would easily disrupt human civilization and usher in an event called the *Singularity*. While these scenarios are unlikely to come to fruition (they would require significant research and funding), the effects could include challenges to human financial, military, and electrical systems.

. . . Crafting a future that offers broad-based security and prosperity may prove to be the greatest challenge for our time.

Toward a New Economic Paradigm

In the context of robotics, the job market must be thought of as a pyramid, not a ladder. At the top of the pyramid are a small number of professionals and entrepreneurs with fine-tuned skills and capabilities. Meanwhile, the base of the pyramid comprises routine and repetitive jobs across a number of sectors. Although it has become increasingly clear that automation and algorithm-learning machines are consuming the bottom of the pyramid, the "safe" area at the top is also likely to shrink over time thanks to AI applications. Unfortunately, the solutions that are typically proposed to quash the threat of automation fall short:

- *More education*. Where education was once a way to get ahead, the returns on higher education are diminishing today. Studies show that many American graduates are either underprepared or overqualified for the jobs they obtain. Additionally, awarding more college degrees to aspiring workers results in credential inflation.
- *Less automation*. The solution of putting a stop to the ongoing progression toward more automation is unrealistic. Ultimately, business owners do not want to hire more workers if they can get the same work done in a more efficient, cost-effective way. To stop automation would require modifying the basic incentives built into the market economy.

According to Ford, the most effective solution to the threat of a jobless future is some form of basic income guarantee. If citizens can no longer rely on traditional support systems, it behooves the government to enact a policy that provides a safety net against economic adversity. In order to create a viable guaranteed income, however, it is necessary to first get the incentives right. Ford believes the goal here is to supplement low incomes in a way that does not create a disincentive to work but rather to be as productive as possible. Consequently, the income should be enough to get by but not enough to be comfortable. Additionally, it should be phased out at a very high level so that people will not get stuck in the "poverty trap," where they are afraid to go out and get more work because it would eliminate their passive income from the state.

Although a basic income would cause some people to drop out of the workforce altogether, it is important to remember that these are society's least ambitious members. As jobs become increasingly scarce, unmotivated people are less likely to get hired. Instead they will become the customer to the entrepreneur who is also receiving the same basic income. Ford suggests that to pay for the basic income guarantee, the government can eliminate existing, less effective social service programs like welfare, food stamps, and housing. Additionally, the income could be taxable and certain taxes could be raised. Alternatively, businesses could provide everyone with a sizeable balance in a mutual fund, or the government could provide each citizen with a diversified portfolio of equity, and the returns could help pay for a basic income.

Features of the Book

Estimated Reading Time: 6–7 hours, 352 pages

Rise of the Robots would be beneficial to economists, entrepreneurs, and all other professionals interested in the potential effects of accelerating technology. Martin Ford leverages his experience as a software developer to discuss the implications of automated machines and artificial intelligence on society. Additionally, he describes the fundamentals of economics to illustrate just how dangerous the impact of robotics on the workforce may be. The book is best read in chapter order, as each chapter builds off the previous one.

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About the Author

Martin Ford, the founder of a Silicon Valley-based software development firm, has over 25 years of experience in computer design and software development. The author of *The Lights in the Tunnel: Automation, Accelerating Technology and the Economy of the Future*, he lives in Sunnyvale, California.