

# Impact of Technology on the Future of Work

## Inspiration Pack



**September 2014**

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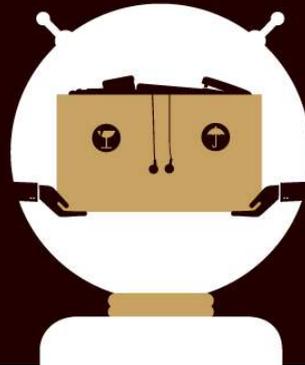
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FEATURED STORY

# How Technology Is Destroying Jobs

By David Rotman on June 12, 2013

759 COMMENTS



## How Technology Is Destroying Jobs

- By [David Rotman](#) on June 12, 2013

Given his calm and reasoned academic demeanor, it is easy to miss just how provocative Erik Brynjolfsson's contention really is. Brynjolfsson, a professor at the MIT Sloan School of Management, and his collaborator and coauthor Andrew McAfee have been arguing for the last year and a half that impressive advances in computer technology—from improved industrial robotics to automated translation services—are largely behind the sluggish employment growth of the last 10 to 15 years. Even more ominous for workers, the MIT academics foresee dismal prospects for many types of jobs as these powerful new technologies are increasingly adopted not only in manufacturing, clerical, and retail work but in professions such as law, financial services, education, and medicine.

That robots, automation, and software can replace people might seem obvious to anyone who's worked in automotive manufacturing or as a travel agent. But Brynjolfsson and McAfee's claim is more troubling and controversial. They believe that rapid technological change has been destroying jobs faster than it is creating them, contributing to the stagnation of median income and the growth of inequality in the United States. And, they suspect, something similar is happening in other technologically advanced countries.

Perhaps the most damning piece of evidence, according to Brynjolfsson, is a chart that only an economist could love. In economics, productivity—the amount of economic value created for a given unit of input, such as an hour of labor—is a crucial indicator of growth and wealth creation. It is a

measure of progress. On the chart Brynjolfsson likes to show, separate lines represent productivity and total employment in the United States. For years after World War II, the two lines closely tracked each other, with increases in jobs corresponding to increases in productivity. The pattern is clear: as businesses generated more value from their workers, the country as a whole became richer, which fueled more economic activity and created even more jobs. Then, beginning in 2000, the lines diverge; productivity continues to rise robustly, but employment suddenly wilts. By 2011, a significant gap appears between the two lines, showing economic growth with no parallel increase in job creation. Brynjolfsson and McAfee call it the "great decoupling." And Brynjolfsson says he is confident that technology is behind both the healthy growth in productivity and the weak growth in jobs.

It's a startling assertion because it threatens the faith that many economists place in technological progress. Brynjolfsson and McAfee still believe that technology boosts productivity and makes societies wealthier, but they think that it can also have a dark side: technological progress is eliminating the need for many types of jobs and leaving the typical worker worse off than before. Brynjolfsson can point to a second chart indicating that median income is failing to rise even as the gross domestic product soars. "It's the great paradox of our era," he says. "Productivity is at record levels, innovation has never been faster, and yet at the same time, we have a falling median income and we have fewer jobs. People are falling behind because technology is advancing so fast and our skills and organizations aren't keeping up."

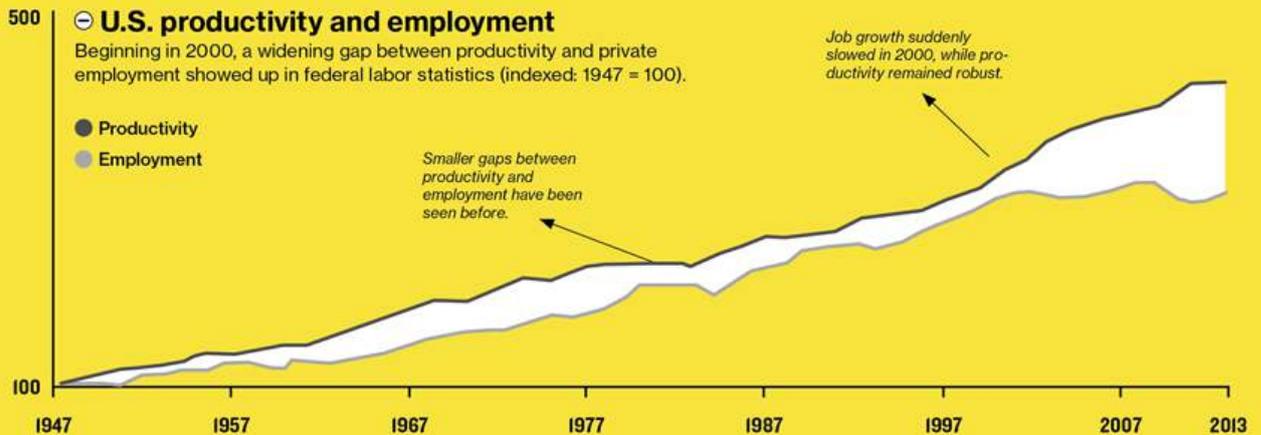
Brynjolfsson and McAfee are not Luddites. Indeed, they are sometimes accused of being too optimistic about the extent and speed of recent digital advances. Brynjolfsson says they began writing *Race Against the Machine*, the 2011 book in which they laid out much of their argument, because they wanted to explain the economic benefits of these new technologies (Brynjolfsson spent much of the 1990s sniffing out evidence that information technology was boosting rates of productivity). But it became clear to them that the same technologies making many jobs safer, easier, and more productive were also reducing the demand for many types of human workers.

# Decoupling Productivity and Employment

Digital technologies have boosted productivity in the United States without also spurring the expected job growth, argue Erik Brynjolfsson and Andrew McAfee. A result of this decoupling is that while gross domestic product (GDP) has risen, median income has not, and inequality has grown.

## U.S. productivity and employment

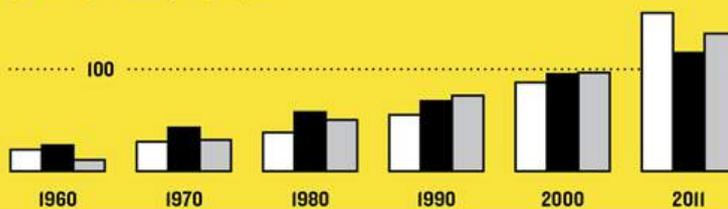
Beginning in 2000, a widening gap between productivity and private employment showed up in federal labor statistics (indexed: 1947 = 100).



## Output per employed person in manufacturing

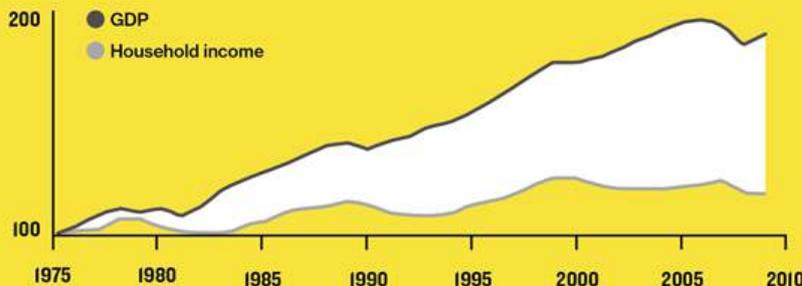
In leading advanced manufacturing countries, output per worker has grown impressively as factories have become more automated (indexed: 2002 = 100).

○ US ● Germany ○ Japan



## U.S. GDP per capita and household income

While the nation's total output has generally grown over the last 25 years, the median household income has been nearly stagnant (indexed: 1975 = 100).



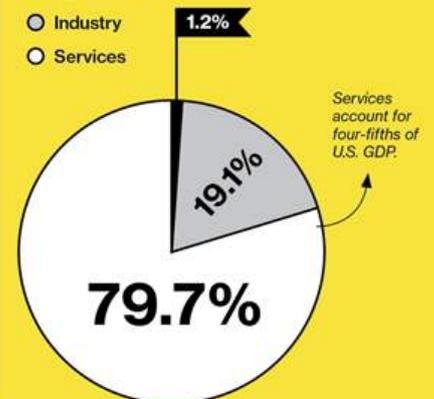
**320k** Industrial robots sold in the last two years



## Automation in services has a dramatic effect

Making service work more efficient has an outside impact on productivity figures because the sector is so large.

● Agriculture  
● Industry  
○ Services



Anecdotal evidence that digital technologies threaten jobs is, of course, everywhere. Robots and advanced automation have been common in many types of manufacturing for decades. In the United States and China, the world's manufacturing powerhouses, fewer people work in manufacturing today than in 1997, thanks at least in part to automation. Modern automotive plants, many of which were transformed by industrial robotics in the 1980s, routinely use machines that autonomously weld and paint body parts—tasks that were once handled by humans. Most recently, industrial robots like Rethink Robotics' Baxter (see "[The Blue-Collar Robot](#)," May/June 2013), more flexible and far cheaper than their predecessors, have been introduced to perform simple jobs for small manufacturers in a variety of sectors. The website of a Silicon Valley startup called Industrial Perception features a video of the robot it has designed for use in warehouses picking up and throwing boxes like a bored elephant. And such sensations as Google's driverless car suggest what automation might be able to accomplish someday soon.

A less dramatic change, but one with a potentially far larger impact on employment, is taking place in clerical work and professional services. Technologies like the Web, artificial intelligence, big data, and improved analytics—all made possible by the ever increasing availability of cheap computing power and storage capacity—are automating many routine tasks. Countless traditional white-collar jobs, such as many in the post office and in customer service, have disappeared. W. Brian Arthur, a visiting researcher at the Xerox Palo Alto Research Center's intelligence systems lab and a former economics professor at Stanford University, calls it the "autonomous economy." It's far more subtle than the idea of robots and automation doing human jobs, he says: it involves "digital processes talking to other digital processes and creating new processes," enabling us to do many things with fewer people and making yet other human jobs obsolete.

It is this onslaught of digital processes, says Arthur, that primarily explains how productivity has grown without a significant increase in human labor. And, he says, "digital versions of human intelligence" are increasingly replacing even those jobs once thought to require people. "It will change every profession in ways we have barely seen yet," he warns.

McAfee, associate director of the MIT Center for Digital Business at the Sloan School of Management, speaks rapidly and with a certain awe as he describes advances such as Google's driverless car. Still, despite his obvious enthusiasm for the technologies, he doesn't see the recently vanished jobs coming back. The pressure on employment and the resulting inequality will only get worse, he suggests, as digital technologies—fueled with "enough

computing power, data, and geeks”—continue their exponential advances over the next several decades. “I would like to be wrong,” he says, “but when all these science-fiction technologies are deployed, what will we need all the people for?”

## **New Economy?**

But are these new technologies really responsible for a decade of lackluster job growth? Many labor economists say the data are, at best, far from conclusive. Several other plausible explanations, including events related to global trade and the financial crises of the early and late 2000s, could account for the relative slowness of job creation since the turn of the century. “No one really knows,” says Richard Freeman, a labor economist at Harvard University. That’s because it’s very difficult to “extricate” the effects of technology from other macroeconomic effects, he says. But he’s skeptical that technology would change a wide range of business sectors fast enough to explain recent job numbers.

Employment trends have polarized the workforce and hollowed out the middle class.

David Autor, an economist at MIT who has extensively studied the connections between jobs and technology, also doubts that technology could account for such an abrupt change in total employment. “There was a great sag in employment beginning in 2000. Something did change,” he says. “But no one knows the cause.” Moreover, he doubts that productivity has, in fact, risen robustly in the United States in the past decade (economists can disagree about that statistic because there are different ways of measuring and weighing economic inputs and outputs). If he’s right, it raises the possibility that poor job growth could be simply a result of a sluggish economy. The sudden slowdown in job creation “is a big puzzle,” he says, “but there’s not a lot of evidence it’s linked to computers.”

To be sure, Autor says, computer technologies are changing the types of jobs available, and those changes “are not always for the good.” At least since the 1980s, he says, computers have increasingly taken over such tasks as bookkeeping, clerical work, and repetitive production jobs in manufacturing—all of which typically provided middle-class pay. At the same time, higher-paying jobs requiring creativity and problem-solving skills, often aided by computers, have proliferated. So have low-skill jobs: demand has increased for restaurant workers, janitors, home health aides, and others doing service work that is nearly impossible to automate. The result, says Autor, has been a “polarization” of the workforce and a

“hollowing out” of the middle class—something that has been happening in numerous industrialized countries for the last several decades. But “that is very different from saying technology is affecting the total number of jobs,” he adds. “Jobs can change a lot without there being huge changes in employment rates.”

What’s more, even if today’s digital technologies are holding down job creation, history suggests that it is most likely a temporary, albeit painful, shock; as workers adjust their skills and entrepreneurs create opportunities based on the new technologies, the number of jobs will rebound. That, at least, has always been the pattern. The question, then, is whether today’s computing technologies will be different, creating long-term involuntary unemployment.

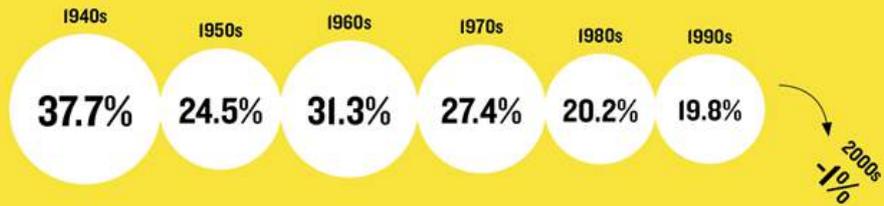
At least since the Industrial Revolution began in the 1700s, improvements in technology have changed the nature of work and destroyed some types of jobs in the process. In 1900, 41 percent of Americans worked in agriculture; by 2000, it was only 2 percent. Likewise, the proportion of Americans employed in manufacturing has dropped from 30 percent in the post–World War II years to around 10 percent today—partly because of increasing automation, especially during the 1980s.

# Where the Jobs Are Going

There is plenty of evidence that technological advances are affecting what jobs are in demand. High-skill positions that often take advantage of computers are growing, as are low-skill jobs doing work, such as home health care, that is difficult to automate. Many mid-skill jobs, however, are disappearing.

## U.S. job growth by decade

The percentage change in nonfarm employment through the last seven decades illustrates just how dismal job prospects have been since 2000.



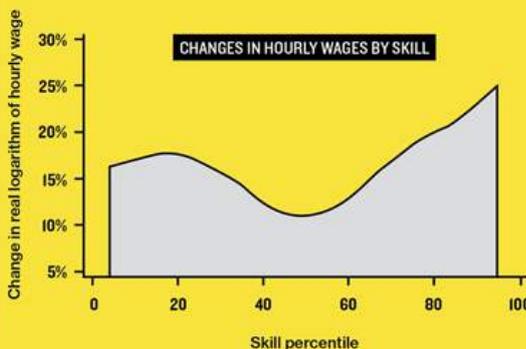
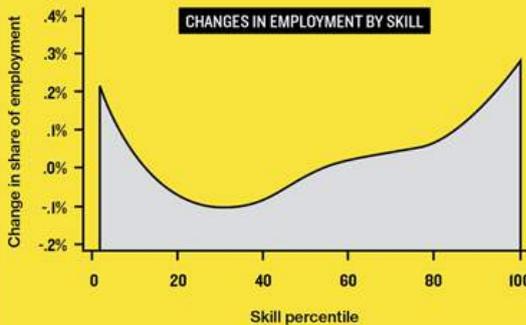
## Manufacturing employment

Employment in manufacturing now accounts for only one in 10 jobs in the United States. Germany, a manufacturing powerhouse, has fared somewhat better.



## Hollowing out the middle

Research by MIT economist David Autor shows that between 1980 and 2005, the middle class suffered both in share of jobs and in wage growth. The top chart shows share of employment held by workers of different skill levels; the bottom shows changes in wages.



## The mix of jobs

The fastest-growing jobs in the U.S. from 2000 to 2010 reflect the demand for highly technical skills and those lower-skill jobs that are hard to automate. Highly routine jobs are especially vulnerable to automation.

### FASTEST-GROWING JOBS

- 1 Software engineers-applications
- 2 Computer support workers
- 3 Software engineers-systems
- 4 Network administrators
- 5 Network systems analysts
- 6 Desktop publishers
- 7 Database administrators
- 8 Personal and home care aides
- 9 Computer systems analysts
- 10 Medical assistants

### VULNERABLE JOBS?

- 1 Butchers
- 2 Secretaries and stenographers
- 3 Payroll clerks
- 4 Bank tellers
- 5 File clerks
- 6 Cashiers
- 7 Typists
- 8 Pharmacists
- 9 Bookkeepers
- 10 Postal clerks

While such changes can be painful for workers whose skills no longer match the needs of employers, Lawrence Katz, a Harvard economist, says

that no historical pattern shows these shifts leading to a net decrease in jobs over an extended period. Katz has done extensive research on how technological advances have affected jobs over the last few centuries—describing, for example, how highly skilled artisans in the mid-19th century were displaced by lower-skilled workers in factories. While it can take decades for workers to acquire the expertise needed for new types of employment, he says, “we never have run out of jobs. There is no long-term trend of eliminating work for people. Over the long term, employment rates are fairly stable. People have always been able to create new jobs. People come up with new things to do.”

Still, Katz doesn't dismiss the notion that there is something different about today's digital technologies—something that could affect an even broader range of work. The question, he says, is whether economic history will serve as a useful guide. Will the job disruptions caused by technology be temporary as the workforce adapts, or will we see a science-fiction scenario in which automated processes and robots with superhuman skills take over a broad swath of human tasks? Though Katz expects the historical pattern to hold, it is “genuinely a question,” he says. “If technology disrupts enough, who knows what will happen?”

### **Dr. Watson**

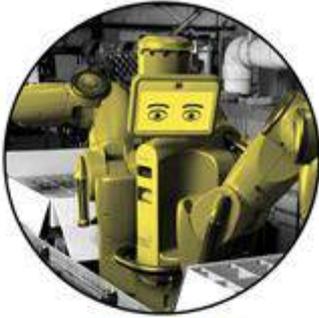
To get some insight into Katz's question, it is worth looking at how today's most advanced technologies are being deployed in industry. Though these technologies have undoubtedly taken over some human jobs, finding evidence of workers being displaced by machines on a large scale is not all that easy. One reason it is difficult to pinpoint the net impact on jobs is that automation is often used to make human workers more efficient, not necessarily to replace them. Rising productivity means businesses can do the same work with fewer employees, but it can also enable the businesses to expand production with their existing workers, and even to enter new markets.

Take the bright-orange Kiva robot, a boon to fledgling e-commerce companies. Created and sold by Kiva Systems, a startup that was founded in 2002 and bought by Amazon for \$775 million in 2012, the robots are designed to scurry across large warehouses, fetching racks of ordered goods and delivering the products to humans who package the orders. In Kiva's large demonstration warehouse and assembly facility at its headquarters outside Boston, fleets of robots move about with seemingly endless energy: some newly assembled machines perform tests to prove they're ready to be shipped to customers around the world, while others

wait to demonstrate to a visitor how they can almost instantly respond to an electronic order and bring the desired product to a worker's station.

A warehouse equipped with Kiva robots can handle up to four times as many orders as a similar unautomated warehouse, where workers might spend as much as 70 percent of their time walking about to retrieve goods. (Coincidentally or not, Amazon bought Kiva soon after a press report revealed that workers at one of the retailer's giant warehouses often walked more than 10 miles a day.)

Despite the labor-saving potential of the robots, Mick Mountz, Kiva's founder and CEO, says he doubts the machines have put many people out of work or will do so in the future. For one thing, he says, most of Kiva's customers are e-commerce retailers, some of them growing so rapidly they can't hire people fast enough. By making distribution operations cheaper and more efficient, the robotic technology has helped many of these retailers survive and even expand. Before founding Kiva, Mountz worked at Webvan, an online grocery delivery company that was one of the 1990s dot-com era's most infamous flameouts. He likes to show the numbers demonstrating that Webvan was doomed from the start; a \$100 order cost the company \$120 to ship. Mountz's point is clear: something as mundane as the cost of materials handling can consign a new business to an early death. Automation can solve that problem.



### **BAXTER**

*Rethink Robotics' Baxter is a robot meant to work with people in smaller manufacturing facilities. Its expressive eyes reveal what the robot is "looking" at and let a nearby human know if it's confused.*

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### **KIVA**

*A Kiva Systems robot can scurry about the floor of a large warehouse to find ordered products. It then fetches the correct rack or pallet and brings it to a worker who packages the goods.*

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### **WATSON**

*IBM's Watson, the computer that won at Jeopardy! in 2011, combines artificial intelligence with big data and natural-language processing to advise doctors or callers to customer-support lines.*

Meanwhile, Kiva itself is hiring. Orange balloons—the same color as the robots—hover over multiple cubicles in its sprawling office, signaling that the occupants arrived within the last month. Most of these new employees are software engineers: while the robots are the company's poster boys, its lesser-known innovations lie in the complex algorithms that guide the robots' movements and determine where in the warehouse products are stored. These algorithms help make the system adaptable. It can learn, for example, that a certain product is seldom ordered, so it should be stored in a remote area.

Though advances like these suggest how some aspects of work could be subject to automation, they also illustrate that humans still excel at certain tasks—for example, packaging various items together. Many of the traditional problems in robotics—such as how to teach a machine to recognize an object as, say, a chair—remain largely intractable and are especially difficult to solve when the robots are free to move about a relatively unstructured environment like a factory or office.

Techniques using vast amounts of computational power have gone a long way toward helping robots understand their surroundings, but John Leonard, a professor of engineering at MIT and a member of its Computer Science and Artificial Intelligence Laboratory (CSAIL), says many familiar difficulties remain. "Part of me sees accelerating progress; the other part of me sees the same old problems," he says. "I see how hard it is to do anything with robots. The big challenge is uncertainty." In other words, people are still far better at dealing with changes in their environment and reacting to unexpected events.

For that reason, Leonard says, it is easier to see how robots could work *with* humans than on their own in many applications. "People and robots working together can happen much more quickly than robots simply replacing humans," he says. "That's not going to happen in my lifetime at a massive scale. The semiautonomous taxi will still have a driver."

One of the friendlier, more flexible robots meant to work with humans is Rethink's Baxter. The creation of Rodney Brooks, the company's founder, Baxter needs minimal training to perform simple tasks like picking up objects and moving them to a box. It's meant for use in relatively small manufacturing facilities where conventional industrial robots would cost too much and pose too much danger to workers. The idea, says Brooks, is to have the robots take care of dull, repetitive jobs that no one wants to do.

It's hard not to instantly like Baxter, in part because it seems so eager to please. The "eyebrows" on its display rise quizzically when it's puzzled; its arms submissively and gently retreat when bumped. Asked about the claim that such advanced industrial robots could eliminate jobs, Brooks answers simply that he doesn't see it that way. Robots, he says, can be to factory workers as electric drills are to construction workers: "It makes them more productive and efficient, but it doesn't take jobs."

The machines created at Kiva and Rethink have been cleverly designed and built to work with people, taking over the tasks that the humans often don't want to do or aren't especially good at. They are specifically designed to enhance these workers' productivity. And it's hard to see how even these increasingly sophisticated robots will replace humans in most manufacturing and industrial jobs anytime soon. But clerical and some professional jobs could be more vulnerable. That's because the marriage of artificial intelligence and big data is beginning to give machines a more humanlike ability to reason and to solve many new types of problems.

Even if the economy is only going through a transition, it is an extremely painful one for many.

In the tony northern suburbs of New York City, IBM Research is pushing super-smart computing into the realms of such professions as medicine, finance, and customer service. IBM's efforts have resulted in Watson, a computer system best known for beating human champions on the game show *Jeopardy!* in 2011. That version of Watson now sits in a corner of a large data center at the research facility in Yorktown Heights, marked with a glowing plaque commemorating its glory days. Meanwhile, researchers there are already testing new generations of Watson in medicine, where the technology could help physicians diagnose diseases like cancer, evaluate patients, and prescribe treatments.

IBM likes to call it cognitive computing. Essentially, Watson uses artificial-intelligence techniques, advanced natural-language processing and analytics, and massive amounts of data drawn from sources specific to a given application (in the case of health care, that means medical journals, textbooks, and information collected from the physicians or hospitals using the system). Thanks to these innovative techniques and huge amounts of computing power, it can quickly come up with "advice"—for example, the most recent and relevant information to guide a doctor's diagnosis and treatment decisions.

Despite the system's remarkable ability to make sense of all that data, it's still early days for Dr. Watson. While it has rudimentary abilities to "learn" from specific patterns and evaluate different possibilities, it is far from having the type of judgment and intuition a physician often needs. But IBM has also announced it will begin selling Watson's services to customer-support call centers, which rarely require human judgment that's quite so sophisticated. IBM says companies will rent an updated version of Watson for use as a "customer service agent" that responds to questions from consumers; it has already signed on several banks. Automation is nothing new in call centers, of course, but Watson's improved capacity for natural-language processing and its ability to tap into a large amount of data suggest that this system could speak plainly with callers, offering them specific advice on even technical and complex questions. It's easy to see it replacing many human holdouts in its new field.

## **Digital Losers**

The contention that automation and digital technologies are partly responsible for today's lack of jobs has obviously touched a raw nerve for many worried about their own employment. But this is only one consequence of what Brynjolfsson and McAfee see as a broader trend. The rapid acceleration of technological progress, they say, has greatly widened the gap between economic winners and losers—the income inequalities that many economists have worried about for decades. Digital technologies tend to favor "superstars," they point out. For example, someone who creates a computer program to automate tax preparation might earn millions or billions of dollars while eliminating the need for countless accountants.

New technologies are "encroaching into human skills in a way that is completely unprecedented," McAfee says, and many middle-class jobs are right in the bull's-eye; even relatively high-skill work in education, medicine, and law is affected. "The middle seems to be going away," he adds. "The top and bottom are clearly getting farther apart." While technology might be only one factor, says McAfee, it has been an "underappreciated" one, and it is likely to become increasingly significant.

Not everyone agrees with Brynjolfsson and McAfee's conclusions—particularly the contention that the impact of recent technological change could be different from anything seen before. But it's hard to ignore their warning that technology is widening the income gap between the tech-savvy and everyone else. And even if the economy is only going through a transition similar to those it's endured before, it is an extremely painful one for many workers, and that will have to be addressed somehow. Harvard's

Katz has shown that the United States prospered in the early 1900s in part because secondary education became accessible to many people at a time when employment in agriculture was drying up. The result, at least through the 1980s, was an increase in educated workers who found jobs in the industrial sectors, boosting incomes and reducing inequality. Katz's lesson: painful long-term consequences for the labor force do not follow inevitably from technological changes.

Brynjolfsson himself says he's not ready to conclude that economic progress and employment have diverged for good. "I don't know whether we can recover, but I hope we can," he says. But that, he suggests, will depend on recognizing the problem and taking steps such as investing more in the training and education of workers.

"We were lucky and steadily rising productivity raised all boats for much of the 20th century," he says. "Many people, especially economists, jumped to the conclusion that was just the way the world worked. I used to say that if we took care of productivity, everything else would take care of itself; it was the single most important economic statistic. But that's no longer true." He adds, "It's one of the dirty secrets of economics: technology progress does grow the economy and create wealth, but there is no economic law that says everyone will benefit." In other words, in the race against the machine, some are likely to win while many others lose.

Credits: Noma Bar (Illustration); Data from Bureau of Labor Statistics (Productivity, Output, GDP Per Capita); International Federation of Robotics; CIA World Factbook (GDP by Sector), Bureau of Labor Statistics (Job Growth, Manufacturing Employment); D. Autor and D. Dorn, U.S. Census, American Community Survey, and Department of Labor (Change in Employment and Wages by Skill, Routine Jobs)

Source: <http://www.technologyreview.com/featuredstory/515926/how-technology-is-destroying-jobs/>

# The future of jobs: The onrushing wave

**Previous technological innovation has always delivered more long-run employment, not less. But things can change**

The Economist | Jan 18th 2014 | [From the print edition](#)



IN 1930, when the world was “suffering...from a bad attack of economic pessimism”, John Maynard Keynes wrote a broadly optimistic essay, “Economic Possibilities for our Grandchildren”. It imagined a middle way between revolution and stagnation that would leave the said grandchildren a great deal richer than their grandparents. But the path was not without dangers.

One of the worries Keynes admitted was a “new disease”: “technological unemployment...due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour.” His readers might not have heard of the problem, he suggested—but they were certain to hear a lot more about it in the years to come.

For the most part, they did not. Nowadays, the majority of economists confidently wave such worries away. By raising productivity, they argue, any automation which economises on the use of labour will increase incomes. That will generate demand for new products and services, which will in turn create new jobs for displaced workers. To think otherwise has meant being tarred a Luddite—the name taken by 19th-century textile workers who smashed the machines taking their jobs.

For much of the 20th century, those arguing that technology brought ever more jobs and prosperity looked to have the better of the debate. Real incomes in Britain scarcely doubled between the beginning of the common era and 1570. They then tripled from 1570 to 1875. And they more than tripled from 1875 to 1975. Industrialisation did not end up eliminating the need for human workers. On the contrary, it created employment opportunities sufficient to soak up the 20th century's exploding population. Keynes's vision of everyone in the 2030s being a lot richer is largely achieved. His belief they would work just 15 hours or so a week has not come to pass.

### **When the sleeper wakes**

Yet some now fear that a new era of automation enabled by ever more powerful and capable computers could work out differently. They start from the observation that, across the rich world, all is far from well in the world of work. The essence of what they see as a work crisis is that in rich countries the wages of the typical worker, adjusted for cost of living, are stagnant. In America the real wage has hardly budged over the past four decades. Even in places like Britain and Germany, where employment is touching new highs, wages have been flat for a decade. Recent research suggests that this is because substituting capital for labour through automation is increasingly attractive; as a result owners of capital have captured ever more of the world's income since the 1980s, while the share going to labour has fallen.

At the same time, even in relatively egalitarian places like Sweden, inequality among the employed has risen sharply, with the share going to the highest earners soaring. For those not in the elite, argues David Graeber, an anthropologist at the London School of Economics, much of modern labour consists of stultifying "bullshit jobs"—low- and mid-level screen-sitting that serves simply to occupy workers for whom the economy no longer has much use. Keeping them employed, Mr Graeber argues, is not an economic choice; it is something the ruling class does to keep control over the lives of others.

Be that as it may, drudgery may soon enough give way to frank unemployment. There is already a long-term trend towards lower levels of employment in some rich countries. The proportion of American adults participating in the labour force recently hit its lowest level since 1978, and although some of that is due to the effects of ageing, some is not. In a recent speech that was modelled in part on Keynes's "Possibilities", Larry Summers, a former American treasury secretary, looked at employment

trends among American men between 25 and 54. In the 1960s only one in 20 of those men was not working. According to Mr Summers's extrapolations, in ten years the number could be one in seven.

This is one indication, Mr Summers says, that technical change is increasingly taking the form of "capital that effectively substitutes for labour". There may be a lot more for such capital to do in the near future. A 2013 paper by Carl Benedikt Frey and Michael Osborne, of the University of Oxford, argued that jobs are at high risk of being automated in 47% of the occupational categories into which work is customarily sorted. That includes accountancy, legal work, technical writing and a lot of other white-collar occupations.

Answering the question of whether such automation could lead to prolonged pain for workers means taking a close look at past experience, theory and technological trends. The picture suggested by this evidence is a complex one. It is also more worrying than many economists and politicians have been prepared to admit.

### **The lathe of heaven**

Economists take the relationship between innovation and higher living standards for granted in part because they believe history justifies such a view. Industrialisation clearly led to enormous rises in incomes and living standards over the long run. Yet the road to riches was rockier than is often appreciated.

In 1500 an estimated 75% of the British labour force toiled in agriculture. By 1800 that figure had fallen to 35%. When the shift to manufacturing got under way during the 18th century it was overwhelmingly done at small scale, either within the home or in a small workshop; employment in a large factory was a rarity. By the end of the 19th century huge plants in massive industrial cities were the norm. The great shift was made possible by automation and steam engines.

Industrial firms combined human labour with big, expensive capital equipment. To maximise the output of that costly machinery, factory owners reorganised the processes of production. Workers were given one or a few repetitive tasks, often making components of finished products rather than whole pieces. Bosses imposed a tight schedule and strict worker discipline to keep up the productive pace. The Industrial Revolution was not simply a matter of replacing muscle with steam; it was a matter of

reshaping jobs themselves into the sort of precisely defined components that steam-driven machinery needed—cogs in a factory system.

The way old jobs were done changed; new jobs were created. Joel Mokyr, an economic historian at Northwestern University in Illinois, argues that the more intricate machines, techniques and supply chains of the period all required careful tending. The workers who provided that care were well rewarded. As research by Lawrence Katz, of Harvard University, and Robert Margo, of Boston University, shows, employment in manufacturing “hollowed out”. As employment grew for highly skilled workers and unskilled workers, craft workers lost out. This was the loss to which the Luddites, understandably if not effectively, took exception.



With the low-skilled workers far more numerous, at least to begin with, the lot of the average worker during the early part of this great industrial and social upheaval was not a happy one. As Mr Mokyr notes, "life did not improve all that much between 1750 and 1850." For 60 years, from 1770 to 1830, growth in British wages, adjusted for inflation, was imperceptible because productivity growth was restricted to a few industries. Not until the late 19th century, when the gains had spread across the whole economy, did wages at last perform in line with productivity (see chart 1).

Along with social reforms and new political movements that gave voice to the workers, this faster wage growth helped spread the benefits of industrialisation across wider segments of the population. New investments in education provided a supply of workers for the more skilled jobs that were by then being created in ever greater numbers. This shift continued into the 20th century as post-secondary education became increasingly common.

Claudia Goldin, an economist at Harvard University, and Mr Katz have written that workers were in a "race between education and technology" during this period, and for the most part they won. Even so, it was not until the "golden age" after the second world war that workers in the rich world secured real prosperity, and a large, property-owning middle class came to dominate politics. At the same time communism, a legacy of industrialisation's harsh early era, kept hundreds of millions of people around the world in poverty, and the effects of the imperialism driven by European industrialisation continued to be felt by billions.

The impacts of technological change take their time appearing. They also vary hugely from industry to industry. Although in many simple economic models technology pairs neatly with capital and labour to produce output, in practice technological changes do not affect all workers the same way. Some find that their skills are complementary to new technologies. Others find themselves out of work.

Take computers. In the early 20th century a "computer" was a worker, or a room of workers, doing mathematical calculations by hand, often with the end point of one person's work the starting point for the next. The development of mechanical and electronic computing rendered these arrangements obsolete. But in time it greatly increased the productivity of those who used the new computers in their work.

Many other technical innovations had similar effects. New machinery displaced handicraft producers across numerous industries, from textiles to

metalworking. At the same time it enabled vastly more output per person than craft producers could ever manage.

## **Player piano**

For a task to be replaced by a machine, it helps a great deal if, like the work of human computers, it is already highly routine. Hence the demise of production-line jobs and some sorts of book-keeping, lost to the robot and the spreadsheet. Meanwhile work less easily broken down into a series of stereotyped tasks—whether rewarding, as the management of other workers and the teaching of toddlers can be, or more of a grind, like tidying and cleaning messy work places—has grown as a share of total employment.

But the “race” aspect of technological change means that such workers cannot rest on their pay packets. Firms are constantly experimenting with new technologies and production processes. Experimentation with different techniques and business models requires flexibility, which is one critical advantage of a human worker. Yet over time, as best practices are worked out and then codified, it becomes easier to break production down into routine components, then automate those components as technology allows.

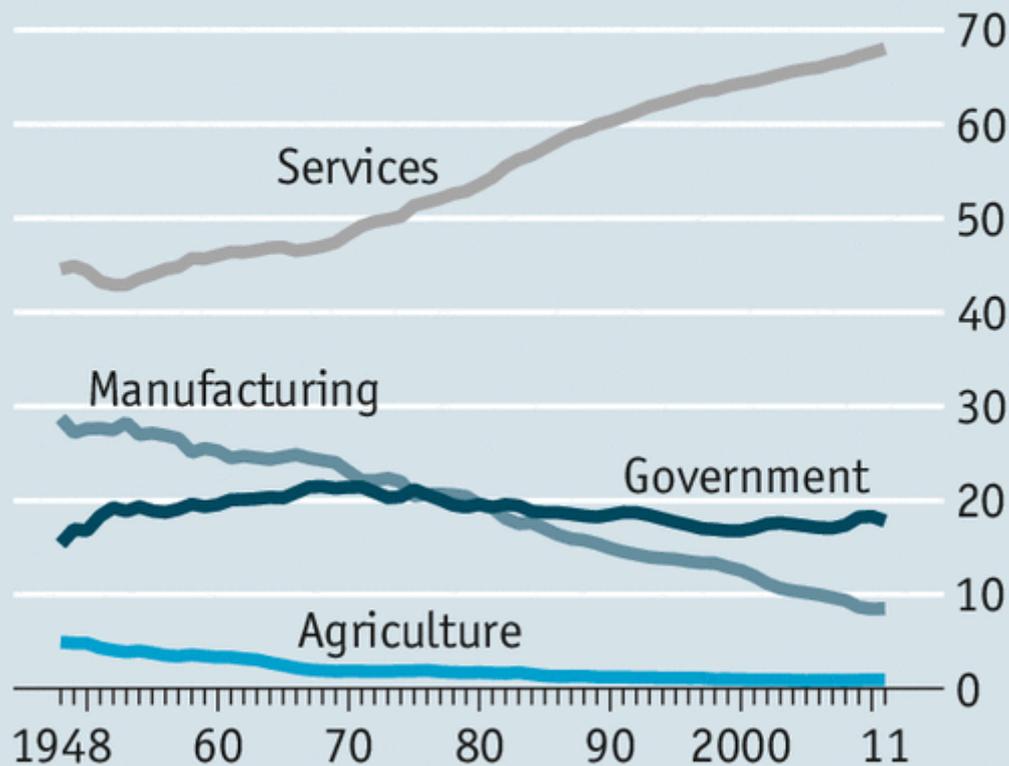
If, that is, automation makes sense. As David Autor, an economist at the Massachusetts Institute of Technology (MIT), points out in a 2013 paper, the mere fact that a job can be automated does not mean that it will be; relative costs also matter. When Nissan produces cars in Japan, he notes, it relies heavily on robots. At plants in India, by contrast, the firm relies more heavily on cheap local labour.

Even when machine capabilities are rapidly improving, it can make sense instead to seek out ever cheaper supplies of increasingly skilled labour. Thus since the 1980s (a time when, in America, the trend towards post-secondary education levelled off) workers there and elsewhere have found themselves facing increased competition from both machines and cheap emerging-market workers.

## Not what it was

2

US employment by sector, % of total employment



Source: US Bureau of Labour Statistics

Such processes have steadily and relentlessly squeezed labour out of the manufacturing sector in most rich economies. The share of American employment in manufacturing has declined sharply since the 1950s, from almost 30% to less than 10%. At the same time, jobs in services soared, from less than 50% of employment to almost 70% (see chart 2). It was inevitable, therefore, that firms would start to apply the same experimentation and reorganisation to service industries.

A new wave of technological progress may dramatically accelerate this automation of brain-work. Evidence is mounting that rapid technological progress, which accounted for the long era of rapid productivity growth from the 19th century to the 1970s, is back. The sort of advances that allow people to put in their pocket a computer that is not only more powerful than any in the world 20 years ago, but also has far better software and far greater access to useful data, as well as to other people and machines, have implications for all sorts of work.

The case for a highly disruptive period of economic growth is made by Erik Brynjolfsson and Andrew McAfee, professors at MIT, in "The Second Machine Age", a book to be published later this month. Like the first great era of industrialisation, they argue, it should deliver enormous benefits—but not without a period of disorienting and uncomfortable change. Their argument rests on an underappreciated aspect of the exponential growth in chip processing speed, memory capacity and other computer metrics: that the amount of progress computers will make in the next few years is always equal to the progress they have made since the very beginning. Mr Brynjolfsson and Mr McAfee reckon that the main bottleneck on innovation is the time it takes society to sort through the many combinations and permutations of new technologies and business models.

A startling progression of inventions seems to bear their thesis out. Ten years ago technologically minded economists pointed to driving cars in traffic as the sort of human accomplishment that computers were highly unlikely to master. Now Google cars are rolling round California driver-free no one doubts such mastery is possible, though the speed at which fully self-driving cars will come to market remains hard to guess.

### **Brave new world**

Even after computers beat grandmasters at chess (once thought highly unlikely), nobody thought they could take on people at free-form games played in natural language. Then Watson, a pattern-recognising supercomputer developed by IBM, bested the best human competitors in America's popular and syntactically tricky general-knowledge quiz show "Jeopardy!" Versions of Watson are being marketed to firms across a range of industries to help with all sorts of pattern-recognition problems. Its acumen will grow, and its costs fall, as firms learn to harness its abilities.

The machines are not just cleverer, they also have access to far more data. The combination of big data and smart machines will take over some occupations wholesale; in others it will allow firms to do more with fewer workers. Text-mining programs will displace professional jobs in legal services. Biopsies will be analysed more efficiently by image-processing software than lab technicians. Accountants may follow travel agents and tellers into the unemployment line as tax software improves. Machines are already turning basic sports results and financial data into good-enough news stories.

Jobs that are not easily automated may still be transformed. New data-processing technology could break "cognitive" jobs down into smaller and

smaller tasks. As well as opening the way to eventual automation this could reduce the satisfaction from such work, just as the satisfaction of making things was reduced by deskilling and interchangeable parts in the 19th century. If such jobs persist, they may engage Mr Graeber's "bullshit" detector.

Being newly able to do brain work will not stop computers from doing ever more formerly manual labour; it will make them better at it. The designers of the latest generation of industrial robots talk about their creations as helping workers rather than replacing them; but there is little doubt that the technology will be able to do a bit of both—probably more than a bit. A taxi driver will be a rarity in many places by the 2030s or 2040s. That sounds like bad news for journalists who rely on that most reliable source of local knowledge and prejudice—but will there be many journalists left to care? Will there be airline pilots? Or traffic cops? Or soldiers?

## Bring on the personal trainers

Probability that computerisation will lead to job losses within the next two decades, 2013

(1=certain)

<b>Job</b>	<b>Probability</b>
Recreational therapists	0.003
Dentists	0.004
Athletic trainers	0.007
Clergy	0.008
Chemical engineers	0.02
Editors	0.06
Firefighters	0.17
Actors	0.37
Health technologists	0.40
Economists	0.43
Commercial pilots	0.55
Machinists	0.65
Word processors and typists	0.81
Real estate sales agents	0.86
Technical writers	0.89
Retail salespersons	0.92
Accountants and auditors	0.94
Telemarketers	0.99

Source: "The Future of Employment: How Susceptible are Jobs to Computerisation?" by C.Frey and M.Osborne (2013)

There will still be jobs. Even Mr Frey and Mr Osborne, whose research speaks of 47% of job categories being open to automation within two decades, accept that some jobs—especially those currently associated with high levels of education and high wages—will survive (see table). Tyler Cowen, an economist at George Mason University and a much-read blogger, writes in his most recent book, “Average is Over”, that rich economies seem to be bifurcating into a small group of workers with skills highly complementary with machine intelligence, for whom he has high hopes, and the rest, for whom not so much.

And although Mr Brynjolfsson and Mr McAfee rightly point out that developing the business models which make the best use of new technologies will involve trial and error and human flexibility, it is also the case that the second machine age will make such trial and error easier. It will be shockingly easy to launch a startup, bring a new product to market and sell to billions of global consumers (see article). Those who create or invest in blockbuster ideas may earn unprecedented returns as a result.

In a forthcoming book Thomas Piketty, an economist at the Paris School of Economics, argues along similar lines that America may be pioneering a hyper-unequal economic model in which a top 1% of capital-owners and “supermanagers” grab a growing share of national income and accumulate an increasing concentration of national wealth. The rise of the middle-class—a 20th-century innovation—was a hugely important political and social development across the world. The squeezing out of that class could generate a more antagonistic, unstable and potentially dangerous politics.

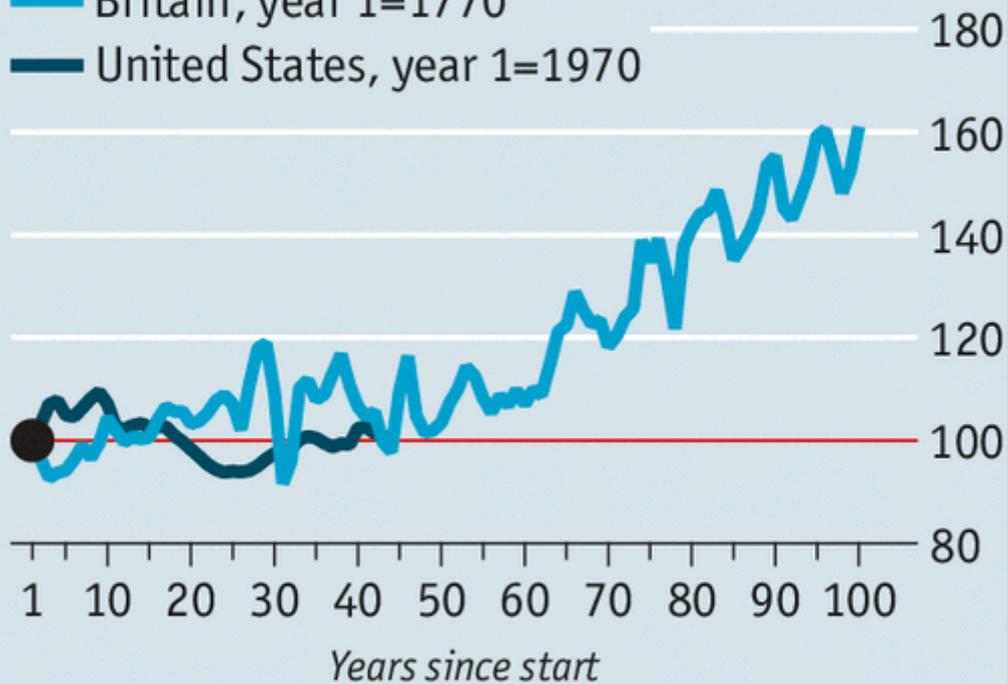
The potential for dramatic change is clear. A future of widespread technological unemployment is harder for many to accept. Every great period of innovation has produced its share of labour-market doomsayers, but technological progress has never previously failed to generate new employment opportunities.

## A history to repeat?

Average real wage, year 1=100

— Britain, year 1=1770

— United States, year 1=1970



Sources: "Pessimism Preserved: Real Wages in the British Industrial Revolution" by R.C. Allen (2013); US Bureau of Labour Statistics

The productivity gains from future automation will be real, even if they mostly accrue to the owners of the machines. Some will be spent on goods and services—golf instructors, household help and so on—and most of the rest invested in firms that are seeking to expand and presumably hire more labour. Though inequality could soar in such a world, unemployment would not necessarily spike. The current doldrum in wages may, like that of the early industrial era, be a temporary matter, with the good times about to roll (see chart 3).

These jobs may look distinctly different from those they replace. Just as past mechanisation freed, or forced, workers into jobs requiring more cognitive dexterity, leaps in machine intelligence could create space for people to specialise in more emotive occupations, as yet unsuited to machines: a world of artists and therapists, love counsellors and yoga instructors.

Such emotional and relational work could be as critical to the future as metal-bashing was in the past, even if it gets little respect at first. Cultural norms change slowly. Manufacturing jobs are still often treated as “better”—in some vague, non-pecuniary way—than paper-pushing is. To some 18th-century observers, working in the fields was inherently more noble than making gewgaws.

But though growth in areas of the economy that are not easily automated provides jobs, it does not necessarily help real wages. Mr Summers points out that prices of things-made-of-widgets have fallen remarkably in past decades; America’s Bureau of Labour Statistics reckons that today you could get the equivalent of an early 1980s television for a twentieth of its then price, were it not that no televisions that poor are still made. However, prices of things not made of widgets, most notably college education and health care, have shot up. If people lived on widgets alone— goods whose costs have fallen because of both globalisation and technology—there would have been no pause in the increase of real wages. It is the increase in the prices of stuff that isn’t mechanised (whose supply is often under the control of the state and perhaps subject to fundamental scarcity) that means a pay packet goes no further than it used to.

So technological progress squeezes some incomes in the short term before making everyone richer in the long term, and can drive up the costs of some things even more than it eventually increases earnings. As innovation continues, automation may bring down costs in some of those stubborn areas as well, though those dominated by scarcity—such as houses in desirable places—are likely to resist the trend, as may those where the state keeps market forces at bay. But if innovation does make health care or higher education cheaper, it will probably be at the cost of more jobs, and give rise to yet more concentration of income.



## The machine stops

Even if the long-term outlook is rosy, with the potential for greater wealth and lots of new jobs, it does not mean that policymakers should simply sit on their hands in the mean time. Adaptation to past waves of progress rested on political and policy responses. The most obvious are the massive improvements in educational attainment brought on first by the institution of universal secondary education and then by the rise of university attendance. Policies aimed at similar gains would now seem to be in order. But as Mr Cowen has pointed out, the gains of the 19th and 20th centuries will be hard to duplicate.

Boosting the skills and earning power of the children of 19th-century farmers and labourers took little more than offering schools where they could learn to read, write and do algebra. Pushing a large proportion of college graduates to complete graduate work successfully will be harder and more expensive. Perhaps cheap and innovative online education will indeed make new attainment possible. But as Mr Cowen notes, such programmes may tend to deliver big gains only for the most conscientious students.

Another way in which previous adaptation is not necessarily a good guide to future employment is the existence of welfare. The alternative to joining the 19th-century industrial proletariat was malnourished deprivation. Today, because of measures introduced in response to, and to some extent on the

proceeds of, industrialisation, people in the developed world are provided with unemployment benefits, disability allowances and other forms of welfare. They are also much more likely than a bygone peasant to have savings. This means that the “reservation wage”—the wage below which a worker will not accept a job—is now high in historical terms. If governments refuse to allow jobless workers to fall too far below the average standard of living, then this reservation wage will rise steadily, and ever more workers may find work unattractive. And the higher it rises, the greater the incentive to invest in capital that replaces labour.

Everyone should be able to benefit from productivity gains—in that, Keynes was united with his successors. His worry about technological unemployment was mainly a worry about a “temporary phase of maladjustment” as society and the economy adjusted to ever greater levels of productivity. So it could well prove. However, society may find itself sorely tested if, as seems possible, growth and innovation deliver handsome gains to the skilled, while the rest cling to dwindling employment opportunities at stagnant wages.

Source: <http://www.economist.com/news/briefing/21594264-previous-technological-innovation-has-always-delivered-more-long-run-employment-not-less>

# How Technology Wrecks the Middle Class

By *DAVID H. AUTOR and DAVID DORN*

August 24, 2013 2:35 pm August 24, 2013 2:35 pm

Photo



*Robot arms welded a vehicle on the assembly line at a General Motors plant in Lansing, Mich., in 2010. Credit Bill Pugliano/Getty Images*

In the four years since the Great Recession officially ended, the productivity of American workers — those lucky enough to have jobs — has risen smartly. But the United States still has two million fewer jobs than before the downturn, the unemployment rate is stuck at levels not seen since the early 1990s and the proportion of adults who are working is four percentage points off its peak in 2000.

This job drought has spurred pundits to wonder whether a profound employment sickness has overtaken us. And from there, it's only a short leap to ask whether that illness isn't productivity itself. Have we mechanized and computerized ourselves into obsolescence?

Are we in danger of losing the "race against the machine," as the M.I.T. scholars Erik Brynjolfsson and Andrew McAfee argue in a recent book? Are we becoming enslaved to our "robot overlords," as the journalist Kevin Drum warned in *Mother Jones*? Do "smart machines" threaten us with "long-term misery," as the economists Jeffrey D. Sachs and Laurence J. Kotlikoff prophesied earlier this year? Have we reached "the end of labor," as Noah Smith laments in *The Atlantic*?

Of course, anxiety, and even hysteria, about the adverse effects of technological change on employment have a venerable history. In the early 19th century a group of English textile artisans calling themselves the Luddites staged a machine-trashing rebellion. Their brashness earned them a place (rarely positive) in the lexicon, but they had legitimate reasons for concern.

Economists have historically rejected what we call the "lump of labor" fallacy: the supposition that an increase in labor productivity inevitably reduces employment because there is only a finite amount of work to do. While intuitively appealing, this idea is demonstrably false. In 1900, for example, 41 percent of the United States work force was in agriculture. By 2000, that share had fallen to 2 percent, after the Green Revolution transformed crop yields. But the employment-to-population ratio rose over the 20th century as women moved from home to market, and the unemployment rate fluctuated cyclically, with no long-term increase.

Labor-saving technological change necessarily displaces workers performing certain tasks — that's where the gains in productivity come

from — but over the long run, it generates new products and services that raise national income and increase the overall demand for labor. In 1900, no one could foresee that a century later, health care, finance, information technology, consumer electronics, hospitality, leisure and entertainment would employ far more workers than agriculture. Of course, as societies grow more prosperous, citizens often choose to work shorter days, take longer vacations and retire earlier — but that too is progress.

So if technological advances don't threaten employment, does that mean workers have nothing to fear from "smart machines"? Actually, no — and here's where the Luddites had a point. Although many 19th-century Britons benefited from the introduction of newer and better automated looms — unskilled laborers were hired as loom operators, and a growing middle class could now afford mass-produced fabrics — it's unlikely that skilled textile workers benefited on the whole.

Fast-forward to the present. The multi-trillionfold decline in the cost of computing since the 1970s has created enormous incentives for employers to substitute increasingly cheap and capable computers for expensive labor. These rapid advances — which confront us daily as we check in at airports, order books online, pay bills on our banks' Web sites or consult our smartphones for driving directions — have reawakened fears that workers will be displaced by machinery. Will this time be different?

A starting point for discussion is the observation that although computers are ubiquitous, they cannot do everything. A computer's ability to accomplish a task quickly and cheaply depends upon a human programmer's ability to write procedures or rules that direct the machine to take the correct steps at each contingency. Computers excel at "routine" tasks: organizing, storing, retrieving and manipulating information, or executing exactly defined physical movements in production processes.

These tasks are most pervasive in middle-skill jobs like bookkeeping, clerical work and repetitive production and quality-assurance jobs.

Logically, computerization has reduced the demand for these jobs, but it has boosted demand for workers who perform “nonroutine” tasks that complement the automated activities. Those tasks happen to lie on opposite ends of the occupational skill distribution.

At one end are so-called abstract tasks that require problem-solving, intuition, persuasion and creativity. These tasks are characteristic of professional, managerial, technical and creative occupations, like law, medicine, science, engineering, advertising and design. People in these jobs typically have high levels of education and analytical capability, and they benefit from computers that facilitate the transmission, organization and processing of information.

On the other end are so-called manual tasks, which require situational adaptability, visual and language recognition, and in-person interaction. Preparing a meal, driving a truck through city traffic or cleaning a hotel room present mind-bogglingly complex challenges for computers. But they are straightforward for humans, requiring primarily innate abilities like dexterity, sightedness and language recognition, as well as modest training. These workers can't be replaced by robots, but their skills are not scarce, so they usually make low wages.

Computerization has therefore fostered a polarization of employment, with job growth concentrated in both the highest- and lowest-paid occupations, while jobs in the middle have declined. Surprisingly, overall employment rates have largely been unaffected in states and cities undergoing this rapid polarization. Rather, as employment in routine jobs has ebbed,

employment has risen both in high-wage managerial, professional and technical occupations and in low-wage, in-person service occupations.

So computerization is not reducing the quantity of jobs, but rather degrading the quality of jobs for a significant subset of workers. Demand for highly educated workers who excel in abstract tasks is robust, but the middle of the labor market, where the routine task-intensive jobs lie, is sagging. Workers without college education therefore concentrate in manual task-intensive jobs — like food services, cleaning and security — which are numerous but offer low wages, precarious job security and few prospects for upward mobility. This bifurcation of job opportunities has contributed to the historic rise in income inequality.

HOW can we help workers ride the wave of technological change rather than be swamped by it? One common recommendation is that citizens should invest more in their education. Spurred by growing demand for workers performing abstract job tasks, the payoff for college and professional degrees has soared; despite its formidable price tag, higher education has perhaps never been a better investment. But it is far from a comprehensive solution to our labor market problems. Not all high school graduates — let alone displaced mid- and late-career workers — are academically or temperamentally prepared to pursue a four-year college degree. Only 40 percent of Americans enroll in a four-year college after graduating from high school, and more than 30 percent of those who enroll do not complete the degree within eight years.

The good news, however, is that middle-education, middle-wage jobs are not slated to disappear completely. While many middle-skill jobs are susceptible to automation, others demand a mixture of tasks that take advantage of human flexibility. To take one prominent example, medical paraprofessional jobs — radiology technician, phlebotomist, nurse

technician — are a rapidly growing category of relatively well-paid, middle-skill occupations. While these paraprofessions do not typically require a four-year college degree, they do demand some postsecondary vocational training.

These middle-skill jobs will persist, and potentially grow, because they involve tasks that cannot readily be unbundled without a substantial drop in quality. Consider, for example, the frustration of calling a software firm for technical support, only to discover that the technician knows nothing more than the standard answers shown on his or her computer screen — that is, the technician is a mouthpiece reading from a script, not a problem-solver. This is not generally a productive form of work organization because it fails to harness the complementarities between technical and interpersonal skills. Simply put, the quality of a service within any occupation will improve when a worker combines routine (technical) and nonroutine (flexible) tasks.

Following this logic, we predict that the middle-skill jobs that survive will combine routine technical tasks with abstract and manual tasks in which workers have a comparative advantage — interpersonal interaction, adaptability and problem-solving. Along with medical paraprofessionals, this category includes numerous jobs for people in the skilled trades and repair: plumbers; builders; electricians; heating, ventilation and air-conditioning installers; automotive technicians; customer-service representatives; and even clerical workers who are required to do more than type and file. Indeed, even as formerly middle-skill occupations are being “deskilled,” or stripped of their routine technical tasks (brokering stocks, for example), other formerly high-end occupations are becoming accessible to workers with less esoteric technical mastery (for example, the work of the nurse practitioner, who increasingly diagnoses illness and prescribes drugs in lieu of a physician). Lawrence F. Katz, a labor

economist at Harvard, memorably called those who fruitfully combine the foundational skills of a high school education with specific vocational skills the “new artisans.”

The outlook for workers who haven’t finished college is uncertain, but not devoid of hope. There will be job opportunities in middle-skill jobs, but not in the traditional blue-collar production and white-collar office jobs of the past. Rather, we expect to see growing employment among the ranks of the “new artisans”: licensed practical nurses and medical assistants; teachers, tutors and learning guides at all educational levels; kitchen designers, construction supervisors and skilled tradespeople of every variety; expert repair and support technicians; and the many people who offer personal training and assistance, like physical therapists, personal trainers, coaches and guides. These workers will adeptly combine technical skills with interpersonal interaction, flexibility and adaptability to offer services that are uniquely human.

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# As machines take on more human work, what is left for us?

AUGUST 15, 2014

By Drew DeSilver1 comment

For decades, labor economists have sought to quantify and predict the the impact of computer technology on both current and future employment, a subject that a new Pew Research Center report probed with a survey of nearly 1,900 experts. Computers had typically been thought of as best suited for jobs that involve routine, repetitive tasks that can easily be reduced to lines of code. But with computer-controlled devices and systems already capable of doing far more than projected even a few years ago, many experts now see more complex jobs coming into play. The first approach is perhaps summed up by MIT economist David Autor and David Dorn, an economist at Spain's CEMFI institute, who've done much of the spade work in this line of research. They wrote in a 2013 paper: "The adoption of computers substitutes for low-skill workers performing routine tasks — such as bookkeeping, clerical work, and repetitive production and monitoring activities — which are readily computerized because they follow precise, well-defined procedures."

## Jobs Most and Least Susceptible to Automation

Occupations ranked by routine-task intensity (RTI), a measure of its potential susceptibility to automation

Occupations with highest RTI scores	Share of total U.S. employment in:		
	1980	2005	
Proofreaders	0.02%	0.01%	↓
Motion picture projectionists	0.01	0.01	↔
Meter readers	0.04	0.03	↓
Butchers and meat cutters	0.31	0.17	↓
Secretaries and stenographers	3.82	2.53	↓
Payroll and timekeeping clerks	0.17	0.12	↓
Bank tellers	0.47	0.27	↓
Barbers	0.10	0.06	↓
File clerks	0.23	0.22	↓
Boilermakers	0.04	0.01	↓
Announcers	0.04	0.03	↓
Cashiers	1.31	1.49	↑
Typists	0.61	0.23	↓
Pharmacists	0.16	0.16	↔
Bookkeepers and accounting and auditing clerks	1.70	0.98	↓

### Occupations with lowest RTI scores

Athletes, sports instructors, and officials	0.05%	0.13%	↑
Fire fighting, fire prevention, and fire inspection occupations	0.34	0.33	↓
Railroad conductors and yardmasters	0.06	0.05	↓
Recreation and fitness workers	0.03	0.17	↑
Foresters and conservation scientists	0.04	0.02	↓
Public transportation attendants and inspectors	0.06	0.11	↑
Locomotive operators: engineers and firemen	0.10	0.06	↓
Kindergarten and earlier school teachers	0.12	0.32	↑
Archivists and curators	0.01	0.03	↑
Police and detective, public service	0.59	0.75	↑
Primary school teachers	1.96	2.20	↑
Airplane pilots and navigators	0.08	0.13	↑
Surveyors, cartographers, mapping scientists/technicians	0.11	0.10%	↓
Actors, directors and producers	0.06	0.13	↑
Bus drivers	0.30	0.33	↑

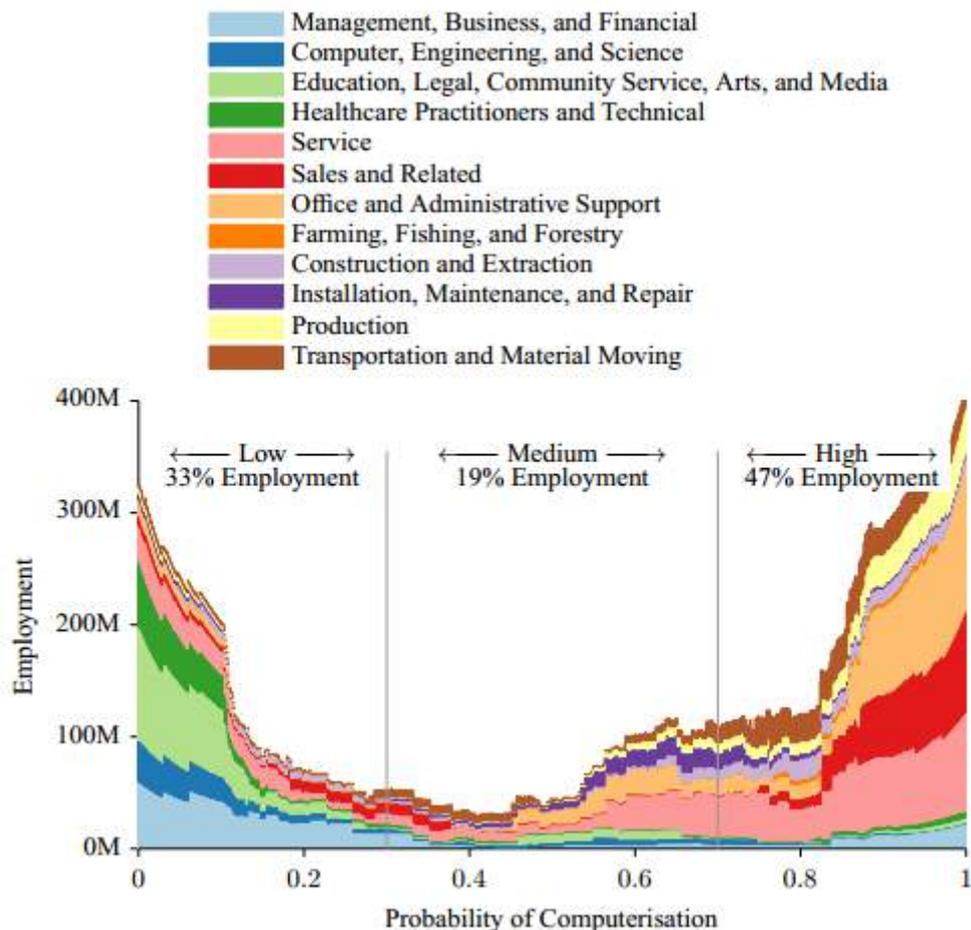
Note: Agricultural, supervisory and residual occupations excluded.

Consequently, Autor and Dorn say, computerization has been a major contributor to the “hollowing-out” of middle-skilled, middle-wage jobs and a corresponding rise in employment at both the high and low ends of the skills spectrum. To quantify this, the researchers developed an index of “routine task intensity,” or RTI. The higher an occupation’s RTI, the more it’s characterized by routine tasks with relatively little manual labor or abstract reasoning involved. Dorn, in a separate paper, said RTI could “be interpreted as an occupation’s potential susceptibility to displacement by automation.”

A look at the highest- and lowest-ranking nonfarm occupations by RTI seems to bear that out. Of the 15 occupations with the highest RTI scores, only one (cashiers) accounted for a higher share of U.S. employment in 2005 than it did in 1980, while 10 of the 15 lowest-RTI occupations grew as a share of total employment over that timespan.

But as computing devices have become both more powerful and ever-more woven into the fabric of our lives, they’ve steadily moved into tasks that only a few years ago would have been thought safely in the “humans only” zone. In 2004, for instance, Frank Levy and Richard Murnane wrote that “executing a left turn across oncoming traffic involves so many factors that it is hard to imagine discovering the set of rules that can replicate [a] driver’s behavior.” Today, Google is rapidly making self-driving cars a reality.

Last year, two Oxford researchers proposed a new way of estimating how vulnerable different occupations are to future technological advances. The researchers, Carl Benedikt Frey and Michael Osborne, focused on the extent to which occupations involve three types of tasks — perception and manipulation, creative intelligence and social intelligence — that, they argue, are least likely to be fully and successfully automated within the next few decades. The more a job involves such tasks, the less susceptible it is to computerization.



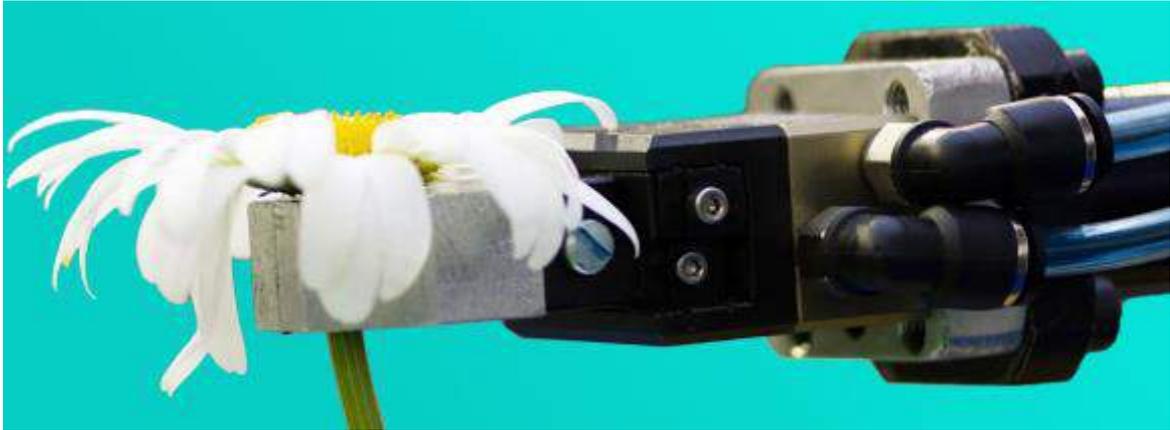
*Credit: Carl Benedikt Frey and Michael Osborne*

Frey and Osborne analyzed 702 occupations this way, sorting them into high, medium and low risk of computerization. They concluded that 47% of total U.S. employment is in the high risk category, including most workers in transportation and logistics occupations, office and administrative support occupations, and production workers. Among the jobs at the highest risk for computerization: telemarketers, title examiners, insurance underwriters, watch repairers and tax preparers.

Much of the near-term risk of computerization, Frey and Osborne conclude, will be borne by low-skill, low-wage workers — a reversal of the “hollowing out” phenomenon that has characterized the computing age up to now. “As technology races ahead,” they write, “low-skill workers will reallocate to tasks that are non-susceptible to computerization — i.e., tasks requiring creative and social intelligence. For workers to win the race, however, they will have to acquire creative and social skills.”

*Topics: Emerging Technology Impacts, Work and Employment*

Source: <http://www.pewresearch.org/fact-tank/2014/08/15/as-machines-take-on-more-human-work-whats-left-for-us/>



# Experts Have No Idea If Robots Will Steal Your Job

by Walter Frick | 9:37 AM August 8, 2014

Experts disagree about the future. That might seem unextraordinary, but it's the conclusion of a new survey on robots from Pew, and it's more significant than it sounds. For all the talk of "robots stealing jobs," 2,551 experts surveyed were deeply divided over the following question:

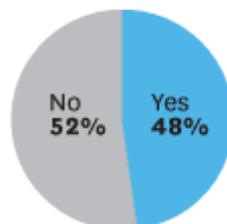
- *Will networked, automated, artificial intelligence (AI) applications and robotic devices have displaced more jobs than they have created by 2025?*

48% agreed with this pessimistic take, while a thin majority was more optimistic.

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## EXPERTS ARE DIVIDED ON WHETHER ROBOTS WILL DISPLACE MORE JOBS THAN THEY CREATE

*Will networked, automated, artificial intelligence applications and robotic devices have replaced more jobs than they have created by 2025?*



SOURCE PEW RESEARCH CENTER

HBR.ORG

Perhaps the most obvious takeaway is that a grain of salt is needed whenever prognosticators claim to know which jobs will be automated and which won't. These exercises are valuable in that they help us think through the role of automation in society, but the truth is we simply don't know how many jobs of which kinds will be automated when.

To those in fear of being replaced by automation, the fact that experts are divided may seem like consolation – unfortunately, it’s anything but.

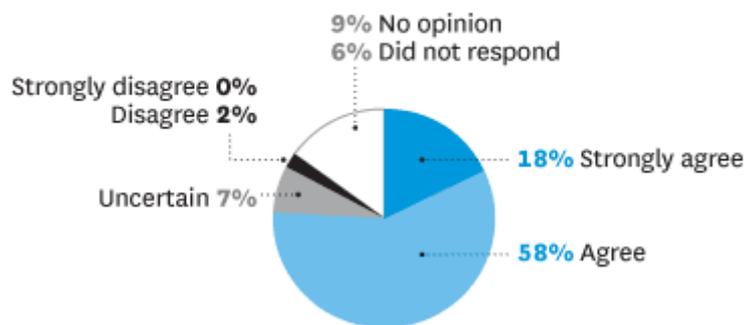
Instead, the second takeaway is that the skeptics are gaining ground. Conventional wisdom has long held that, while technology may displace workers in the short-term, it does not reduce employment over the long-term.

This encouraging bit of historical consensus was illustrated in a poll of economists taken this February by the University of Chicago. Only 2% of those surveyed believe that automation has reduced employment in the U.S.

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### ECONOMISTS AGREE THAT AUTOMATION HAS NOT HISTORICALLY HURT EMPLOYMENT

*Agreement with the statement “Advancing automation has not historically reduced employment in the United States.”*



SOURCE CHICAGO BOOTH IGM FORUM

HBR.ORG

Against this backdrop, Pew’s 50-50 split is more troubling. Some of the gap may reflect economists’ general optimism, but more than that, it signals the recognition that this wave of technological disruption could in fact be different.

Historically, fears of technology-driven unemployment have failed to materialize both because demand for goods and services continued to rise, and because workers learned new skills and so found new work. We might need fewer workers to produce food than we once did, but we’ve developed appetites for bigger houses, faster cars, and more elaborate entertainment that more than make up for the difference. Farmworkers eventually find employment producing those things, and society moves on.

In their recent book, *The Second Machine Age*, MIT’s Erik Brynjolfsson and Andrew McAfee challenge the assumption that this pattern will repeat itself, arguing that the sheer pace of today’s digital change threatens to leave many workers behind.

- *What if this process [of skill adjustment] takes a decade? And what if by then, technology has changed again? ... Once one concedes that it takes time for workers and organizations to adjust to technical change, then it becomes apparent that accelerating technical change can lead to widening gaps and increasing possibilities for technological unemployment.*

Much of the book is dedicated to making the case that technical change is accelerating, due to Moore's Law, the observation that computing power roughly doubles every 18 months.

Several Pew respondents — experts from a wide range of technology-related fields — echoed this line of thinking. As technology consultant and futurist Bryan Alexander put it:

- *The education system is not well positioned to transform itself to help shape graduates who can 'race against the machines.' Not in time, and not at scale. Autodidacts will do well, as they always have done, but the broad masses of people are being prepared for the wrong economy.*

There are counterpoints, of course, like those made recently here at HBR by Boston University's James Bessen, who argues that technology eventually boosts demand for even less educated workers. Numerous Pew respondents agree. Internet pioneer and Google VP Vint Cerf put it succinctly:

- *Historically, technology has created more jobs than it destroys and there is no reason to think otherwise in this case. Someone has to make and service all these advanced devices.*

Economist Tyler Cowen summed up his own thoughts on the subject, writing on his blog that:

- *The law of comparative advantage has not been repealed. Machines take away some jobs and create others, while producing more output overall.*

But not unlike Moore's Law, comparative advantage — the insight that workers shift to the tasks to which they are best suited — is not set in stone. Of the former, Brynjolfsson and McAfee write:

- *Moore's Law is very different from the laws of physics that govern thermodynamics or Newtonian classical mechanics. Those laws describe how the universe works; they're true no matter what we do. Moore's Law, in contrast, is a statement about the work of the computer industry's engineers and scientists; it's an observation about how constant and successful their efforts have been.*

Comparative advantage is more than just observation — it's one of the most enduring findings of social science. It describes how economies work in a wide range of circumstances, but it is subject to revision. If the entire structure of the economy changes, thanks to technology, so too might the rules of comparative advantage.

In their book, Brynjolfsson and McAfee highlight how predictions made in 2004 on the basis of comparative advantage failed to predict even today's division of labor between people and machines. Economists Frank Levy and Richard Murnane theorized that computers would handle

arithmetic and rule-based work, while humans would be required for pattern recognition – like driving – as well as communication. Today, self-driving cars are well on their way to adoption and speech recognition is embedded in every smartphone.

The list of things that machines can do better than humans continues to grow, confounding our predictions. The jobs we think are safe may not be, and the ones we fear we'll lose may be safer than we think.

Source: <http://blogs.hbr.org/2014/08/experts-have-no-idea-if-robots-will-steal-your-job/>

# Automation Alone Is Not Killing Jobs

APRIL 5, 2014

Photo



*Credit John Hersey*

Although the labor market report on Friday showed modest job growth, employment opportunities remain stubbornly low in the United States, giving new prominence to the old notion that automation throws people out of work.

Back in the 19th century, steam power and machinery took away many traditional jobs, though they also created new ones. This time around, computers, smart software and robots are seen as the culprits. They seem to be replacing many of the remaining manufacturing jobs and encroaching on service-sector jobs, too.

Driverless vehicles and drone aircraft\* are no longer science fiction, and over time, they may eliminate millions of transportation jobs. Many other examples of automatable jobs are discussed in “The Second Machine Age,” a book by Erik Brynjolfsson and Andrew McAfee, and in my own book, “Average Is Over.” The upshot is that machines are often filling in for our smarts, not just for our brawn — and this trend is likely to grow.

How afraid should workers be of these new technologies? There is reason to be skeptical of the assumption that machines will leave humanity without jobs. After all, history has seen many

waves of innovation and automation, and yet as recently as 2000, the rate of unemployment was a mere 4 percent. There are unlimited human wants, so there is always more work to be done. The economic theory of comparative advantage suggests that even unskilled workers can gain from selling their services, thereby liberating the more skilled workers for more productive tasks.

Nonetheless, technologically related unemployment — or, even worse, the phenomenon of people falling out of the labor force altogether because of technology — may prove a tougher problem this time around.

Labor markets just aren't as flexible these days for workers, especially for men at the bottom end of the skills distribution. Through much of the 20th century, workers moved out of agriculture and into manufacturing jobs. A high school diploma and a basic willingness to work were often enough, at least for white men, because the technologies of those times often relied on accompanying manual labor.

Many of the new jobs today are in health care and education, where specialized training and study are required. Across the economy, a college degree is often demanded where a high school degree used to suffice. It's now common for a fire chief to be expected to have a master's degree, and to perform a broader variety of business-related tasks that were virtually unheard-of in earlier generations. All of these developments mean a disadvantage for people who don't like formal education, even if they are otherwise very talented. It's no surprise that current unemployment has been concentrated among those with lower education levels.

There is also a special problem for some young men, namely those with especially restless temperaments. They aren't always well-suited to the new class of service jobs, like greeting customers or taking care of the aged, which require much discipline or sometimes even a subordination of will. The law is yet another source of labor market inflexibility: The number of jobs covered by occupational licensing continues to rise and is almost one-third of the work force. We don't need such laws for, say, barbers or interior designers, although they are commonly on the books.

Many expanding economic sectors are not very labor-intensive, be they tech fields like online retailing or even new mining and extraction industries. That means it's harder for the rate of job creation to keep up with the rate of job destruction, because a given amount of economic growth isn't bringing as many jobs.

A new paper by Alan B. Krueger, Judd Cramer and David Cho of Princeton has documented that the nation now appears to have a permanent class of long-term unemployed, who probably can't be helped much by monetary and fiscal policy. It's not right to describe these people as "thrown out of work by machines," because the causes involve complex interactions of technology, education and market demand. Still, many people are finding this new world of work harder to navigate.

Sometimes, the problem in labor markets takes the form of underemployment rather than outright joblessness. Many people, especially the young, end up with part-time and temporary service jobs — or perhaps a combination of them. A part-time retail worker, for example, might also write

for a friend's website and walk dogs for wealthier neighbors. These workers often aren't climbing career ladders that build a brighter or more secure future.

Many of these labor market problems were brought on by the financial crisis and the collapse of market demand. But it would be a mistake to place all the blame on the business cycle. Before the crisis, for example, business executives and owners didn't always know who their worst workers were, or didn't want to engage in the disruptive act of rooting out and firing them. So long as sales were brisk, it was easier to let matters lie. But when money ran out, many businesses had to make the tough decisions — and the axes fell. The financial crisis thus accelerated what would have been a much slower process.

Subsequently, some would-be employers seem to have discriminated against workers who were laid off in the crash. These judgments weren't always fair, but that stigma isn't easily overcome, because a lot of employers in fact had reason to identify and fire their less productive workers.

In a nutshell, what we're facing isn't your grandfather's unemployment problem. It does have something to do with modern technology, and it will be with us for some time.

**TYLER COWEN is professor of economics at George Mason University.**

***A version of this article appears in print on April 6, 2014, on page BU6 of the New York edition with the headline: Automation Alone Isn't Killing Jobs.***

Source: <http://www.nytimes.com/2014/04/06/business/automation-alone-isnt-killing-jobs.html>

March 25, 2013

# Robots Aren't the Problem: It's Us

By Richard Florida



Swikar Patel for The Chronicle Review

**E**veryone has an opinion about technology. Depending on whom you ask, it will either: a) Liberate us from the drudgery of everyday life, rescue us from disease and hardship, and enable the unimagined flourishing of human civilization; or b) Take away our jobs, leave us broke, purposeless, and miserable, and cause civilization as we know it to collapse.

The first strand of thinking reflects "techno-utopianism"—the conviction that technology paves a clear and unyielding path to progress and the good life. George F. Gilder's 2000 book *Telecosm* envisions a radiant future of unlimited bandwidth in which "liberated from hierarchies that often waste their time and talents, people will be able to discover their most productive roles." Wired's Kevin Kelly believes that, although robots will take away our jobs, they will also "help us discover new jobs for ourselves, new tasks that expand who we are. They will let us focus on becoming more human than we were."

The technology critic Evgeny Morozov dubs today's brand of technology utopianism "solutionism," a deep, insidious kind of technological determinism in which issues can be minimized by supposed technological fixes (an extreme example he gives is how a set of "smart" contact lenses edit out the homeless from view). We latch on to such fixes because they enable us to displace our anxieties about our real-world distress, the New Yorker staff writer George Packer explains: "When things don't work in the realm of stuff, people turn to the realm of bits." Morozov points to a future in which dictators and governments increasingly use technology (and robots) to watch over us; Packer worries about "the politics of dissolution," the way information technology erodes longstanding identities and atomizes us.

**O**n the other side stand the growing ranks of "techno-pessimists." Some say that technology's influence is greatly overstated, seeing instead a petering out of innovation and its productive forces. According to the George Mason University economist Tyler Cowen, for example, America and other advanced nations are entering a prolonged "great stagnation," in which the low-hanging fruits of technological advance have largely been exhausted and the rates of innovation and economic growth have slowed. Robert J. Gordon, an economist at Northwestern University, adds additional statistical ammunition to this argument in his much-talked-about paper, ["Is U.S. Economic Growth Over?"](#) Computers and biotechnology have advanced at a phenomenal clip, he demonstrates, but they have created only a short-lived revival of growth. Today's innovations do not have the kind of world-shaking impact that the invention of modern plumbing or the introduction of self-propelled vehicles did (they're "pipsqueaks" by comparison)—and they are more likely to eliminate than to add jobs.

Another techno-dystopian strand sees the "rise of the robots" as a threat not just to blue-collar jobs but also to knowledge work. "To put it bluntly, it seems that high-skill occupations can be mechanised and outsourced in much the same way as car manufacturing and personal finance," Tom Campbell, a novelist and consultant in the creative sector, blogs, pointing to commercial software that already analyzes legal contracts or diagnoses disease.

The dustbin of history is littered with dire predictions about the effects of technology. They frequently come to the fore in periods in which economies and societies are in the throes of sweeping transformation—like today.

During the upheaval of the Great Depression, the late Harvard University economist Alvin Hansen, often called the "American Keynes," said that our economy had exhausted its productive forces and was doomed to a fate of secular stagnation in which the government would be constantly called upon to stoke demand to keep it moving. Of course we now know from the detailed historical research of Alexander J. Field that the 1930s were, in the title of his 2008 paper, "The Most Technologically Progressive Decade of the Century," when technological growth outpaced the high-tech innovations of the 1980s, 1990s, and 2000s.

As the late economist of innovation Christopher Freeman long ago argued, innovation slows down during the highly speculative times leading up to great economic crises, only to surge forward as the crisis turns toward recovery. While data are scanty so early into our current recovery cycle, a new, detailed report from the Brookings Institution shows a considerable uptick in patented innovations over the last couple of years,

More than 100 years ago, during an earlier depression, H.G. Wells's *The Time Machine* imagined a distant future when humanity had degenerated into two separate species—the dismal Morlock, the descendants of the working class, who lived underground and manned the machines, and the ethereal Eloi, their former masters, who had devolved to a state of abject dependency. A little more than half a century later, Kurt Vonnegut's *Player Piano* depicted a world in which "any man who cannot support himself by doing a job better than a machine" is shipped off to the military or assigned to do menial work under the auspices of the government.

**T**his either-or dualism misses the point, for two reasons.

The obvious one is the simple fact that technology cuts both ways. In their influential book *Race Against the Machine*, Erik Brynjolfsson and Andrew McAfee,

both at the Massachusetts Institute of Technology, point out how technology eliminates some jobs but upgrades others. Similarly, Scott Winship, an economist with Brookings, recently noted in an article in *Forbes* that "technological development will surely eliminate some specific jobs." But the productivity gains from those developments, he added, "will lower the cost of goods and produce more discretionary income, which people will use to pay other people to do things for them, creating new jobs."

What economists dub "skill-biased technical change" is, in fact, causing both the elimination of formerly good-paying manufacturing jobs and the creation of high-paying new jobs. As a result, work is being bifurcated—into high-pay, high-skill knowledge jobs and low-pay, low-skill service jobs.

The second and more fundamental problem with the debate between utopians and dystopians is that technology, while important, is not deterministic. As the great theorists of technology, economic growth, and social development Karl Marx and Joseph Schumpeter argued—and modern students of technological innovation have documented—technology is embedded in the larger social and economic structures, class relationships, and institutions that we create. All the way back in 1858, in *Grundrisse*, Marx noted: "Nature builds no machines, no locomotives, railways, electric telegraphs, self-acting mules, etc. These are products of human industry." Technological innovation, he went on "indicates to what degree general social knowledge has become a direct force of production, and to what degree, hence, the conditions of the process of social life itself have come under the control of the general intellect and been transformed in accordance with it."

In his landmark 1990 book on economic progress from classical antiquity to the present, *The Lever of Riches*, the economic historian Joel Mokyr also distinguishes *homo economicus*, "who makes the most of what nature permits him to have," from the Promethean *homo creativus*, who "rebels against nature's dictates." He places emphasis, like Schumpeter perhaps, on human beings' underlying creative ability to mold technology by building institutions, forging social compacts, making work better, building societies. Technology does not force us into a preordained path but enables us, or, more to the point, forces us to make choices about what we want our future to be like.

We do not live in the world of *The Matrix* or the *Terminator* movies, where the machines are calling the shots. When all is said and done, human beings are technology's creators, not its passive objects. Our key tasks during economic and social transformations are to build new institutions and new social structures and to create and put into effect public policies that leverage technology to improve our jobs, strengthen our economy and society, and generate broader shared prosperity.

**O**ur current period is less defined by either the "end of technology" or the "rise of robots" than by deep and fundamental transformations of our economy, society, and class structures. The kinds of work that Americans do have changed radically over the course of the last two centuries, particularly during major economic crises, like the Panic and Depression of 1873; the Great Depression of the 1930s; the Crash of 2008. Each shift has been hugely disruptive, eliminating previously dominant forms of employment and work, while generating entirely new ones.

In 1800 more than 40 percent of American workers made their livings in farming, fishing, or forestry, while less than 20 percent worked in manufacturing, transportation, and the like. By 1870, the share of workers engaged in those agricultural jobs had dropped to just 10 percent; during those same decades, the ranks of blue-collar manufacturing workers had risen to more than 60 percent.

That was not a smooth change, to say the very least. Rural people feared—often rightly—that their friends and family who were moving to the cities were dooming themselves to immiseration and brutal exploitation, working 16-hour days for subsistence wages. When labor began to organize for better conditions, management hit back hard—in some cases unleashing armed Pinkertons on strikers. The Panic of 1873 and the Long Depression that followed it began as a banking crisis precipitated by insolvent mortgages and complex speculative instruments, and it brought the entire economy to a virtual standstill. But the technological advances perfected and put into place during that decade of economic stagnation—everything from telephones to streetcars—created the powerhouse industrial cities that underpinned a vast industrial expansion.

The battles, and the terrible working conditions, continued well into the 1930s, when my father went to work in a Newark, N.J., factory at age 13. Nine people in his family had to work—both parents, both grandparents, and several siblings—to make one family wage. The Industrial Revolution had been going on for more than a century before a new social compact was forged—a product of worker militancy, enlightened self-interest on the part of owners and management, and pressure from the government—that brought safety, dignity, and security to blue-collar work. It was this compact that buttressed the great age of productivity in the post-World War II era. When he returned from the war, my father's job in the very same factory he had previously worked in had been transformed into a good, high-paying occupation, the kind we pine for today, which enabled him to buy a home and support a family.

But beginning around 1950, when Kurt Vonnegut was working for General Electric and writing *Player Piano*, the share of working-class jobs began to fall precipitously. It wasn't just automation that was doing it—our whole economy was shifting again, and our society was changing with it. There was the civil-rights movement and later the anti-war youth movement, feminism, and gay rights. People began to rebel against the enforced conformity of corporate life. A new ethos was bubbling up, in Haight-Ashbury and Woodstock through music and art and fashion, and in Silicon Valley with computers and high tech. Some economists began to talk about how the industrial economy was transitioning to a service economy; others, like the sociologist Daniel Bell, saw the rise of a postindustrial economy powered by science, technology, and a new technocratic elite. The pioneering theorist Peter Drucker dubbed it a "knowledge economy."

Almost a decade ago, in my book *The Rise of the Creative Class*, I called it a "creative economy," because creativity, not knowledge, has become the fundamental factor of production. Our economy uses technology, but it is not principally powered by it. Its motive force is creativity. Economic and social progress result from the interweaving of several distinctive, related strands of creativity: innovative or technological creativity, entrepreneurship or economic creativity, and civic or artistic creativity.

## **Our current economic circumstance is not simply the product of faceless technology; it is also informed and structured by socioeconomic class.**

The key organizing unit of the postindustrial creative economy is no longer the factory or the giant corporation. It is our communities and our cities. Cities are the organizing or pivot point for creativity, its great containers and connectors. Unlike the services we produce, the technologies we create, or the knowledge and information that is poured into our heads, creativity is an attribute we all share. It is innate in every human being. But it is also social, it lives among us: We make each other creative. With their dense social networks, cities push people together and increase the kinetic energy among them. If the powerhouse cities of the industrial era depended on their locations near natural resources or transportation centers, our great cities today turn on the people who live in them—they are where we combine and recombine our talents to generate new ideas and innovations.

Like the Industrial Revolution, the rise of the knowledge-driven, creative economy has transformed the composition of the work force, with harrowing consequences. The picture is brutally clear: Working-class employment has declined by 50 percent in the last half century. Blue-collar workers made up 40 percent of the work force in 1980; they are just 20 percent of the work force today. In just the one decade between 2000 and 2010, the United States shed more than 5.7 million production jobs.

As the working class, like the agricultural class before it, has faded, two new socioeconomic classes have arisen: the creative class (40 million strong in the United States, roughly a third of the work force) and the even larger service class (60 million strong and growing, about 45 percent of the work force). If the creative class is growing, the service class is growing even faster. Last year the U.S. Bureau of Labor Statistics published a list of the fastest-growing occupational categories in the United States, projected out to 2020. Most of the top 10 were in the service sector. The two fastest-growing jobs, which are expected to grow by roughly 70 percent by 2020, were personal-care aides and home health aides. The former, which pays a median of just \$19,640, will add more than 600,000 jobs; the latter, which pays \$20,560, will grow by more than 700,000 jobs. There was only one

clearly creative-class job in the top 10—biomedical engineer (an \$81,540-a-year job).

Our current economic circumstance is not simply the product of faceless technology; it is also informed and structured by socioeconomic class. The creative class is highly skilled and educated; it is also well paid. Creative-class jobs average more than \$70,000 in wages and salaries; some pay much more. Service-class jobs in contrast average just \$29,000. The service class makes up 45 percent of the work force but earns just a third of wages and salaries in the United States; the creative class accounts for just a third of employment but earns roughly half the wages and salaries.

The divide goes even deeper. Add the ranks of the unemployed, the displaced, and the disconnected to those tens of millions of low-wage service workers, and the population of postindustrialism's left-behinds surges to as many as two-thirds of all Americans. That produces a much larger, and perhaps more permanent, version of the economic, social, and cultural underclass that Michael Harrington long ago dubbed "the other America." Only this time, it's a clear majority.

The effects of class extend far beyond our work and incomes to virtually every facet of our social lives. One class is not only wealthier and better educated than the other, its members are also healthier, happier, live in places with better services and resources of all sorts, and they pass their advantages on to their children.

**T**o blame technology for all this is to miss the point. Instead of looking at technology as a simple artifact that imposes its will on us, we should look at how it affects our social and economic arrangements—and how we have failed to adapt them to our circumstances.

If nearly half the jobs that our economy is creating are low paid and unskilled and roughly two-thirds of our population is being left behind, then we need to create new and better social and economic structures that improve those jobs. That means more than just raising wages (though that has to be done), but actively and deliberately improving jobs. We did it before with factory jobs, like my father's.

We have to do it again, this time with low-wage, low-skill service work. That isn't charity or an entitlement—it's tapping workers' intelligence and capabilities as a source of innovation and productivity improvements.

My own research, and that of others, has identified two sets of skills that increase pay and improve work. Cognitive skills have to do with intelligence and knowledge; social skills involve the ability to mobilize resources, manage teams, and create value. These skills literally define high-wage knowledge work: When you add more of them to that work, wages go up. But here's the thing: When those skills are added to service work, wages increase at a steeper rate than they do in creative jobs.

Paying workers better also offers substantial benefits to the companies that employ them and to the economy writ large. While that may seem counterintuitive, detailed academic research backs it up. Zeynep Ton of MIT's Sloan School of Management argues that the notion that keeping wages low is the long way to achieve low prices and high profits is badly mistaken: "The problem with this very common view is that it assumes that an employee working at a low-cost retailer can't be any more productive than he or she currently is. It's mindless work so it doesn't matter who does it. If that were true, then it really wouldn't make any sense to pay retail workers any more than the least you can get away with."

In a study published in the *Harvard Business Review*, Ton finds that the retail companies that invest the most in their lowest paid workers "also have the lowest prices in their industries, solid financial performance, and better customer service than their competitors." As she has pointed out, the companies and jobs provide a powerful model that can be extended to other service-based jobs like those in hospitals, restaurants, banks, and hotels. Upgrading service jobs in this way, she says, "could help provide the kind of economic boost the economy needs."

We can't simply write off the tens of millions of workers who toil in dead-end service jobs, or the millions more who are unemployed and underemployed. The key to a broadly shared prosperity lies in new social and economic arrangements that more fully engage, not ignore and waste, the creative talents of all of our people.

Just as we forged a new social compact in the 1930s, 40s, and 50s that saw manufacturing workers as a source of productivity improvements and raised their wages to create a broad middle class to power growth, we need a new social compact—a Creative Compact—that extends the advantages of our emergent knowledge and creative economy to a much broader range of workers. Every job must be "creatified"; we must harness the creativity of every single human being.

I'm optimistic, even in the face of deep economic, social, and political troubles, because the logic of our future economic development turns on the further development and engagement of human creativity.

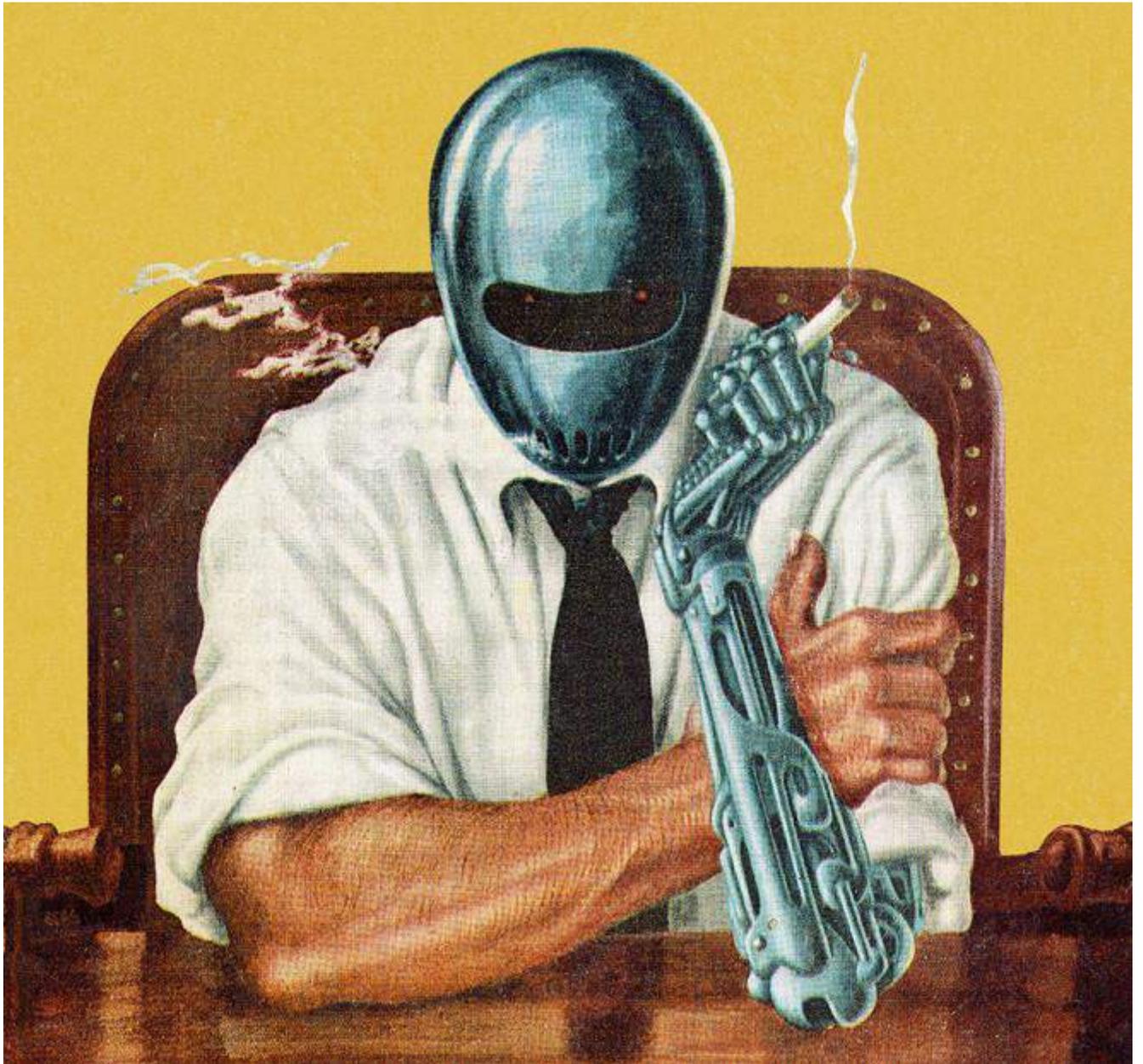
As in the past, it won't be technology that defines our economic future. It will be our ability to mold it to our needs.

Richard Florida is director of the Martin Prosperity Institute at the University of Toronto's Rotman School of Management and Global Research Professor at New York University.

Source: <https://chronicle.com/article/Robots-Arent-the-Problem-/138007/>

# When Robots Take All the Work, What Will Be Left for Us to Do?

- BY MARCUS WOHLSEN
- 08.08.14 |
- 6:30 AM |



Robots have loomed over the future of labor for decades—at least since robotic arms started replacing auto workers on the assembly line in the early 1960s. Optimists say that more robots will lead to greater productivity and economic growth, while pessimists complain that huge swaths of the labor force will see their employment options automated out of existence.

Each has a point, but there's another way to look at this seemingly inevitable trend. What if both are right? As robots start doing more and more of the work humans used to do, and doing it so much more efficiently than we ever did, what if the need for jobs disappears altogether? What if the robots end up producing more than enough of everything that everyone needs?

The redefinition of work itself is one of the most intriguing possibilities imagined in a recent Pew Research report on the future of robots and jobs. Certainly, the prospect of a robot-powered, post-scarcity future of mandatory mass leisure feels like a far-off scenario, and an edge case even then. In the present, ensuring that everyone has enough often seems harder for humans to accomplish than producing enough in the first place. But assuming a future that looks more like *Star Trek* than *Blade Runner*, a lot of people could end up with a lot more time on their hands. In that case, robots won't just be taking our jobs; they'll be forcing us to confront a major existential dilemma: if we didn't have to work anymore, what would we do?

The answer is both a quantitative and qualitative exercise in defining what makes human intelligence distinct from the artificial kind, a definition that seems to keep getting narrower. And in the end, we might figure out that a job-free roboticized future is even scarier than it sounds.

## Humanity as a Service

One prevailing answer kind of dodges the question, but it also seems like one of the most plausible outcomes. Maybe many jobs can't be automated in the first place. Several respondents canvassed by Pew believe that the need for human labor will persist because so many of our basic human qualities are hard to code. "Truth be told, computers are not very smart. All they are is giant calculators," game designer and author Celia Pearce told Pew. "They can do things that require logic, but logic is only one part of the human mind."

Humans will continue to be useful workers, the argument goes, because of things like empathy, creativity, judgment, and critical thinking. Consider the all-too-common experience of calling customer service reps whose employers force them to follow a script—a kind of pseudo-automation. When made to follow a decision tree the way a computer would, all four of those qualities are sucked out of the interaction—no opportunity to exercise creativity, empathy, judgment, or critical thinking—and the service provided tends to stink.

"Detecting complaints is an AI problem. Sending the complaints to the correct customer service entity is an AI problem," said one unnamed Pew respondent described as a university professor and researcher. "But customer service itself is a human problem."

Overall, the kinds of jobs that respondents predicted humans would still be needed to do involved interactions with other people. Healthcare, education, and caring for the elderly and children were all seen as occupations that would still require a human touch. "Those areas in which human compassion is important will be less changed than those where compassion is less or not important," said Herb Lin, chief scientist on the Computer Science and Telecommunications Board at the National Academies of Science.

Future job options may even extend beyond the caring professions to include work that the fluid integration of body and mind still make it most efficient for humans to perform. In a piece looking at the “instant gratification” economy of same-day delivery, San Francisco UPS driver Rafael Monterrosa tells *Recode* he’s not worried about a self-driving car taking his place. “As far as delivery goes, you still need someone to carry something up the stairs.”

## No Job Required

Still, as industries from manufacturing to transportation to journalism are overtaken by artificial intelligence, the sheer number of new openings in more human service-related industries may not keep up with the number of other jobs lost. That could leave many, many people out of work. But it could also end up changing our economy in enormous ways.

Traditionally, increased productivity correlates with economic growth *and* job growth, since human labor has historically driven production. A robot workforce, however, can drive productivity and growth on its own, eliminating jobs in the process. That might mean the whole paradigm of exchanging labor for pay starts to break down. “If we persist in the view that the dividends from robots’ increased productivity should accrue to robot owners, we’ll definitely come to a future where there aren’t enough owners of robots to buy all the things that robots make,” Cory Doctorow wrote in a recent *Boing Boing* post.

Doctorow suggests the possibility that robot-driven abundance could undermine the need for markets as we know them. “Property rights may be a way of allocating resources when there aren’t enough of them to go around, but when automation replaces labor altogether and there’s lots of everything, do we still need it?” Assuming a post-scarcity system of distribution evolves to peacefully and fairly share the fruits of robot-driven post-scarcity production, jobs as we know them might not just become unnecessary—they might stop making sense altogether.

The idea that robots could make employment itself optional may sound fantastic. No more work! But the end result could be more, not less angst. We’d still have to find our place among the robots, except this time without work as a guidepost for defining a sense of purpose. By eliminating the need for people to work, robots would free us up to focus on what really makes us human. The scariest possibility of all is that only then do we figure out what really makes us human is work.

Source: <http://www.wired.com/2014/08/when-robots-take-all-the-work-whatll-be-left-for-us-to-do/>

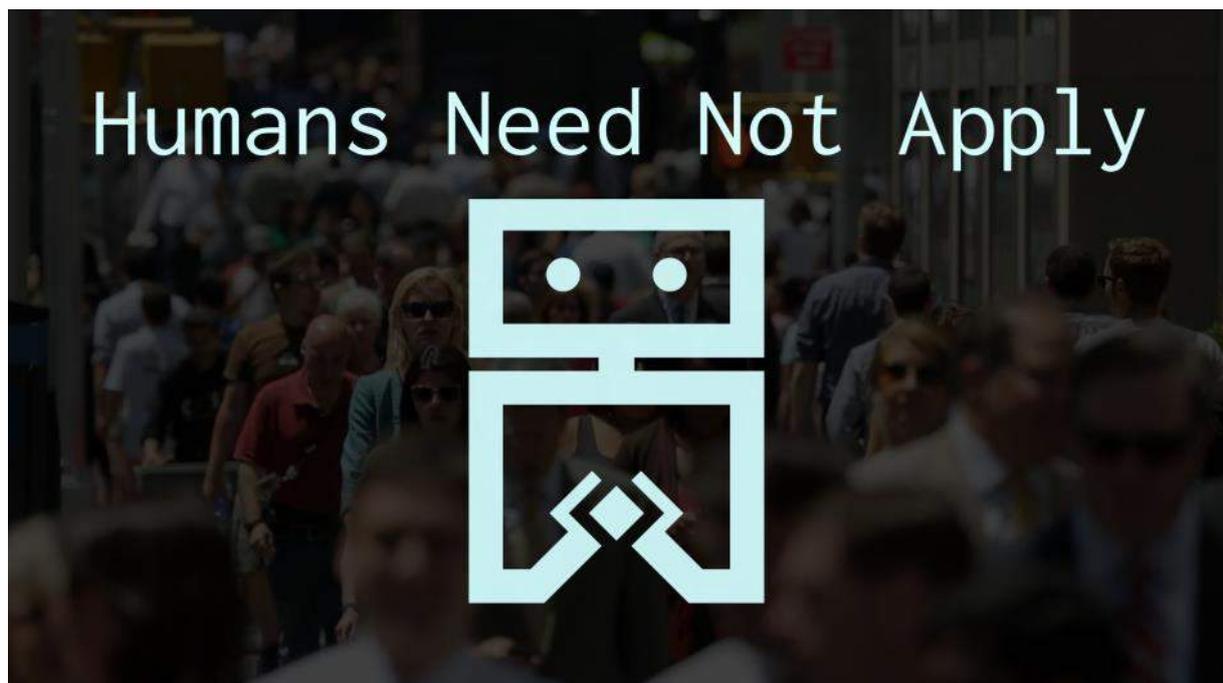
## Video: Humans Need Not Apply

By CGP Grey

Published on Aug 13, 2014

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