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TECHNOLOGY

What Clever Robots Mean for Jobs

Experts rethink belief that tech always lifts employment as machines take on skills once thought uniquely human

By **TIMOTHY AEPPEL**
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CAMBRIDGE, Mass.—Economist Erik Brynjolfsson had long dismissed fears that automation would soon devour jobs that required the uniquely human skills of judgment and dexterity.

Many of his colleagues at the Massachusetts Institute of Technology, where a big chunk of tomorrow's technology is conceived and built, have spent their careers trying to prove such machines are within reach.

When Google Inc. announced in 2010 that a specially equipped fleet of driverless Toyota Prius cars had safely traveled more than 1,000 miles of U.S. roads, Mr. Brynjolfsson realized he might be wrong.

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"Something had changed," Mr. Brynjolfsson said, recalling his astonishment at machines navigating the many unpredictable moments that face drivers.

From steam engines to robotic welders and ATMs, technology has long displaced humans—always creating new, often higher-skill jobs in its wake.

But recent advances—everything from driverless cars to computers that can read human facial expressions—have pushed experts like Mr. Brynjolfsson to look anew at the changes automation will bring to the labor force as robots wiggle their way into higher reaches of the workplace.

They wonder if automation technology is near a tipping point, when machines finally master traits that have kept human workers irreplaceable.

"It's gotten easier to substitute machines for many kinds of labor. We should be able to have a lot more wealth with less labor," Mr. Brynjolfsson said. "But it could happen that there are people who want to work but can't."

In the Australian Outback, for example, mining giant Rio Tinto uses self-driving trucks and drills that need no human operators at iron ore mines. Automated trains will soon carry the ore to a port 300 miles away.

The Port of Los Angeles is installing equipment that could cut in half the number of longshoremen needed in a workplace already highly automated.

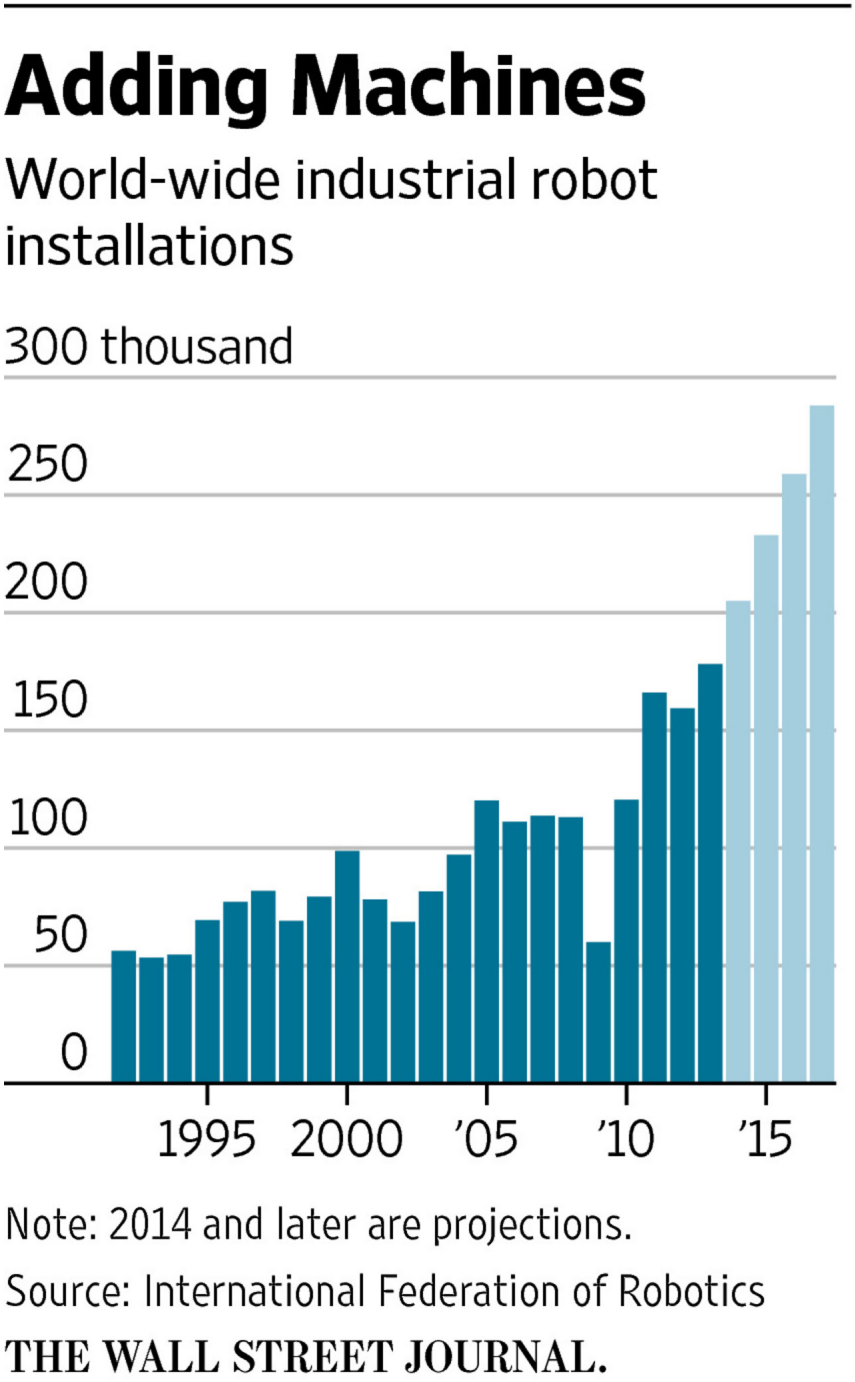
Computers do legal research, write stock reports and news stories, as well as translate conversations; at car dealers, they generate online advertising; and, at banks, they churn out government-required documents to flag potential money laundering—all jobs done by human workers a short time ago.

Microsoft co-founder Bill Gates , speaking in Washington last year, said automation threatens all manner of workers, from drivers to waiters to nurses. "I don't think people have that in their mental model," he said.

Robot employment

Gartner Inc., the technology research firm, has predicted a third of all jobs will be lost to automation within a decade. And within two decades, economists at Oxford University

forecast nearly half of the current jobs will be performed with machine technology.



"When I was in grad school, you knew if you worried about technology, you were viewed as a dummy—because it always helps people," MIT economist David Autor said. But rather than killing jobs indiscriminately, Mr. Autor's research found automation commandeering such middle-class work as clerk and bookkeeper, while creating jobs at the high- and low-end of the market.

This is one reason the labor market has polarized and wages have stagnated over the past 15 years, Mr. Autor said. The concern among economists shouldn't be machines soon replacing humans, he said: "The real problem I see with automation is that it's contributed to growing inequality."

Mr. Autor and other experts say much of the new technology are tools to make workers more productive, not replace them. Markets will yield new, yet-to-be-imagined work, they said, and, according to modern economic history, plenty of jobs.

The short- and long-term impact of technology is debated at MIT, where research labs hatch much of the hardware and software reshaping markets.

Landmark breakthroughs by MIT scientists include Marc Raibert 's development of robots with "dynamic" balance, without which the machines would tip over constantly. Another colleague, Rodney Brooks, made "Genghis" in the late 1980s, a six-legged clambering robot inspired by spiders and now in the Smithsonian.

MIT campus scientists and economists meet regularly to discuss the implications of their work. The talks started after Mr. Brynjolfsson co-wrote a 2011 book that spelled out his epiphany about automation's new era. The book noted that only six years before Google's startling driverless car announcement, fellow MIT economist and automation expert Frank Levy had published a well-regarded book that said driverless cars were impossible.

Erik Brynjolfsson, a professor at the Massachusetts Institute of Technology Sloan School of Management, sits with a robot named Baxter at MIT's Robotics Lab last month. *PHOTO: GRETCHEN ERTL FOR THE WALL STREET JOURNAL*

Mr. Levy wasn't happy to be singled out that way, he said, and was hardly a Luddite. The subtitle of his book is: "How Computers Are Creating the Next Job Market." Mr. Levy stands by the idea that automation's advance to uniquely human tasks, including driving, won't happen as fast as many predict.

The debate inspired him to get economists and scientists talking. MIT robotics professor John Leonard helped set up the meetings, which are held about once a month.

Topics span the prosaic—warehouse robots—to the philosophical—What happens if there is no meaningful work for humans?

A recent session featured Henrik Christensen, head of the Georgia Institute of Technology's robotics program and a specialist in industrial robots. Automation is spreading to factories world-wide, and China recently overtook the U.S. as the world's largest market for robots, he told the group, packed into a room in MIT's Frank Gehry-designed computer-science center.

"Most truck drivers won't have those jobs 10 years from now," said Mr. Christensen, who is especially bullish on self-driving cars. He predicted children born today won't need to learn to drive but will find plenty of jobs.

Automation may move slower than many expect. Bank ATMs spread quickly throughout the U.S. over the past three decades, but the number of tellers has only recently declined. In 1985, the U.S. employed 484,000 bank tellers, compared with 472,000 in 2007—reflecting the growth in banking. Since the recession, the number has fallen to 361,000.

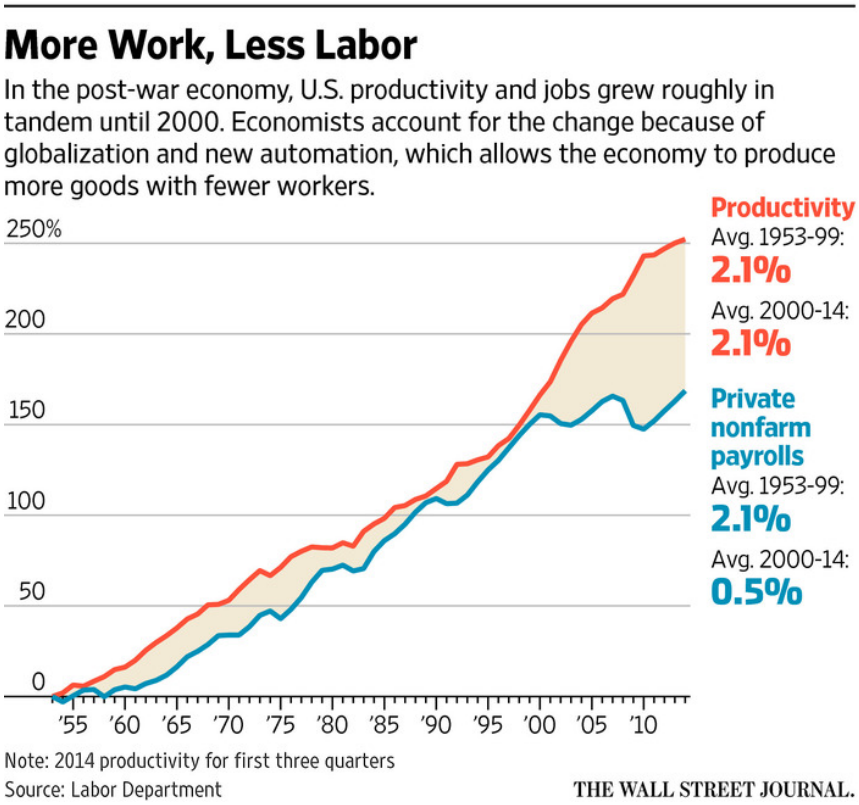
Scott Stern, an MIT economist who spoke to the group last year, is among those who believe that technology may have reached a tipping point. He had once thought the latest wave of automation would crest gradually, he said, "playing out along the lines of prior technological transitions."

But technological advances are moving at a faster speed, Mr. Stern said, with unpredictable results.

The large question under debate by scientists here is how close are breakthroughs that will allow robots to interact with humans in complex tasks.

One group at MIT says computing capacity is the only barrier. The world is building vast pools of data and computing muscle that, this view holds, will soon enable machines to do jobs that previously required skilled people.

Others say scientists are far from translating common sense, sight and dexterity into a string of code. Absent that, computing power won't help.



Automation skeptics

Mr. Leonard, the robotics professor who helped initiate the talks with economists, is skeptical such breakthroughs will come soon. "There's something about robots that makes people think we're close to Arnold Schwarzenegger and the Terminator movies," he said.

To make his point, Mr. Leonard mounted a camera on his car's dashboard to record his daily commute. The idea was to collect an inventory of the sort of unexpected events a computer would face while driving.

Snapping open his laptop, Mr. Leonard showed a series of images from his dash-cam that would confound a machine, he said, including a left-hand turn in traffic. The 49-year-old professor said driverless cars won't be able to navigate busy city streets in his lifetime.

Google recently gave Mr. Leonard a ride in a driverless car, and he compared the experience to the Wright brother's flight at Kittyhawk. "It was a remarkable event," he said of the first flight. "But look how long it took" to reach commercial air travel, he said, aviation's lasting economic transformation.

The first time automation spawned fears of a jobless future might have been in the 19th century, when English textile workers attacked the first mechanical knitting machines. They were right to fear the contraptions, which eventually replaced them. Another wave of fear hit in the 1960s, when industrial robots began to eat into U.S. manufacturing for the first time.

Yet a recent survey of top economists by the University of Chicago found 88% either

agreed or strongly agreed that automation has never historically led to reduced U.S. employment.

Economists in the minority are often said to embrace the so-called lump of labor fallacy: that the amount of work is finite. To date, the job market hasn't worked that way. Some new machines are so efficient they push down prices and create more demand—which in many cases spawns more jobs, not fewer.

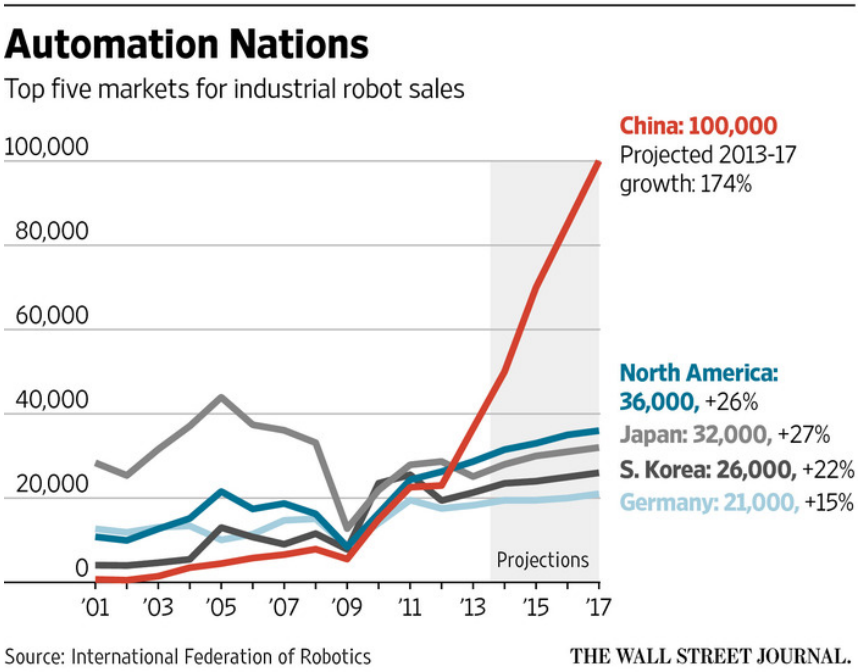
The invention of the automobile threw blacksmiths out of work, but created far more jobs building and selling cars. Displaced workers with obsolete skills are always hurt. but the total number of jobs has never declined over time.

Bill Freeman, a professor of engineering and computer science at MIT, joins colleagues from the campus during a meeting last month about new frontiers in automation. *PHOTO: GRETCHEN ERTL FOR THE WALL STREET JOURNAL*

That seems to be the case at Rio Tinto's Australian mines. John McGagh, the company's head of technology and innovation, said the surge of automation began about a decade ago, made possible by "more powerful computer chips and highly accurate GPS."

The new equipment cut many driving jobs, of course. But the reductions will be partly offset by new types of work. The company now needs more network technicians, Mr. McGagh said, and "mechatronics engineers," a hybrid of electrical and mechanical engineering that hardly existed five years ago.

The robot at Aloft hotel in Cupertino, Calif., covers errands. It trundles items to guests



from the front desk, weaving pilotless through hotel corridors. The machine has a compartment kept locked until it reaches the guest's door. Instead of knocking, it calls the room phone and waits.

No tipping is required. But a built-in screen asks guests for a rating. The robot chirps "Wheee" for a good rating, jiggling back and forth on its wheels.

"We considered having them talk," said Steve Cousins, chief executive of Savioke, the robot's creator. "But the issue is, if it talks to you—you'll assume it understands you." That remains a skill monopolized by hotel employees.

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