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By Anek Belbase and Andrew D. Eschtruth*

Introduction

Technological change is not new, particularly to the United States. Founded during the dawn of the Industrial Revolution, the country has been a leader in new technologies – from the cotton gin and the lightbulb to the personal computer and the internet. These advances have enabled people to lead lifestyles today that would have been unimaginable a century ago. But progress has not been painless for workers, as each wave of innovation has created laborsaving machines that have disrupted jobs. Each time, workers replaced by machines have faced difficult short-term transitions, but, through retraining and career changes, have eventually found jobs in rising industries.

Today, as computer-powered machines perform tasks that would have seemed impossible only a decade ago, policymakers and workers alike are beginning to wonder – will workers continue to be able to adapt or is this time fundamentally different? The effect of new machines on older workers is of particular concern, because older workers make up a growing share of the workforce and increasingly need to work until their late 60s to attain a secure retirement.

This *brief* wraps up a three-part series on the effects of laborsaving machines on older workers. The first *brief* reviewed the impact of machines over the past two centuries, and the second *brief* examined how the recent rise of computers has affected older workers so far. The current *brief* turns to the near future and explores how emerging computers, with expanding capabilities that rely on artificial intelligence, might affect the job prospects of older workers over the next two decades.

The *brief* proceeds as follows. The first section describes the unique features of emerging computer technology. The second section explains how the new computers might affect demand for workers based on occupation and education. The third section examines whether older workers might be uniquely affected. The final section concludes that age is unlikely to determine how workers will be impacted. Instead, workers' education levels – which are now roughly similar by age group – and social skills – which tend to get better with age – will play important roles in how they fare.

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The Computerization of "Non-Routine" Work

From the 1980s to the present, computers have increasingly taken on "routine" tasks, which involve carrying out well-defined procedures. Jobs heavily reliant on these tasks generally require less education. As a result, computers have narrowed the job options of workers without a college degree and increased the options of those with a degree.[1]

Looking to the future, a key difference will be the enormous increase in computer capabilities. Until very recently, despite improvements in processing speed, storage capacity, connectivity, and sensor technology, computers were limited to tasks that could be anticipated and converted into explicit instructions. For example, computer-powered robots could bolt together car parts in an assembly line because the assembly line limited the number of scenarios that a programmer would need to anticipate. But even relatively simple tasks done by humans, like driving a car or performing an oil change, were beyond the reach of computers because of the sheer number of rules to be understood and coded.[2]

Today, however, advances in artificial intelligence, especially machine learning, have eliminated the bottleneck – the need to provide step-by step instructions – that limited computers to routine work. Now, computers can learn by example rather than through explicit instructions. In the past, a programmer might have "taught" a computer to recognize a cat by writing rules on how to identify ears, eyes, and whiskers. Today's machine-learning algorithms can derive rules to identify cats by examining a "training" dataset with millions of images, tagged as either "cat" or "not-cat."

Such advances are making it possible to computerize virtually any task with a measurable outcome and sufficient training data. Tasks already performed by computers include: image and speech recognition (Siri, Alexa, and Google Assistant); translation (Google Translate); anomaly detection (credit monitoring systems); and prediction (recommendations from Amazon or Netflix). Many emerging applications of machine learning involve tasks currently done by blue-collar or service workers (like driving cars, stocking shelves, fulfilling orders, and checking out retail customers). An explosion of training data from increasingly advanced sensors and the growing availability of data warehouses are accelerating the deployment of these applications.[3]

Despite their increasing capabilities, computers still have some limitations compared to humans. Recent studies have highlighted both how far computers have come and where humans still retain an advantage (see Table 1).[4] For example, while computers have an edge in many physical abilities, humans are better than machines at tasks that require mobility in non-standard spaces, such as home repairs to electrical wiring. In terms of cognitive skills, one area in which humans stand out is creativity, which covers jobs ranging from business consulting to video content creation. And humans still have a monopoly in social skills, such as a teacher's ability to sense and respond to students' emotions. An important question is, which occupations primarily involve these skills – making them less likely to be replaced by computers – and which do not? And what types of workers are in these various occupations?

Table 1. Comparison of Selected Human and Computer Capabilities

	Computers more able than average human	Average human more able than computers
Sensory	• Sensory perception	
Physical	• Fine motor skills • Gross motor skills • Navigation	• Mobility
Cognitive	• Recognizing known patterns & categories • Information retrieval • Optimization & planning • Information formatting & delivery	• Creativity • Logic & problem solving • Coordination w/ multiple agents • Generating novel patterns or categories
Social & emotional		• Sensing • Reasoning • Expression

Source: Adapted from McKinsey Global Institute (2017).

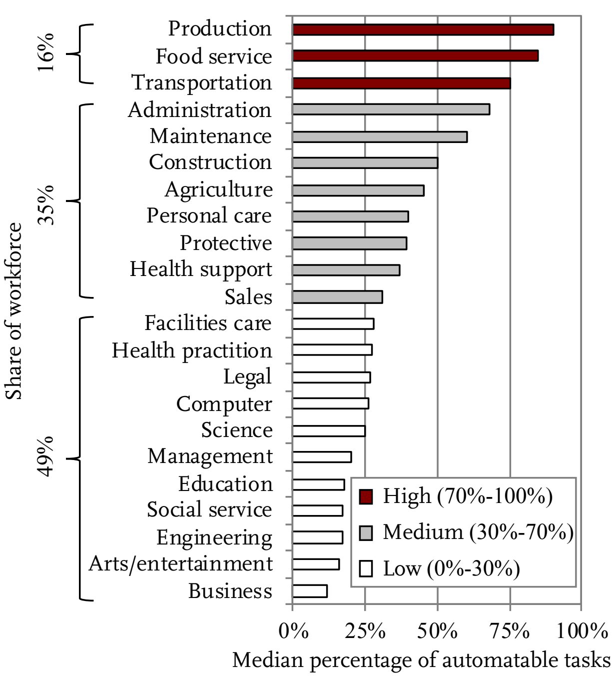
What Jobs Will Emerging Computers Replace?

Several studies have analyzed the extent to which workers might be replaced by computers over the next two decades. While differences in methodology lead them to disagree on the share working in "highly susceptible" occupations, their conclusions on the relative susceptibility of workers by occupation and education is largely consistent.[5]

One common finding is that certain jobs – like quality control inspectors, baristas, and truck drivers – are increasingly likely to be taken on by machines. Such jobs are concentrated in the production, food-service, and transportation areas (see Figure 1). Machines will also be able to take on a majority of the tasks performed by workers in administration, maintenance, and construction, while workers engaged in creative and social occupations, like business, entertainment, engineering, and social services are unlikely to face significant machine-led disruptions to their jobs. The high-risk occupations account for 16 percent of the labor force, those at medium risk for 35 percent, with the remaining 49 percent of workers at low risk.

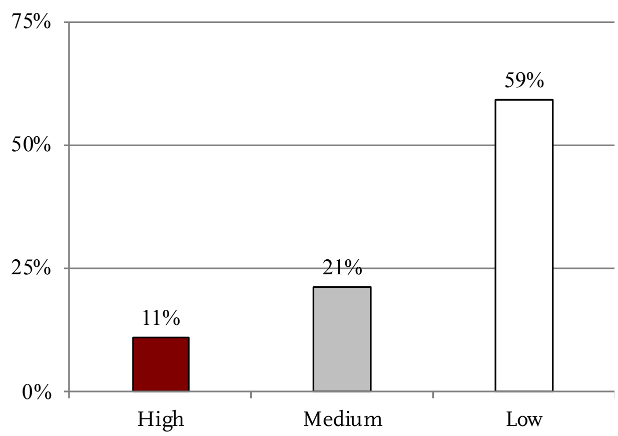
The question is what types of workers are in the occupations that are most at risk of automation. The distinguishing characteristic is their level of education. Figure 2 shows that very few workers in the high-risk occupations have a college degree.[6] In contrast, a majority of the workers in the low-risk occupations – jobs like software developer, engineer, and scientist – are college educated.

Figure 1. Percentage of Tasks with Automation Potential, by Occupational Group, 2016



Note: The bars are the median percentage of tasks that are automatable for the jobs within each occupation.
Sources: Authors' calculations using data from the U.S. Census Bureau's *Current Population Survey* (CPS) (2016); and automation potential definitions from Muro, Maxim, and Whiton (2019).

Figure 2. Percentage of Workers Ages 25-64 with a College Degree, by Automation Potential, 2016



Notes: The bars are the percentage of workers with a college degree in jobs with high, medium, or low potential for automation, defined as the median percentage of tasks that are automatable for the jobs within each group.
Sources: Authors' calculations using CPS (2016); and Muro, Maxim, and Whiton (2019).

While education has long been an important determinant of job prospects, its role is likely to be accentuated going forward. For example, during the first wave of computerization from 1980 to the present, when machines were depressing job growth in occupations based on routine tasks, some less-educated workers in physical jobs were relatively insulated. The reason is that their jobs relied on non-routine tasks in occupations like food service or transportation that – at that time – were difficult to automate. Now, though, these occupations are among those at the highest risk of automation in the near future due to the advances in artificial intelligence. Going forward, then, unskilled workers may look more to jobs less susceptible to automation, in fields that involve assisting people such as social services, education, or health care.

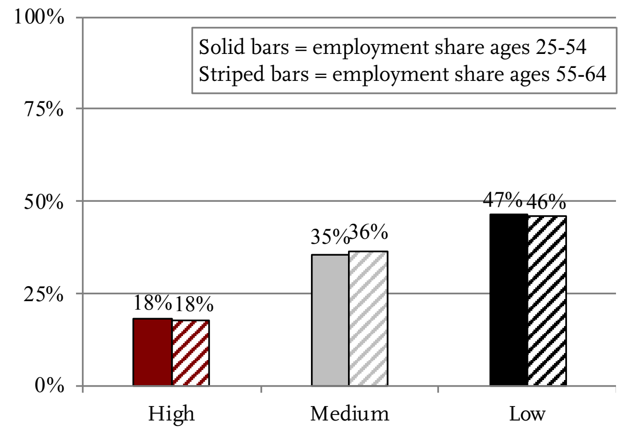
This analysis comes with two important caveats. First, it only looks at the potential *loss* of jobs associated with automation. Historically, laborsaving machines have also created new jobs, although the specific jobs and their skill requirements have been hard to predict in advance. For example, as the country industrialized, many unskilled workers were able to transition from farm to factory while, recently, new job creation has been more amenable to educated workers. In any case, the types of new jobs that are created over the next two decades will also play an important role in shaping workers' job prospects.[7] Second, this analysis looks only at the technical possibilities of emerging machines. The way in which technology is adopted (for example, whether self-driving technology is used to assist truck drivers or replace them) and the adoption rate (for example, mass adoption over 5 years versus 20 years) will also help determine the impact of machines on workers in the next two decades.

How Will Older Workers Fare?

In theory, laborsaving technology could have a unique effect on older workers because they have more knowledge that could become obsolete, less time for training to pay off, and age-dependent abilities that could limit their job options. However, the analysis presented here suggests that recent trends, observed since the 1980s, will likely continue: older workers will be impacted by emerging computers in a similar way as prime-age workers for several reasons. First, older workers are equally likely to be in occupations susceptible to automation (see Figure 3). Second, the skills needed for tasks that machines cannot yet perform – involving social interaction, abstract thinking, and complex perceptual and manipulation abilities – do not decline significantly with age.[8] And third, workers in their 50s and 60s today are about as likely to have a college degree as the average prime-age worker.

Despite having similar exposure to computers, an important question is how older workers without a college degree will fare as employment opportunities

Figure 3. Employment Share of Workers Ages 25-54 and 55-64, by Automation Potential



Notes: The bars are the percentage of workers by age in jobs with high, medium, or low potential for automation, defined as the median percentage of tasks that are automatable for the jobs within each group.
Sources: Authors' calculations using CPS (2016); and Muro, Maxim, and Whiton (2019).

shrink. In the recent past, even if workers in routine occupations lost their jobs, a growing services sector provided them with an alternative. As machines continue to erode the value of widespread human abilities, like basic hand-eye coordination, visual processing, and speech recognition, will untrained workers maintain their economic value? The studies reviewed here suggest that workers without a college degree or other specialized skills may need to consider switching to jobs that mostly rely on their social skills.[9]

Conclusion

Laborsaving machines are ubiquitous for a reason: they make life easier. While most people do not question the benefits of consumer-oriented machines such as dishwashers or smartphones, workers (and policymakers) have always had mixed feeling about machines in the workplace because of their potential to eliminate jobs.

To explore the extent to which machines could threaten the economic security of older workers, this series has examined their impact over three timeframes – since the Industrial Revolution; since the rise of computers in the 1980s; and over the next two decades. The analysis supports several conclusions.

First, over the long run, laborsaving machines have driven tremendous economic growth by allowing people to produce more with less effort. This outcome has been possible because workers replaced by machines – despite short-term hardships – have been largely successful in finding jobs that machines could not perform. Second, since the 1980s, education, rather than age, has been the key reason why some workers benefited from computerization and others were hurt – computers have increased demand for the workers with a college degree and reduced demand for those without one. Third, looking ahead, increasingly capable computers are likely to make the importance of education even more pronounced, with the least-educated workers increasingly exposed to the risk of being replaced. This latter group may turn to jobs that allow them to rely on humans' natural social skills, which are less susceptible to automation.

The increasing importance of education should come as no surprise. Throughout history, as machines have become more capable, education has provided a way for workers to similarly expand their own abilities in domains that machines could not yet enter. While technology's impact on the future labor market depends on many factors beyond the sheer capabilities of emerging machines, such as the way that these machines are applied to reinvent work, education will likely continue to provide workers with a reliable way to adapt.

Endnotes

1 Computers have had little impact on the availability of "non-routine" jobs open to workers with less education, which mainly involve physical tasks (like serving food or assisting retail customers), and generally pay low wages. In contrast, computers have dramatically increased the jobs available to college-educated workers, who can perform the non-routine mental tasks that take advantage of computers' capabilities (e.g. programmers, analysts, and consultants). See the second *brief* in this series (Belbase and Chen 2019) for more on this subject.

2 Autor, Levy, and Murnane (2003).

3 See MIT Task Force on Work of the Future (2019) for an up-to-date review of the emerging applications of machine learning and other computer technologies. While many white-collar occupations will also be affected by computerization, as with prior waves of computerization, these applications are likely to be complementary for workers with a college education.

4 See McKinsey Global Institute (2017) and Frey and Osborne (2017).

5 McKinsey Global Institute (2017), Frey and Osborne (2017), and Arntz, Terry, and Ulrich (2016) have carried out studies in this area using, as a starting point, the definition of tasks associated with occupations listed in the U.S. Department of Labor's O*Net database (or international equivalents). The studies diverge in the extent to which they define a task as automatable or not. For example, Frey and Osborne try to identify the extent to which the tasks involve "bottlenecks," or abilities that machines do not have (assuming all other tasks will be automatable in the next two decades), while McKinsey relies on expert opinion of which tasks can be automated in the next two decades. The studies also diverge on the percentage of tasks that need to be automatable for an occupation to be considered "highly susceptible" to automation. Finally, Arntz, Terry, and Ulrich (2016) use jobs, rather than occupations, as the unit of analysis.

6 For simplicity, this *brief* uses college as a way to communicate advanced training, which can be acquired through apprenticeships and non-formal means as well (e.g. electricians and plumbers.)

7 Factors other than technology also will shape the labor market. For example, an aging population will alter both the supply of workers (as workers retire) and the demand for workers (as people change consumption habits, for example, by spending more on health care). See McKinsey Global Institute (2017) and MIT Task Force on Work of the Future (2019).

8 See Belbase, Sanzenbacher, and Gills (2015), which summarizes the literature on which skills do – and do not – decline significantly with age.

9 An important question is the extent to which workers currently in non-routine physical jobs will be able to move into non-routine mental ones (Alabdulkareem et al., 2018).

References

Alabdulkareem, Ahmad, Morgan R. Frank, Lijun Sun, Bedoor AlShebli, César Hidalgo, and Iyad Rahwan. 2018. "Unpacking the Polarization of Workplace Skills." *Science Advances* 4(7): 1-9.

Arntz, Melanie, Terry Gregory, and Ulrich Zierahn. 2016. *The Risk of Automation in OECD Countries: A Comparative Analysis*. Social, Employment, and Migration Working Paper No. 189. Paris, France: OECD.

Autor, David H., Frank Levy, and Richard J. Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." *The Quarterly Journal of Economics* 118(4): 1279-1333.

Belbase, Anek and Anqi Chen. 2019. "How Did Computerization Since the 1980s Affect Older Workers?" *Issue in Brief* 19-19. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Belbase, Anek, Sanzenbacher, Geoffrey, and Gillis, Christopher. 2015. "Does Age-related Decline in Ability Correspond with Retirement Age?" Working Paper 2015-24. Chestnut Hill, MA: Center for Retirement Research at Boston College.

Frey, Carl Benedikt and Michael A. Osborne. 2017. "The Future of Employment: How Susceptible Are Jobs to Computerisation?" *Technological Forecasting and Social Change* 114 (2017): 254-280.

McKinsey Global Institute. 2017. *A Future That Works: Automation, Employment, and Productivity*. New York, NY.

MIT Task Force on Work of the Future. 2019. "Shaping Technology and Institutions." Fall Report. Cambridge, MA: Massachusetts Institute of Technology.

Muro, Mark, Robert Maxim, and Jacob Whiton. 2019. "Automation and Artificial Intelligence: How Machines are Affecting People and Places." Washington, DC: Brookings Institution.

U.S. Census Bureau. *Current Population Survey,* 2016. Washington, DC.

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