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SKILL SHIFT
AUTOMATION AND THE FUTURE OF THE WORKFORCE

DISCUSSION PAPER
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IN BRIEF

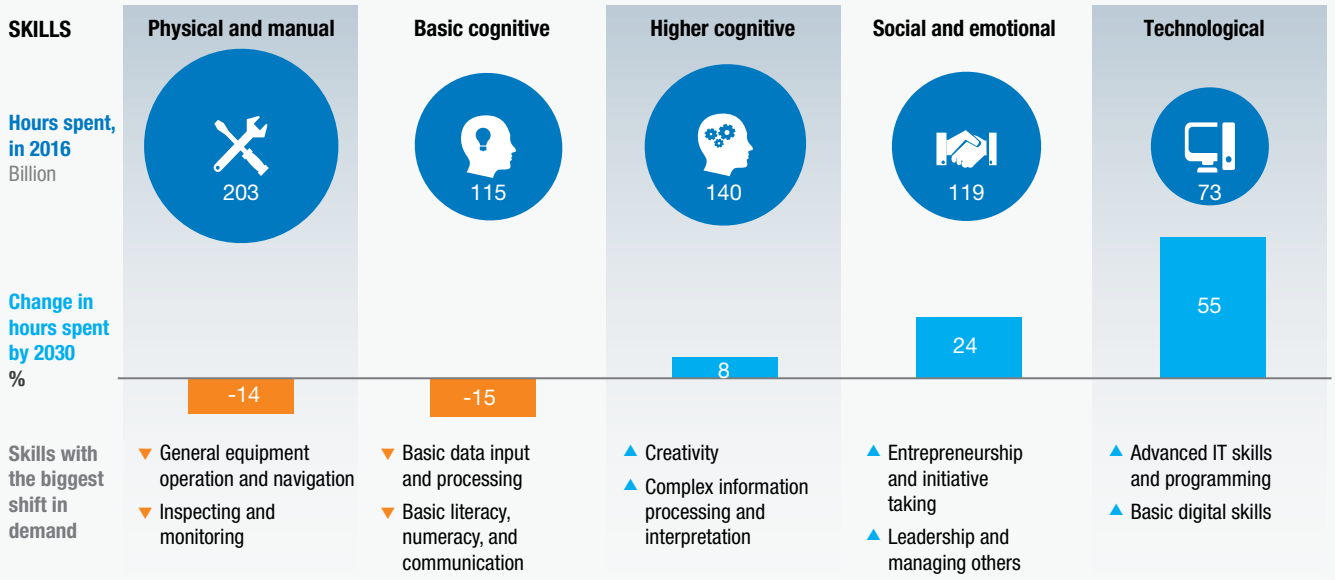
SKILL SHIFT: AUTOMATION AND THE FUTURE OF THE WORKFORCE

Automation and artificial intelligence (AI) are changing the nature of work. In this discussion paper, part of our ongoing research on the impact of technology on the economy, business, and society, we present new findings on the coming shifts in demand for workforce skills and how work is organized within companies, as people increasingly interact with machines in the workplace. We quantify time spent on 25 core workplace skills today and in the future for the United States and five European countries, with a particular focus on five sectors: banking and insurance, energy and mining, healthcare, manufacturing, and retail. Key findings:

- Automation will accelerate the shift in required workforce skills we have seen over the past 15 years. Our research finds that the strongest growth in demand will be for technological skills, the smallest category today, which will rise by 55 percent and by 2030 will represent 17 percent of hours worked, up from 11 percent in 2016. This surge will affect demand for basic digital skills as well as advanced technological skills such as programming. Demand for social and emotional skills such as leadership and managing others will rise by 24 percent, to 22 percent of hours worked. Demand for higher cognitive skills will grow moderately overall, but will rise sharply for some of these skills, especially creativity.
- Some skill categories will be less in demand. Basic cognitive skills, which include basic data input and processing, will decline by 15 percent, falling to 14 percent of hours worked from 18 percent. Demand for physical and manual skills, which include general equipment operation, will also drop, by 14 percent, but will remain the largest category of workforce skills in 2030 in many countries, accounting for 25 percent of the total hours worked. Skill shifts will play out differently across sectors. Healthcare, for example, will see a rising need for physical skills, even as demand for them declines in manufacturing and other sectors.
- Companies will need to make significant organizational changes at the same time as addressing these skill shifts to stay competitive. A survey of more than 3,000 business leaders in seven countries highlights a new emphasis on continuous learning for workers and a shift to more cross-functional and team-based work. As tasks change, jobs will need to be redefined and companies say they will need to become more agile. Independent work will likely grow. Leadership and human resources will also need to adapt: almost 20 percent of companies say their executive team lacks sufficient knowledge to lead adoption of automation and artificial intelligence. Almost one in three firms are concerned that lacking the skills they need for automation adoption will hurt their future financial performance.
- Competition for high-skill workers will increase, while displacement will be concentrated mainly on low-skill workers, continuing a trend that has exacerbated income inequality and reduced middle-wage jobs. Companies say that high-skill workers are most likely to be hired and retrained, and to see rising wages. Firms in the forefront of automation adoption expect to attract the talent they need, but slower adopters fear their options will be more limited.
- Almost half of the companies we surveyed say they expect to take the lead in building the workforce of the future, but all stakeholders will need to work together to manage the large-scale retraining and other transition challenges ahead. Firms can collaborate with educators to reshape school and college curricula. Industry associations can help build talent pipelines, while labor unions can help with cross-sector mobility. Governments will need to strengthen safeguards for workers in transition and encourage mobility, including with a shift to portable benefits, as ways of working and the workplace itself are transformed in the new era.

Automation and AI will change the skills needed in the workforce

Total is for United States and 14 Western European countries



HOW WORKFORCE SKILLS WILL SHIFT

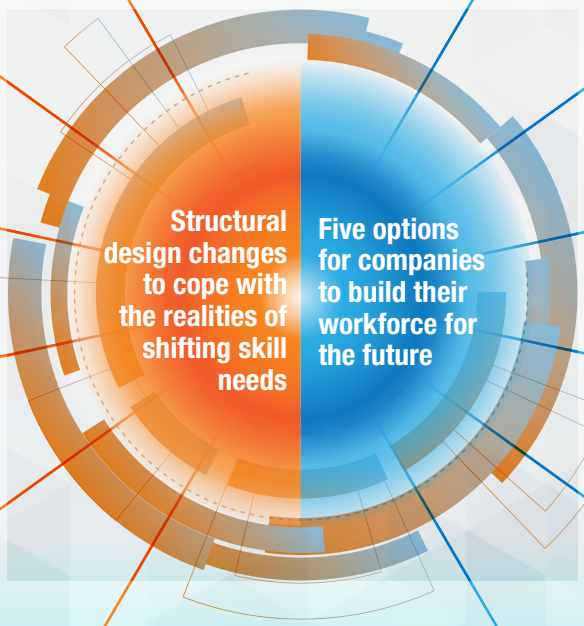
MINDSET SHIFT
Instilling a culture of life-long learning and providing training opportunities for employees

ORGANIZATIONAL SET-UP
More agile corporate structures featuring less hierarchy and more collaborative team networks

"NEW COLLAR" JOBS
Activities will be reallocated between workers with different skill levels, creating a new set of middle-skill positions

WORKFORCE COMPOSITION
The booming gig economy will lead to a rise in the use of independent contractors and freelancers

C-SUITE AND HR CHANGES
Senior leadership and key functions will also need to adapt, including a change in CEO mindset and talent strategies to orchestrate the changes



RETRAIN
Raise skill levels of employees by teaching them new or more advanced skills

REDEPLOY
Shift parts of the workforce by redefining work tasks or redesigning processes

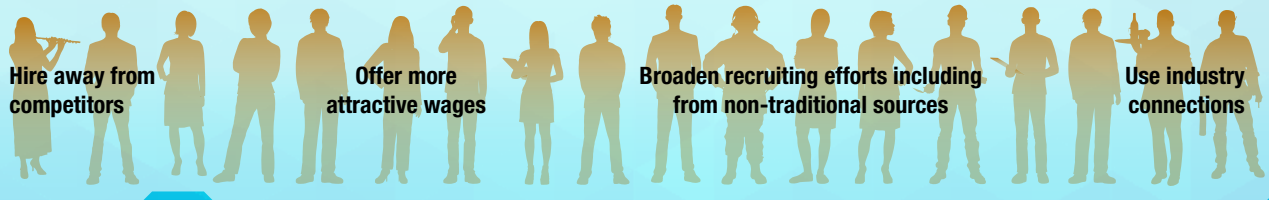
HIRE
Acquire individuals or teams with the requisite skills, increasing the workforce

CONTRACT
Leverage external workers, such as contractors, freelancers, or temporary workers

RELEASE
Remove skills not needed by freezing new hiring, waiting for normal attrition and retirement, or, in some cases, laying off workers

Competition for talent

To recruit the people they need for a new era of automation, companies say they will



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1. HOW WILL DEMAND FOR WORKFORCE SKILLS CHANGE WITH AUTOMATION?

Over the next 10 to 15 years, the adoption of automation and artificial intelligence technologies will transform the workplace, as people increasingly interact with ever smarter machines. These technologies, and that human-machine interaction, will bring numerous benefits, in the form of higher economic growth, improved corporate performance, and new prosperity. Automation will replace aging workers at a time when the working-age population in many countries is declining. It will help solve societal problems as well; already AI-powered machines are more adept than expert doctors at diagnosing some diseases from X-rays and MRIs. Our prior research suggests that automation and AI could give a boost to productivity growth, which has waned in advanced countries over the past decade, and generate considerable value for companies across sectors, from agriculture and media to healthcare and pharmaceuticals. Firms use these technologies to conduct predictive maintenance in manufacturing, personalize "next product to buy" recommendations, optimize pricing in real time, and identify fraudulent transactions, among other uses.[1]

These technologies will also change the skills required of human workers—the focus of this discussion paper.

Skill shifts in the workforce are not new; indeed, skill requirements have changed ever since the first Industrial Revolution reconfigured the role of machines and workers (see Box 1, "Skill shifts in the past and present"). Companies in many countries complain that they have trouble finding the talent they need, and workers often complain about being underqualified or even overqualified for their jobs.[2] Skill shortages and mismatches have negative implications for the economy and the labor market. They can result in increased labor costs, lost production due to unfilled vacancies, slower adoption of new technologies, and the implicit and explicit costs of higher unemployment rates.[3] Conversely, appropriate skills can boost economic growth: one study that has sought to quantify the linkage finds that an increase in educational achievement by 50 points in the OECD's PISA student assessment tests translates into a 1 percentage point higher long-run growth rate.[4]

In this opening chapter, we look at the demand for skills used by the workforce today and we model how that could change as new automation technologies including artificial intelligence are increasingly deployed in the workplace. To understand which skills will be needed more—and those needed less—we looked at the economy as a whole and in depth at five sectors: banking and insurance; energy and mining; healthcare; manufacturing; and retail. MGI's hallmark micro-to-macro approach uses micro insights from industries and companies to inform broader macroeconomic trends. This has enabled us to identify some of the key skill shifts in the future that will profoundly affect not just individual workers, but also companies and organizations.

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1 Recent MGI research on automation and AI in the workplace includes *A future that works: Automation, employment, and productivity*, January 2017; *Jobs lost, jobs gained: Workforce transitions in a time of automation*, December 2017; *Artificial intelligence: The next digital frontier?* June 2017; and *Notes from the AI frontier: Insights from hundreds of use cases*, April 2018. For a discussion of technology and productivity, see *Solving the productivity puzzle: The role of demand and the promise of digitization*, February 2018.

2 For example, see Dominic Barton, Diana Farrell, and Mona Mourshed, *Education to employment: Designing a system that works*, January 2013; Müge Adalet McGowan and Dan Andrews, *Labour market mismatch and labour productivity: Evidence from PIAAC data*, OECD, April 2015.

3 *Better skills, better jobs, better lives: A strategic approach to skills policies*, OECD, July 2012.

4 Ludger Woessmann, *The economic case for education, European Expert Network on Economics of Education*, report 20, December 2014.

Box 1. Skill shifts in the past and present

Technical innovation brought about shifts in skills needed in the workplace long before the advent of today's automation technologies. During the Industrial Revolution in Europe and the United States in the early 19th century, the steam engine and other technologies raised the productivity of workers with primarily basic manual skills, enabling them to undertake work that had previously been done by high-skill and high-paid laborers, including master weavers and other artisans. In our era, computers and robots have had the opposite effect, increasing the productivity and complementing the work of high-skill workers, even as they substitute for the routine tasks previously undertaken by low-skill workers, such as those working on assembly lines or as switchboard operators.[1]

This has contributed to a decline in middle-wage jobs across advanced economies over the past three decades.[2] In the United States, for example, the share of adults living in middle-income households has declined from 61 percent in 1971 to just 50 percent in 2015. While about one-third of those have shifted down to lower-middle and the lowest income households, two-thirds of this shift has been up, to upper-middle and higher income households, creating an hourglass-like effect.[3]

In the past 50 years alone, the skills used in several professions have fundamentally changed—even as the professions themselves have continued thriving. The changes can be seen by comparing official descriptions of roles as defined by the US Department of Labor.[4] For example, coal miners in the past used to carry out heavy physical and manual tasks requiring gross motor skills and physical strength. Today, they increasingly operate machines that do the heavy and dangerous toiling, and need to apply more complex skills by monitoring equipment and problem solving. Nurses in 1957 were required to administer medicines, monitor patients by taking their pulse and temperature, and help with therapeutic tasks including bathing, massaging, and feeding patients. Today, they still administer medicines to patients but also help perform diagnostic tests and can analyze the results—employing skills and filling roles that were more common to doctors a half-century ago. Bank tellers, too, have shifted from mainly handing out cash or collecting deposits to handling customers' queries and complaints, and selling financial products.

A still-unanswered question about AI and the latest automation technologies is whether they will continue to favor high-skill workers over low-skill ones—or perhaps affect workers at all skill levels. One risk is that the recent decline of middle-income jobs and growing inequality could intensify as companies compete for talent to overcome both an excess supply of some skills and an excess demand for others. The impact on wages for different job profiles could be a greater polarization even than today, with people who carry out nonrepetitive, digital work seeing above-average wages, while pay for repetitive, nondigital jobs might be below average. Today, we have the advantage of foreseeing the skill shifts to come, which gives us some time to anticipate and adjust for these and other social changes that may accompany automation and AI adoption.

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1 See David Hounshell, *From the American system to mass production, 1800–1932: The development of manufacturing technology in the United States*, Baltimore, MD, JHU Press, 1985; David H. Autor, Frank Levy, and Richard J. Murnane, "The skill content of recent technological change: An empirical exploration," *The Quarterly Journal of Economics*, Volume 118, Number 4, November 2003.

2 Daron Acemoglu and David Autor, "Skills, tasks, and technologies: Implications for employment and earnings," in *Handbook of Labor Economics*, Volume 4b, Orley Ashenfelter and David Card, eds., 2011.

3 *The American middle class is losing ground*, Pew Research Center, December 2015.

4 Frank Levy and Richard J. Murnane, *The new division of labor: How computers are creating the next job market*, Princeton, NJ, Princeton University Press, 2005.

ALREADY, THERE IS EVIDENCE OF SKILL MISMATCHES IN THE UNITED STATES AND EUROPE

A growing body of evidence suggests a mismatch between the skills the workforce has and the skills employers are looking for. The OECD, for example, finds mismatches both in the skills of individuals and in the educational credentials they hold, compared with what companies need.[5] In the European Union, there is evidence of a long-standing qualification mismatch over the past decade, with more than 20 percent of workers receiving either more or less formal education than is required for their job.

A mismatch in the skills of the workforce (as opposed to the educational credentials) is even more pronounced. In a 2015 survey of LinkedIn users, 37 percent of respondents said their current jobs did not fully use their skills.[6] The OECD finds that the percentage of the workforce reporting a skill mismatch does not fall below 30 percent in any of the 34 countries it analyzed. In the United States, researchers at the Brookings Institution and elsewhere have focused on changing skill requirements for middle-skill employment, which increasingly demands technical and digital skills lacking in the workforce.[7]

In parallel, many employers report that they face recruitment problems due to skill shortages. According to one survey, the time it took to fill a vacancy in 2016 was markedly higher than in 2005—28 days versus 20 days—even though the unemployment rate in both years was comparable, around 5 percent.[8] A 2013 survey commissioned by McKinsey found that only 43 percent of employers in nine countries (Brazil, Germany, India, Mexico, Morocco, Saudi Arabia, Turkey, the United Kingdom, and the United States) said they could find enough skilled entry-level workers.[9]

Academic research suggests that these skill mismatches are partly the result of a changing labor market, with the decline of some occupations such as production and clerical jobs, which require relatively little education, and the growth of other occupations in healthcare and other service sectors that require more postsecondary education—and which are proving the hardest to fill.[10]

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5 *Getting skills right: Assessing and anticipating changing skill needs*, OECD, April 2016.

6 *A labor market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

7 Mark Muro et al., *Digitalization and the American workforce*, Brookings Institution, November 2017.

8 *DHI hiring indicators report*, DHI Group Inc., October 2016. In addition to the increasing time it takes companies to fill vacancies, an analysis of the Beveridge curve for the US economy published by the Bureau of Labor Statistics in April 2018 suggests that a structural shift in terms of job openings took place in the timeframe analyzed. Specifically, the US job openings rate has been about 0.50 to 0.75 percentage points higher between 2009 and 2018 than it was in the 2001–07 period across a range of unemployment levels.

9 Ibid. Mona Mourshed et al., *Education to employment*, January 2013.

10 Harry J. Holzer, *Skill mismatches in contemporary labor markets: How real? And what remedies?* Georgetown University and American Institutes of Research, November 2013.

Technological skills are one specific area of mismatch. Several countries report shortages of specialized information technology workers and data scientists. For example, France expects a shortage of 80,000 workers in IT and electronics jobs by 2020.[11] Prior MGI research has estimated that there could be a shortfall of some 250,000 data scientists in the short term in the United States.[12] The skill shortage also extends to more basic digital skills. A British parliamentary report in 2016 found that 23 percent of the UK population, or 12.6 million people, lacked basic digital skills, at a time when about 90 percent of new jobs require them.[13] A survey of business leaders that we conducted for this report corroborates this finding. The top three areas identified by respondents as having the largest skill shortages today are data analytics, IT/mobile/web design, and R&D.[14]

AUTOMATION WILL PROMPT A LARGER SHIFT IN DEMAND FOR WORKFORCE SKILLS AS IT TRANSFORMS OCCUPATIONS

Economists, other researchers, and organizational practice experts use different definitions when discussing workforce "skills." The US Labor Department's occupational information network (O*NET), for example, differentiates between abilities ("enduring attributes of the individual") and skills ("developed capacities") in order to define and track a comprehensive list of 87 attributes that affect a worker's ability to carry out a particular job.[15] The OECD's survey of adult skills focuses on three foundational skills—literacy, numeracy, and problem solving in technology-rich environments—to allow for consistent quantification and comparison of skill levels in different populations over time.[16]

To understand the nature and magnitude of the coming skill shift, we take a business-oriented approach to our definition. We include both intrinsic abilities (for example, gross motor skills and strength, creativity, and empathy) and specific learned skills, such as those in advanced IT and programming, advanced data analysis, and technology design. This allows us to build a comprehensive view of the changing nature of workforce skills and provide a sufficient level of detail to motivate concrete actions and interventions.

We end up with a set of 25 skills across five broad categories: physical and manual, basic cognitive, higher cognitive, social and emotional, and technological skills. Within each category are more specific skills (Exhibit 1). For instance, within social and emotional skills, we include advanced communication and negotiation, interpersonal skills and empathy, leadership and managing others, entrepreneurship and initiative taking, adaptability and continuous learning, and teaching and training others. We have also separated technological skills from higher cognitive skills, although some of the former require higher cognitive capabilities (see Box 2, "Our sources of insight for this paper").

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11 Grégoire Normand, "Emploi: une pénurie de main d'œuvre à prévoir dans le numérique," *La Tribune*, September 22, 2017.

12 *The age of analytics: Competing in a data-driven world*, McKinsey Global Institute, December 2016.

13 Of this 23 percent of the population without basic digital skills, about half are disabled and 60 percent have no formal education. *Digital skills crisis*, United Kingdom House of Commons, Science and Technology Committee, second report of session 2016–17, June 2016.

14 Survey conducted in March 2018 among more than 3,000 C-level executives from companies with more than 30 employees across 14 sectors in Canada, France, Germany, Italy, Spain, the United Kingdom, and the United States. See technical appendix.

15 O*NET Online, onetonline.org/find/descriptor/browse/Abilities/.

16 *Program for the international assessment of adult competencies*, OECD. See Box 3 for our discussion of the supply of skills in relation to projected demand in 2030.

Exhibit 1

We have defined a set of 25 skills.

Based on McKinsey Global Institute workforce skills model

Low High

Category	Hours worked in 2016, % United States and Western Europe	Skills	Sample occupations
Physical and manual skills		General equipment operation and navigation	Drivers, assembly line workers
		General equipment repair and mechanical skills	Car and truck mechanics
		Craft and technician skills	Stonemasons, roofers, electricians
		Fine motor skills	Nurses, food preparation workers
		Gross motor skills and strength	Machine feeders, cleaners, packers
		Inspecting and monitoring skills	Security guards, quality control
Basic cognitive skills		Basic literacy, numeracy, and communication	Cashiers, customer service
		Basic data input and processing	Typists, data entry, accounting clerks
Higher cognitive skills		Advanced literacy and writing	Editors, paralegals, writers
		Quantitative and statistical skills	Financial analysts, accountants
		Critical thinking and decision making	Doctors, insurance underwriters
		Project management	Purchasing agents, front-line supervisors
		Complex information processing and interpretation	Market research analysts, lawyers
		Creativity	PR specialists, music composers
Social and emo-tional skills		Advanced communication and negotiation skills	Sales representatives, real estate agents
		Interpersonal skills and empathy	Counselors, social workers, therapists
		Leadership and managing others	Managers, executives
		Entrepreneurship and initiative-taking	Business development, strategists
		Adaptability and continuous learning	Emergency responders, programmers
		Teaching and training others	Teachers, instructors, trainers
Techno-logical skills		Basic digital skills	Administrative assistants, desktop publishers
		Advanced IT skills and programming	Software development, network administrators
		Advanced data analysis and mathematical skills	Statisticians, operations research analysts
		Technology design, engineering, and maintenance	Engineers, robotics experts, product designers
		Scientific research and development	Scientists

NOTE: Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

Box 2. Our sources of insight for this paper

The research is based on four main sources of insight. For details of our methodology, see the technical appendix at the end of this paper.

- First, we define a new taxonomy of 25 workforce skills and quantify time spent using each skill. We group skills into five categories: physical and manual, basic cognitive, higher cognitive, social and emotional, and technological skills. We quantify the time workers spend on each of the 25 skills today and how the amount of time worked will shift post-automation. While workers use multiple skills to perform a given task, for the purposes of our quantification, we identified the predominant skill used. For example, in banking and insurance, we mapped "prepare business correspondence" and "prepare legal or investigatory documentation" to the skill "advanced literacy and writing," which is grouped in the category of higher cognitive skills. In retail, we classified "stock products or parts" into gross motor skills and strength in the category of physical and manual skills, while "greeting customers, patrons, or visitors" is mapped to basic communication skills, in the basic cognitive category.
- Second, we quantify how automation will shift the demand for workforce skills in 2030. We use the MGI automation model to assess which work activities will decline, as described in our January 2017 report, A future that works: Automation, employment, and productivity. However, we build on that model by also considering jobs lost to productivity gains, and then compare jobs gained both from adoption of automation and AI directly, as well as from the productivity gains created by automation and AI. This enables us to examine in depth the coming occupational and skill shifts within five industry case studies (banking and insurance, energy and mining, healthcare, manufacturing, and retail).
- Third, we conducted a detailed executive survey of 3,031 respondents in Canada, the United States, and five European countries: France, Germany, Italy, Spain, and the United Kingdom. The survey targeted C-level executives from organizations familiar with at least one automation or AI technology and its application in business. The findings complement the quantitative results and highlight differences in the way extensive and limited adopters of automation and AI view the opportunities created by these technologies and how they are responding to shifting skill requirements.
- Fourth, we conducted in-person interviews with chief human resources officers and other industry executives on their current and future skill mismatches and their strategies for building the workforce of the future. We also drew on the industry and function expertise and client experience of our colleagues at McKinsey & Company.

AUTOMATION IS LIKELY TO ACCELERATE SKILL SHIFTS COMPARED WITH THE HISTORICAL TREND

Our analysis highlights significant shifts in workforce skills that will be in demand in an automated future. The biggest change will take place in technological skills, both in advanced skills such as programming, advanced data analysis, and tech design, for example, and also in more basic digital skills relating to the increasing prevalence of digital technologies in all workplaces. Other skills will also see a significant increase in demand, including various types of social and emotional skills. A shift will take place from basic to higher cognitive skills. Demand for physical and manual skills as a predominant skill set will continue to decrease, although these skills will remain a major component of the workplace of the future.

Assessing the accelerating impact of automation on skill shifts

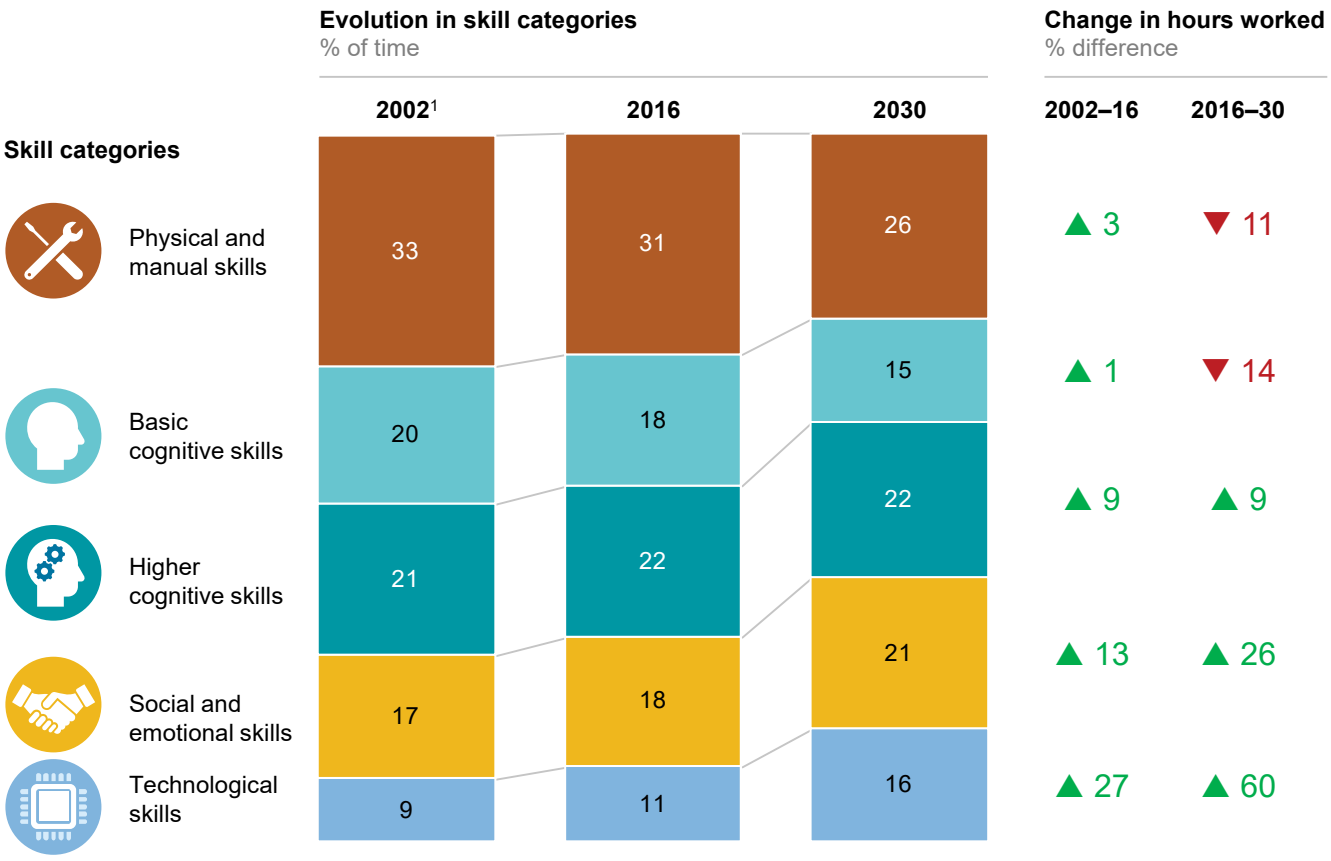
To measure the acceleration of skill shifts from automation and AI, we first examined historical skill shifts from 2002 to 2016 in the United States and modeled skill shifts going forward to 2030 (Exhibit 2). (See the technical appendix for details on how we model skill shifts to 2030).

While the demand for technological skills has been growing since 2002, it accelerates in the 2016 to 2030 period. Similarly, the increase in the need for social and emotional skills will also accelerate. By contrast, both basic cognitive skills and physical and manual skills will decline.

Exhibit 2

Automation and AI will accelerate skill shifts.

Based on McKinsey Global Institute workforce skills model
United States, all sectors, 2002–30



1 Calculated using the 2004 to 2016 CAGR extrapolated to a 14-year period.
NOTE: Based on difference between hours worked per skill in 2016 and modeled hours worked in 2030. Numbers may not sum due to rounding.

SOURCE: U.S. Bureau of Labor statistics; McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

Exhibit 3 shows the shift in broad skill categories between 2016 and 2030 including the impact of automation for the United States and 14 Western European countries.[17] There are interesting nuances in the changes of demand for specific skills within each category, which we discuss below.

Our analysis is based on an automation adoption scenario that is in the middle of the range set out in prior MGI research.[18] We also tested what would happen to skill shifts in the event that automation adoption were faster or slower than our midpoint baseline, and found that the broad trends would remain the same, although the rate of decline of demand for physical and manual and basic cognitive skills would be considerably higher if automation were more rapid, whereas the need for social and emotional skills and higher cognitive ones would be larger.

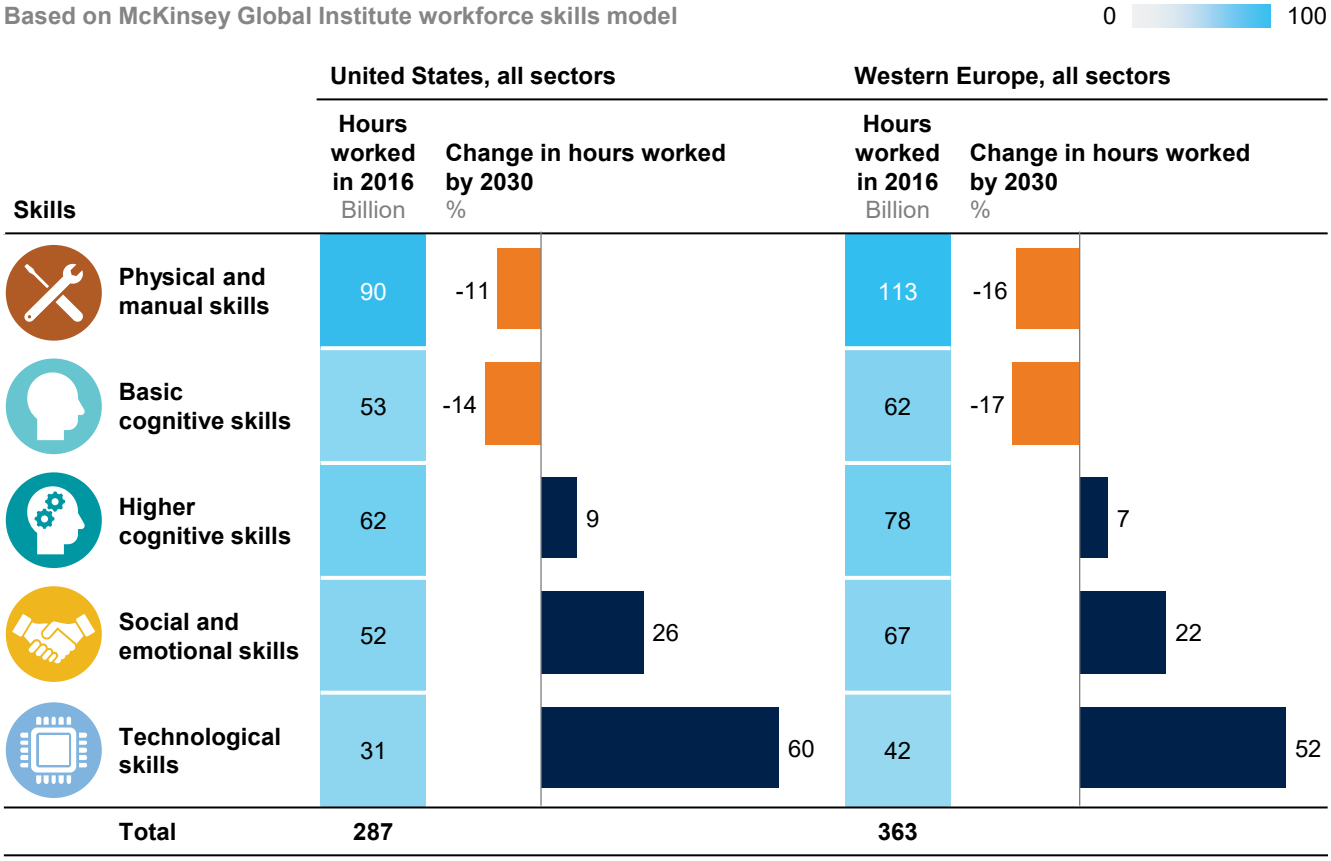
17 Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

18 Ibid. *A future that works: Automation, employment, and productivity*, January 2017.

Exhibit 3

Automation and AI will accelerate the shift in skills that the workforce needs.

Based on McKinsey Global Institute workforce skills model



NOTE: Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

All technological skills, both advanced and basic, will see a very substantial growth in demand

Advanced technologies require people who understand how they work and can innovate, develop, and adapt them—and service them in the workplace. Occupations requiring technological skills include big data scientists, IT professionals and programmers, technology designers, engineers, advanced technology maintenance workers, and scientific researchers. Our research suggests that the time spent on these skills will grow rapidly as companies deploy automation, robotics, AI, advanced analytics, and other new technologies. Overall, we find that time spent on advanced technological skills will increase by 50 percent in the United States and by 41 percent in Europe.

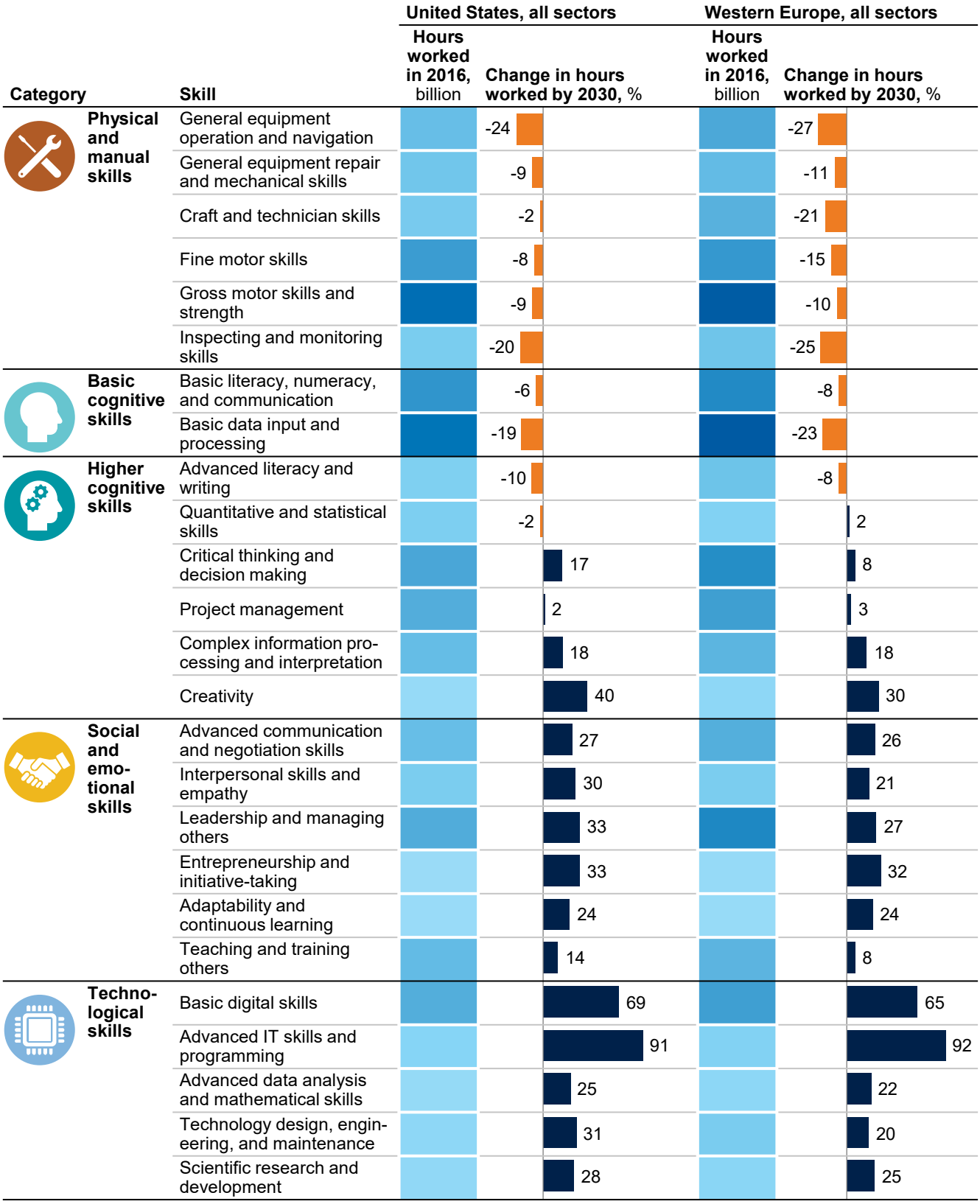
The demand for specific advanced technological skills differs. We expect the fastest rise in the need for advanced IT and programming skills, which could grow as much as 90 percent between 2016 and 2030. As AI and automation become a core part of each sector, companies will need to significantly increase their tech talent, well beyond what they may have had in the past. Demand for other skills that constitute this category, including advanced data analysis and mathematics, technology design, engineering and maintenance, and scientific research and development, will also grow, but not as strongly. (Exhibit 4).

Exhibit 4

Social and emotional skills will grow rapidly, along with technological skills and some advanced cognitive skills, while basic cognitive and manual skills will decline.

Based on McKinsey Global Institute workforce skills model

Low High



NOTE: Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

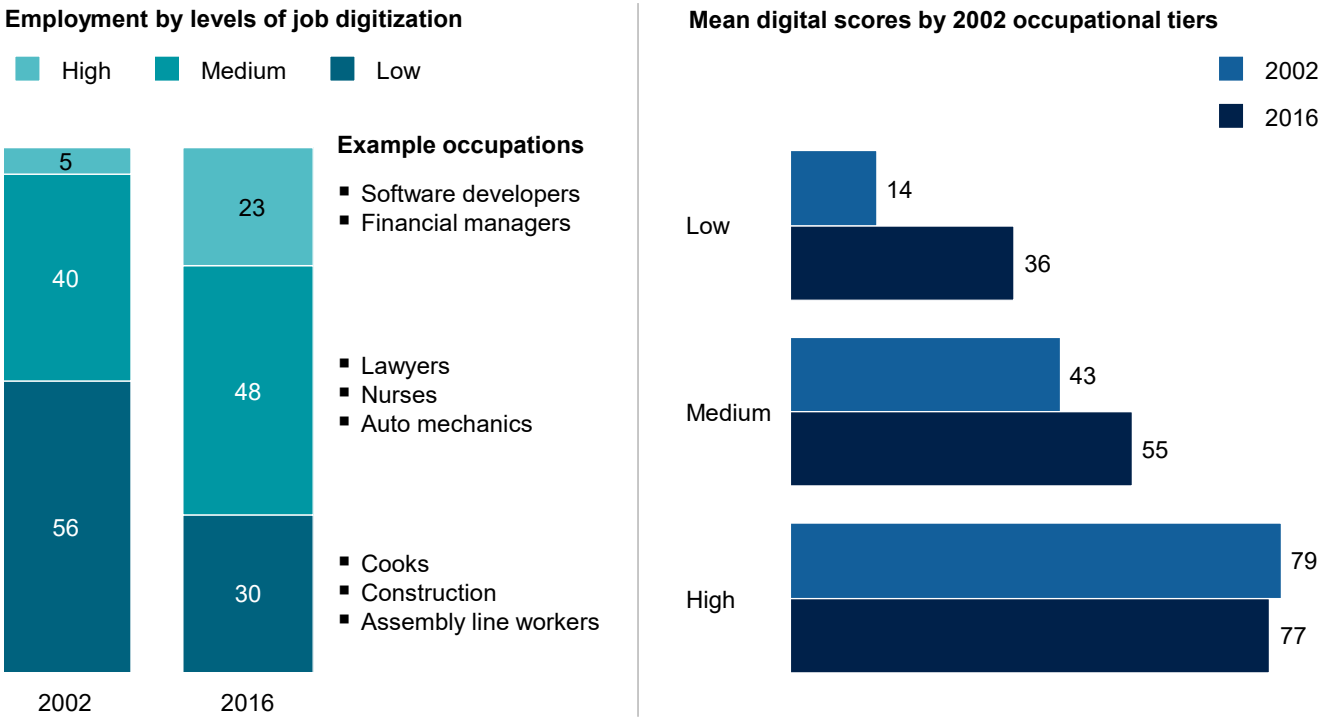
While advanced technological skills are essential for running a highly automated and digitized economy, people with these skills will inevitably be a minority. However, there is also a significant need for everyone to develop basic digital skills for the new age of automation. We find that basic digital skills are the second fastest-growing category among our 25 skills—after advanced IT and programming skills. They increase by 69 percent in the United States and by 65 percent in Europe. Our executive survey indicates that workers in all corporate functions are expected to improve their digital literacy over the next three years, and especially employees in functions including sourcing, procurement, and supply-chain management.

This anticipated increase in demand to 2030 marks the continuation of existing trends. Research by Mark Muro at Brookings identified a substantial increase between 2002 and 2016 in the digital component of occupations such as nurses and construction workers, which traditionally did not require digital skills.[19] Indeed, whereas just over half of occupations had only low digital requirements in 2002, that proportion dropped to 30 percent in 2016, Brookings has estimated (Exhibit 5).

Exhibit 5

The share of jobs requiring few digital skills has fallen, while the digital requirements of most jobs has increased.

2002–16



NOTE: The 2002 and 2016 figures above are based on data provided by Brookings. Numbers may not sum due to rounding.

SOURCE: Mark Muro et al., *Digitalization and the American workforce*, Metropolitan Policy Program at Brookings, November 2017; McKinsey Global Institute analysis

[19] Ibid. Mark Muro et al., *Digitization and the American workforce*, November 2017.

Demand for social and emotional skills will grow rapidly

Accompanying the adoption of advanced technologies into the workplace will be an increase in the need for workers with finely tuned social and emotional skills—skills that machines are a long way from mastering.

Our research finds that workers of the future will spend considerably more time deploying these skills than they do today. In aggregate, between 2016 and 2030, demand for these social and emotional skills will grow across all industries by 26 percent in the United States and by 22 percent in Europe. While some of these social and emotional skills are innate, such as empathy, they can also be honed and, to some extent, taught more easily than technological skills—for example, advanced communication.

Among all the skill shifts our analysis indicated, the rise in demand for entrepreneurship and initiative taking will be the fastest growing, with a 33 percent increase in the United States and a 32 percent rise in Europe. Other social and emotional skills, such as leadership and managing others, also showed strong increases.

This is part of an ongoing trend. Academic research has shown that nonroutine interpersonal and analytical tasks in occupations have been rising over the past 50 years, even as routine manual and cognitive tasks have declined.[20] At the same time, jobs such as caretaker and manager which require astute social skills grew as a share of total employment and wages between 1980 and 2012, even as the employment share of manufacturing and support roles declined.[21]

Demand for cognitive skills will shift from basic to higher ones, although the need for some types of higher cognitive skills will decline with automation

Our research also finds a shift from activities that require only basic cognitive skills to those that use higher cognitive skills (Exhibit 6). Indeed, the decline in work activities that mainly require basic cognitive skills is the largest across our five categories of skills. For cognitive skills, both basic and higher, we also looked at the supply of skills, not just demand for them, to gauge potential mismatches (see Box 3. “An analysis of the supply of cognitive skills suggests a potential growing mismatch”).

Demand for higher cognitive skills such as creativity, critical thinking and decision making, and complex information processing will grow through 2030, at cumulative double-digit rates. We estimate that demand for these skill categories will increase by 19 percent in the United States and by 14 percent in Europe, from sizable bases today. The growing need for creativity is seen in many activities, including developing high-quality marketing strategies. The rise in complex information processing, meanwhile, is related to the need to be aware of market trends and the regulatory environment that affect a company’s operation, or the need to understand and explain to customers the technical details of a company’s products and services.

Other types of higher cognitive skills—such as advanced literacy and writing, and quantitative and statistical skills—will not see a similar increase in demand, and indeed our analysis suggests the need for them could remain stable or even decline to 2030. In writing and editing, computer programs already produce basic news stories about sporting results and stock market movements for many newspaper chains. Of course, the decline in this skill does not imply that there will be no authors, writers, or editors in the future—but as in many other occupations, some of the more basic aspects of the work will shift to machines.

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[20] David H. Autor and Brendan Price, *The changing task composition of the US labor market: An update of Autor, Levy, and Murnane (2003)*, MIT Working Paper, June 2013.

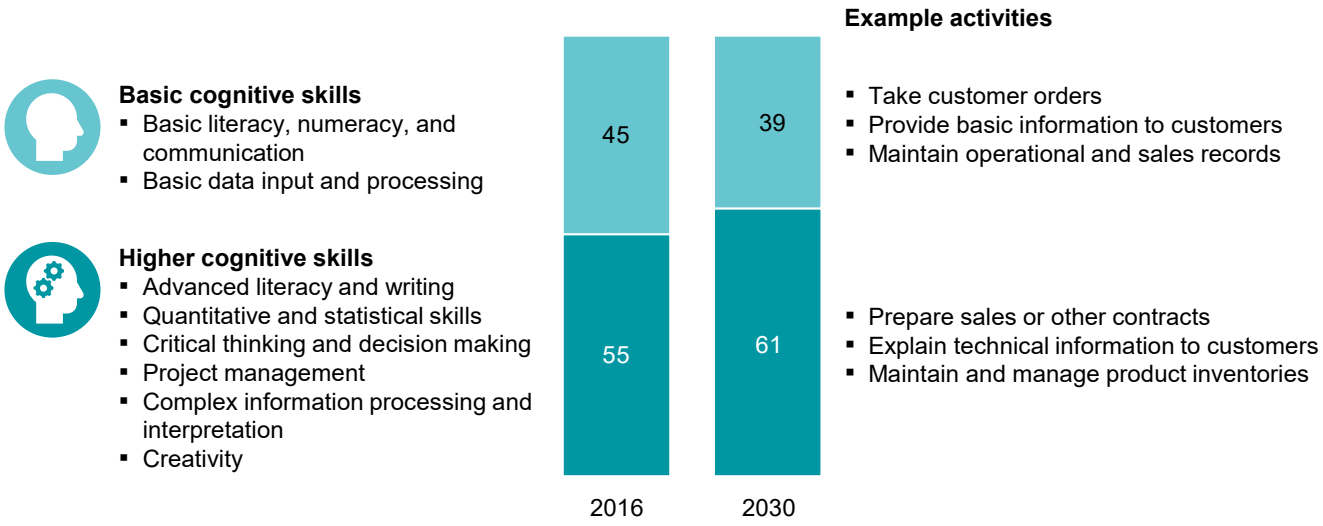
[21] David J. Deming, *The growing importance of social skills in the labor market*, NBER Working Paper Number 21473, August 2015.

Exhibit 6

Higher cognitive skills are increasingly displacing basic cognitive skills across occupations.

Based on McKinsey Global Institute workforce skills model

United States and Western Europe
% of time spent on cognitive skills



NOTE: Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

Box 3. An analysis of the supply of cognitive skills suggests a potential growing mismatch

While our analysis for this paper focuses mainly on demand for skills in the future, we also tried to assess the extent to which there may be a growing mismatch of skills. Cognitive skills lend themselves to this exercise, because of a wealth of data from the OECD's program for the international assessment of adult competencies (PIAAC). This program tests adult literacy and numeracy skills, as well as problem-solving skills in technology-rich environments among 16 to 65-year-olds in 24 countries.[1] We used the result of the second PIAAC survey dated 2014—16 to project supply of these skills in 2030 in a number of countries.

Our analysis finds that supply of problem-solving skills in technology-rich environments in Germany, the United Kingdom, and the United States could grow by between 5 and 10 percent to 2030. These skills match some of the higher cognitive skills in our taxonomy, although there are differences in methodology and categorization. This additional supply corresponds to our calculation of a growth of demand for higher cognitive skills in 2030 of 8 percent in Europe and 9 percent in the United States. This analysis suggests that the current balance (or imbalance) between the supply and demand for cognitive skills may remain stable.

However, looking at basic literacy and numeracy skills in the PIAAC database, which approximates our basic cognitive skills, we see that there could be a growing excess of supply in some countries, since the work tasks that require these skills as the predominant skill will decrease, whereas the supply will remain stable or increase slightly.

[1] *Survey of adult skills (PIAAC)*, OECD, www.oecd.org/skills/piaac/. See also a report on the initial PIAAC study, *Skills of US unemployed, young, and older adults in sharper focus: Results from the program for the international assessments of adult competencies (PIAAC) 2012/2014*, National Center for Education Statistics, March 2016.

The lack of growth in demand for simpler quantitative and statistical skills may reflect the potential for a range of back-office functions to be automated, including in financial reporting, accounting, actuarial sciences, insurance claims processing, credit scoring, loan approval, or tax calculation. Computer algorithms and "robotic process automation" can drastically reduce the time and manpower devoted to these activities. At one bank, for instance, the financial reporting process for producing quarterly financial results was cut from ten days to four, 70 percent of tasks were automated, and costs were reduced by 30 percent. While automation transformed manufacturing in the past 15 years, large swaths of white-collar jobs within corporate headquarters may be affected in the next 15.

Work activities that require only basic cognitive skills will particularly decline as automation advances. Basic data input and processing skills will be especially affected by automation, falling by 19 percent in the United States and by 23 percent in Europe in the 2016 to 2030 period, according to our analysis. The decline will be in virtually all sectors, as machines increasingly take over straightforward data input tasks. Along with general equipment operation and navigation and inspecting and monitoring, this is the largest decline among our 25 skills. The biggest factor in this decline is the expected drop in the need for basic data processing, which is highly susceptible to automation and can be found across sectors.

Unlike data processing, basic literacy, numeracy, and communication will remain useful overall but will likely not suffice in the future without additional skill sets. In the United States, for example, demand for basic literacy declines by 6 percent across the entire economy, but by 27 percent in banking and insurance. However, in retail and healthcare, demand for basic literacy and communication skills will rise by 12 percent and 8 percent, respectively, as personal interaction continues to be important in some occupations. Examples of these types of activities include greeting customers, assisting them, or answering their questions in retail, and referring patients to the right resources or providing information and supporting them in healthcare.

While the need for most physical and manual skills will decline, they will remain the single largest category of workforce skills by 2030

Finally, the demand for physical and manual skills will continue to decline, as it has for 15 to 20 years, in most but not all sectors. Demand for these skills will decline by 11 percent overall in the United States and by 16 percent overall in Europe between 2016 and 2030, according to our analysis. The mix of physical and manual skills required in occupations will change depending on the extent to which work activities can be automated. For example, operating vehicles or stocking and packaging products are more susceptible to automation than assisting patients in a hospital or some types of cleaning. Our findings suggest that general equipment operation and navigation (skills used by manufacturing assembly workers and drivers) and inspecting and monitoring skills will decline faster than other physical and manual skills.

The overall trend of declining demand for physical and manual skills does not hold true for some individual sectors, however. In the US healthcare sector, for example, our analysis finds the need for both gross and fine motor skills will increase by about 30 percent, as an aging population drives demand for nursing, doctor, and physical therapy activities.

Perhaps more surprisingly, physical and manual skills will continue to be the single largest category of skills (measured by time spent) even in 2030, based on our analysis. In all, this category will shrink from 31 percent of workers' time in 2016 to 25 percent in 2030 across the United States and Western Europe. But this is still 20 percent more time than workers will spend using social and emotional skills, and about 50 percent more time than they will spend using technological skills.

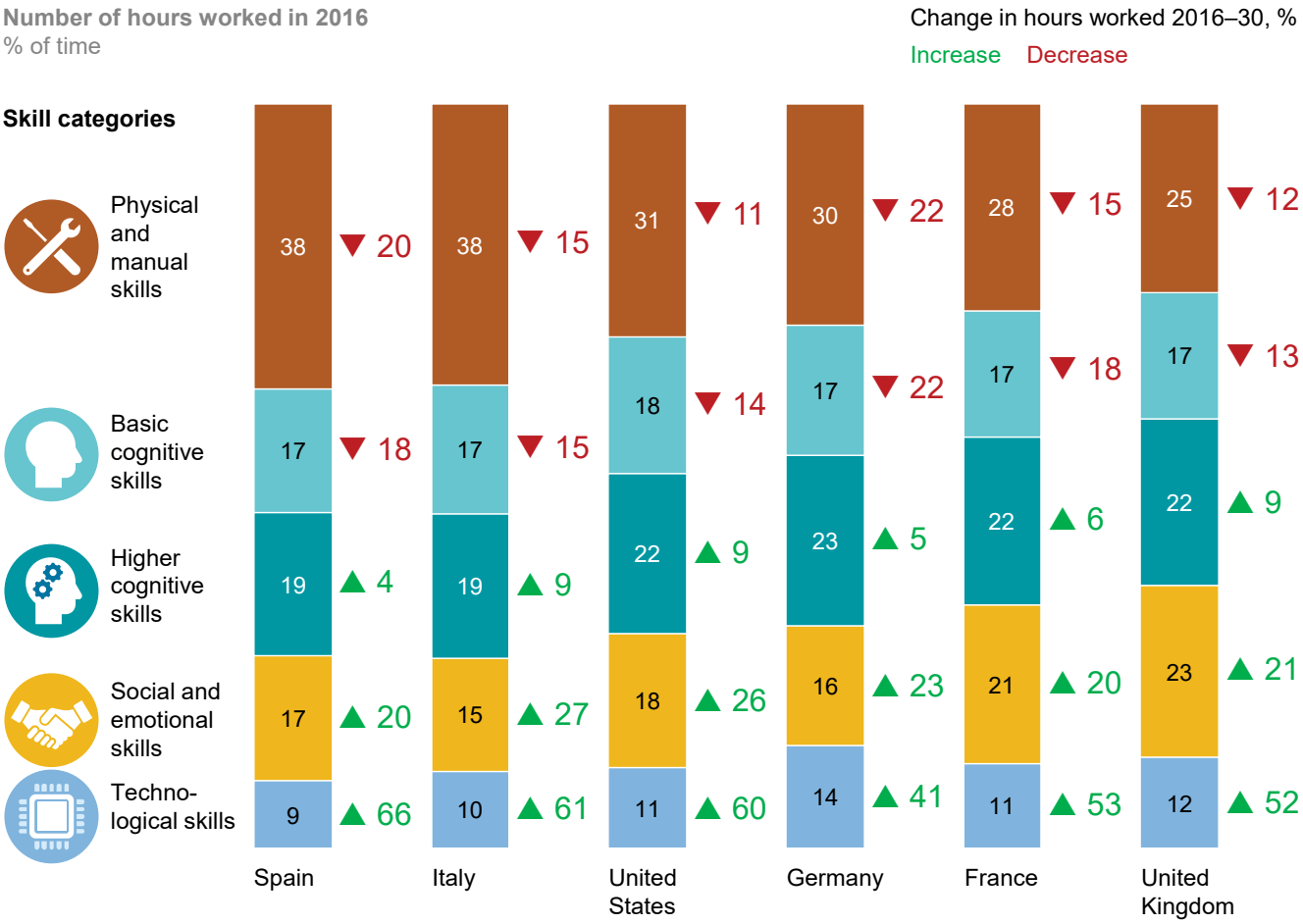
SKILL SHIFTS WILL PLAY OUT DIFFERENTLY ACROSS COUNTRIES, DEPENDING ON ECONOMIC STRUCTURE, SECTOR MIX, AND LEVEL OF DIGITIZATION

We find differences in how skill shifts play out in the countries we focused on for this research. These largely reflect different economic structures and sector mixes, including the degree of digital technology adoption. While we have already discussed cross-geography trends above, in this section we look more closely at individual European countries (Exhibit 7).

Exhibit 7

Skill shifts will play out differently across countries, depending on economic structure, sector mix, and level of digitization.

Based on McKinsey Global Institute workforce skills model



NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

The United Kingdom, for example, has the lowest proportion of physical and manual skills today and the highest share of social and emotional skills, partly reflecting the size of its knowledge-based economy. Financial services, which account for a significant proportion of the UK's GDP, barely use physical and manual skills, for example, while the manufacturing and energy and mining sectors, which require physical and manual skills, are relatively small in the United Kingdom, at just 9 percent of the UK economy compared with 20 percent in Germany and 19 percent in Italy. Moreover, the manufacturing sector in the United Kingdom appears to be more highly automated than in the United States. For example, while US workers spend considerable time operating, packaging, and measuring, their

British counterparts in manufacturing devote more work hours to installing, testing, and controlling—activities that are less susceptible to automation.

The United Kingdom's significant share of social and emotional skills is expected to remain a feature of the economy in 2030, according to our analysis. These skills accounted for more than 21 percent of the working hours across the economy in 2016 compared with 18 percent in the United States, and we estimate that this proportion will rise to 26 percent in 2030 versus 21 percent in the United States. The main difference is related to the number of hours spent on tasks including directing, supervising, managing, and coordinating.

In Spain and Italy, by comparison, physical and manual skills remain the most significant skill sets, and we estimate that this will remain the case in 2030. Indeed, the share of physical and manual skills in these two countries even in 2030 are projected be as high as they are today in the United States and some other countries. One explanation is the continuing importance of manual skills in manufacturing and healthcare. For example, 32 percent of the skills in healthcare in Spain are manual, compared with 27 percent in the United States and 26 percent in the United Kingdom.

In Germany, meanwhile, our analysis suggests that basic digital skills will grow relatively slowly compared with our other focus countries. This is likely to reflect Germany's relatively advanced application of technology in the workplace already today, especially in manufacturing, and the different sector mix. But Germany will see further increases in its share of technology design skills to 2030, according to our analysis, to just over 4 percent in 2030. That proportion is more than double that of the United Kingdom, the second highest, where technology design skills rise to just 2 percent in the same period, and two and a half times the share in the United States, where technology design skills only rise to 1.7 percent in 2030. This relative importance and growth may be explained by the prevalence of industrial-equipment design activities in Germany. The manufacturing sector there focuses heavily on developing new manufacturing technology and equipment, whereas the United States skews relatively more toward using pre-existing technology. There are signs that this gap could be narrowing, however, as technology design skills grow by almost double the rate in the United States (31 percent) as they do in Germany (17 percent).

In three of the countries we looked—France, Germany, and the United Kingdom—the share of physical and manual skills in the economy will decline by 2030 such that this is not the largest skill group. In France and the United Kingdom, it is overtaken by social and emotional skills, while in Germany, it is overtaken as the largest category by higher cognitive skills.

EXECUTIVE SURVEY CONFIRMS GROWING SKILL SHIFTS, WITH LEADING AUTOMATION AND AI ADOPTERS PULLING AHEAD IN ADDRESSING THE SHIFT

The results of the executive survey we conducted reveal that almost all executives foresee a skill mismatch in the future, and the findings are largely consistent with our quantitative analysis.[22] Whereas the quantitative analysis sizes the shifts in skills, the survey highlights corporate expectations. Some findings stand out.

The survey confirms the paramount importance of advanced IT and programming skills. These are viewed as the most important skills needed in the next three years (Exhibit 8). Advanced data analysis and mathematical skills are also seen as very important. Higher cognitive skills and social and emotional skills will also be more in demand, according to company executives.

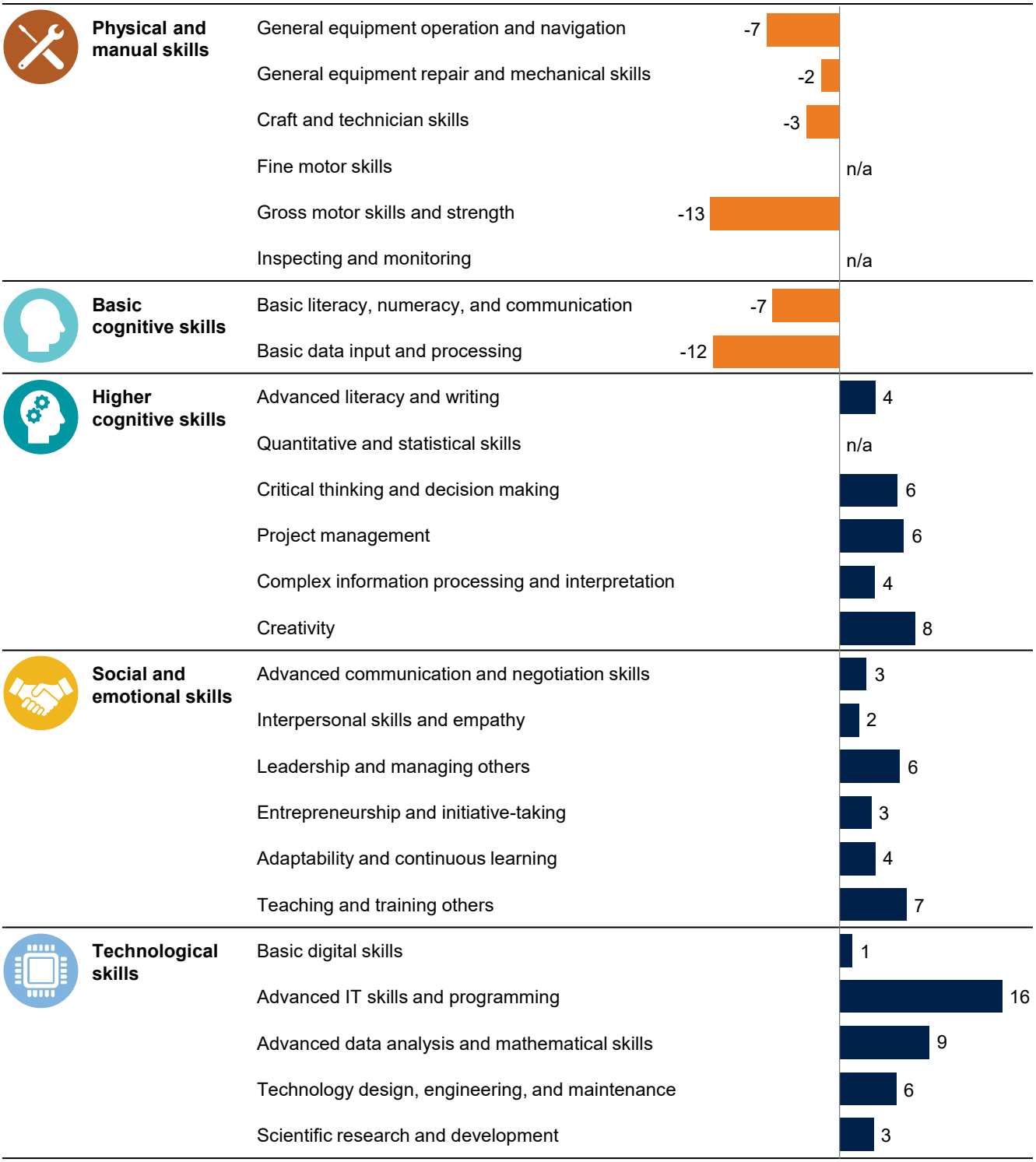
[22] Executives in the survey came from 14 sectors: high tech/IT/technology, manufacturing, construction, retail/trade, media and entertainment, telecommunications, tourism/hospitality/leisure, travel/transport/logistics, financial services/banking/insurance, professional services, education, healthcare, energy/mining/oil and gas/utilities, and government. See technical appendix for details.

Exhibit 8

Survey respondents expect social and emotional, technological, and higher cognitive skills to increase.

Based on McKinsey Global Institute workforce skills executive survey, March 2018

Difference between respondents reporting needing less vs more of a skill in next 3 years
Percentage points



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States. Difference between % of survey respondents expecting to need a skill more and % of survey respondents expecting to need a skill less. Survey did not include fine motor skills, inspecting and monitoring, and quantitative and statistical skills.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

Respondents across industries expect declines in the need for physical and manual skills, and particularly for gross motor skills and strength needed for occupations such as movers, machine feeders, and warehouse packers. They also expect declines in basic cognitive skills, particularly in the need for basic data input and processing skills that are used by data entry clerks, typists, and in a range of back-office functions.

Along with these general observations, which largely hold true across sectors and countries, our survey indicates that larger companies—as measured by the size of their current labor force—expect a more pronounced skill shift than smaller companies. Specifically, they expect a stronger decrease in the demand for physical and manual and basic cognitive skills, and an even stronger increase in the demand for technological skills, than their smaller peers. This may be because they plan to adopt automation and AI technologies at greater rates than midsize and smaller companies, reflecting their ability to finance the large investments needed. Prior MGI research has found that small and medium-size businesses overall have been slower to adopt digital technologies.[23]

Our survey also confirms that workers in all corporate functions will need to improve their digital literacy, moving from the ability to use basic digital tools to more advanced digital skills. In particular, employees in the corporate functions of sourcing, procurement, and supply-chain management will need to use more advanced digital technologies over the next three years.

Functions that are the most automated today experience the largest skill mismatches

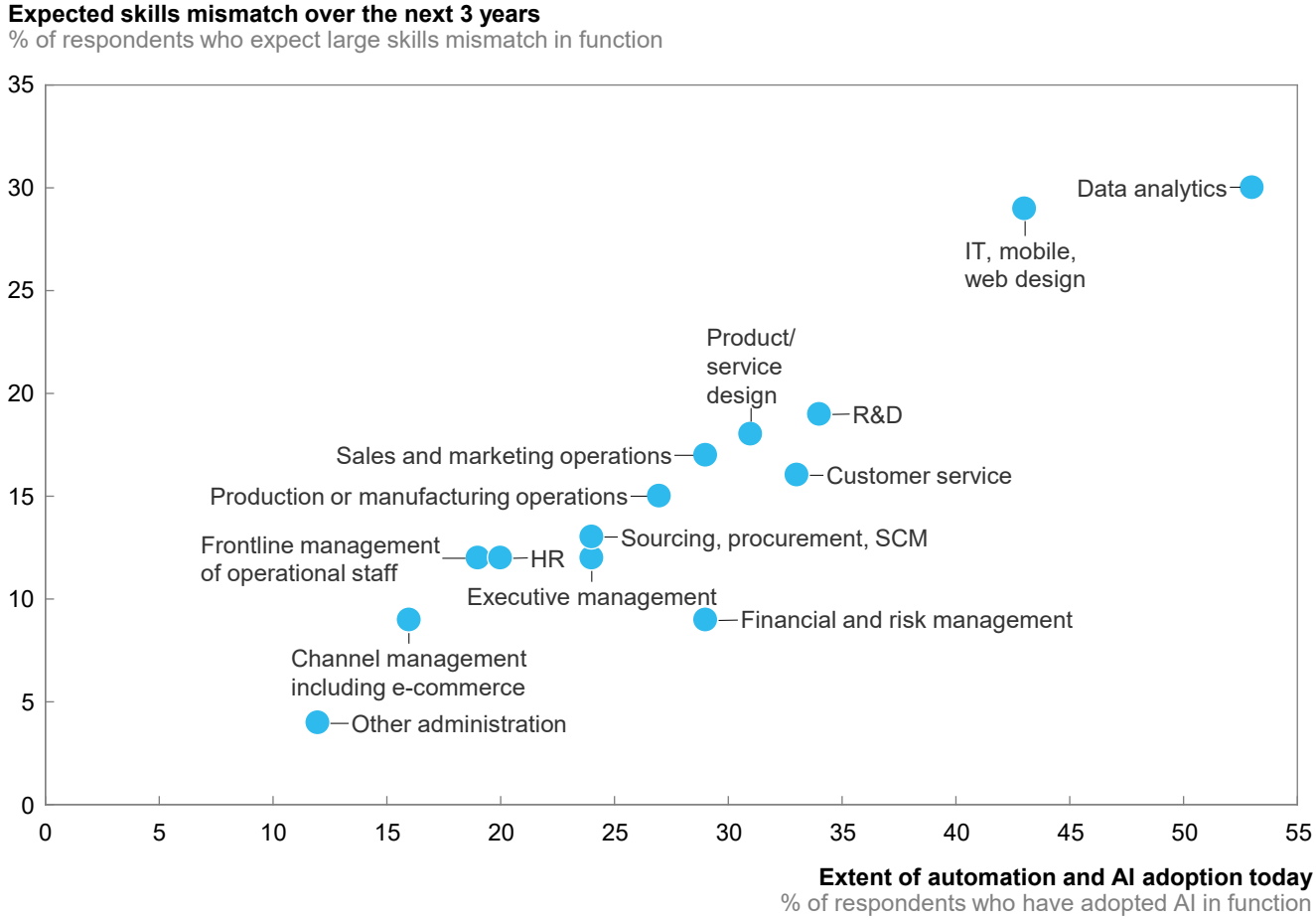
Our survey shows that functions that are already the most automated are experiencing the largest skill mismatches. These functions include data analytics, IT/mobile/web design, and research and development (Exhibit 9). This finding holds true across almost all sectors, with the notable exception of manufacturing, where skill mismatches are expected to be largest in production and manufacturing operations.

[23] See *Digital America: A tale of the haves and have-mores*, McKinsey Global Institute, December 2015.

Exhibit 9

Executives expect skills mismatches to occur in functions that have already started adopting automation and AI technologies.

Based on McKinsey Global Institute workforce skills executive survey, March 2018



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States. Chart based on survey questions "When you think about how automation and AI will change your workforce skill needs, in which functions do you think skills mismatches will be largest over the next 3 years? (Select up to 3)" and "Which of your organization's functions have adopted automation and AI technologies to date? (Select all that apply)."

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

Skills of today and skills of tomorrow: Today's experience and perceptions of future needs

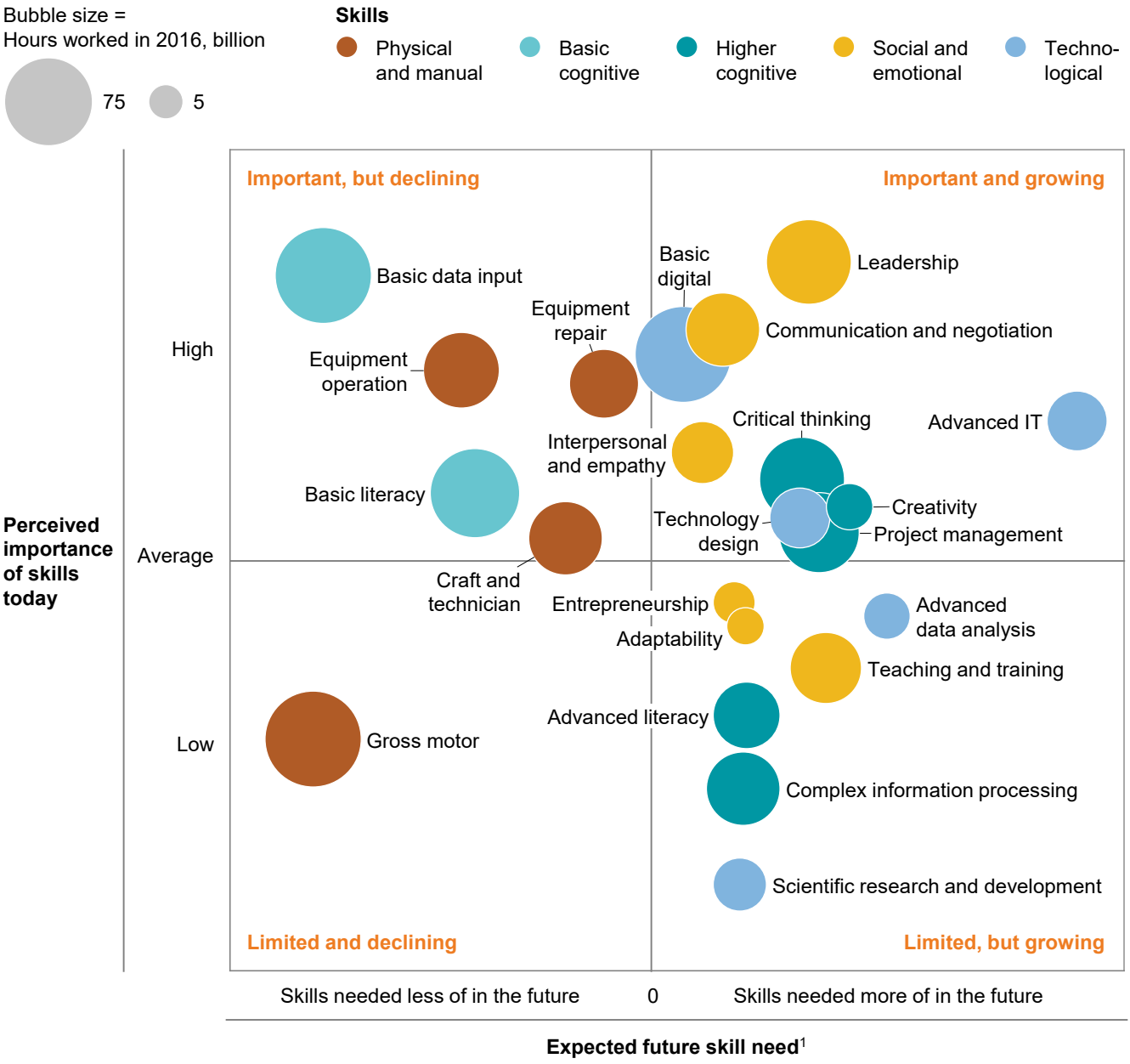
Contrasting the importance of skills needed today with those required in the future reveals an interesting pattern. Based on our survey responses, Exhibit 10 shows individual skills based on their perceived importance today and whether employers expect to need more or less of those skills in the future. Overall, employers expect to need more of the social and emotional, higher cognitive, and technology skills in the future, and less of the basic cognitive and physical and manual skills.

Four specific groups of skills stand out. Those in the upper-right quadrant are perceived as very important today and needed even more in the future. They include leadership, advanced communication, advanced IT and programming, and critical-thinking skills. In the lower-right quadrant are skills that are ranked as less important today but growing strongly in the future: advanced data analysis, complex information processing, adaptability—as well as teaching and training.

Exhibit 10

Skills of today vs skills of tomorrow: technological, social and emotional skills will become even more important.

Based on McKinsey Global Institute workforce skills executive survey, March 2018



1 Difference between % of survey respondents that expect to need a skill more and % of survey respondents that expect to need it less.
NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, the United Kingdom, and the United States. Chart based on % of survey respondents. Skills descriptions were shortened. Chart does not include fine motor skills, inspecting and monitoring, and quantitative and statistical skills. Bubble sizes are based on number of hours worked.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

On the left side of the chart are skills that employers expect to need less in the future. In the upper-left quadrant, physical and manual and basic cognitive skills that are key today will experience a stark decline in coming years. These skills include basic data input and processing; basic literacy, numeracy and communication; and general equipment operation and navigation. Similarly, gross motor skills are perceived as less important today and will decline in the future. It is interesting to note, however, that while gross motor skills were identified as being less important today, they are one of the largest skill categories in both the United States and Europe, accounting for more than 10 percent of hours worked.

2. SHIFTING SKILL REQUIREMENTS IN FIVE SECTORS

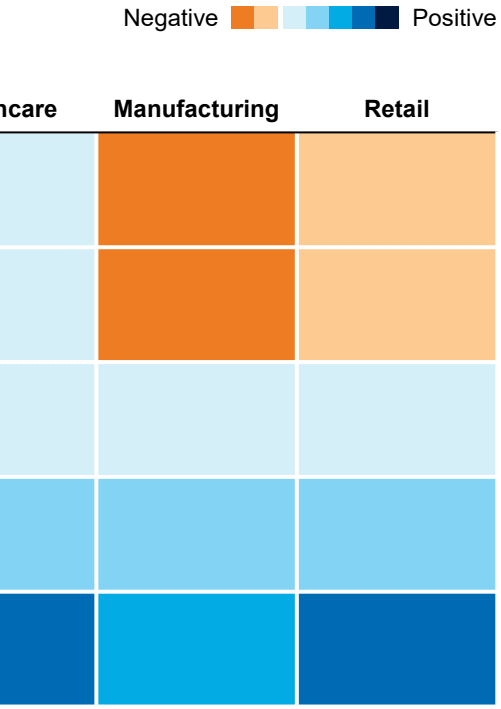
Our analysis of skill shifts in five sectors highlights many similarities in changing patterns of skills' requirements, but also some considerable variation (Exhibit 11). For example, while social and emotional skills will be in growing demand across all five sectors, the need for basic cognitive skills will decline in banking and manufacturing but stay flat in healthcare and only fall back slightly in retail. Exhibit 12 shows the key skills categories in each sector.[24] (A more detailed set of infographics at the end of this chapter highlights the anticipated skill shifts for each sector).

In general, while the range of required skills varies from sector to sector, workers in all sectors will need to become more adaptable in the future, as automation and AI adoption transform the workplace. Just as emotional intelligence was recognized in the 1990s as an increasingly important determining factor for individual success, alongside more general intelligence, adaptability may become a significant differentiator for workers in a future with automation.[25]

Exhibit 11

Skill shifts will vary across sectors as automation and AI are adopted.

Based on McKinsey Global Institute workforce skills model



NOTE: Based on difference between hours worked per skill in 2016 and modeled hours worked in 2030. Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

[24] The data for skill shifts in these sectors are based on MGI's mid-point automation adoption scenario. The variation in skill distribution will be larger or smaller if AI diffusion is faster or slower. AI diffusion may take place at different speeds, depending on country.

[25] Daniel Goleman, *Emotional intelligence*, New York, 1996.

Exhibit 12

Skills categories show mixed sector shift going forward.

Based on McKinsey Global Institute workforce skills model
United States and Western Europe, 2016–30

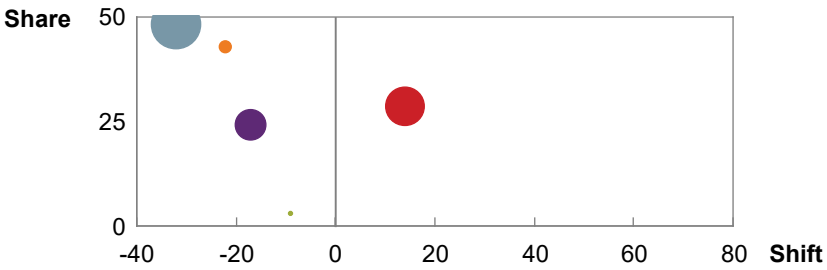
Banking and insurance
Energy and mining
Healthcare
Manufacturing
Retail

Share of sector hours worked (% of 2016)

Bubble size =
Hours worked in 2016, billion
35
1

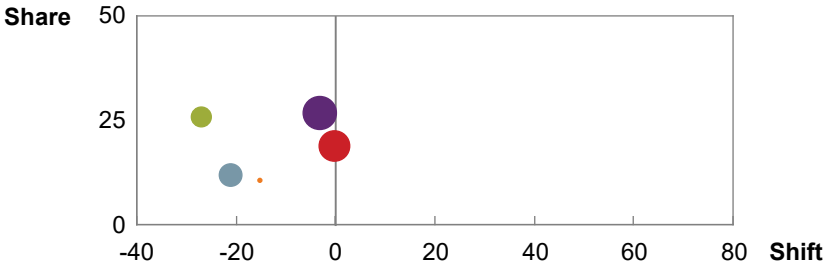
Shift, 2016–30 (Net variation, %)

Physical and manual skills



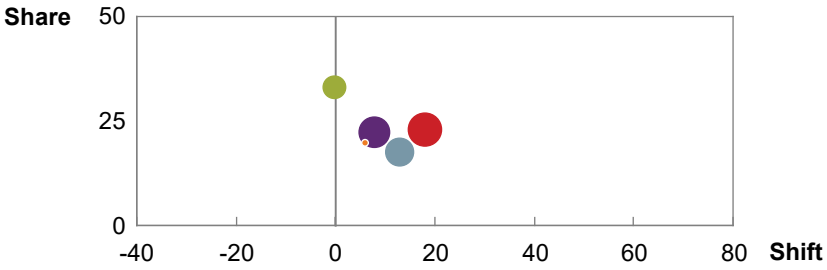
Machinery operation skills decline in manufacturing but fine motor skills grow in healthcare

Basic cognitive skills



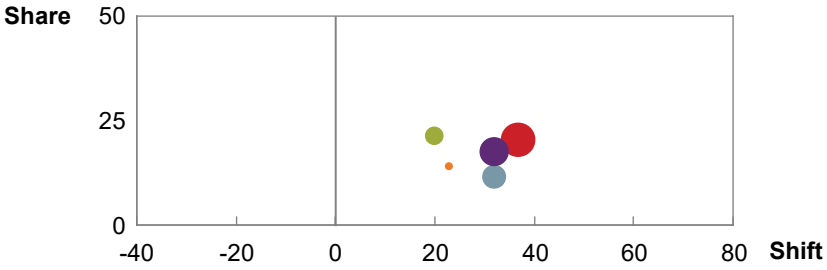
Basic literacy/ communication skills grow in retail and healthcare, while data processing skills is heavily displaced in other industries

Higher cognitive skills



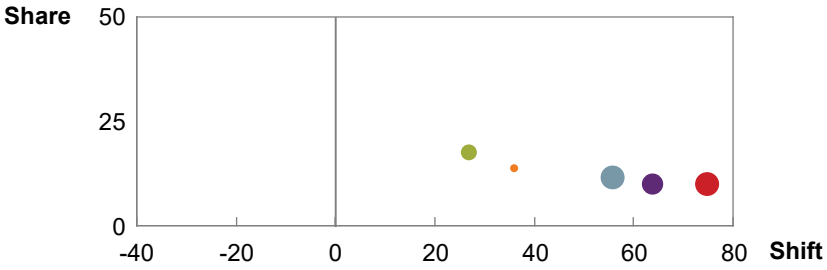
Complex data processing and interpretation skills grow in retail, banking and energy, and critical thinking/decision making in healthcare and manufacturing

Social and emotional skills



Interpersonal skills grow strongly in healthcare while advanced communication and leadership skills drive other sectors growth

Technological skills



Basic digital skills catch up in healthcare and retail, while banking sees growth in data analytics and manufacturing in tech design skills

NOTE: Western Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: McKinsey Global Institute workforce skills model; McKinsey Global Institute analysis

Banking and insurance

Financial services have been at the forefront of digital adoption, and banking and insurance is likely to be one of the sectors with the most pervasive workforce transition in the years ahead, with significant implications for skill shifts.[26] Machine learning and new capabilities in deep learning—which include artificial neural networks, among the most advanced AI techniques—will allow for more intelligent predictions concerning assessing and managing risk for loan underwriting and fraud detection.[27] The potential AI use is also significant in marketing and sales, where evolving technologies enable personalized targeting of products for customers. Functions including those undertaken by paralegals, insurance underwriters, and sales agents, could be increasingly automated.

The next wave of smart automation will have a sizable impact on the industry: 38 percent of employment is currently in back-office jobs that are more susceptible to automation and which will see a decrease in total hours worked by 2030 of as much as 20 percent. Our analysis indicates that jobs such as tellers, accountants, and brokerage clerks will decline substantially as automation is adopted. As a result, the need for a workforce using only basic cognitive skills, such as data input and processing and basic literacy and numeracy, will likely decline sharply in this sector. The number of technology and other professionals will grow, and we also see growth in customer interaction occupations, including managers. This will drive strong growth in demand for social and emotional skills. All financial institutions will also continue to hire technologists and AI experts who will develop and manage their applications, hence lifting demand for technological skills, although not as strongly as for other sectors, as banking is already one of the most digitized sectors.

Energy and mining

Digital technologies and automation have already begun to change the basic materials and energy industries (including mining, oil and gas, and utilities), enabling companies to tap into new reserves and increase extraction efficiency. Fully integrated digital platforms can optimize material and equipment flow and anticipate equipment failures, as well as enable real-time operations management.[28] AI applications could have a significant impact in extraction and production, including through analytics-driven lean programs, in operations focusing on predictive maintenance, and in support functions, where smart capital spending programs could reduce financing costs, for example.

As automation is increasingly deployed in the industry, as much as 30 percent of predictable manual work will be displaced, including activities carried out by power plant and welding machine operators, along with administrative jobs that involve data manipulation, such as meter readers. Conversely, our analysis shows strong growth in technological jobs along the tech value chain and including software developers and computer systems analysts. As a result, physical and manual skills along with basic cognitive skills are expected to decrease, while demand for all other skills in higher cognitive, social and emotional, and technological categories should grow.

Healthcare

The healthcare sector is expected to grow significantly as populations age. At current trends in expenditures, total spending on healthcare could reach 20 percent or more of GDP in Western European countries and up to 24 percent in the United States by 2030. Digital will play a big part of this growth through connectivity, enabling patient co-management, real-time analytics, and automation that will improve patient experience, clinical outcomes, and provider efficiency. Healthcare employment growth in the United States and Europe has been driven by demographic change, as populations in these countries age, and could

[26] *Remaking the bank for an ecosystem world*, McKinsey Banking Annual Review 2017.
[27] *Notes from the AI frontier: Insights from hundreds of use cases*, McKinsey Global Institute, April 2018.
[28] *Beyond the supercycle: How technology is reshaping resources*, McKinsey Global Institute, February 2017.

continue increasing. However, growth could be constrained by the availability of suitable talent. Care providers such as nursing assistants, registered nurses, and home health aides have become fast-growing occupations (although shortages of nurses and other caring professionals may constrain their growth going forward).

AI and automation will change the interaction between patients and healthcare professionals, as AI technologies complement care providers as part of their daily routine.[29] In terms of jobs, care providers such as nurses will continue to see growth, while office support staff will see decreases due to automation of tasks in record keeping and administration. Overall total employment is expected to grow. Advanced IT skills, basic digital skills, entrepreneurship, and adaptability will see the largest double-digit cumulative growth. However, demand for skills such as inspecting and monitoring patient vitals and medical equipment will stagnate, despite the overall growth in healthcare, as machines take over more routine tasks.

Perhaps more surprisingly, healthcare is the only sector in our analysis in which the need for physical and manual skills will grow in the years to 2030. This reflects the gross motor skills and strength needed for occupations such as eldercare and physical therapy, and the fine motor skills required of registered nurses inserting IVs and other medical devices, and of surgeons and other doctors. Nonetheless, the share of physical and manual skills and basic cognitive skills in the workforce will still decrease compared to other skills.

Manufacturing

AI and automation should drive considerable value along the manufacturing value chain to 2030, including with predictive maintenance and automated supply chain, real-time production, and smart robotics and autonomous machines. Employment in the sector has been falling in the United States and Europe, although in the United States, it started rising again in the past five years, even as productivity has been growing about 2.5 percent per year there and in Europe.

Industry 4.0 will disrupt production functions in factories through better analytics and increased human-machine collaboration. It will also have an impact on product development and on marketing and sales.

Jobs will be significantly affected by automation adoption, especially in predictable manual occupations such as assembly workers, which represent 46 percent of employment in the sector today. Occupations such as machine feeders or packaging machine operators could decrease by close to 50 percent, according to our analysis. The need for physical and manual skills overall in the sector is decreasing at more than twice the rate for the whole economy. Similarly, the need for basic cognitive skills decreases as office support functions are automated.

At the same time, professional occupations such as sales representatives, engineers, managers, and executives are expected to grow. This will lead to growth in the need for social and emotional skills, especially advanced communication and negotiation, leadership and management, and adaptability. The need for technological skills will increase, both for advanced IT skills and basic digital skills, as more technology professionals are required but also more technology-enabled jobs such as engineers are created. Finally, the need for higher cognitive skills will grow, driven by the need for greater creativity and complex information processing.

[29] *Artificial intelligence: The next digital frontier?* McKinsey Global Institute, June 2017.

Retail

Digital technologies will drive significant skill shifts in the retail sector in the years to 2030. E-commerce and online channels are now standard for all major retailers, and this has prompted a shift in employment within the industry. Customer interaction, managers and executives, and professional occupations have grown rapidly within retail, while office support and predictable manual skills, used in activities such as stocking, have been flat or declining.

AI and smart automation will continue to reshape the revenue and margins of retailers.[30] In the United States, self-checkout machines will replace cashiers, robots will restock shelves, machine learning will improve prediction of customer demand, and sensors will help inventory management—and transform how stores operate. The transformation could be dramatic.

Our analysis shows that the share of predictable manual jobs, such as drivers, packers, and shelf stockers, will decline substantially, by more than 25 percent. Jobs that remain will be concentrated in customer service, management, and technology deployment and maintenance. Demand for all physical and manual skills and for basic data input and processing will decline by cumulative double-digit percentages, while growth will be very strong in skills required to help customers find goods and make sales: creativity and interpersonal skills and empathy will grow by close to 50 percent. Advanced IT skills and programming alongside complex information processing skills will also see a surge in demand, as retailers harness the potential of data analytics and AI. Many large retail chains will find they need more flexible workers, who can alternatively help customers, answer queries, and take on supervisory roles. They will need fewer workers with only basic cognitive skills, including cashiers collecting payments. Even after factoring in rising incomes and population growth to 2030, total employment in the industry may decline in Europe and grow only slightly in the United States as new technologies raise productivity.

Some of this will be offset by growth in e-commerce fulfillment centers.[31] E-commerce is projected to grow by 12.3 percent annually in the United States and by 8.5 percent annually in Western Europe over the next five years to 2022, reaching $700 billion in sales in the United States and $400 billion in Western Europe.[32] But the shift to e-commerce will translate into changing demand for a range of skills, including less need for basic communication skills, as workers in fulfillment centers do not directly interact with customers.

•••

Skills are shifting. As occupations are transformed by the rise of automation and AI technologies, the requirements for workers will also change markedly. Some basic physical and cognitive skills will no longer suffice to ensure that people find work, as machines take over activities from assembly-line processing to routine data entry. At the same time, advanced skills—both technological and more broadly higher cognitive—will see a growth in demand. Social and emotional skills will be at a premium, as some caring professions in healthcare and other occupations requiring human interaction continue to employ people, and as creativity, problem solving, and people leadership grow in importance. The implications of these changes are highly significant for companies and for the workers they employ. In the next chapter, we explore how the changes could play out in the workplace.

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30 Ibid. *Notes from the AI frontier*, April 2018.

31 Michael Mandel, *A historical perspective on tech job growth*, Progressive Policy Institute, January 2017.

32 Euromonitor International database.

SKILL SHIFTS BY INDUSTRY

Industry deep-dives, United States and Western Europe, 2016–30

Banking and insurance

Introduction

Financial services have been at the forefront of digital adoption, and are leading in the adoption of AI and robotic process automation as well. Data processing and collection, underwriting, and actuarial activities are all highly susceptible to automation, and AI can also improve quality in areas such as risk assessment, predicting customer demand and next product to buy, and personalizing products.

Banking and insurance will face one of the most pervasive workforce transitions in the years to come. Jobs such as tellers, financial analysts, and brokerage clerks will decline substantially, while the number of technology professionals and customer-interfacing roles will grow. The need for workers who use mainly basic cognitive skills, such as data input and processing and basic literacy and numeracy, will likely decline, while the need for workers with advanced technology skills, and those with social and emotional skills, will grow.

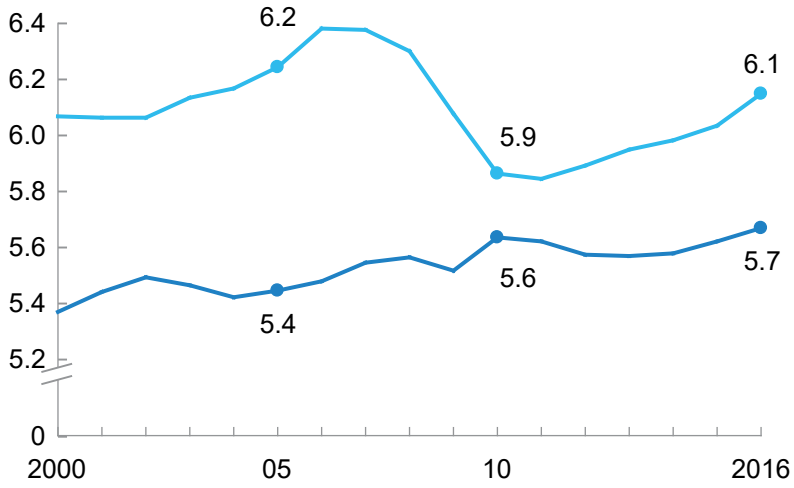
Sector trends at a glance

Industry snapshot

United States[1] Western Europe[2]

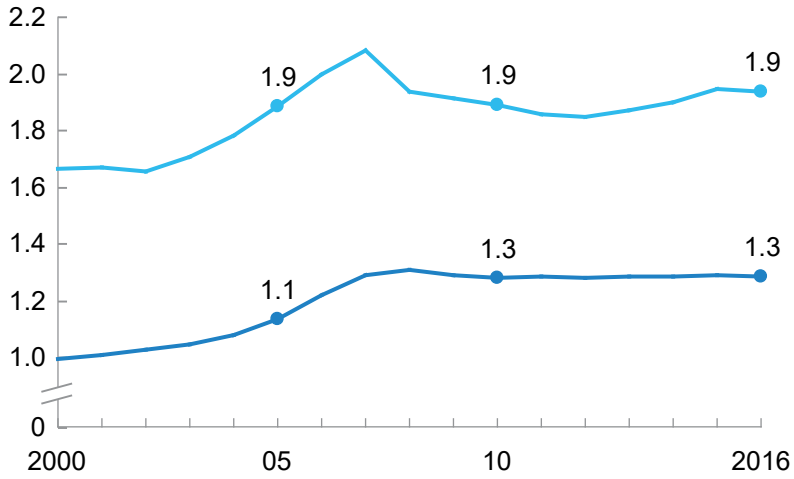
Employment

Million FTEs



Revenue

$ trillion, 2016 exchange rate



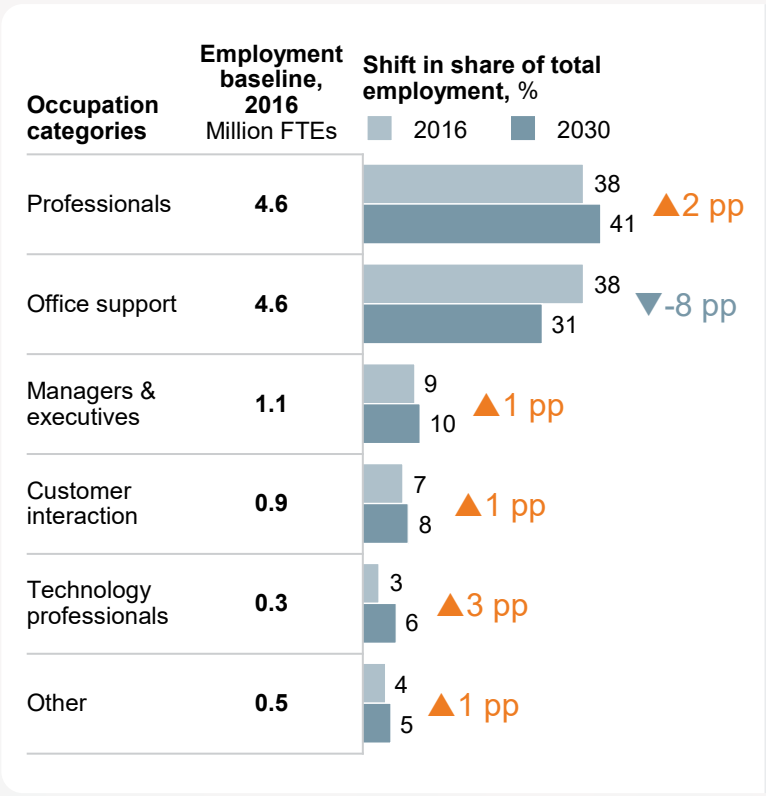
Labor productivity

	Loans per FTE, 2016 $ million	CAGR, 2000–16 %
United States	3.6	3.9
Western Europe	4.4	4.6

1 Employment in the United States for the years 2000 and 2001 was calculated based on the 2004–16 CAGR.
2 Western Europe comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: IHS (revenues); BLS (US employment); OECD (EU employment); McKinsey Global Institute analysis

Sector job shift by 2030



Top occupations growing and declining

Top growing

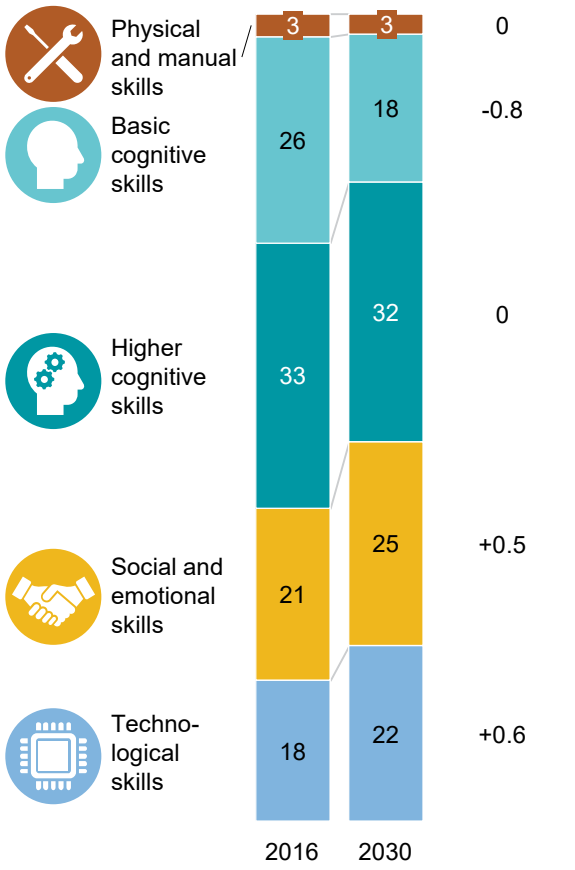
- Software developers (app, web, computer)
- Customer service representatives
- Computer systems analysts
- General and operations managers
- Financial analysts
- Computer and information systems managers
- Human resources managers
- Loan officers
- Business operations specialists
- Personal finance advisors

Top declining

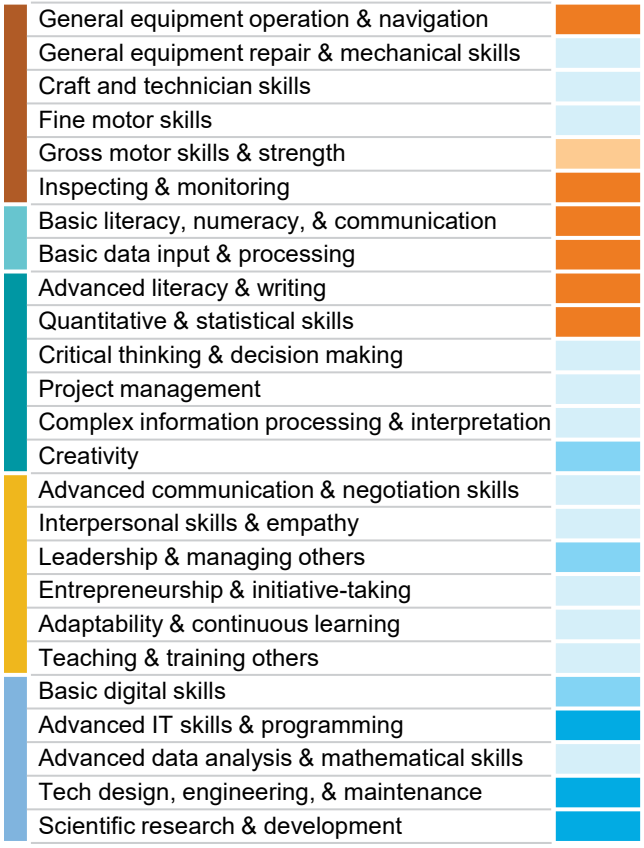
- Bill and account collectors
- Word processors and typists
- Data entry keyers
- Computer network support specialists
- Secretaries and administrative assistants
- Insurance sales agents
- Tellers
- Office clerks (billing, accounting, reception, etc)
- Computer user support specialists

Sector skill shifts by 2030

Evolution in skill categories



Evolution in 25 skills



NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

Industry deep-dives, United States and Western Europe, 2016–30

Energy and mining

Introduction

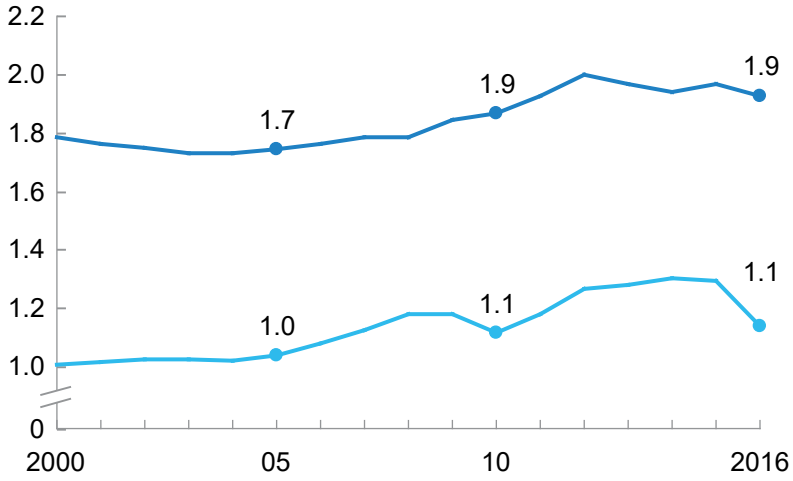
Automation and digital technologies have already begun to change the mining and energy industries, enabling companies to tap new reserves, increase extraction efficiency, and optimize material and equipment flow. The next wave of AI and smart automation will enable further improvements, enabling more accurate demand forecasts, predictive maintenance, and fully automated extraction operations.

Predictable manual work, such as drivers and field operators, is susceptible to being displaced, as are administrative jobs and those that involve data manipulation, such as meter readers, while demand for technological jobs will be buoyant. As a result, demand for physical and manual skills along with basic cognitive skills are expected to decrease, while demand for all other skills in higher cognitive, social and emotional, and technological categories are expected to grow.

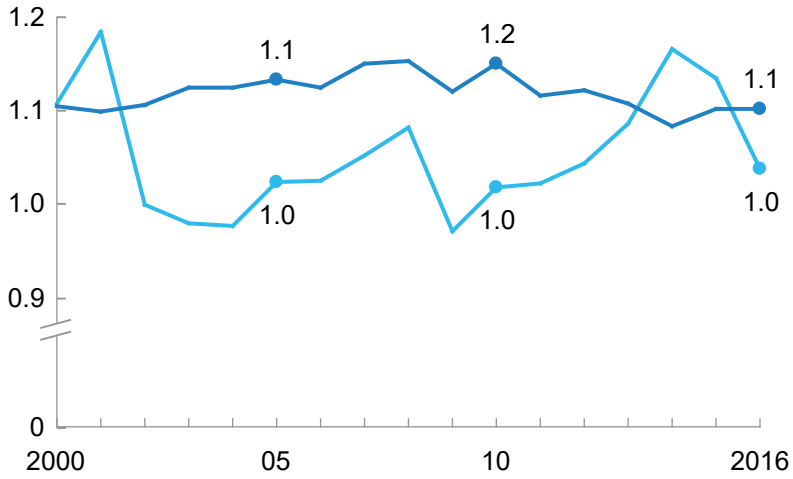
Sector trends at a glance

Industry snapshot

Employment
Million FTEs



Revenue
$ trillion, 2016 exchange rate



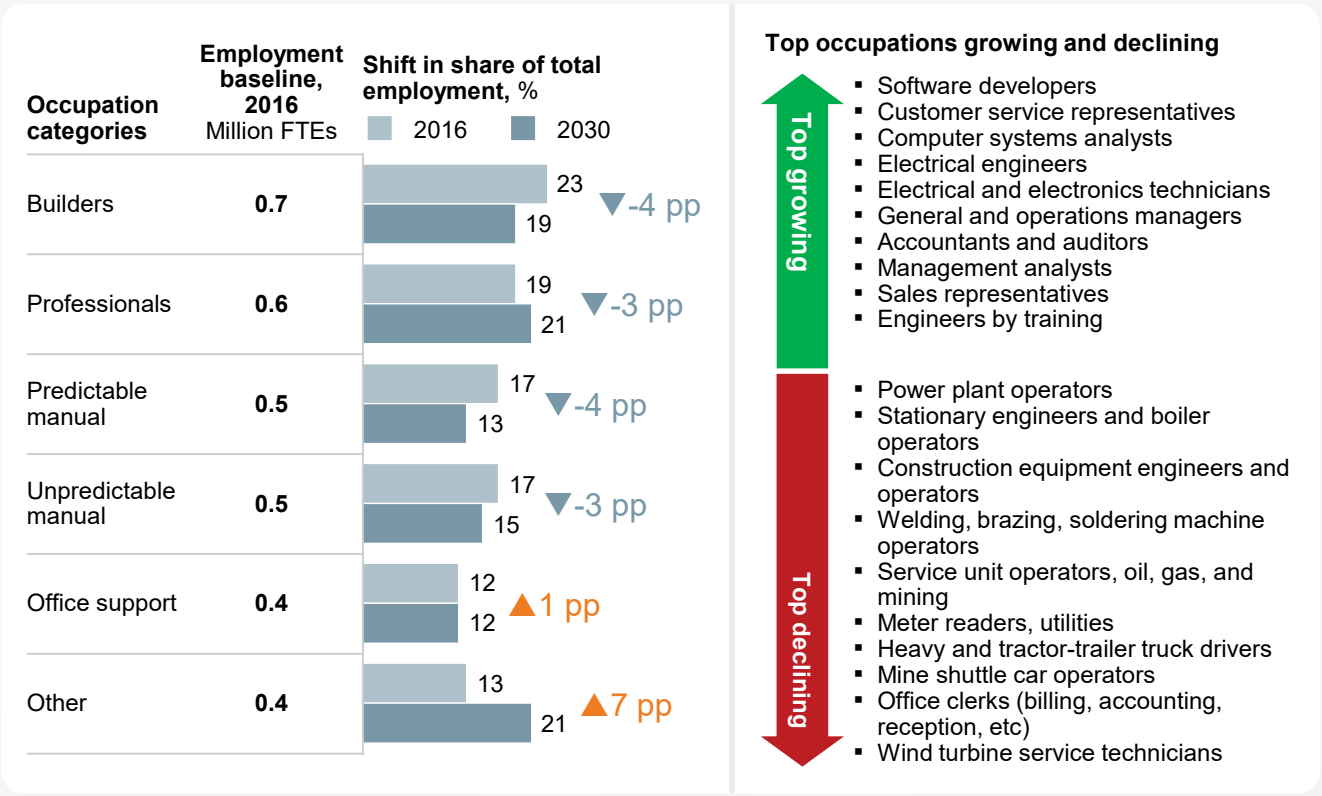
Labor productivity

	Revenue per FTE, 2016 $ million	CAGR, 2000–16 %
United States	0.9	-1.2
Western Europe	0.6	-0.5

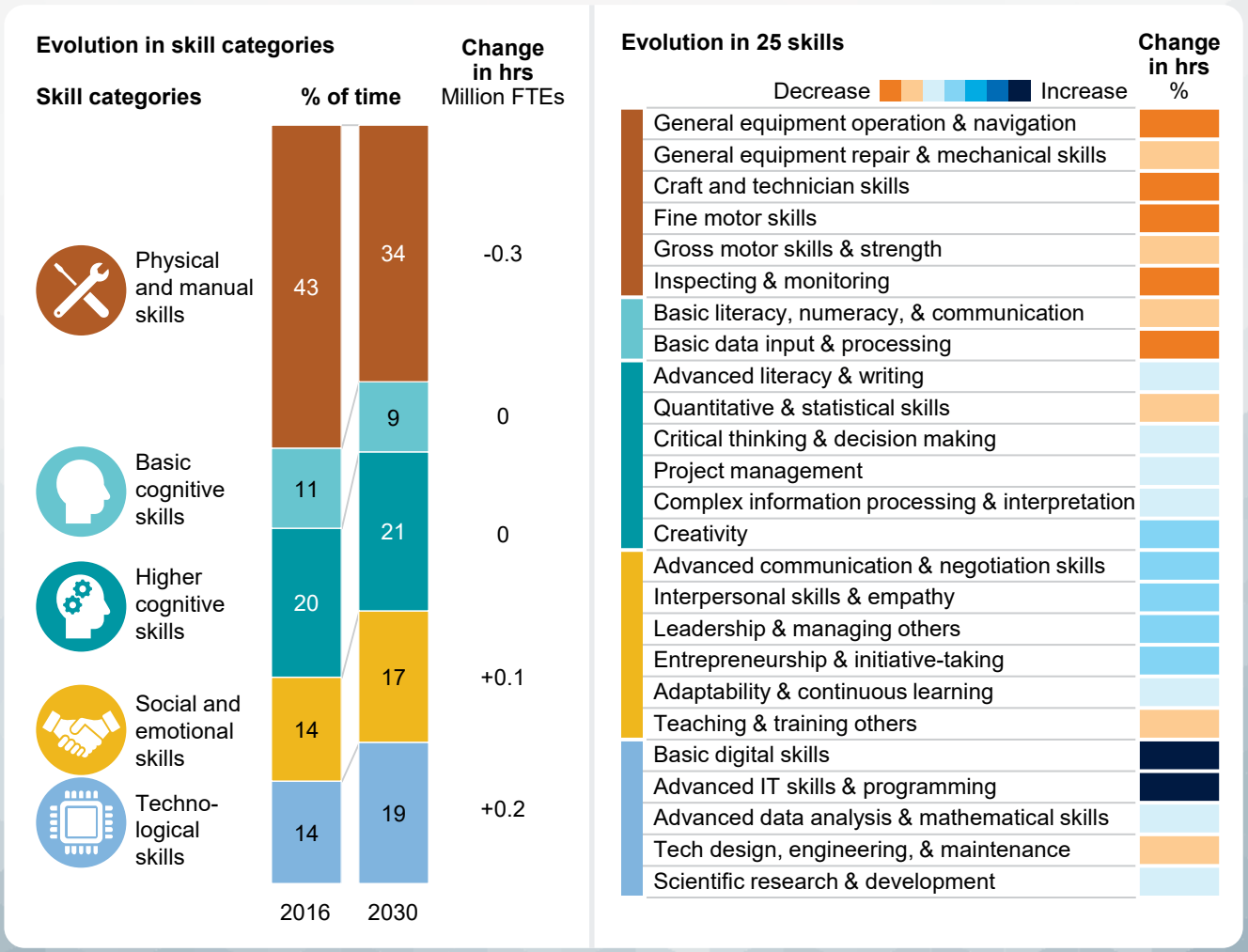
1 Employment in the United States for the years 2000 and 2001 was calculated based on the 2004–16 CAGR.
2 Western Europe comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: IHS (revenues); BLS (US employment); OECD (EU employment); McKinsey Global Institute analysis

Sector job shift by 2030



Sector skill shifts by 2030



NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

Industry deep-dives, United States and Western Europe, 2016–30

Healthcare

Introduction

Demand for healthcare is expected to grow significantly as populations age, although cost pressures and potential shortages of care workers may constrain growth. Automation and AI will enable large gains in both efficiency and quality, enabling patient co-management, real-time analytics, and improved treatment methods.

Care providers such as nurses will continue to see growing demand, while office support staff will see decreases due to automation of tasks in record keeping and administration. Advanced IT skills, basic digital skills, entrepreneurship, and creativity will see the largest double-digit growth in demand. However, demand for skills such as inspecting and monitoring patient vitals and medical equipment will stagnate. Healthcare is one of the few sectors that will see growing need for physical and manual skills, reflecting gross motor skills and strength needed for eldercare and physical therapy, and fine motor skills required of registered nurses inserting IVs, and of surgeons and other doctors.

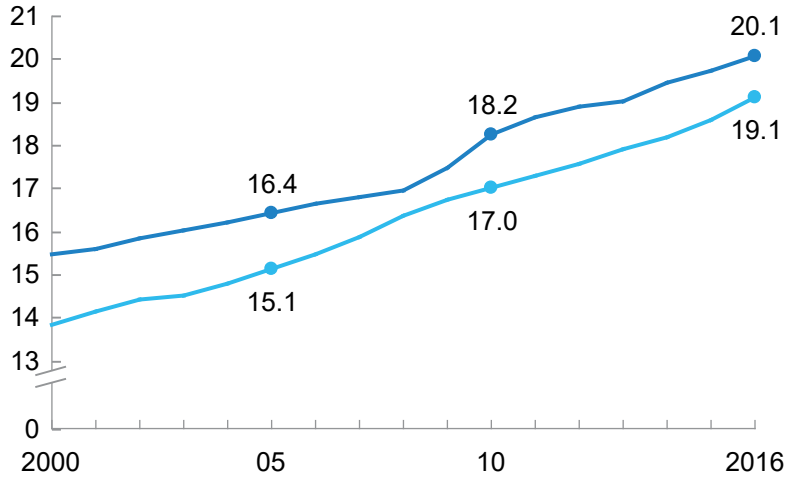
Sector trends at a glance

Industry snapshot

United States[1] Western Europe[2]

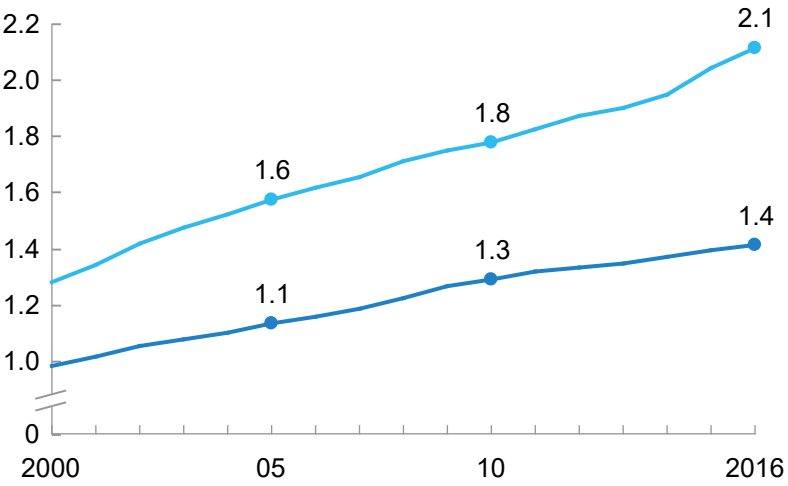
Employment

Million FTEs



Revenue

$ trillion, 2016 exchange rate



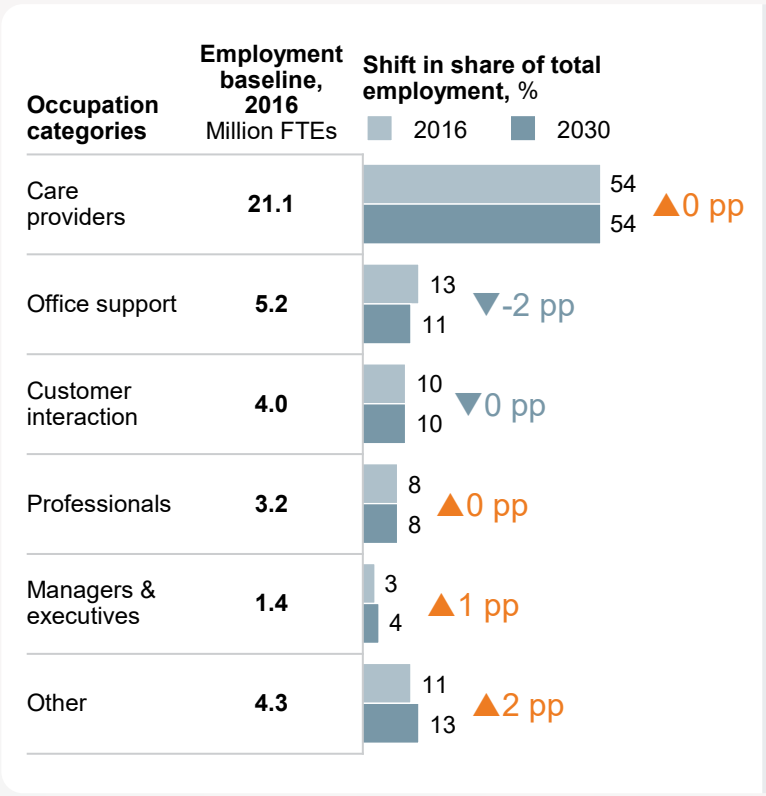
Labor productivity

	Population per FTE, 2016 People per healthcare employee	CAGR, 2000–16 %
United States	16.8	-1.2
Western Europe	18.5	-1.2

1 Employment in the United States for the years 2000 and 2001 was calculated based on the 2004–16 CAGR.
2 Western Europe comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: IHS (revenues); BLS (US employment); OECD (EU employment); McKinsey Global Institute analysis

Sector job shift by 2030



Top occupations growing and declining

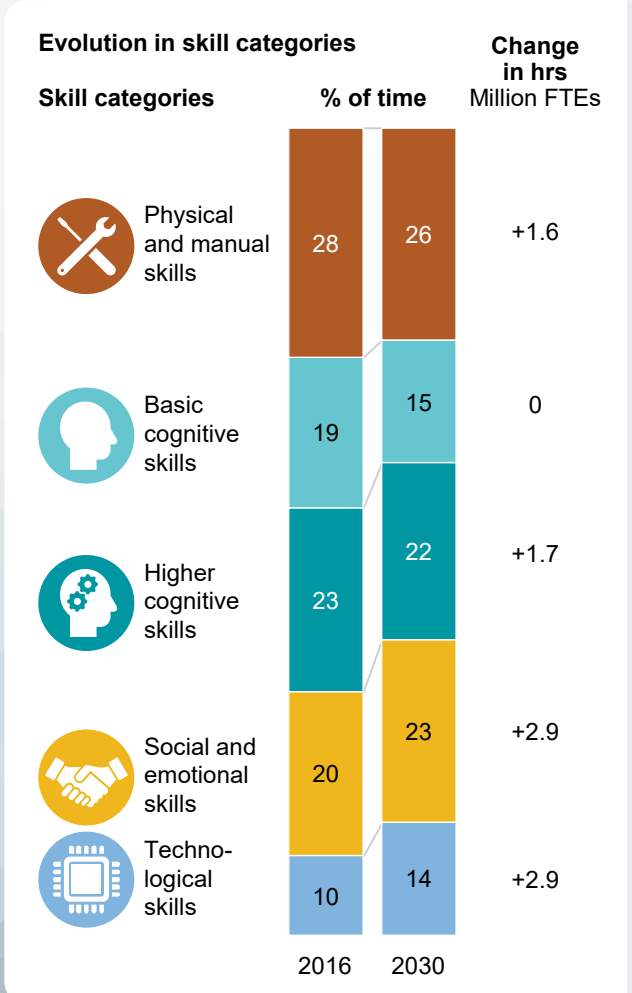
Top growing

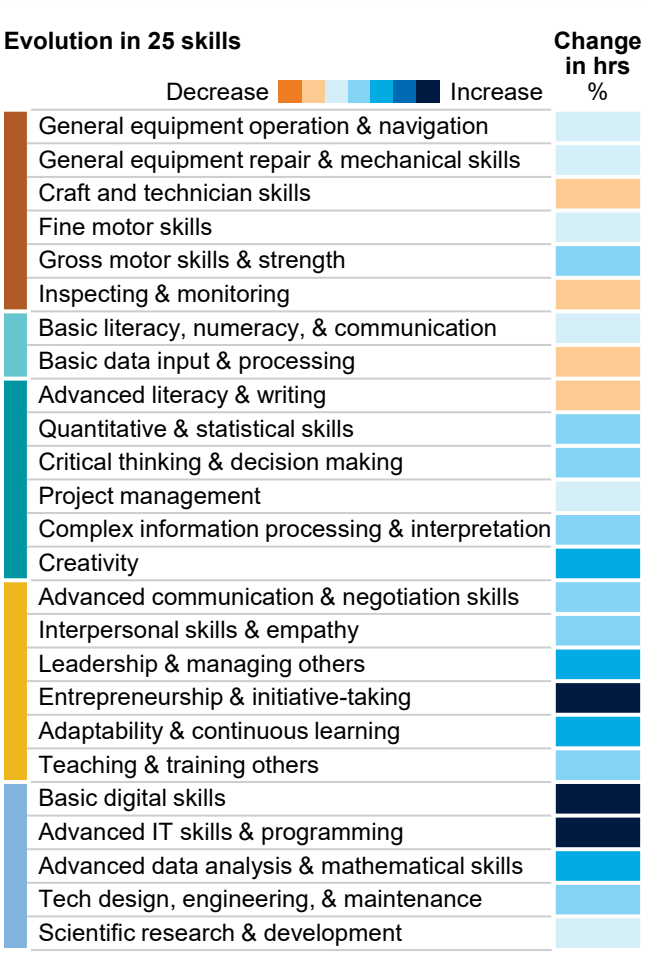
- Registered nurses
- Personal care aides
- Home health aides
- Software developers (app, web, computer)
- Childcare workers
- Dental hygienists
- Maids and cleaners
- Physical therapists
- Medical and health services managers
- Customer service representatives

Top declining

- Food preparation workers
- Medical secretaries
- Pharmacy technicians
- Telephone operators
- Data entry keyers
- Medical transcriptionists
- Medical and clinical laboratory technicians
- Word processors and typists
- Medical equipment repairers
- Office clerks (billing, accounting, reception, etc)

Sector skill shifts by 2030





NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

Industry deep-dives, United States and Western Europe, 2016–30

Manufacturing

Introduction

The next wave of automation and AI in manufacturing will continue to disrupt production functions in factories through better analytics, predictive maintenance, and increased human-machine collaboration. It will also have an impact on product development and on marketing and sales.

Demand for physical and manual skills overall in the sector is decreasing at more than twice the rate for the whole economy, and demand for basic cognitive skills is also declining as office support functions are automated. Professional occupations such as sales representatives and engineers will grow, as will production technicians. This will drive an increase in the need for social-emotional and higher cognitive skills, such as communication and negotiation, adaptability and continuous learning, and leadership. The need for technological skills will also increase, both for advanced IT skills for technology professionals and basic digital skills required of technicians and others.

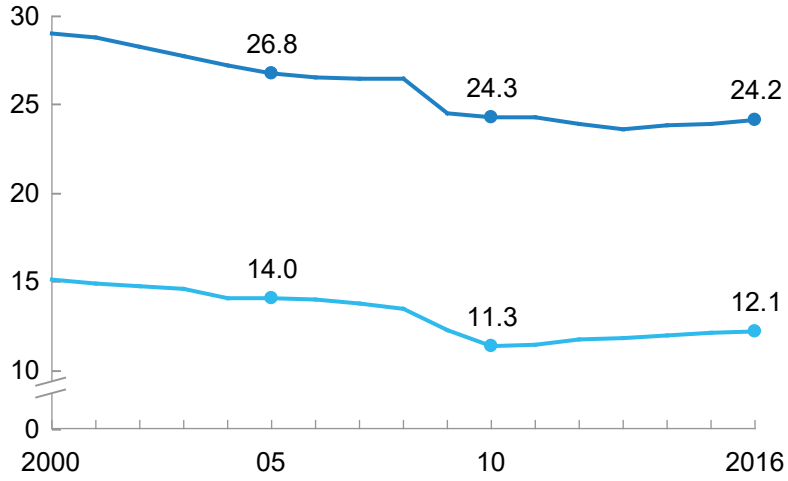
Sector trends at a glance

Industry snapshot

United States[1] Western Europe[2]

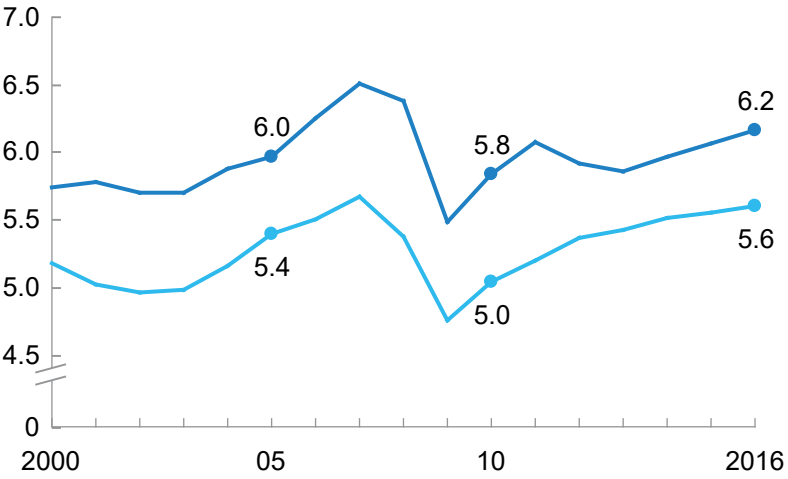
Employment

Million FTEs



Revenue

$ trillion, 2016 exchange rate



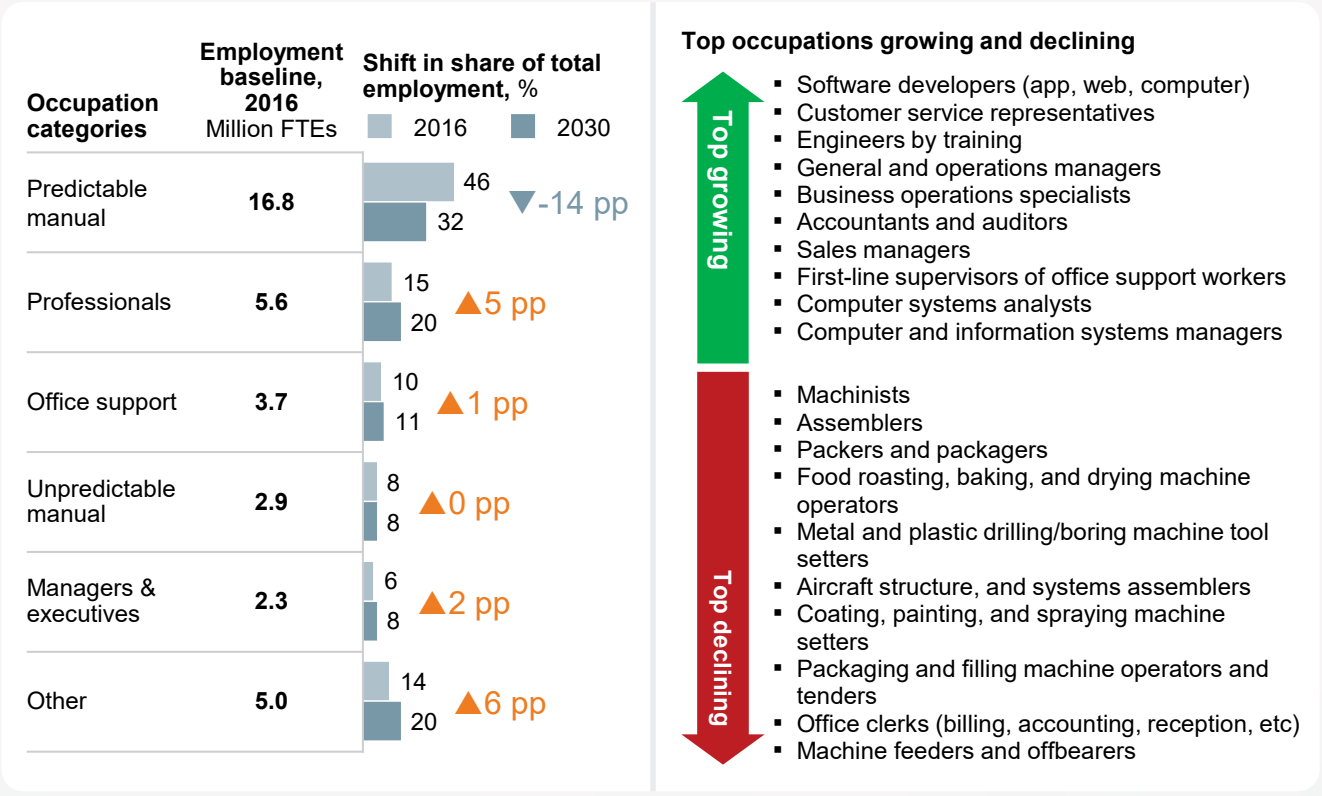
Labor productivity

	Gross output per FTE, 2016 $ thousand	CAGR, 2008–16 %
United States	158	2.5
Western Europe	99	2.4

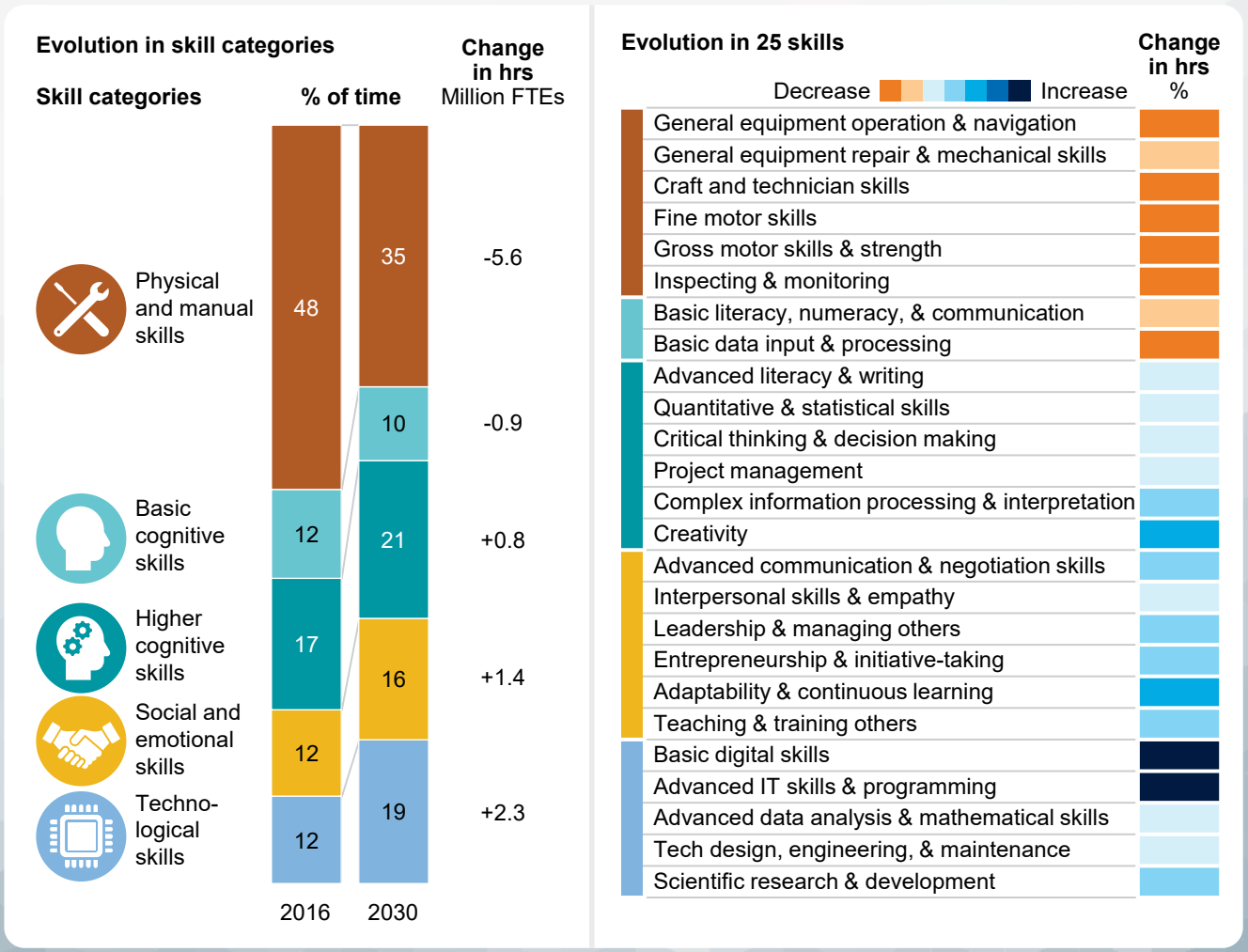
1 Employment in the United States for the years 2000 and 2001 was calculated based on the 2004–16 CAGR.
2 Western Europe comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: IHS (revenues); BLS (US employment); OECD (EU employment); McKinsey Global Institute analysis

Sector job shift by 2030



Sector skill shifts by 2030



NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

Retail

Introduction

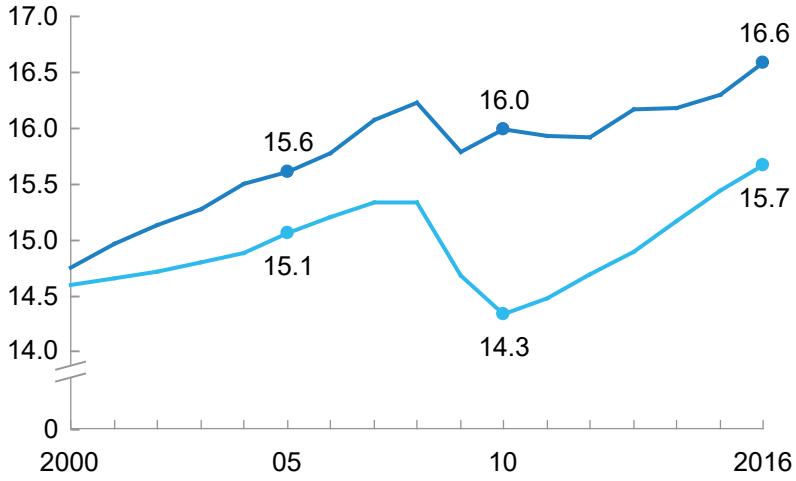
Digital technologies will drive significant skill shifts in the retail sector. E-commerce and online channels are now standard for all major retailers, and AI and smart automation will transform the retail experience, as self-checkout machines replace cashiers, robots restock shelves, and machine learning improves prediction of customer demand.

Jobs requiring physical and manual skills will decline, such as drivers, packers, and shelf stockers. Positions requiring mainly basic cognitive skills, such as cashiers, will also decline. Jobs that remain will be concentrated in customer service, management, and technology deployment and maintenance. The sector will see strong growth in workers with interpersonal skills, creativity, and adaptability. Advanced IT skills and programming skills will also see a surge in demand, as new technologies are deployed and maintained across the sector.

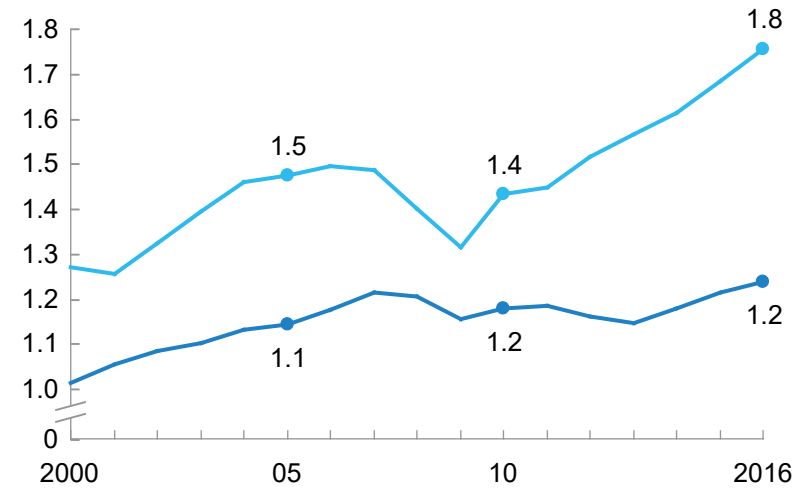
Sector trends at a glance

Industry snapshot

Employment
Million FTEs



Revenue
$ trillion, 2016 exchange rate



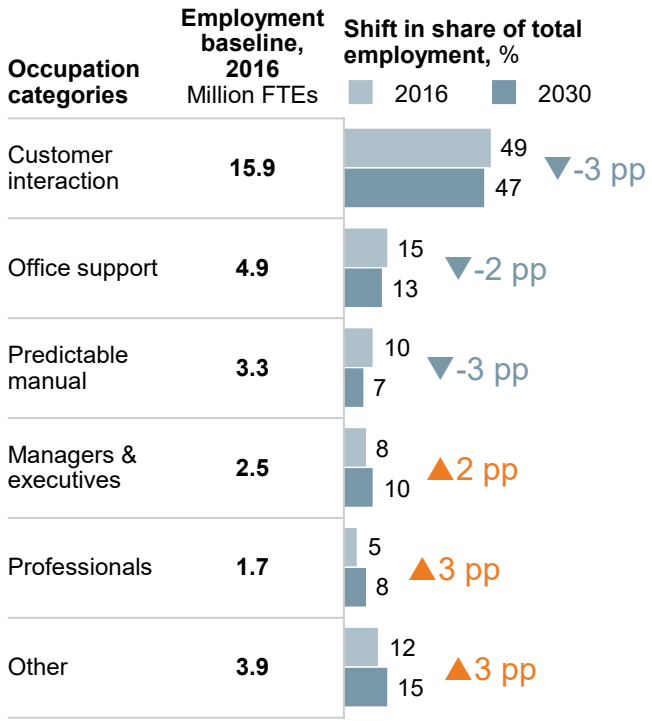
Labor productivity, 2016

	Revenue per FTE, 2016 $ thousand	CAGR, 2000–16 %
United States	112	1.6
Western Europe	73	0.5

1 Employment in the United States for the years 2000 and 2001 was calculated based on the 2004–16 CAGR.
2 Western Europe comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

SOURCE: IHS (revenues); BLS (US employment); OECD (EU employment); McKinsey Global Institute analysis

Sector job shift by 2030



Top occupations growing and declining

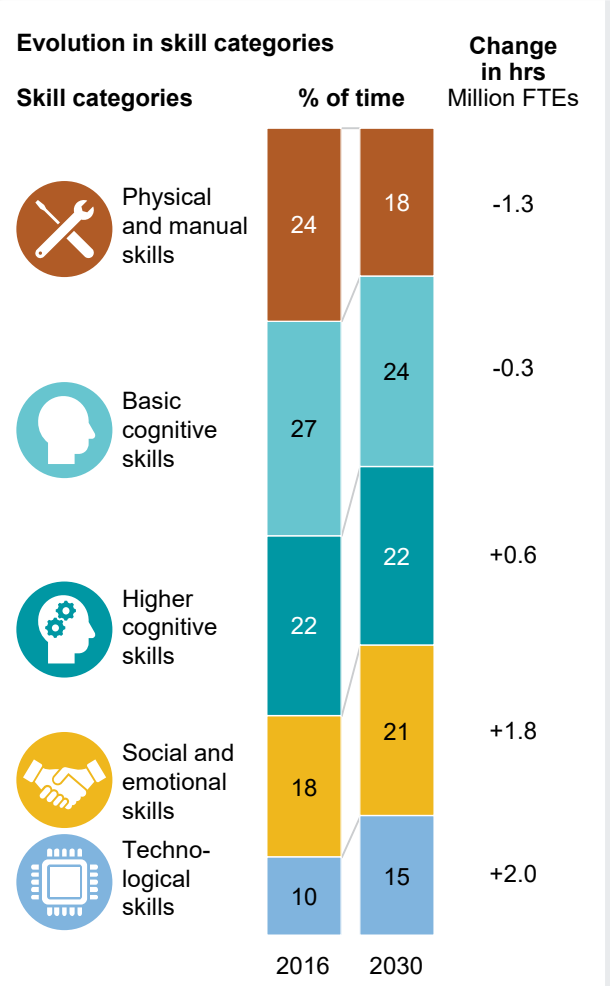
Top growing

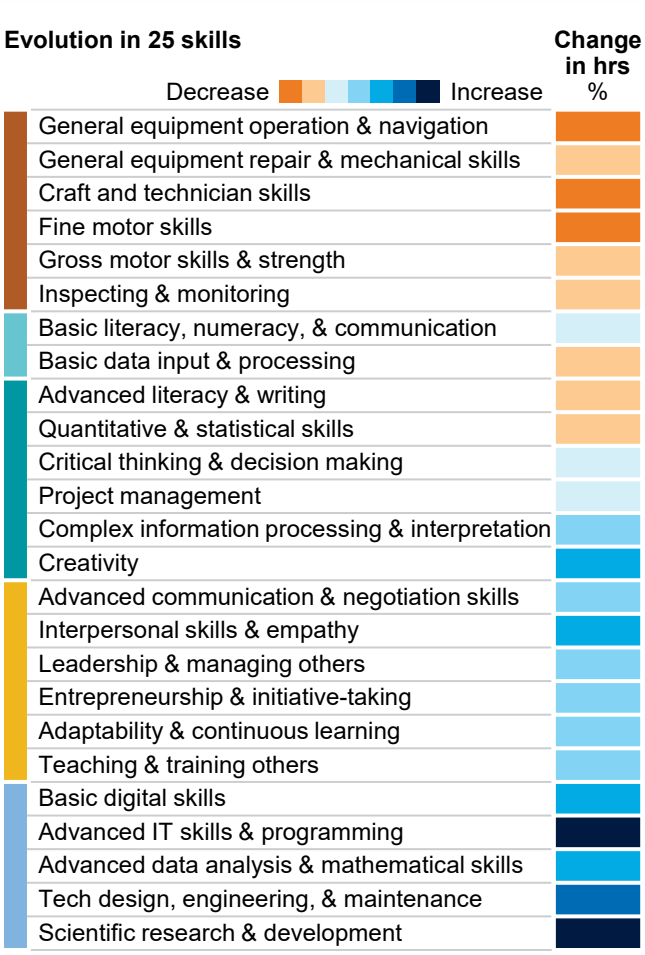
- Software developers (app, web, computer)
- General and operations manager
- Customer service representatives
- Sales representatives
- Demonstrators and product promoters
- Computer and information systems managers
- First-line supervisors of retail sales workers
- Laborers and freight, stock and material movers
- Market research and marketing specialists
- Pharmacists

Top declining

- Cargo and freight agents
- Heavy and tractor-trailer truck drivers
- Weighers, measurers, checkers, and samplers
- Food preparation workers
- Word processors and typists
- Butchers and meat cutters
- Automotive service technicians and mechanics
- Packers and packagers
- Light truck or delivery services drivers
- Office clerks (billing, accounting, reception, etc)

Sector skill shifts by 2030





NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

3. HOW WILL ORGANIZATIONS ADAPT?

Automation adoption will not only accelerate skill shifts for individual workers. It will also have profound implications for the workplace and the way companies are organized. To harness the new technologies to their full effect, firms will need to rethink and retool their corporate structure and their approaches to work. That means redesigned business processes and a new focus on the talent they have—and the talent they need.

In this chapter, we look at the changing paradigms around work as new technologies alter long-established patterns of corporate organization. Contrary to much conventional wisdom in the public debate over AI, companies do not expect that adoption of these technologies will reduce aggregate employment in the short term; indeed, companies that have already extensively adopted automation and AI expect to raise headcount rather than reduce it, as they innovate and grow. Our research also highlights the expectations of business leaders that organizations in the future will be flatter, with more cross-functional teams and greater use of external contractors. We may see a significant reallocation of some tasks between workers of different skill and qualification levels, creating "new collar" jobs, as firms seek to deploy their talent pool more effectively—a development that could help boost middle-wage jobs. Human resources (HR) departments, but also executive leadership teams, will need to evolve along with the workforce and structure of their organizations.

MOST COMPANIES EXPECT THE SIZE OF THEIR WORKFORCES IN EUROPE AND THE UNITED STATES TO STAY THE SAME OR GROW AS THEY ADOPT AUTOMATION

A finding of our executive survey concerns overall employment levels over the next three years.[33] About 77 percent of the respondents in our survey expect no net change in the size of their workforces either in the United States or in Europe as a result of adopting automation and AI technologies. Indeed, over 17 percent expect their workforces on both sides of the Atlantic to grow. The composition of jobs and skills will shift, however. Some jobs will shrink after automation, while others will expand. And about 6 percent of companies foresee an overall decline in the size of their US and European workforces.

The expectation of a growing or unchanged workforce in the short term is most pronounced among companies that see themselves as extensive adopters of automation and AI, with almost one in four saying they expect their workforces to grow (Exhibit 13). Extensive adopters also see a substantial financial upside from their automation strategies, and are focused on new growth opportunities from adopting these technologies rather than cost-cutting (see Box 4, "Extensive adopters invest heavily in automation and AI, and expect substantial revenue gains, amplifying 'superstar' dynamics").

This survey only gauges relatively short-term expectations for the next three years. Nonetheless it confirms other findings, both from other surveys and from our own prior quantitative modeling, that support the idea of no substantial aggregate employment declines relating to automation and AI adoption. A McKinsey & Company survey in February 2018 that asked similar questions about employment prospects found that top executives expect far smaller changes in the size of their workforces than others fear. C-suite respondents to that survey said they expected only 5 percent of the workforce would be displaced and about 19 percent of employees to move laterally into different or new roles. This forecast outcome was different from that given by midlevel managers at the

[33] Survey conducted in March 2018 among 3,031 C-level executives from companies with more than 30 employees in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States, across 14 sectors: high tech/IT/technology, manufacturing, construction, retail/trade, media and entertainment, telecommunications, tourism/hospitality/leisure, travel/transport/logistics, financial services/banking/insurance, professional services, education, healthcare, energy/mining/oil and gas/utilities, and government; see appendix for details.

same companies, who expected 10 percent of employees to be displaced, or double the proportion envisaged by senior managers.[34]

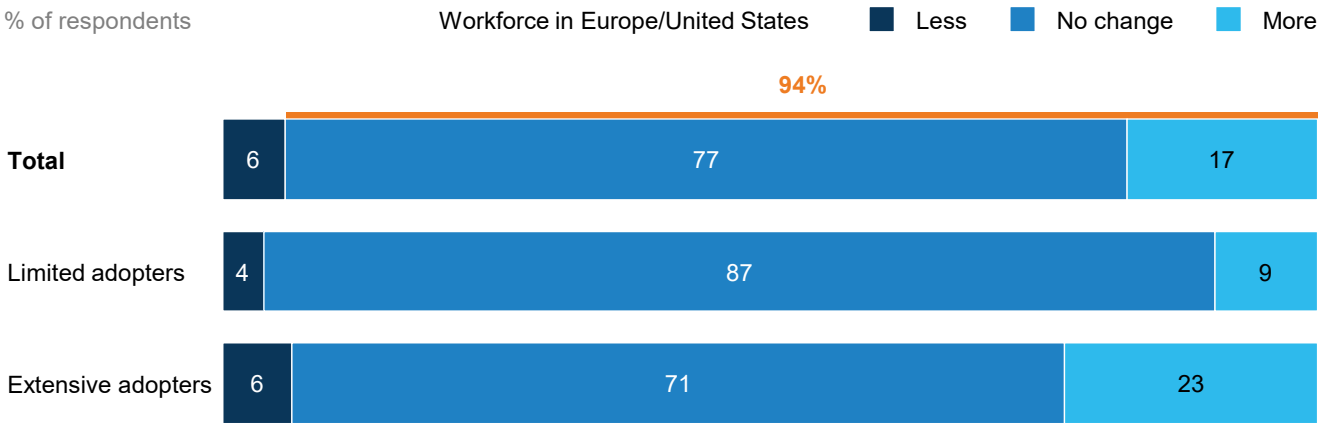
In a previous report on workforce transitions, we modeled job losses from automation and AI compared with the jobs potentially gained from the higher productivity and new products and services enabled by new technologies.[35] That research, along with the work of others, confirms the broader finding that automation will likely lead to aggregate job increases rather than decreases.[36] In addition, history shows that many new jobs of the future will be in occupations that do not exist today. One study found that 0.56 percent of new jobs in the United States each year are in new occupations, implying that roughly 7 percent of jobs in 2030 will be in occupations that do not currently exist.[37] A key question for policy makers, companies, and individual workers will be to ensure that the job reallocation happens faster than the shift in skills.

Exhibit 13

Only 6 percent of companies expect their workforce in the United States and Europe to shrink as a result of automation and AI.

Based on McKinsey Global Institute workforce skills executive survey, March 2018

Q: What impact do you think adopting automation and AI will have on the geographic location of your operations?



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, the United Kingdom, and the United States. Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

[34] See the results of a 2018 McKinsey & Company Global Survey on automation, to be published in June 2018.

[35] We estimated that between 400 and 800 million workers could be displaced under automation adoption scenarios on the one hand, and, on the other hand, that labor demand from selected catalysts could create work for between 555 and 890 million full-time equivalents in the same period. Those catalysts include rising incomes, especially in emerging economies, rising healthcare needs of aging populations, and investment in infrastructure, energy and technology development itself. Ibid. *Jobs lost, jobs gained*, December 2017.

[36] Also see, for example, *Asian Development Outlook 2018: How technology affects jobs*, Asian Development Bank, March 2018; James Manyika and Michael Spence, "The false choice between automation and jobs," *Harvard Business Review*, February 5, 2018.

[37] Jeffrey Lin, *Technological adaptation, cities, and new work*, Federal Reserve Bank of Philadelphia, working paper, July 28, 2009.

Box 4. Extensive adopters invest heavily in automation and AI, and expect substantial revenue gains, amplifying "superstar" dynamics

Our prior work on digital technologies has highlighted the "winner takes all" dynamics and superior performance of companies at the frontier of adopting digital technologies and AI compared with lagging firms.[1] Firms that are early adopters of automation might benefit from technology investments through product and service innovations and extensions. This in turn would likely lead to the rise of new "superstar" companies that have a high-skill and highly paid workforce doing digital, nonroutine tasks. On the other hand, a cohort of companies that are late adopters of automation—or do not adopt it at all—might also emerge. However, absent retraining efforts, these would lose market share to early adopters and would have difficulties sourcing the talent they need.

The companies in our survey largely reflect these trends, with the more extensive adopters of automation and AI having better financial performance than their peers and investing more in new technologies. Two-thirds of the companies that classified themselves as extensive adopters of automation and AI technologies invest more than 25 percent of their total investment budgets on digitization technologies—and 71 percent of them expect revenue increases of more than 10 percent. Four in five of these extensive adopters also report better financial performance than their peers. (Extensive adopters claim to have adopted automation and AI technologies in most of their business processes or throughout their entire operating model; limited adopters claim to have adopted these technologies in none or only some minor aspects of their business.)

These expectations are significantly higher than the revenue expectations and reported financial performance of limited adopters, which are less inclined to invest heavily and which expect less top-line payoff from adopting automation and AI. Perhaps what most starkly sets limited and extensive adopters apart is their vision for the adoption of automation and AI technologies. While extensive adopters seek to fundamentally redesign their business model, most limited adopters are looking for incremental business process improvements and cost advantages (Exhibit 14).

As with the adoption of other technologies, the pattern of significant growth and revenue gains going to firms at the forefront of adoption looks set to continue. Their ability to reinvest these gains and pull even further ahead of competitors may create an insurmountable advantage, and increases the importance of all companies to consider how automation and AI could affect their businesses.

The most advanced adopters of AI and automation will also have an advantage when it comes to hiring, as they will tend to attract talent and can offer higher wages, if they successfully reap the productivity and performance gains from the technology adoption. They will have the freedom of choice to hire, as well as potentially contracting or retraining as suits their approach to ensuring that they have the relevant skills they need. This may be much harder for companies at the other end of the spectrum, those slow to adopt AI and automation, or are resistant to it. The risk for these firms is that their attractiveness to talent may be limited and that the wages they offer may be lower as a result of not reaping the economic benefits from the technologies as much as their superstar peers. This will in turn limit their strategic talent choices, forcing them to depend more on retraining and contracting.

This bifurcation between leaders and laggards may have macroeconomic consequences. The lack of people upgrading skills sufficiently fast at the laggard companies might limit the return on investment in AI technology itself. And limited wage growth of workers doing nondigital, nonroutine work might, by consequence, also limit the overall economic benefit from overspill to overall consumption in other sectors.

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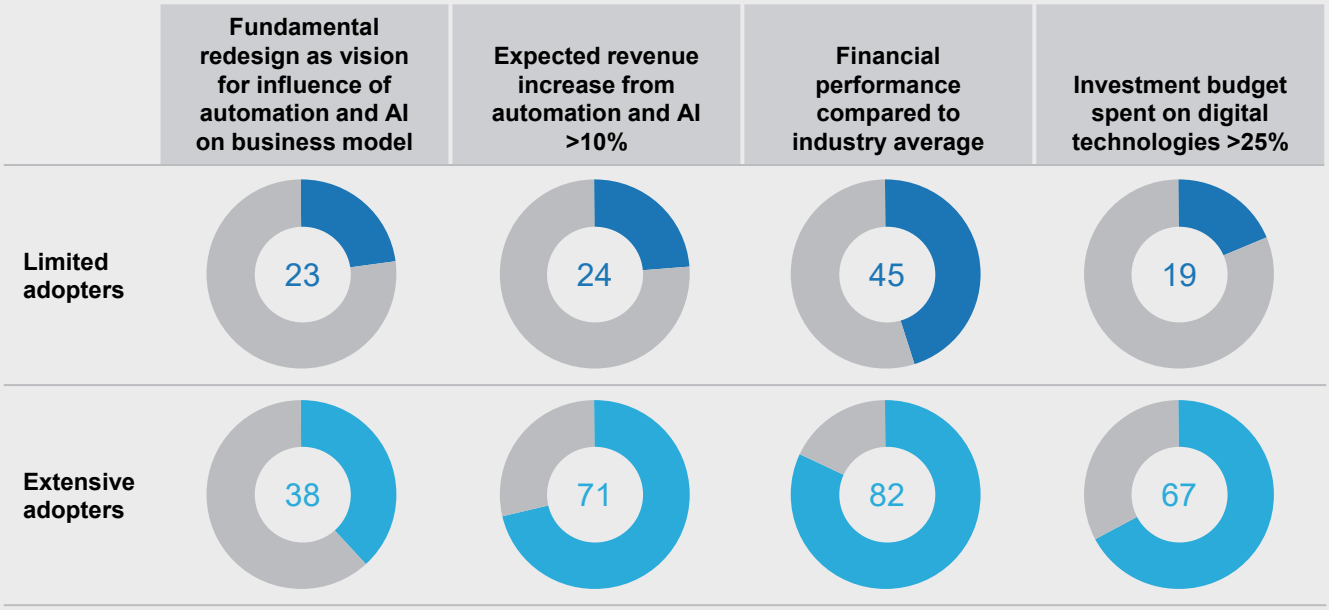
[1] *Digital America: A tale of the haves and have-mores*, McKinsey Global Institute, December 2015; and *Digital Europe: Pushing the frontier, capturing the benefits*, McKinsey Global Institute, June 2016.

Exhibit 14

Extensive adopters of automation and AI expect to fundamentally redesign their businesses and grow revenue, while limited adopters focus on costs.

Based on McKinsey Global Institute workforce skills executive survey, March 2018
% of respondents by level of adoption



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, the United Kingdom, and the United States.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

NEW TECHNOLOGIES WILL REQUIRE FUNDAMENTAL CHANGES IN ORGANIZATIONAL STRUCTURES AND WAYS OF WORKING

Many companies expect organizational changes will be necessary as they adopt automation and AI. This expectation is consistent with a growing body of evidence—and sometimes painful experiences—with previous attempts at technology implementation. The first wave of information and communications technologies and the internet, which began in the 1990s, took many years before companies began to realize the benefits, which they only felt after they redesigned their business processes to harness the power of the new technologies.[38] The productivity improvements from adoption of computer technology took time to show up in overall economic data, a lag often known as the "Solow paradox," after the MIT economist Robert Solow, who was among the first to point it out in his famous quip: "You can see the computer age everywhere but in the productivity statistics."[39]

In our survey, four in ten of the business leaders who are extensive adopters expect to "fundamentally" change their companies' organizational structure as a result of adopting automation and AI. Among the moderate adopters, more than one in four expect a fundamental organizational reorganization, but that drops to one in ten for the limited adopters (Exhibit 15).[40]

[38] *How IT enables productivity growth*, McKinsey & Company, November 2002.
[39] Robert Solow, "We'd better watch out," *New York Times Book Review*, July 12, 1987.
[40] Percentages are based on self-reported levels of adoption, pre-weighting.

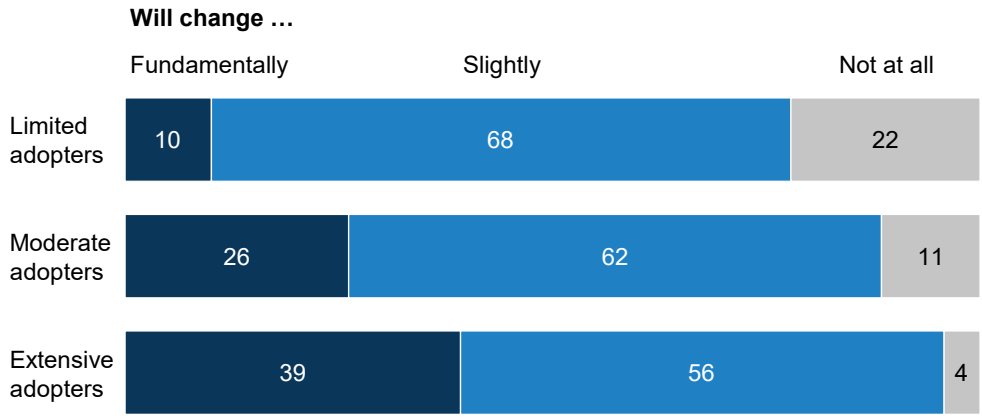
Exhibit 15

Two in five extensive adopters of automation and AI say the technologies will require a fundamental change in their organization.

Based on McKinsey Global Institute workforce skills executive survey, March 2018

Q: To what extent to do you expect your organizational structure to change as a result of adopting automation and AI technologies?

% of respondents per level of adoption, single response



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States. Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

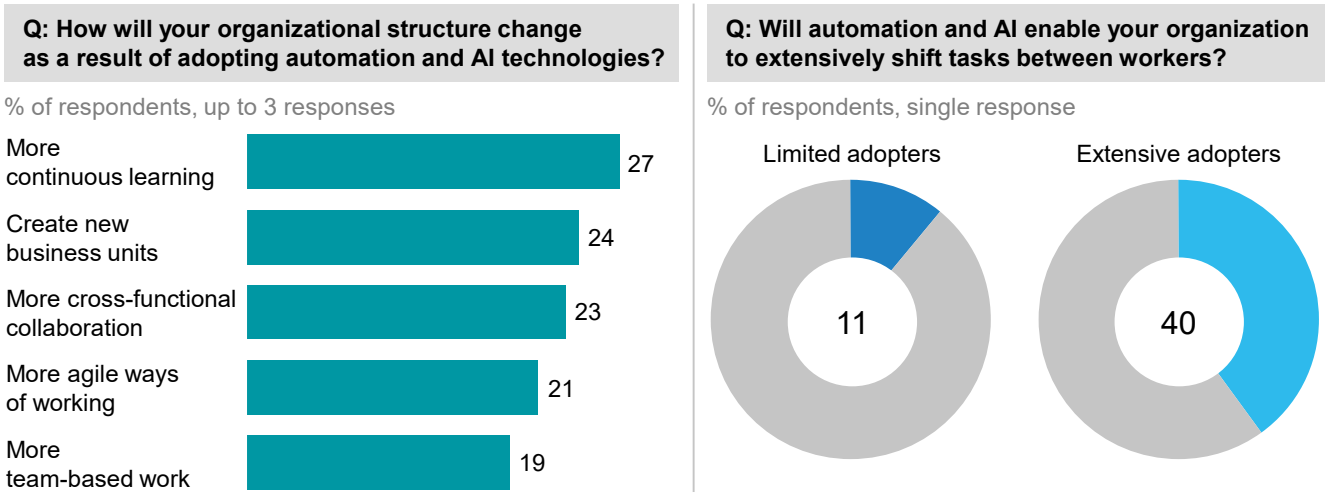
Our findings suggest that organizations will change in four key ways.[41] First, companies will undergo a mindset shift: a key to their future success will be in providing continuous learning options and instilling a culture of lifelong learning throughout the organization. Second, the basic organizational setup will change: there will be a strong shift toward cross-functional and team-based work, more agile ways of working with less hierarchy, and new business units may need to be created. Third, the allocation of work activities will be altered, with work being "unbundled" and "rebundled." This will allow companies (and particularly extensive adopters) to make the most effective use of different qualification levels in their workforce. Fourth, workforce composition will shift. More work will be contracted to freelancers and other contractors, boosting the emerging "gig" or "sharing" economy (Exhibit 16). To orchestrate these changes, senior leadership and certain functions will be key. CEOs and their top executives who will face these challenges will need to adopt the right automation and AI mindset, along with the knowledge they need to navigate the change. Human resources departments will also have to undergo profound change in the way they work, as skills and roles change and as talent grows in importance.

[41] For a discussion of workplace changes, see Jacques Bughin, Susan Lund, and Jaana Remes, "Ten new work orthodoxies for the second machine age," in Bruno Lanvin and Paul Evans, eds., *Talent and Technology: The global talent competitiveness index 2017*, INSEAD, 2016; Leslie Willcocks, "Why robots may not be taking your job—at least, not in the next 10 years: How organisations can embrace automation," *European Business Review*, March 2016; Ravin Jesuthasan and John Boudreau, "Thinking through how automation will affect your workforce," *Harvard Business Review*, April 20, 2017.

Exhibit 16

Companies plan to introduce a range of organizational and cultural changes; especially extensive adopters of automation will shift more tasks between workers.

Based on McKinsey Global Institute workforce skills executive survey, March 2018



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

Continuous learning is viewed as the most important element for a changing workforce

Irrespective of their expected level of automation adoption, a large portion of the companies we surveyed see a significant need for their workforce to upgrade their skills and continue to learn and adapt throughout their working lives. In fact, establishing a culture of lifelong learning was ranked by companies across most sectors as the change most needed for developing the workforce of the future.

This is in line with our finding that providing on-the-job training is essential for preparing the workforce for the skills of the future, which all sectors and levels of adoption agree on (38 percent of respondents in total). Similarly, 34 percent of respondents say that providing lifelong learning opportunities for employees is a top priority for navigating the change.

The need to continuously retrain and provide new skills to the workforce applies to all companies, even tech giants, such as Google. When the Mountain View, California-based internet company moved from a desktop-first to a mobile-first and then to an AI-first mindset, skills had to be upgraded accordingly—especially among the engineers. The firm introduced a "Learn with Google AI" training program as a fast-paced introduction to machine learning and trained more than 18,000 employees globally over two years, a third of its engineering headcount. The course has now been made available publicly free of charge.[42] In mining, Rio Tinto is increasingly adopting autonomous vehicles in some of its mines, which will require workers to develop new vehicle repair, operation, and maintenance skills.[43]

[42] *Re:Work*, "Learning & development," Google blog entry, rework.withgoogle.com/subjects/learning-development/; "Learn with Google AI," Google, ai.google/education/#?modal_active=none; *The Keyword*, "Learn with Google AI: Making ML education available to everyone," blog entry by Zuri Kemp, February 28, 2018, blog.google/topics/machine-learning/learn-google-ai-making-ml-education-available-everyone/.

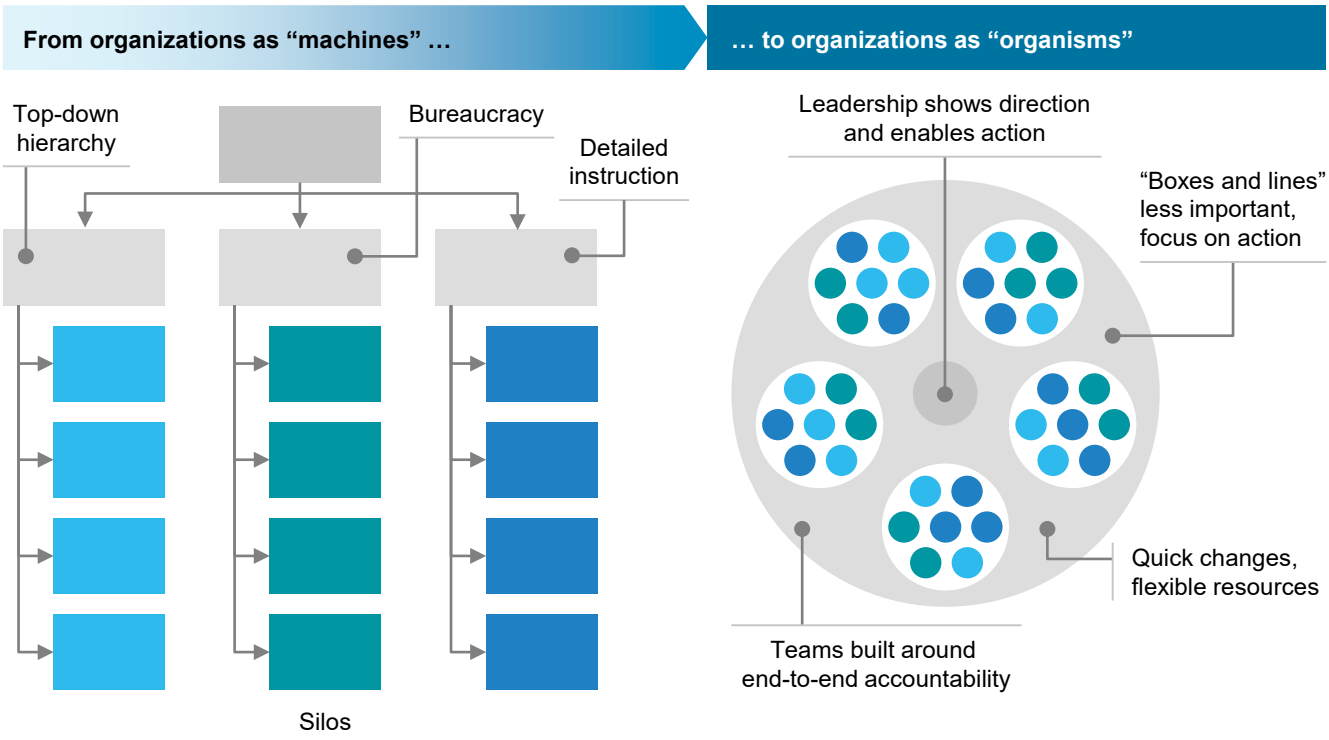
[43] *Beyond the supercycle: How technology is reshaping resources*, McKInsey Global Institute, February 2017.

Moving to an agile corporate structure that features less hierarchy and more collaborative team networks

Just as "lean management" became a major trend starting in the 1970s, "agility" has become a core management topic in recent years, as companies have sought to shift from "mechanical" to "organic" organizations (see Box 5, "Taking "lean" to the extreme: the "Holacracy" self-management system"). Agility has acquired a specific meaning in management terms, as the ability of an organization to renew itself, adapt, change quickly, and succeed in a rapidly changing, ambiguous and sometimes turbulent environment.[44] In management literature, this has come to embrace different types of teams and organizational units known as "chapters," "guilds," "squads," and "tribes," as well as modes of working, such as "sprints." In place of siloed departments governed by hierarchies, organizations see themselves shifting toward a more flexible system in which individuals move among teams and projects (Exhibit 17).[45]

Exhibit 17

Agile organizations focus on teamwork and the ability to adapt quickly, rather than slower-moving hierarchies.



SOURCE: *The five trademarks of agile organizations*, McKinsey & Company, January 2018; McKinsey Global Institute analysis

[44] Wouter Aghina, Aaron De Smet, Monica Murarka, and Luke Collins, *The keys to organizational agility*, McKinsey & Company, December 2015.

[45] Management literature on the theme of agility has proliferated. See, for example, *The five trademarks of agile organizations*, McKinsey & Company, January 2018; *Leadership & organization blog*, "Getting agile right in your organization," McKinsey & Company blog post by Aaron De Smet, February 5, 2018; Jeff Boss, "5 reasons why this CEO leverages cross functional teams for better business performance," *Forbes*, February 13, 2017; Aaron De Smet, Susan Lund, and Bill Schaninger, "Organizing for the future," *McKinsey Quarterly*, January 2016; Judith Heerwagen, Kevin Kelly, and Kevin Kampschroer, *The changing nature of organizations, work, and workplace*, WBDG, May 10, 2016; Linda Holbeche, *The agile organization: How to build an innovative, sustainable and resilient business*, London, Kogan Page, 2015; Pamela Meyer, *The agility shift: Creating agile and effective leaders, teams, and organizations*, New York, Bibliomotion, 2015; Daryl Kulak and Hong Li, *The journey to enterprise agility: Systems thinking and organizational legacy*, Cham, Switzerland, Springer, 2017.

Box 5. Taking "lean" to the extreme: the "Holacracy" self-management system

The Lean Enterprise Model was introduced by Toyota in the 1970s and quickly found admirers around the world. Lean thinking—based on the reduction of waste and inefficiencies and the elimination of non-value adding activities, among other things—has led to numerous organizational changes to improve the efficiency of internal processes. These include a reduced hierarchical structure, teams as basic building blocks, and blurred boundaries between the different parts of the organization. As such, it has much in common with the more recent push for corporate agility.[1]

Today, more "extreme" forms of lean management and agility are being tested. They include "Holacracy," a self-management practice for organizations based on the elimination of job titles and manager roles, increased autonomy for teams and individuals, and an adaptable organizational structure. Rigid job descriptions are replaced by fluid roles, manager authority is distributed to teams and roles, and decisions are made locally. Organizational structures are regularly revisited and revised—and transparent. The method was created in 2007 by software developer Brian Robertson and Tom Thomison, an engineer. who say that hundreds of companies worldwide have since adopted the method.[2]

One of the most prominent adopters of Holacracy—and, with more than 1,500 employees, also by far the largest—is Zappos, the Las Vegas-based online shoe and apparel retailer. The company decided to topple classic organizational hierarchies and adopt the Holacracy method in 2013. This meant distributing decision-making authority in self-organizing circles, made up of employees who hold multiple roles, with each circle arranged around a purpose statement. Zappos founder Tony Hsieh says he hopes this makes the company more adaptable, innovative, and resilient, and that it empowers employees to find the intersection of what they are good at, passionate about, and adds value to the business.[3] The company's organizational chart changes numerous times a day, but is always available in real time online, and employees can view every other employee's roles and responsibilities. Hsieh says Zappos employees have turned into mini-entrepreneurs who are fully empowered to pursue their ideas and interests, while being united by common values and a joint purpose. The experiment has attracted considerable media attention.[4]

1 Ibid. Judith Heerwagen, Kevin Kelly, and Kevin Kampschroer, *The changing nature of organizations, work, and workplace*, WBDG, May 10, 2016.

2 HolacracyOne, https://www.holacracy.org/how, retrieved May 2, 2018.

3 Aaron De Smet and Chris Gagnon, "Safe enough to try: An interview with Zappos CEO Tony Hsieh," *McKinsey Quarterly*, October 2017.

4 Ethan Bernstein and John Bunch, "The Zappos Holacracy experiment," *Harvard Business Review*, July 28, 2016; Ethan Bernstein, John Bunch, Niko Canner, and Michael Lee, "Beyond the Holacracy hype," *Harvard Business Review*, July 2016; Alison Coleman, "Banishing the bosses brings out Zappos' hidden entrepreneurs," *Forbes*, April 7, 2016.

Unlike traditional hierarchies, which are designed mainly for stability, agile organizations are designed for both stability and dynamism. They typically consist of a network of teams and are notable for rapid learning and fast decision cycles. Companies that have adopted team-based and project work have experienced a boost in productivity—if they match the right people with the right jobs.[46] Leadership indicates the direction and enables action but gives teams end-to-end accountability. The teams can thus act and are free to navigate flexibly and make changes quickly.

Companies that move to more fluid team-based working environments experience a boost in productivity of their workforces from better matching of employees to tasks and from higher employee engagement. In our survey, companies listed agility and working together in teams that collaborate across functional lines as among the most important organizational changes that will result from adopting automation and AI technologies. More than 20 percent of respondents said that introducing more agile ways of working will be a major organizational change, and a similar proportion described more cross-functional collaboration as a key going forward. As companies redesign work to harness new technologies, they often find that processes can become adaptable, requiring a more flexible workforce.

46 See Susan Lund, James Manyika, and Kelsey Robinson, "Managing talent in a digital age," *McKinsey Quarterly*, March 2016.

Company leaders in our survey also ranked "less hierarchy" among the coming top seven organizational changes they envisaged. This is consistent with more agility, as moving to team-based work removes some layers of middle management. In practical terms, less hierarchy also means moves toward flatter organizations, in which employees make more lateral career moves to gain experience in different areas, in contrast to the traditional model of vertical promotions up a career ladder. Some consider that the hierarchical, ladder-like progression is outdated, and is being supplanted by a more supple "lattice" structure.[47] This enables workers to build a wider variety of skills and engage in continuous learning.

For some companies, more team-based work and reduced hierarchy lead to private offices with open work spaces. There is increasing recognition among executives that the design of office space can foster collaboration and innovation—or hinder it. Open offices, in particular, are drawing criticism.[48]

Examples of companies across different sectors who have been integrating such changes in their operations include:

- In financial services, the Dutch banking group ING in 2015 shifted its traditional organization to an "agile" model inspired by companies such as Google, Netflix, and Spotify. Comprising about 350 nine-person "squads" in 13 so-called tribes, the new approach at ING has already improved time to market, boosted employee engagement, and increased productivity.[49]

- In manufacturing, 3M, a US maker of office supplies and other products, created an internal workforce planning platform that increased mobility within the company and flexibility in forming teams; it experienced a 4 percent overall boost to productivity as a result.[50]

- In automotive manufacturing, after years of building robotic factories, BMW in South Carolina is ramping up hiring of human workers. It says that combining people with machines on its automotive assembly lines increases the flexibility to build multiple models in smaller batches and thus respond to shifting customer demands more quickly.[51]

- In tech, software company Adobe redesigned its Manhattan office, the use of which was declining as many employees chose to work remotely. The company decided to move away from a layout consumed with individual offices. Instead of just opting for more collaborative space, Adobe management involved their employees to determine what they needed to support their daily work. The result was a more transparent office space that allowed for greater perspective on others' activities and more technology to support collaboration—both virtual and in-person.[52]

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47 Killian Fox and Joanne O'Connor, "Five ways work will change in the future," *The Guardian*, November 29, 2015; Sean T. Lyons, Linda Schweitzer, and Eddy S. W. Ng, "How have careers changed? An investigation of changing career patterns across four generations," *Journal of Managerial Psychology*, Volume 30, Issue 1, 2015.

48 Alina Dizik, Open offices are losing some of their openness," *The Wall Street Journal*, October 2, 2016.

49 Peter Jacobs, Bart Schlatmann, and Deepak Mahadevan,"ING's agile transformation," *McKinsey Quarterly*, January 2017.

50 Vijay Govindarajan and Srikanth Srinivas, "The innovation mindset in action: 3M Corporation," *Harvard Business Review*, August 6, 2013.

51 Abe Hardesty, "Robots part of workforce evolution at BMW," *Independent Mail*, June 23, 2017; Mark Allinson, "BMW shows off its smart factory technologies at its plants worldwide," *Robotics and Automation News*, March 4, 2017.

52 Peter Bacevice, Liz Burow, and Mat Triebner, "7 factors of great office design," *Harvard Business Review*, May 20, 2016.

The "new collar" jobs: unbundling and rebundling tasks into jobs

As business processes are redefined and automation and AI take over some activities, companies have an opportunity to reassess which workers do which tasks. In particular, they can reallocate tasks among workers of different qualification levels, for example shifting some activities previously undertaken by their most skilled and best-paid talent to workers with lower skills, who would thus be empowered to take on more complex tasks. Such unbundling and rebundling raises company efficiency—and it can also create a new set of middle-skill jobs.[53] For example, registered nurses and physician assistants now do some of the tasks that primary care physicians once carried out, such as administering vaccinations, prescribing medication, and examining patients with routine illnesses. At utilities, grid technicians can spend more time on problem solving instead of logging inspection status by hand. Other examples are proliferating across industries, as companies seek to free up time of their top talent and harness their creativity. One of the effects of this reallocation is to reduce the need for middle management.[54]

As manufacturing employment declines across advanced economies, these new, rebundled jobs may form the next "middle class." Research by Anthony Carnevale and colleagues at Georgetown University has identified "good jobs" in the United States, those that require less than a four-year college degree but pay more than the median wage.[55] In fact, there are about 30 million "good jobs" that do not require an undergraduate degree and will pay an average of $55,000, and minimum of $35,000.

In our survey, 40 percent of companies describing themselves as extensive adopters of automation and AI expect to extensively shift tasks currently performed by high-skill workers to lower-skill ones. This is significantly higher than for companies with less ambition for their automation: only 20 percent of moderate adopters and 11 percent of limited adopters expressed the expectation of this type of unbundling and rebundling. This reflects the greater willingness—and perhaps experience to date—of extensive adopters of automation to fundamentally reorganize their businesses and workplaces as they harness new technologies.

Companies are already beginning to alter work activity allocation as new job profiles are being created in response to robotic automation. IBM is one company that has started to embrace these "new-collar workers"—individuals with job profiles at the nexus of professional and trade work, combining technical skills with a higher educational background. IBM CEO Virginia Rometty says these entirely new jobs will be relevant in fields such as AI and cybersecurity. To source this new stratum of jobs, IBM is partnering with vocational schools to shape curricula and build a pipeline of future new-collar workers.[56]

New collar jobs at the nexus of traditional blue collar jobs and white collar managerial jobs could redefine the workforce broadly across sectors. For example, as sales organizations use automation to generate leads and identify opportunities for cross-selling and upselling,

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[53] Jacques Bughin, Susan Lund, and Jaana Remes, "Ten new work orthodoxies for the second machine age," in Bruno Lanvin and Paul Evans, eds., *Talent and Technology: The global talent competitiveness index 2017*, INSEAD, 2016; Thomas A. Kochan, David Finegold, and Paul Osterman, "Who can fix the 'middle-skills' gap?" *Harvard Business Review*, December 2012; Steve Lohr, "A new kind of tech job emphasizes skills, not a college degree," *The New York Times*, June 28, 2017; Alicia Sasser Modestino, "The importance of middle-skill jobs," *Issues in Science and Technology*, Volume XXXIII, Issue 1, fall 2016; Harry Holzer, *Job market polarization and U.S. worker skills: A tale of two middles*, Brookings Institution, April 2015.

[54] Brian M. Carney and Isaac Getz, *Freedom, Inc.: Free your employees and let them lead your business to higher productivity, profits, and growth*, 2009.

[55] Anthony P. Carnevale, Jeff Strohl, and Neil Ridley, *Good jobs that pay without a BA: A state-by-state analysis*, Georgetown University Center on Education and the Workforce, November 2017.

[56] Chris Weller, "IBM's concept of 'new collar jobs' could be vital in an automated future," *Business Insider*, January 6, 2017; Anita Balakrishnan and Berkeley Lovelace Jr., "IBM CEO: Jobs of the future won't be blue or white collar, they'll be 'new collar,'" *CNBC*, January 17, 2017; Michael Chui, James Manyika, and Mehdi Miremadi, "Four fundamentals of workplace automation," *McKinsey Quarterly*, November 2015.

frontline salespeople will have more time to interact with customers and improve the quality of offers. Mortgage-loan officers could spend less time inspecting and processing rote paperwork and more time reviewing exceptions. Automation thus will have a tangible effect on job profiles across different industries, yielding new job descriptions.[57]

Growing role of independent contractors and freelancers as project-based work gains in prominence

Another important byproduct of the move toward more team-based work and agile organizations is the potential for companies to hire independent contractors to supply specific skills at specific times. In our survey, greater use of various types of freelancers and temporary workers is one of the top organizational changes. When asked about what types of labor company leaders were planning on using most in the future, 61 percent said they expected to hire more temporary employees (Exhibit 18). Another option is to use external contractors on an individual basis or through agencies.

Exhibit 18

Companies of all sizes plan to use temporary employees and external contractors more than outsourcing agencies.

Based on McKinsey Global Institute workforce skills executive survey, March 2018

Q: With regards to contracting freelance or consulting workers, which of the following types of labor do you expect to be the most important for your organization in 3 years from now?

% of respondents, up to 2 responses

NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

For companies, growing use of contractors has several benefits. It enables them to hire specific types of talent and fill gaps in their workforce skills, and to transform some of the fixed costs. Digital platforms have allowed companies to source specific types of skills and talent to identify potential candidates. The independent workforce could consequently continue its growth in the future.[58]

Digital platforms create large-scale marketplaces where workers connect with buyers of services. In doing so, they are transforming independent work, building on the ubiquity of mobile devices, the enormous pools of workers and customers they can reach, and the ability to harness rich real-time information to make more efficient matches. Specifically, there are three types of platforms for independent work. First, platforms for labor services match individual workers with customers who desire their services (for example, Upwork, Freelancer.com, Uber, Lyft, or Deliveroo). Second, platforms for selling goods function as

[57] Michael Chui, James Manyika, and Mehdi Miremadi, "Four fundamentals of workplace automation," *McKinsey Quarterly*, November 2015; Craig Guillot, "Advanced manufacturing is creating 'new collar' jobs, NAM president says," *Chief Executive*, February 26, 2018.

[58] Ibid. *Independent work*, October 2016.

e-commerce marketplaces. Some of these platforms are sector specific. For example, in retail, platforms such as Etsy and DaWanda enable individual artisans including potters and blanket knitters to sell their goods directly to customers globally. In healthcare, San Diego-based Freelance Physician, provides a marketplace for healthcare professionals. Finally, there are platforms for renting out assets. These have given rise to the sharing economy model. Besides pioneer Airbnb, other platforms allow people to make use temporarily of assets including cars (for example, BlaBlaCar), fashion (Rent the Runway), and yachts (Boatsetter). In 2016, these online marketplaces were used by 15 percent of independent workers. The rapid growth of the largest platforms suggests that we may only have just begun to see their impact. Companies could also use platforms internally to match the best-suited talent when staffing teams.

Previous MGI research documented both the large share of the workforce earning income through independent work and the strong satisfaction of many of those who work independently out of choice.[59] MGI research finds that up to 30 percent of the working-age population in the United States and in the EU-15 earn income through independent work arrangements, including freelancers, contractors, temporary workers placed by staffing agencies, and participants in the online gig or sharing economy. Over 70 percent of these people participate in independent work by choice. A survey by Upwork and the Freelancers Union projects that at current growth rates, over half of the labor force will be independent workers by 2027.[60]

C-SUITE EXECUTIVES AND HUMAN RESOURCE FUNCTIONS WILL ALSO NEED TO ADAPT TO THE NEW AUTOMATION ERA

To bring about these changes is not simply a question of giving orders. Changes of skills and of mindset are also needed in C-suite and HR departments, as companies seek to reap the full benefits of automation and AI. An understanding of the technology is a starting point. In our survey, 19 percent of respondents said their top executives lacked sufficient understanding of technologies to lead the organization through the adoption of automation and AI—the second-highest rated barrier to automation and AI adoption. Senior executive acceptance of technology adoption is crucial.[61] An executive team that itself does not understand the technology enough to see all the potential opportunities cannot lead the significant business process redesign and organizational transformation required. While we are not saying that CEOs and their teams need to become AI experts, they do need a basic understanding of the different types of AI and how they can be applied in a business setting.[62]

Human resources will also need to change as technology alters the way organizations work and the size and nature of the workforce. Nearly all business leaders we surveyed (88 percent) said they believe HR functions will need to adapt at least moderately. However, there are stark differences in perceptions depending on the expected adoption of automation; 36 percent of extensive adopters expect HR functions will need to be fundamentally changed, compared with 19 percent for limited adopters (Exhibit 19).

Across industries, leading companies are promoting the role of the chief human resources officer (CHRO) to join the CFO and CEO as the leadership core.[63] By linking talent and financing, the G3 will work constantly to ensure that both talent and finance will be

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59 Ibid. *Independent work*, October 2016.

60 *Freelancing in America 2017*, Upwork and Freelancers Union, October 17, 2017.

61 Jonathan Bailey and Tim Koller, "Are you getting all you can from your board of directors?" McKinsey.com, November 2014; Laszlo Bock, *Work rules! Insights from inside Google that will transform how you live and lead*, London, John Murray, 2015.

62 See *Notes from the AI frontier: Insights from hundreds of use cases*, McKinsey Global Institute, April 2018.

63 Ram Charan, Dominic Barton, and Dennis Carey, *Talent wins: The new playbook for putting people first*, Harvard Business Review Press, 2018.

appropriately linked in all mission-critical decisions, operations, and planning. "People allocation is as powerful as financial allocation," explains Aon CEO Gregory Case, who works closely with CHRO Tony Goland and CFO Christa Davies to make sure the multinational has the right talent to meet the challenges of the future. "We work together to make talent decisions and integrate solutions. Pure capital allocation standpoint is essential, but that's not enough. Do we have the right talent in place? How should we think about talent development?"[64] For the CHRO to play this strategic role, knowledge of the business operations is essential. This is why many companies are developing business unit executives rather than HR experts for the CHRO role. These CHROs delegate the more administrative aspects of the job to others and focus on the strategic and operational issues of building the workforce of the future.

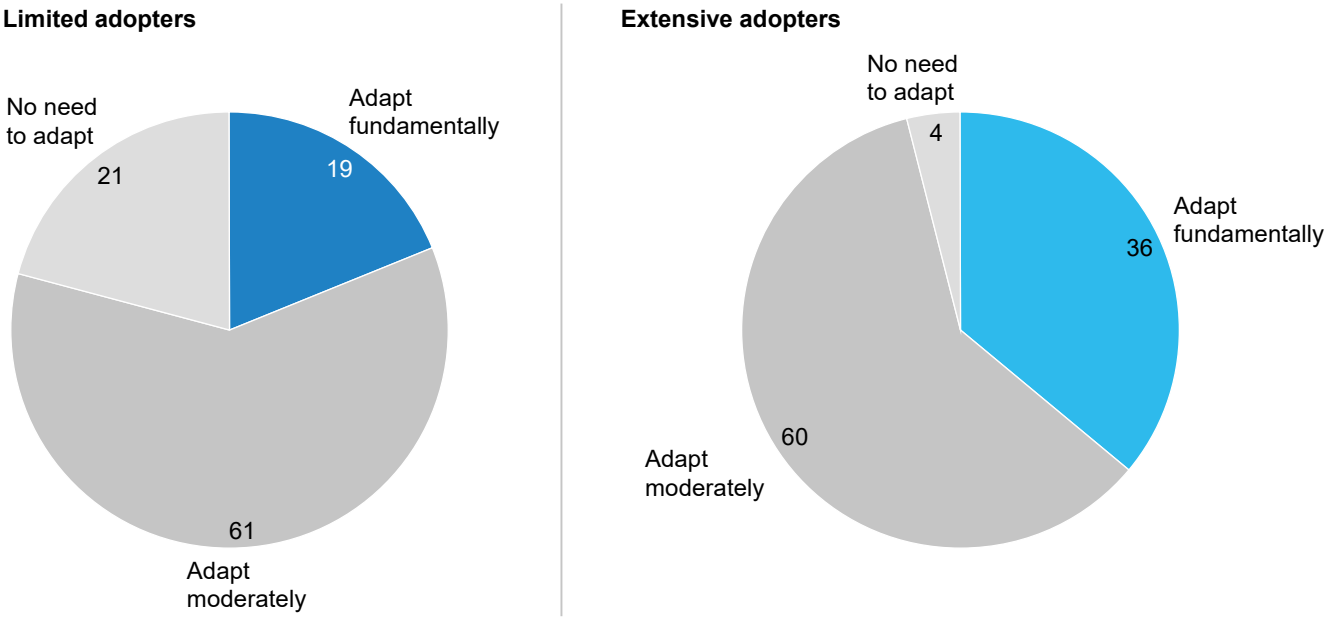
Exhibit 19

Human resources functions will need to adapt to the new era of automation and AI.

Based on McKinsey Global Institute workforce skills executive survey, March 2018

Q: To what extent do you think your organization's Human Resources function will need to adapt in response to the changing workforce?

% of respondents, single response



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States. Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

•••

Adopting automation and AI in the workplace will be an organizational challenge for companies, with significant repercussions for how they think about their operations and how they deploy their workforces. The skill shifts of their workforces will be both a driver of their organizational changes and one of its consequences. In the final chapter, we look at the different options companies have in building the workforce of the future.

[64] Ibid.

4. BUILDING THE WORKFORCE OF THE FUTURE

At a time of more rapidly changing skill requirements and new organizational structures, companies face a substantial challenge in preparing their workforces for the new era. As we have seen from the results of our survey, most firms do not foresee mass substitution of humans by machines as the answer (although in some specific industries and occupations, this may be the case). Rather their focus is on building a workforce with the right skills to complement the new technologies and enable the company to harness their power. That will be a significant challenge not just for the companies themselves, but for society more broadly as it seeks to construct a "learning economy" in which workers' skills continue to evolve, keeping pace with innovation.[65]

In this chapter, we lay out actions that companies can take to build a workforce that is appropriate for their future, and we discuss the experience of some organizations that have already undertaken this mission. The right mix of actions will vary from sector to sector and from company to company, depending on sector dynamics, company positioning, and other considerations. But some elements are common to all sectors across the economy: the imperative to continuously upgrade skills of all workers over time; the need to retrain and redeploy some employees as business models change; the importance of being able to hire or contract new talent to fill gaps (particularly individuals with advanced technology skills); and the need to manage the individual and societal implications when workers are released. The stakes are high for both companies and workers, whose wages could stagnate or even decline, if they are unable to upgrade their skills to meet the requirements of the new era.

LACK OF SKILLS SEEN AS A BARRIER TO REAPING BENEFITS OF AUTOMATION

Companies view lack of talent and skill mismatches as barriers to reaping the benefits of automation. If they cannot source the talent they need to deploy the new technologies, and if they cannot upgrade the skills of their workers fast enough, business leaders worry that this could hurt their financial performance, impede their growth, and lead to the departure of top-performing employees. Their main concerns include employees who do not upgrade skills fast enough, are not sufficiently adaptable to move to new types of work, or lack requisite technical skills (Exhibit 20). These survey results largely corroborate other barometers of company sentiment about concerns over workforce skills and their potentially negative impact on performance.[66]

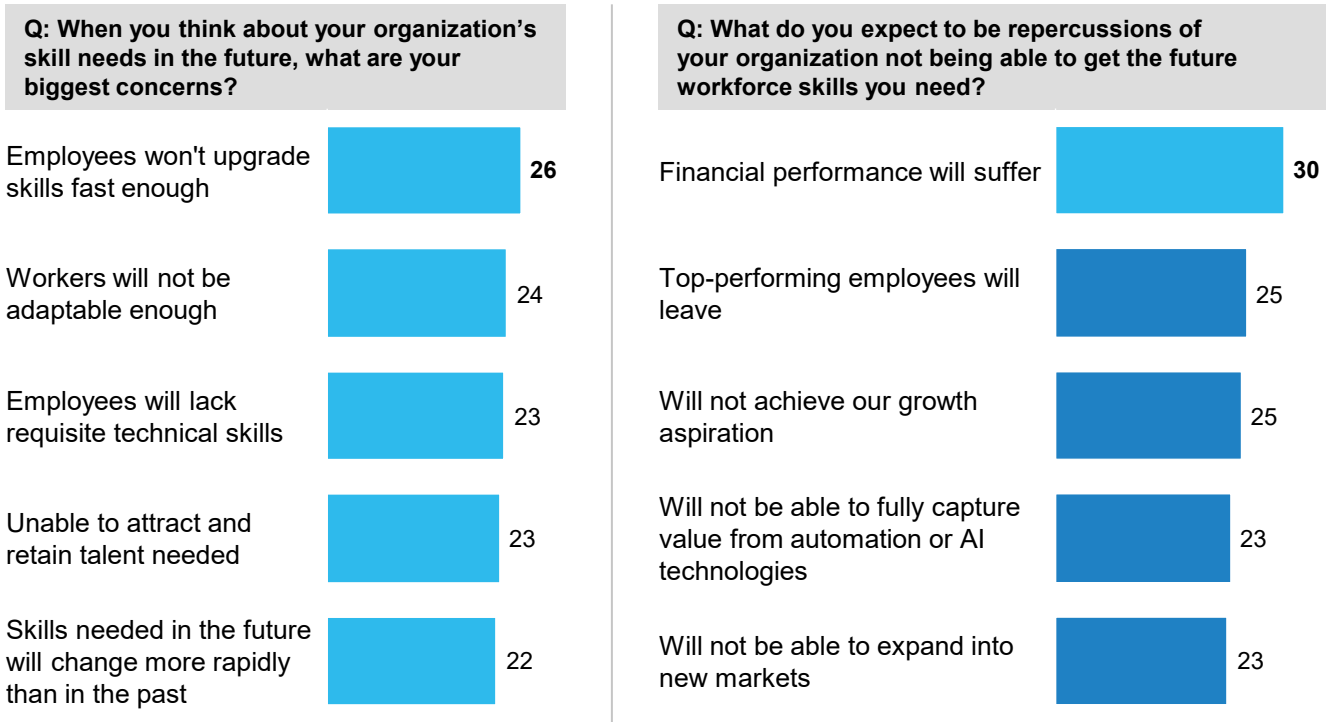
[65] See Bengt-Åke Lundvall, *The learning economy and the economics of hope*, London, Anthem, 2016; Joseph Stiglitz, "Creating a learning society," The Amartya Sen Lecture, June 28, 2012.

[66] In a February 2018 McKinsey survey of 750 executives, almost 30 percent of respondents perceived the skills gap to be the biggest challenge their companies would confront they began their automation efforts. This was the second most cited response after the need to understand the business opportunity of automation and AI.

Exhibit 20

Companies fear that their financial performance will suffer if their workforce does not acquire the skills needed for the automation era.

Based on McKinsey Global Institute workforce skills executive survey, March 2018
% of respondents, up to 3 responses



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

FIVE ACTIONS TO BUILD THE WORKFORCE SKILLS THAT MATTER IN THE FUTURE

There are five main types of actions that companies will take to build the workforce of the future: retrain, redeploy, hire, contract, and release. The combination of options that firms adopt will depend to a significant degree on the automation potential for their businesses and their current workforce skills and dynamics. Companies that seek to aggressively invest in automation to innovate, grow, and capture market share will face a different challenge from those focused on using automation to heighten efficiency in slower-growing businesses.

Each of these categories includes several different specific actions that can be taken and different options that can be pursued. We explore the details of each in the sections below.

Retrain

This involves three distinct actions: raising the skills capacity of current employees by teaching them skills that are new or qualitatively different; raising the existing skills of an employee to a higher level or to keep pace with technological change; or hiring entry-level employees with the goal of training them in the new skills needed.[67] All of these types of retraining and training ensure that in-house functional knowledge, experience, and understanding of company culture are preserved, even as employees acquire the skills they need. This type of investment in human capital can also affect worker motivation and loyalty. Training may require longer-than-usual lead time, however, and the setup costs may be high. A key choice for companies will be whether to pursue training using in-house resources and programs tailored to the company, or to partner with an educational institution to provide external learning opportunities for employees (see Box 6, "A tale of two companies: Differing approaches to the retraining challenge"). Our executive survey responses show that companies plan to focus retraining efforts on skills that are deemed of strategic importance to the company, such as advanced IT skills and programming, advanced literacy skills, critical thinking, and problem solving. In contrast, they are more likely to hire from outside for less complex skills. As discussed in the first chapter of this paper, retraining employees for specific technology or STEM skills is more apparent today than figuring out how to upgrade or impart "soft skills" such as empathy, managing others, and communication, or "intrinsic skills" such as critical thinking or creativity.[68] Making progress in these latter categories of skills will become increasingly important for companies and, more broadly, for educators.[69] Other research we have conducted on the impact of automation and AI in individual Northern European countries highlights the significant return on investment that can be achieved through retraining (see Box 7, "The return on investment from retraining: Evidence from Northern Europe").

Redeploy

A second action is for companies to redeploy workers with specific skills around the firm, thereby making better use of the skills capacity already available to them. They can do this by unbundling the tasks within a job and then rebundling them in different ways, as discussed in the second chapter of this paper; by shifting parts of the workforce to other tasks that are of higher importance or to other entities; or by redesigning work processes, the execution of which depends only partially, or not at all, on external stakeholders. Examples include the German postal service, which is piloting a joint project with the city of Bremen, healthcare services, and welfare associations. Instead of just distributing letters, mail carriers will also look after elderly citizens as part of their daily routes. They will ring the bell of senior inhabitants, ask about their well-being, provide information about care services, or call medical aid in case of emergency. This could both boost revenues for the postal service and reduce cost for care providers.[70] Such redeployment activities ensure that skills are used where they are needed. However, redeployment does not increase the overall capacity of skills within the workforce. In a McKinsey survey of company leaders in February 2018, 55 percent of respondents from companies with $1 billion or more in annual revenue said they would move more people laterally into different or brand-new roles than release them, which underlines the importance of redeployment in conjunction with retraining.[71]

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67 These are sometimes referred to as "reskilling" and "upskilling."

68 George Anders, *You can do anything: The surprising power of a "useless" liberal arts education*, New York, Little, Brown and Company, 2017.

69 Scott Hartley, *The fuzzy and the techie: Why the liberal arts will rule the digital world*, New York, Houghton Mifflin Harcourt, 2017.

70 "Wie sich Brieftraeger kuenftig um Senioren kuemmern sollen," *Frankfurter Allgemeine Zeitung*, April 9, 2018.

71 See the results of a forthcoming 2018 McKinsey & Company Global Survey on automation, to be published in June 2018.

Box 6. A tale of two companies: Differing approaches to the retraining challenge

Irrespective of their expected level of automation adoption, most companies we surveyed see a significant need for their workforces to upgrade their skills and continue to learn and adapt throughout their working lives. Two companies on either side of the Atlantic provide a contrast in approaches to retraining: SAP and AT&T.[1]

Both firms are incumbents in the technology and telecom industries with business models that are undergoing rapid change. AT&T has moved from being a telephone company to a data-powered entertainment and business solution company that requires advanced technical skills, including coding and data science. SAP, a software company, is adopting an Industry 4.0 growth strategy that involves disrupting its existing value chains and product portfolios toward offering more advanced solutions, such as public cloud and machine learning. Each company is starting with a relatively educated workforce, but one that lacks the cutting-edge skills needed. Both plan to retrain up to half their current workforces.

SAP has taken an in-house approach to raising workforce skills. The company first undertook an action-oriented analysis of the current skills supply relative to the future skills demand based on its future product portfolio derived from its strategic business priorities. This led to the quantification of a "skills gap"—and the definition of action areas to address it—both for the existing workforce and for external resources. To source the needed external talent, contracting and strategic hiring were envisaged. As for the current employee base, retraining was designed to address the largest portion of workers, while redeployment in the form of physical relocations accounted for a minor fraction. To fill its future skill needs, SAP mapped comprehensive end-to-end "learning journeys" for thousands of employees to help them transition into new roles or content areas. These learning journeys are based on a blended approach that relies on a sequence of classroom training courses provided in-house, followed by several weeks of on-the-job practice in the new roles or content areas and underpinned by coaching. Overall learning journeys may take between six and 18 months to complete. Shorter-term learning modules were also developed to close specific skills gaps.

AT&T's approach focuses on external partnerships with educators and employee choice. Like SAP, it began by mapping out how its workforce skills will change in the coming years and posting the roles that it believes will decline or grow.[2] An online portal allows employees to see which jobs are available, the credentials and skills required, and whether the role is projected to grow or decline. As part of the transition, AT&T also radically simplified role profiles, consolidating 250 roles into only 80. To enable its workforce to gain the skills needed, AT&T developed a broad set of partnerships with 32 universities and multiple online education platforms to enable employees to earn the credentials needed for the new digital roles. For instance, with Georgia Tech, it has created an online master's degree in programming. It has also created "nanodegree" programs with the online platform Udacity that allows employees to learn specific skills in less time. AT&T covers the tuition for these training programs, and individuals pursue them on their own time. So far it has spent more than $250 million on training and tuition aid for employees since 2013. The results are starting to show: as of March 2018, more than half of its employees have completed 2.7 million online courses in areas such as data science, cybersecurity, agile project management, and computer science. The company has awarded 177,000 virtual "badges" to about 57,000 employees on their internal career profile pages, indicating they've completed the coursework. According to the company, employees that are currently retraining are two times more likely to be hired into one of these newer, mission-critical jobs and four times more likely to make a career advancement.[3]

As a result, both companies are seeing substantial numbers of employees changing their roles or activities. At AT&T, retrained workers are twice as likely to obtain technology and operations management roles than non-retrained workers.

1 *Work in progress: How CEOs are helping close America's skills gap*, Business Roundtable, June 2017.
2 John Donovan and Cathy Benko, "Inside AT&T's talent overhaul," *Harvard Business Review*, October 2016.
3 Susan Caminiti, "AT&T's $1 billion gamble: Retraining half its workforce for jobs of the future," *CNBC*, March 13, 2018.

Box 7. The return on investment from retraining: Evidence from Northern Europe

Other research we have conducted suggests that the return on investment from retraining programs can be significant.

We examined AI and automation adoption in nine Northern European countries that are digital front-runners, in terms of acceptance and deployment of the fast-evolving technologies.[1] However, given the current trajectory and potential from AI, these countries will likely see an increase in the imbalance in the skills most in demand, which in turn will affect the productivity gains potential of the technology adoption. To overcome this potential future skills gap will require large-scale retraining. Our ongoing research finds that this retraining will generate returns that will likely increase in coming years.

The Netherlands is one example. The ongoing research estimates that about 800,000 Dutch workers will need to upgrade their skills. Historical returns to retraining investments amount to between 7 and 9 percent, divided 70-30 between employers and employees. The gains to society are directly related to positive productivity and labor effects. Retraining programs for AI have a higher return of between 13 and 25 percent, according to this preliminary analysis, based on an estimated 15 percent increase in productivity.

In Sweden, the ongoing research also finds potential future mismatches for several skills categories, including advanced cognitive and some social and emotional skills, as well as digital skills. As in the Netherlands, successful retraining and upgrading of skills could give a substantial boost to productivity, as well as leading to a more mobile workforce and ensuring that workers are more readily employable. Overall, this could generate a return on investment in skills training estimated to be as high 30 percent after tax, according to ongoing research.

1 *Shaping the future of work in Europe's digital front-runners*, McKinsey and Company, October 2017.

Hire

Acquiring individuals or entire teams of people with required skill sets is another option—although in aggregate the supply of talent in the market may be insufficient for all companies to pursue this strategy. The total cost of hiring may be lower than some of the other options, including retraining, depending on the skills needed. However, hiring is always a risk as to how a person will perform on the job, and is susceptible to talent shortages in the market. To succeed at hiring key talent, companies need to offer an attractive culture and benefits, and consider hiring from nontraditional sources. New digital tools can vastly improve the ability to source, assess, and recruit new talent. By using a variety of data sources, such as social media profiles, online reputational signals, and gamified tests for job candidates, companies can obtain a granular and rich insight into the skills, working styles, and attributes of potential hires (see Box 8, "How digital tools are revolutionizing recruiting, hiring, and retaining talent"). This leads to better matching of workers with jobs, raising employee productivity.[72] Similar tools can streamline the process of interviewing and onboarding candidates as well, freeing up valuable time of the employees who previously undertook those tasks.[73] Previous MGI research has found that full use of the suite of digital talent management tools can raise overall profit margins by 350 basis points on average—and by far more in industries that rely on highly skilled, highly paid talent.[74] Beyond hiring, retaining employees with scarce talent, or increasing the hours they work, may similarly increase internal skills capacity.

72 *Realizing human potential in the Fourth Industrial Revolution*, World Economic Forum white paper, January 2017.

73 See Laszlo Bock, *Work Rules! Insights from inside Google that will transform how you live and lead*, 2015.

74 See Susan Lund, James Manyika, and Kelsey Robinson, "Managing talent in a digital age," *McKinsey Quarterly*, March 2016.

Box 8. How digital tools are revolutionizing recruiting, hiring, and retaining talent

Technology can help with recruiting efforts. Online talent platforms are increasingly important tools for both individual workers and companies to connect talent with jobs.[1] Digital tools—now typically based on machine learning algorithms that improve with use—allow companies to expand the pool of potential applicants they consider, more rigorously assess their skills and aptitudes, and streamline the hiring process. In our survey, 22 percent of companies say they will rely more on digital tools for their hiring.

Getting recruiting right is a high-stakes business. Most companies review a large number of résumés—250 on average—for each position they fill.[2] Hiring executive search firms is expensive. Moreover, up to 80 percent of employee turnover is due to bad hiring decisions.[3]

New data analytics, online gamified assessment tools, and machine learning algorithms are turning hiring decisions from being made on a "hunch" to hard analytics. Analytics can review source data and current employee performance to identify the best channels for hiring and the types of candidates to target. Automated résumé screening and identification of most successful candidates can reduce the time and cost to hire. Analytics can also identify new, non-traditional sources of hiring and remove unconscious bias in recruiting, thereby increasing diversity.[4]

While large companies often create their own proprietary HR analytics tools, external providers are also available. Pymetrics, for example, combines behavioral data from neuroscience exercises with machine learning algorithms to match candidates with jobs. Unilever and Nielsen are among its clients. Candidates play online games that test candidates on 80 attributes, from memory to risk appetite, circumventing the traditional résumé altogether and helping candidates without conventional qualifications. The hotel chain Hilton shortened the average time it takes to hire a candidate from 42 days to five with the help of HireVue, a startup. It analyzes videos of candidates answering questions and uses AI to judge their verbal skills, intonation, and gestures.[5]

Once companies have hired and onboarded employees, they also need to retain them. Arena is a startup that works with hospitals and nursing home companies, where turnover is high. It helps firms consider retention even during hiring. By using data from job applications and third parties to predict which applicants are likely to stay more than a year, Arena says it has reduced its clients' median turnover by 38 percent.[6] Machine learning programs can help employers spot individuals at risk of leaving. A major insurance company, for instance, was experiencing an inexplicably high attrition rate, despite offering retention bonuses. It deployed machine learning algorithms using internal data to predict which employees were at high risk of leaving. With this information, the employer could ensure that supervisors recognized these individuals and addressed concerns about career advancement, workplace issues, and the like. This approach cut the attrition rate in half and eliminated the need for retention bonuses, bringing significant savings.

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1 Ibid. *A labor market that works*, June 2015.

2 John Sullivan, "Why you can't get a job: Recruiting explained by the numbers," *ERE Recruiting Intelligence*, May 20, 2013.

3 Nicole Torres, "It's better to avoid a toxic employee than to hire a superstar," *Harvard Business Review*, December 9, 2015; Laurie Bassi and Daniel McMurrer, "Maximizing your return on people," *Harvard Business Review*, March 2007.

4 "Robot recruiters: How software helps firms hire workers more efficiently," *The Economist*, April 6, 2013; Jean Martin, "A fairer way to make hiring and promotion decisions," *Harvard Business Review*, August 13, 2013.

5 "Hire education: Managing human resources is about to become easier," *The Economist*, March 31, 2018.

6 Arena website, www.arena.io.

Contract

Another set of options is to bring in skills from outside the organization, for example by using contractors, freelancers, or temporary workers from staffing agencies. Companies could also form strategic partnerships, or outsource entire functions. Contracting allows companies to rapidly acquire the skills they need (if such talent is available). As organizations become more agile and work is done in team-based settings, integrating contract workers into the organization becomes more seamless. As we discussed in Chapter 2, the size of the "independent workforce" in both the United States and Europe is already large and is expected to grow further.[75] The potential downsides to this move include potential loss of proprietary knowledge and intellectual property, and poor fit with the company culture. The survey respondents also plan to use contracting to fill mainly noncore or low-skill roles, rather than using it to find high-skill talent. This is a business model we already see in some industries, such as high-tech companies; in these situations, the core engineers are hired on a permanent basis and groomed, while other business functions rely heavily on contract workers. There is some evidence that this focus on contracting mainly lower-skill workers may shift. One of the fastest-growing segments of the independent workforce is highly educated people, with graduate degrees in law and business and even PhD scientists.[76] These skilled workers increasingly recognize their value in the marketplace and are attracted by the flexibility and autonomy that independent work enables. On the freelance platform Upwork, the highest paid occupations can earn up to $200 an hour, including for freelancers with skills in network analysis, computer vision, and chef.io (a programming language).[77] For nontech positions, intellectual property lawyers and other legal experts do well. As work is redesigned around new technologies, tapping into this pool of independent workers may grow.

Release

Releasing employees may be necessary in some companies, particularly in industries that are not growing very rapidly and in which automation can substitute for labor in a significant way. Often, this can be accomplished by reducing or freezing new hiring while allowing normal attrition and retirement to proceed, or by reducing the work hours of some employees. But sometimes it may require laying off workers. Releasing workers can be an opportunity to accelerate workforce transformations, with potentially significant cost savings. However, the risk is that knowledge of the company, culture, and operations is lost. Layoffs can also diminish employee productivity and satisfaction, and can be difficult and costly to carry out. In the face of potentially large workforce displacement, many executives believe their companies have an obligation: in our survey, about 90 percent of respondents express that they have "some" or even "significant" responsibility to help laid-off employees learn new skills or find new jobs.

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[75] Ibid. *Independent work*, 2016; *Freelancing in America 2017*, October 17, 2017.

[76] See Thomas W. Malone, Robert Laubacher, and Tammy Johns, "The big idea: The age of hyperspecialization," *Harvard Business Review*, July-August 2011.

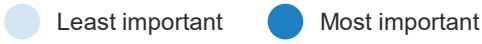
[77] *Upwork blog*, "What are the highest paid skills on Upwork? The top 20 from 2017," blog post by Amy Sept, February 2, 2018, upwork.com/blog/2018/02/highest-paid-skills-upwork-2017/.

THE MIX OF WORKFORCE ACTIONS TAKEN WILL DIFFER BY INDUSTRY DYNAMICS, CURRENT SKILLS, AND NATIONAL FACTORS

Companies will need to make strategic choices among those options, and numerous approaches are possible and likely, depending on the company profile, its workforce, the sector in which it operates, and the ambitions and scope of automation adoption. Exhibit 21 lays out three distinct but non-exhaustive examples of companies in different situations, to illustrate possible approaches.

Exhibit 21

Companies will build their future workforce in different ways, depending on their business model, market dynamics, and current skill mix.



Example	Motivation	Combination of levers					Potential industry examples[1]
		Retrain	Redeploy	Hire	Contract	Release	
Core disruptor	▪ **New technology transforms product portfolio and business model** ▪ Strong overall market growth ▪ Mainly high-skill workforce						▪ Software ▪ Technology ▪ Telecom ▪ Media
Efficiency enhancer	▪ **Automation allows for labor substitution** ▪ Slow/moderate growth potential ▪ Mainly low- and mid-skill workforce						▪ Retail ▪ Banking and insurance ▪ Labor-intensive manufacturing
Human-machine collaborator	▪ **Automation complements labor and raises quality** ▪ Moderate/strong overall market growth ▪ Mainly mid- and high-skill workforce						▪ Healthcare ▪ Advanced manufacturing ▪ Asset management

1 Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States.

SOURCE: McKinsey Global Institute analysis

In the first example, the "core disruptor" company is significantly shifting its product portfolio and business model to take advantage of new technologies. Software, media, telecommunications, and other technology companies are examples, along with some business functions such as marketing. As the AT&T and SAP examples show, their approach to building the workforce skills needed for the future will rely heavily on retraining and redeploying their existing talent, much of which is already highly educated. While some employees will receive training before being redeployed to new and potentially very different roles, new hires and contractors will also be brought in to drive the technology adoption. Only few employees might eventually need to be released.

The second example shown is that of an "efficiency enhancer." These could typically be companies that find themselves in highly competitive industries with pressure on margins and lower overall market growth. Automation may offer significant opportunities to raise efficiency and productivity through labor substitution. Retail, labor-intensive manufacturing, and banking and insurance are examples, along with corporate back-office functions such

as accounting and financial reporting across industries. These industries and functions have significant work activities that can be done by machines. For them, cost reduction will be a key strategic goal of automation. In such environments, releasing employees will be the key action. Some employees may be retrained and redeployed to modified roles, and new hires will focus on technologists, data scientists, and similar roles to create and maintain the deployed technologies.

A third example, which we refer to here as a "human-machine collaborator," is a company for which new technologies are mainly complements to the workforce rather than a substitution. Automation in these industries raises the quality of products and services delivered, but does not require completely new business models. Healthcare, advanced manufacturing, and functions such as marketing and sales are examples. The workforce in these industries is mainly high- and moderate-skilled already, and these companies will look to upgrade the skills of the workforce and redesign work in ways to ensure optimum collaboration between humans and machines. With this approach, many employees will receive training required to augment their roles. A mix of new hires and some temporary contractors will drive the adoption of technology, while few workers will be redeployed and few if any will be released as the business model does not change.

Other possibilities could depend either on the environment, the sector, or the size and the dynamism of the company itself. For example, some fast-growing companies—especially online firms—that are equally ambitious in their automation strategies may have fewer needs to retrain workers. For these dynamic firms, ensuring that they can continuously recruit top talent is a strategic imperative; by consequence their approach will be to leverage their attractive culture to hire actively. They may potentially tap additional external skills through contracting, when required, but their rapid growth makes redeployment and releasing largely unnecessary.

Companies operating in less competitive environments with less potential for automation, such as education and government, may take a different approach altogether, especially if their ability to hire or release is constrained by unions or regulation. Such companies or organizations can see benefits from automation in terms of efficiency and improved quality. But they will typically hire sparingly, partly because it is not seen as a strategic priority and partly because they might have difficulties attracting digital talent for reasons of culture, remuneration, or geography. Retraining is their primary lever to enable their current employees, while technology adoption can be implemented by hiring contractors.

Companies will need to define a portfolio of workforce initiatives and develop strong employee value propositions

Building a workforce that is commensurate with a company's ambitions for automation and AI adoption will require a strategic approach—and time. A first step will be to understand the future talent needs and where critical gaps are to be found in the organization. This assessment stage will need to address questions about the business value at stake in the skills gap.

A second step will be to define a portfolio of initiatives to attend to critical talent needs. As we have noted, CEOs and their teams will need to find the appropriate mix of retraining, redeploying, hiring, contracting, and releasing. They will also need to evaluate how much of the workforce could potentially be retrained and the extent to which hiring and other initiatives could address talent needs. Finally, CEOs will need to execute the talent strategy and leverage existing partnerships, including external stakeholders, to ensure smooth implementation.

Developing a value proposition for employees with the sought-after skills will also be essential. We see four main dimensions to building attractiveness that can be summed up thus: a great company, with great leaders, offering a great job, with attractive benefits. These dimensions touch on a wide range of issues, from whether there is a well-defined business culture with appealing values, and how well leadership motivates and inspires employees, to how interesting the work is, what the opportunities for advancement are, and how employees are recognized and rewarded for their performance. Research by our McKinsey colleagues suggests that people working at companies which successfully develop strong employee value propositions are three times more likely to be satisfied. Such companies are able to attract and retain almost all high performers—and they tend to outperform their peers in long-run stock returns.[78]

National and local factors will also matter, with significant differences between Europe and the United States

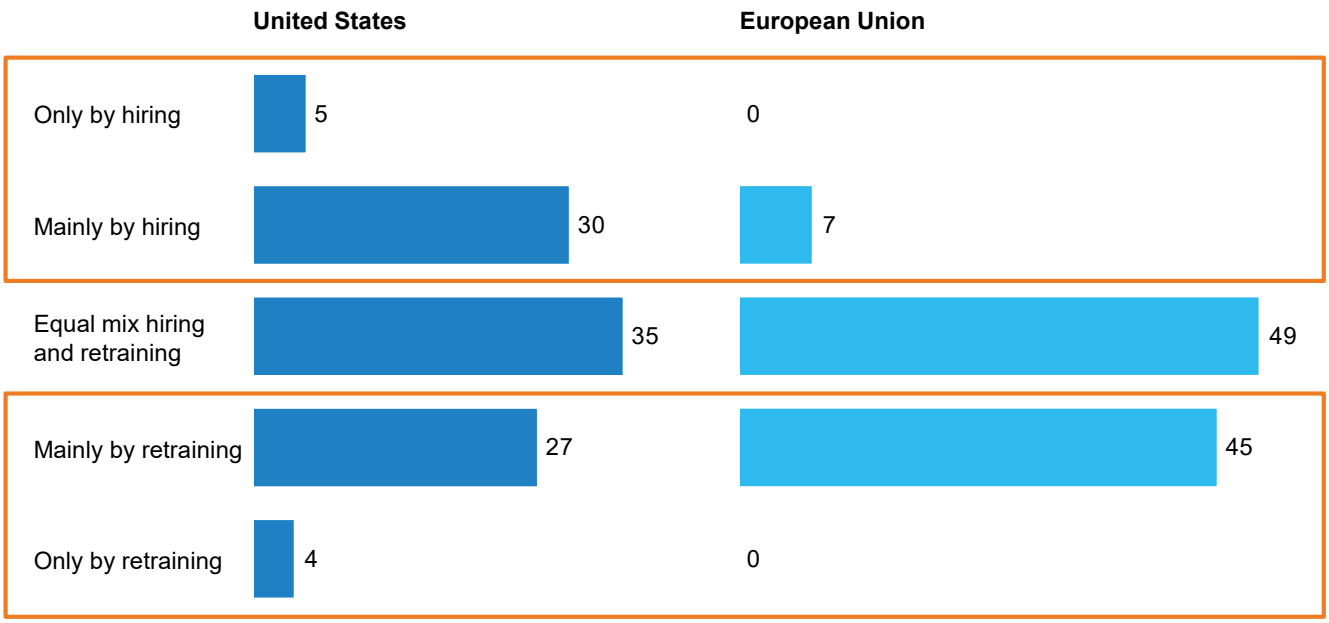
Geography also plays a role in determining workforce skills decisions, with a net difference between US and European companies. In Europe, a much larger proportion of companies—just under half—aims to focus primarily on retraining the existing workforce, whereas in the United States that proportion is substantially lower, at just over one-quarter (Exhibit 22). In the United States, by contrast, hiring is an attractive choice, with 35 percent of companies planning to improve workforce skills only or mainly by hiring, versus just 7 percent in Europe.[79]

Exhibit 22

European companies expect to mainly retrain their workers, whereas US companies also expect to hire.

Q: How can your organization best resolve its potential skills gaps related to automation and/or digitization over the next 5 years?

% of private sector organizations with >$100 million annual revenue who view skill gaps as a top-ten priority



SOURCE: McKinsey & Company *Quarterly* Panel Survey, November 2017 (n = 1,549); McKinsey Global Institute analysis

[78] See also Richard Mosley, "How the best global employers convince workers to join and stay," *Harvard Business Review*, October 2016.

[79] McKinsey & Company Quarterly Panel Survey, November 2017.

These differences likely reflect labor market and cultural factors. In general, releasing workers is a slower and more complicated process in Europe. The Employment Flexibility Index is a measure that combines World Bank data on labor market regulation such as for hiring, working hours, or termination of work contracts. The index shows a range between the United States, ranking second highest with 92.4 of 100 possible points, and large European economies such as Germany (63.5 points), and France, ranking lowest, with 39.4 points.[80] These differences translate into a reluctance to hire—and release—employees in European countries. Moreover, European companies can have incentives to retain their workforces, even in difficult times.[81]

COMPANIES WILL NEED TO BECOME MORE ADAPTABLE AS THEY TRANSITION THEIR ORGANIZATIONS AND WORKFORCES TO THE NEW AUTOMATION AGE

Adaptability will be a hallmark of the transition to a new era. We use the term adaptability to express a company's ability to adjust its organization and workforce for the transition toward a more automated future.[82] We used our survey responses to help gauge the level of that adaptability.

The survey asked respondents about the structural changes they plan to make as they automate work, and one possible response is to increase their organizational agility. We also ask about whether they believe their workforce will need to become more (or less) adaptable in the future. Exhibit 23 shows the results of those two questions, with responses grouped by sector. Organizations in some sectors, such as education and government, do not plan to increase their organizational agility and see little need to increase their workforce adaptability. Not surprisingly, these sectors also rank low on their level of digitization, according to MGI's Industry Digitization Index.[83] Other sectors, including banking and insurance, energy and mining, and manufacturing, are experiencing a great deal of disruptive change and have plans for increasing organizational agility and believe they need to boost workforce adaptability.

Overall, more companies are planning to increase agility in their organizations than see adaptability of workers as a constraint. This reflects rigid internal structures and lack of flexibility today that will stand in the way of transformation and innovation. Not surprisingly, companies that plan to increase their agility in general also see the need for a more adaptable workforce. As discussed in Chapter 2, changes in both top management and in HR teams will be needed to enhance the adaptability of firms and enable them to seize the opportunities presented by new technologies.

In the future, several dynamics may increase the need for adaptability of organizations. First is the potential disruption of a sector, reflected in factors such as the speed of automation and AI adoption, the rise of new competitors in the sector, or an overall strengthening of competitive pressures. Second is how flexible or rigid a company's internal operations are. The third factor is how much of the workforce will be affected by automation adoption—in other words, the relative amounts of retraining, redeployment, hiring, contracting, or releasing as percentages of a company's current workforce. Companies facing high levels of disruption and workforce change, and with rigid internal structures, will have the greatest need to improve their adaptability. The core disruptors highlighted above require high levels of adaptability as they embark upon new business models and large-scale workforce transformations. For efficiency enhancers, in contrast, adaptability is somewhat

[80] *Employment Flexibility Index 2018: EU and OECD countries*, Lithuanian Free Market Institute, 2017.

[81] *The German work-sharing scheme: An instrument for the crisis*, International Labour Office, Geneva, 2010.

[82] Others define adaptability differently, such as being able to read and act on signals and manage complex multi-company systems. See Martin Reeves and Mike Deimler, "Adaptability: The new competitive advantage," *Harvard Business Review*, July 2011.

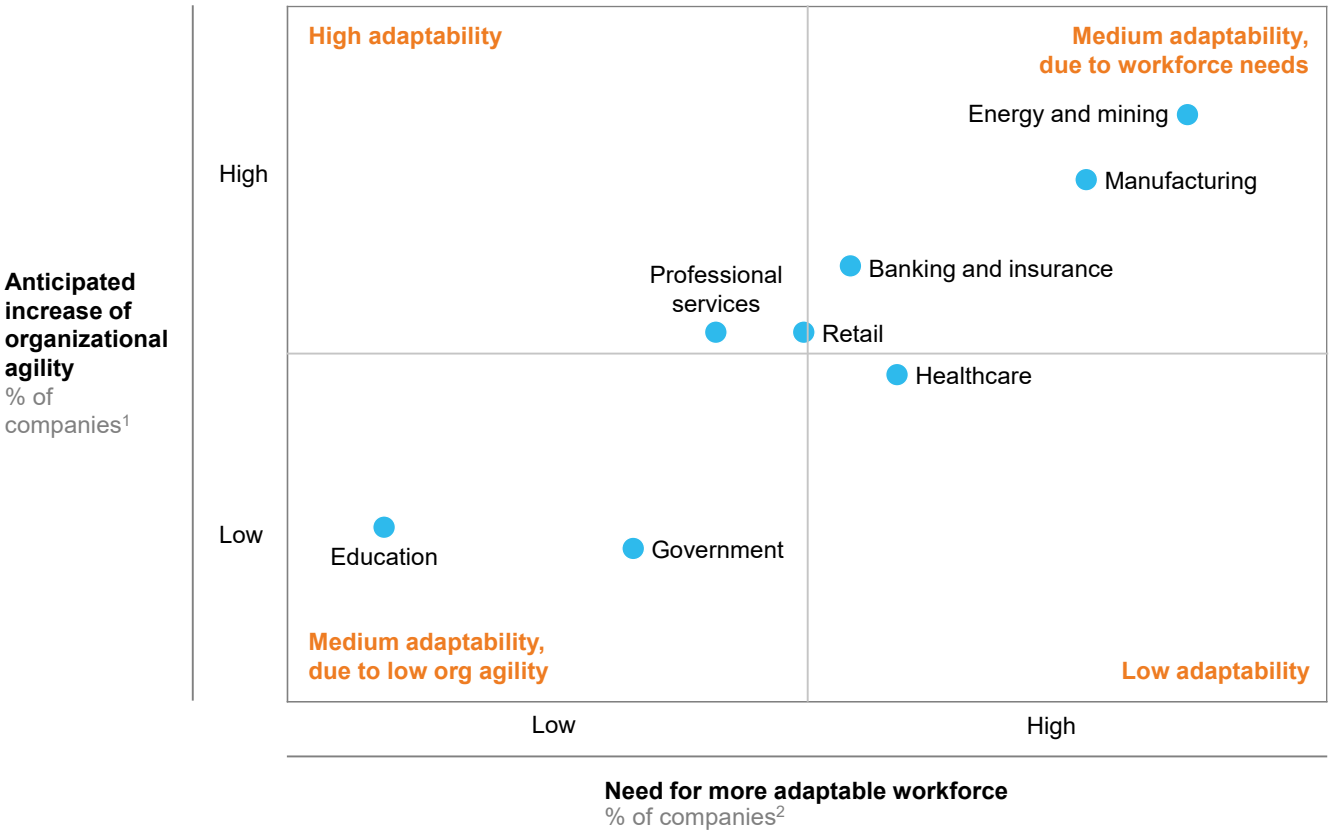
[83] Ibid. *Digital America*, December 2015; *Digital Europe*, June 2016.

less since they will release many workers and hire or contract new people to build their technology capabilities.

Exhibit 23

Organizational agility and workforce adaptability skills define the adaptability of a company to digital disruption.

Based on McKinsey Global Institute workforce skills executive survey, March 2018



Companies that show **high adaptability** to digital disruption score high on 2 factors
- They foresee **more agile ways of working** as a top-priority structural change of organization
- They have a **workforce with high adaptability** and continuous learning skills

1 % of companies that expect to rely on more agile ways of working as one of top 3 structural changes from adopting automation and AI technologies.
2 Difference between % of survey respondents that expect to need more "adaptability and continuous learning" skills and % of survey respondents that expect to need less.
NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States.

SOURCE: McKinsey Global Institute analysis

COMPETITION FOR TALENT WILL BRING HIGHER WAGES AND BENEFITS FOR THE HIGHLY SKILLED, WHILE WAGES FOR OTHERS MAY STAGNATE OR DECLINE

In our survey, we can already see the beginnings of intensified competition for top talent taking shape: companies announce that they will be hiring by adopting a diverse set of actions. About one in four said they would try to use connections to industry associations, offer more attractive wages than competitors, hire from them directly, or broaden their talent sources to attract the talent they need. In some sectors, such as high tech, retail, and healthcare, companies plan to raise wages to get the talent they need, while in banking and insurance, respondents mostly plan to poach from competitors (presumably through more attractive wages and other benefits as well).

Salaries for highly educated workers are set to rise

Respondents in our survey said that individuals with a college degree or higher are more likely to be hired or contracted, more likely to receive retraining, and less likely to be displaced. Likewise, our survey indicates that salaries are also more likely to rise as the educational level of individuals increases, with nearly half of respondents expecting salaries of workers with a graduate degree to rise (Exhibit 24). For lower-skill workers, our survey suggests that more than half of the business leaders surveyed expect no change in wages, with only about one in four expecting an increase.

For some lower-skill workers, wages may fall

More than 20 percent of respondents in the survey see wages for low-skill workers decreasing, and more than half expect them to stagnate. If this expectation becomes a reality, it will exacerbate the already-existing bifurcation of wages between non-routine digital workers whose wages will rise, and lower-skill routine and non-digital workers. Prior MGI research has highlighted the way that rising income inequality in advanced economies following the 2008 financial crisis has stoked political and social tensions.[84]

Companies have varying degrees of confidence about their ability to hire the talent they need

Prior MGI research highlights a growing gap between digital leaders and laggards, with leaders not only benefiting from higher productivity and stronger revenue growth but also paying their workforces higher wages.[85] Our survey suggests that this disparity also extends to confidence about hiring talent. Extensive adopters are highly confident about attracting talent, with 54 percent saying they will be “rather” or “extremely” confident to source the workforce they need, whereas only 18 percent of limited adopters are as confident.

[84] *Poorer than their parents? Flat or falling incomes in advanced economies*, McKinsey Global Institute, July 2016.

[85] Ibid. *Digital America*, December 2015; *Digital Europe*, June 2016.

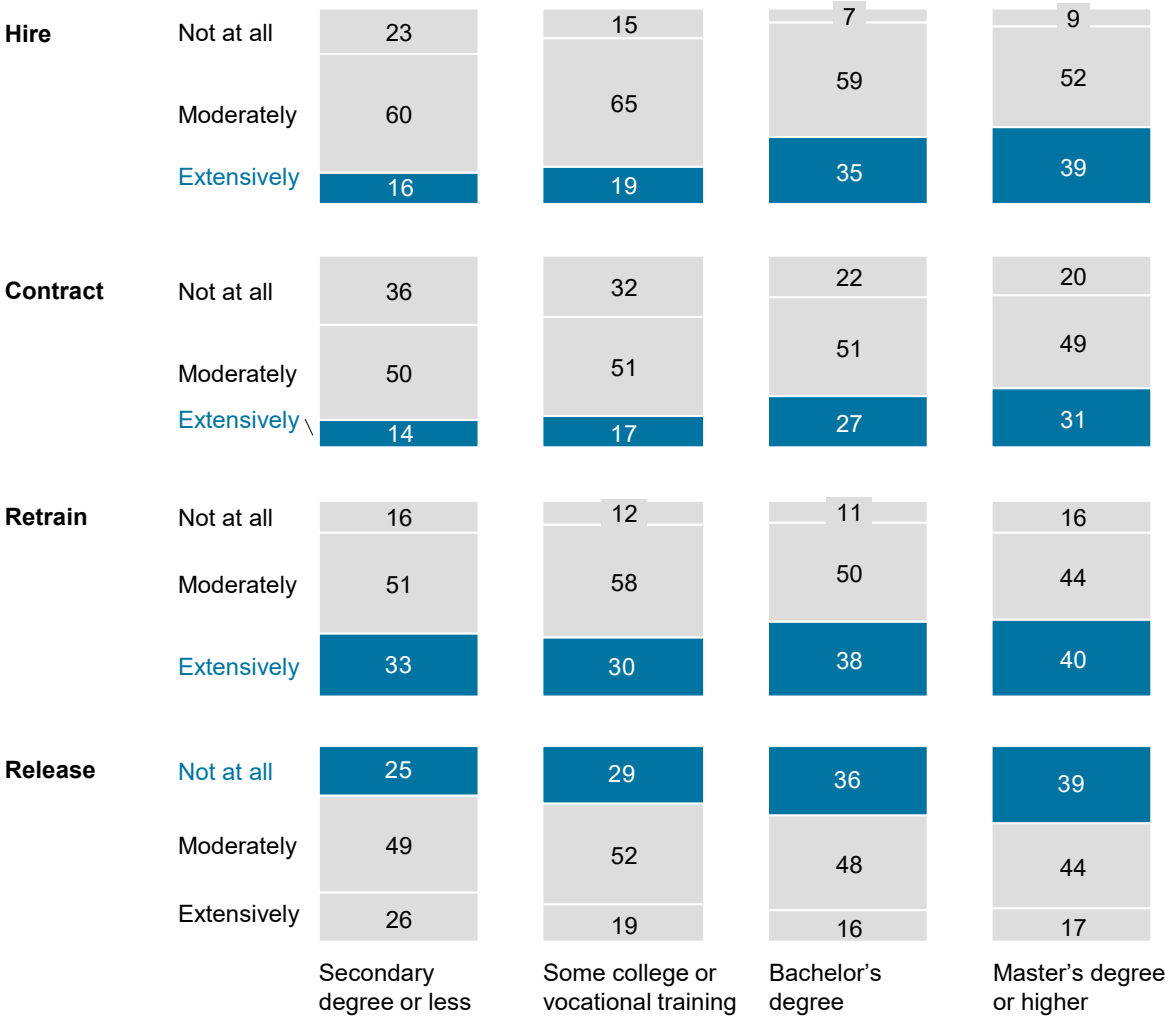
Exhibit 24

Employees with higher education may expect to be more sought after for hiring and contracting, receive more retraining, experience less releasing, and earn higher wages than less educated peers.

Based on McKinsey Global Institute workforce skills executive survey, March 2018

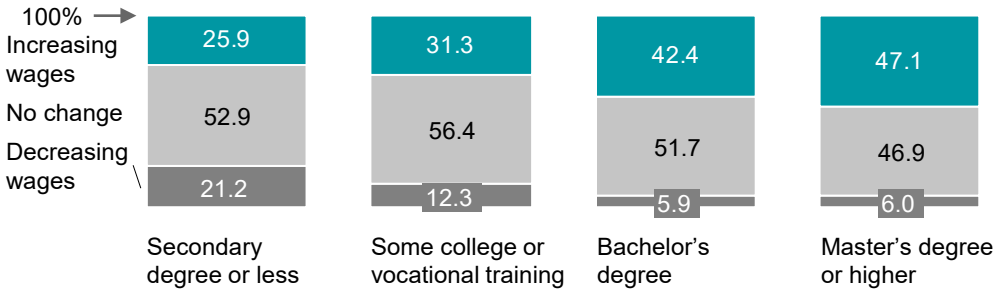
Q: Extent to which workers will be affected by hiring, displacing, contracting and retraining

% of respondents



Q: How do you expect the adoption of automation and AI to change wages of different categories of employees in your organization?

% of respondents



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, the United Kingdom, and the United States. Numbers may not sum due to rounding.

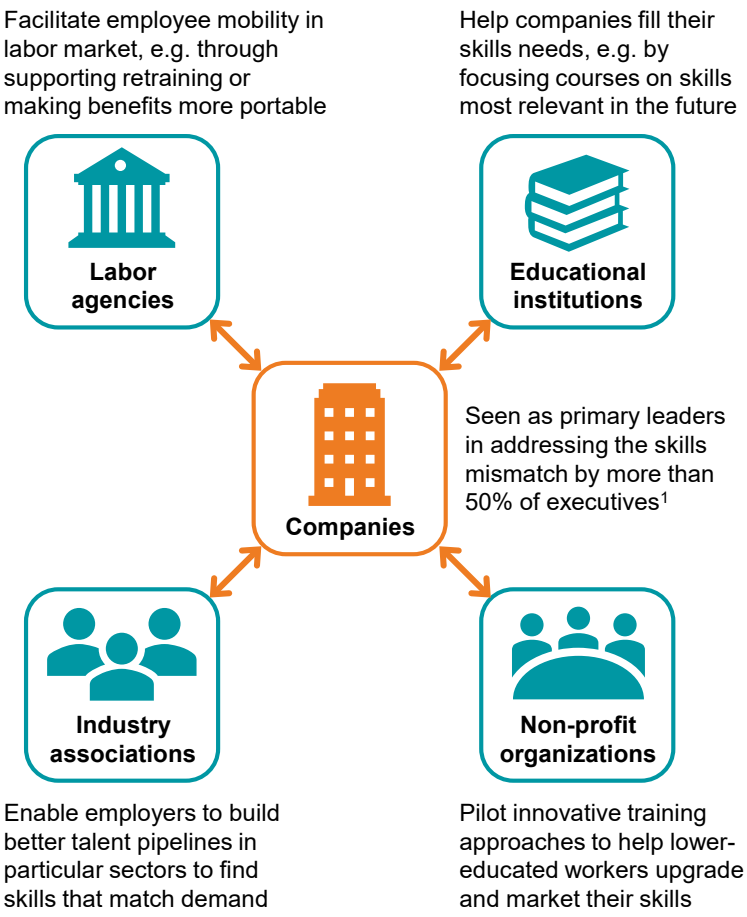
SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

OTHER STAKEHOLDERS ALSO HAVE A ROLE TO PLAY IN BUILDING THE WORKFORCE OF THE FUTURE

Companies can do much to shape the workforce of the future, but other stakeholders also have an active role to play: educational institutions, industry associations, labor agencies, and policy makers, as well as non-profit organizations including foundations (Exhibit 25). Sometimes, partnerships across the ecosystem can be most effective. For now, only 23 percent of US companies and 30 percent of European companies responding to our survey rank partnering with external stakeholders other than educational institutions in the three most important actions to be taken in regard to retraining. Yet already, there are some collaboration programs in a few countries which might provide ideas or inspiration for others. In this chapter we discuss some ideas, while acknowledging that we only skim the possible actions.

Exhibit 25

Companies can call on an ecosystem of stakeholders to help overcome the skills mismatch



> The business side of this is really important. You can't do this, if business thinks labor is just another input where the goal is to minimize cost. That's not the way it works in societies which seem to be succeeding with it mostly. So, I think you need everybody on deck.
>
> – Michael Spence, Nobel Laureate in Economics[2]

1 McKinsey & Company Quarterly Panel Survey, November 2017 (n = 1,549).
2 Video interview with McKinsey & Company, April 2018.

SOURCE: McKinsey Global Institute analysis

Companies can work with educational institutions to help shape curricula and develop needed skills

For now, many companies tend to think in isolation about their retraining programs. In our survey, most firms saw themselves as being responsible for developing and delivering these programs. Only 37 percent of respondents considered it important to build partnerships with educational institutions for effective retraining, for example, compared with 47 percent who planned to do so internally. At the same time, a range of higher education institutions

and other experts have called for universities, colleges, and other educators to play a more active role in filling the needs of the labor market. For example, a 2017 report on German higher education by an association of businesses and foundations called for universities to become more adept at identifying labor market trends and reacting accordingly, including by increasing data science and other high-tech courses.[86] The US Council on Foreign Relations, in a 2018 report on the US workforce, calls for stronger links between education and employment outcomes.[87]

Technology can provide some ways of bridging the gap between educators and companies. Virtual and remote programs are cheaper than classic in-person courses. Ad hoc methods such as massive open online courses (MOOCs), boot camps, and code schools have attracted rising public interest and can sharply reduce the time needed to acquire some skills that previously required classic, degree-oriented programs. Part-time education programs or nondegree certificate courses also allow for broader access than classic full-time programs, especially for the education of adults. However, while MOOCs increase the access to learning opportunities in general, research suggests that people who are already highly educated are overrepresented among today's participants in such courses. To further strengthen the retraining of those underserved today, improved coordination between companies and educational institutions would be beneficial.[88] The case of AT&T discussed above is one example. Companies may find talent with the skills they require more easily if they embrace the benefits of these programs and increase their acceptance of such new formats of education.[89]

The shift in skills that we observe has consequences for the credentialing systems that educational institutions use today. School or university degrees tend to focus on grades that measure skills or knowledge levels in subjects rather than for skills such as problem solving, stakeholder management, or creative thinking—which are becoming more important. Some approaches to measure skills more broadly exist in some countries; in Germany and Switzerland, for example, student behavior is often graded.[90] In principle, such metrics can be a measure of social and emotional skills beyond subject matter. However, grades are not typically determined in separate, dedicated courses for soft skills, but rather synthesized from observations by teachers as to whether students collaborate well or behave respectfully, made in subject matter courses. Educators may need to consider redesigning and establishing new metrics to measure skills in a broader sense. They could also look to teach soft skills such as problem solving or collaboration in a way that is less subject related, for example through making presentations in class, providing detailed critiques on written assignments, and encouraging deeper thinking that explores questions of why and how.[91]

Industry associations and organized labor can improve matching of jobs and skills, including through retraining and talent pipelines

Industry associations and labor unions, working together as social partners, have traditionally played central roles in training efforts in several European countries. Both sets of stakeholders have potentially significant roles to play in addressing shortages of certain skills and retraining in the automation era.

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86 Stifterverband, *Hochschulbildungsreport 2020*, 2017, hochschulbildungsreport2020.de/.

87 *The work ahead: Machines, skills, and U.S. leadership in the twenty-first century*, Council on Foreign Relations, Independent Task Force Report Number 76, 2018.

88 Andrew Ho et al., *HarvardX and MITx: Two years of open online courses*, HarvardX Working Paper Number 10, March 2015.

89 Ibid. *Good jobs that pay without a BA*, November 2017.

90 See for example *Das Zeugnis fuer die Primarstufe*, Zurich Education Directorate, October 2017.

91 Alan D. Greenberg and Andrew H. Nilssen, *The role of education in building soft skills*, Wainhouse Research, April 2015; Herbert Nold, "Using critical thinking teaching methods to increase student success: An action research project," *International Journal of Teaching and Learning in Higher Education*, Volume 29, Number 1, 2017.

At a time when competition for talent is heightening, industry associations can enable employers to collaborate on building more talent faster within a particular sector. In the United States, for example, the US Chamber of Commerce and the National Association of Manufacturers (NAM), an industry association, have formed the Quality Pathways program to create and strengthen "earn and learn" opportunities.[92] The aim is to help employers gain access to the skills they need while providing more affordable career pathways for learners and workers. Their approach is to create a high-quality quality assurance system with increased employer leadership and investment to provide an alternative to accreditation-style business models. In Germany, industry associations typically partner with the labor agency in regional labor markets to identify companies' labor needs. In cities such as Dusseldorf, a strong network of industry associations, educational institutions, and the labor agency informs potential employees about developments on the labor market and educational offers.[93] Associations can also develop and expand apprenticeships, on-the-job training, and other work-study initiatives, to develop required skills in young people. Various programs are successful in Germany and Switzerland.[94]

Labor unions on their own can engage in training initiatives. In the United Kingdom, for example, the Union Learning Fund recruits low-skill workers to participate in relevant training.[95] In some countries with a long tradition of union-management cooperation, joint initiatives are starting to show some success. In Sweden, for example, job security councils funded by companies and unions, but not the state, coach individuals who become unemployed. They provide temporary financial support, transition services and retraining, helping the unemployed find new jobs quickly. They also advise employers and trade unions. Such arrangements among the social partners ensure that more than 85 percent of affected workers find new jobs within a year, causing Sweden to lead the OECD ranking in helping displaced workers.[96]

Labor agencies and policy makers can strengthen support for workers in transition and improve mobility, including with a shift to portable benefits

Appropriate action on retraining and workforce benefits will differ among countries, depending on cultural differences around individual responsibility and the role of the state. In the changing skills environment, policy makers will need to clarify the roles of individuals, companies, and state agencies. Examples of such action include:

- **Revamping labor agencies.** Several European countries have changed the way their national labor agencies operate, by shifting public employment policy from "passive" (unemployment compensation) to "active" (employment agencies becoming "job centers" that manage and facilitate retraining of the unemployed). In Germany, labor market reforms dating to 2002 have helped bring down unemployment from 12 percent in 2005 to 5 percent in 2017 and at the same time raised labor participation. While the number of Germans working has increased, total hours worked have remained constant. This reflects a paradigm shift in which more work has become "shared," that is, more people work in part-time jobs or "mini-jobs."[97] In the United Kingdom, a "work

[92] *Quality pathways, Employer leadership in earn and learn opportunities*, US Chamber of Commerce Foundation, 2018.

[93] Roland Schuessler, "Neues Beratungsangebot in Duesseldorf," *Deutschlandfunk*, October 11, 2017.

[94] *Training in Germany: Go your own way!* Bundesagentur fuer Arbeit, May 2013.

[95] The Union Learning Fund is funded by the British Trades Union Congress.

[96] Andreas Diedrich and Ola Bergström, *The job security councils in Sweden*, Institute for Management of Innovation and Technology (IMIT) report, October 2006; Alana Semuels, "What if getting laid off wasn't something to be afraid of?" *The Atlantic*, October 25, 2017.

[97] Alexander Herzog-Stein, Fabian Lindner, and Simon Sturn, *Explaining the German employment miracle in the Great Recession: The crucial role of temporary working time reductions*, Macroeconomic Policy Institute, June 2013.

first" principle makes benefits and support for job seekers conditional—with sanctions if criteria are not met.[98]

- **More effective spending on adult education.** Higher public spending on adult education does not automatically translate into more participation of employees in such programs. In particular, there is little evidence that it increases the participation of disadvantaged adults, who could profit most.[99] In the United States, an analysis of the Trade Adjustment Assistance Program to retrain displaced workers showed that workers who participate in retraining activities have less income than peers not only while they undergo training, but even several years thereafter.[100] Some research also suggests that unemployment assistance and other types of insurance including disability may discourage work.[101] Policy makers will thus need to investigate ways to make funding for adult education programs more effective. Some countries seek to offer the opportunity to all workers to upgrade their skills. Singapore, for example, has introduced "SkillsFuture Initiative," which provides all Singaporeans aged 25 and above credit of about $400 to pay for approved work-skills related courses.[102] Belgium uses training vouchers to help small and medium-size enterprises raise the skills of their employees.[103] This is particularly effective as companies with fewer than 50 employees can spend as much as 80 percent less on educational training than their larger peers.[104]

- **Moving to "portable" benefits to boost mobility.** One obstacle to the growth of the gig economy is that, under current rules in many countries, independent workers have difficulty obtaining the same social and pension benefits as full-time employees.[105] Past research has focused on establishing key principles for addressing this omission. For example, benefits could be designed to be "portable," that is, not tied to a particular job or company and owned by the workers. Portable benefits would focus on the entire life cycle of a worker, rather than on a specific phase when working for a particular employer. A second principle is for these benefits to be proportionate, in other words, linked to the money earned or time worked. Third, the benefits can be universal, available to all, including independent workers.[106] Some companies that rely heavily on independent workers have recently joined such calls for action.[107] In the United Kingdom, an independent review has proposed clarifying the rights of a third category of workers, between traditional employees and the self-employed, called "dependent contractors." These workers would receive some of the labor market protections of employees, such as the national minimum wage, but would retain the ability to work on flexible

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98 Beth Watts et al., *Welfare sanctions and conditionality in the UK*, Joseph Rowntree Foundation, September 2014.

99 Richard Desjardins, "Cross-national patterns associated with adult learning systems: Patterns of participation, outcomes and coordination," presented at the Fourth PIAAC International Conference in Singapore, November 2017.

100 Ronald D'Amico and Peter Z. Schochet, *The evaluation of the Trade Adjustment Assistance Program: A synthesis of major findings*, December 2012.

101 Edward Alden, *Failure to adjust: How Americans got left behind in the global economy*, Lanham, MD, Rowman & Littlefeld, 2016.

102 See www.skillfuture.sg

103 Ian Stone, *Upgrading workforce skills in small businesses: Reviewing international policy and experience*, Durham University Business School, November 2012.

104 Ans de Vos and Ine Willemse, *Leveraging training skills development in SMEs: An analysis of East Flanders, Belgium*, OECD LEED working paper, November 2017; Ian Stone, *Upgrading workforce skills in small businesses: Reviewing international policy and experience*, Durham University Business School, November 2012.

105 *Self-employment and the gig economy*, UK House of Commons Work and Pensions Committee, Thirteenth Report of Session 2016–17, HC847, May 2017.

106 *Benefits Innovation Fund: Providing seed capital to create innovative portable benefit models*, Aspen Institute Future of Work Initiative, March 2017.

107 See, for example, *Building a portable benefits system for today's world: An open letter to leaders in business, labor and government*, Uber corporate website, January 2018, uber.com.

contracts.[108] In the United States, where companies often provide health insurance and retirement benefits, the idea of portable benefits is gaining momentum.[109]

- **Simplifying cross-sector mobility.** Another area that is becoming a focus of attention is cross-sector mobility—that is, the challenge of helping individuals use their skills in new occupations and sectors. Just as digital ecosystems are forming in which businesses overcome traditional sector boundaries and evolve toward broader, more dynamic alignments, worker mobility will become increasingly important.[110] One example for such efforts is the Australian Industry and Skills Committee, which improves worker mobility through recognition of qualifications between occupations. Cross-sector training programs address new or emerging skills such as general digital skills, automation, cybersecurity, and big data.[111] One flagship project identifies automation skills needed by multiple industry sectors and develops a corresponding training package with the goal of furthering cross-sector employability of those who receive the training.[112] In order for cross-sector mobility to become a common practice, companies will need to agree on definitions and qualifications for specific types of skills. A report by the European Commission finds that a generally accepted skills taxonomy is lacking, and recommends that skill categories need to be updated to ensure greater transferability.[113] Some initiatives are trying to address this, including the Europass CV, which improves recognition of qualifications and skills across borders.[114]

Nonprofit organizations and foundations can work with companies to help workers acquire new skills

Non-profit organizations have a flexibility to develop innovative approaches to issues relating to skills, and some have been testing novel approaches. The Markle Foundation is piloting a program called Skillful which aims to help workers without a college degree upgrade and market their skills. The idea is to focus on both job seekers and employers, and on skills rather than degrees. It brings together companies including Microsoft and LinkedIn, the state government, and local partners, and aims to give educators a clearer picture of which skills are in demand in their areas—and give businesses a better sense of which skills are available in their applicant pools.[115]

Some companies have launched philanthropic initiatives or work with foundations on skills-related issues. Generation provides one example. Launched in 2015, it is an independent non-profit youth employment organization, founded by McKinsey, that seeks to close the skills gap for young people. Generation recruits unemployed and underemployed young adults, trains them in one of 23 professions across four sectors—customer service and sales, technology, healthcare, and skilled trades—and then places them in career-launching jobs. Generation operates in six countries—Hong Kong (China), India, Kenya, Mexico, Spain, and the United States—and will launch in another several countries this year. So far, 19,000 young people have graduated, with a job placement rate of 82 percent at three months post-program with 2,000 employer partners and $55 million in cumulative salary earned to date.[116] The program is now broadening to apply its approach to retraining midcareer workers through ReGeneration.

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[108] Matthew Taylor, *Good work: The Taylor review of modern working practices*, July 2017.

[109] Ibid. *The work ahead*, 2018.

[110] Venkat Atluri, Miklós Dietz, and Nicolaus Henke, "Competing in a world of sectors without borders," *McKinsey Quarterly*, July 2017.

[111] "Cross-sector projects," Australian Industry and Skills Committee, aisc.net.au/content/cross-sector-projects.

[112] "Automation skills project," Skills Impact, skillsimpact.com.au/automation.

[113] *Transferability of skills across economic sectors*, European Commission, 2011.

[114] The Europass helps European citizens make their skills and qualifications understood throughout Europe. europass.cedefop.europa.eu.

[115] Laura Tyson and Lenny Mendonca, "No worker left behind," *Project Syndicate*, April 16, 2018.

[116] *Generation: You employed, Inc.*, www.generation.org.

Skills are a key challenge of this era. The stakes are high. A well-trained workforce equipped with the skills required to adopt automation and AI technologies will ensure that our economies enjoy strengthened productivity growth and that the talents of all workers are harnessed. Failure to address the demands of shifting skills could exacerbate social tensions and lead to rising skill and wage bifurcation—creating a society split between those gainfully employed in rewarding work and those stuck in traditional jobs with diminishing wage prospects. To ensure the former scenario—and ward off the latter—will depend in large part on how well the workforce is trained, and how adaptable companies and workers will prove to be in the face of multiple new challenges from automation adoption. For companies, the organizational and human resources implications are significant. The options of retraining, redeploying, hiring, contracting, and releasing workers may be clear, but finding the appropriate combination will depend on a range of factors, from strategic automation ambitions to the ability to find the required talent to execute on those ambitions. This is not just an issue for companies. Policy makers, labor agencies, non-profit organizations, and business associations and unions will need to work with business leaders to ensure that the conditions are in place for the skills upgrade that will be required. The new imperative of our automation age is the shift to a "learning economy," in which human capital is paramount. The future prosperity of our societies, and the wellbeing of our workforce, depends on whether we are able to attain that goal.

TECHNICAL APPENDIX

In this discussion paper we quantify the nature and size of skills in the workplace in the period 2016 to 2030, and we also report on the results of an executive survey. The quantitative analysis described below is based on models created by the McKinsey Global Institute for two previous reports, *A future that works: Automation, employment, and productivity* (January 2017) and *Jobs lost, jobs gained: Workforce transitions in a time of automation* (December 2017). Each report contains a detailed technical appendix describing methodology and assumptions.

In this technical appendix, we describe how we assigned skills to tasks and how we modeled skill shifts to 2030. We also provide details of the survey we conducted among business leaders to gauge the impact of automation and AI on organizations, workers, and skills.

HOW WE ASSIGNED SKILLS TO TASKS

We sought to quantify the skill shift using a set of 25 workforce skills in five categories: physical and manual, basic cognitive, higher cognitive, social and emotional, and technological skills. These skills are based on previous MGI work, mainly the 17 skills used in the June 2017 report, *Artificial intelligence: The next digital frontier?* as well as other frameworks used externally.

We mapped these skills to individual work tasks by assigning each of the 2,000 workplace activities from the US Department of Labor's O*NET database to a specific skill required to perform the activity. While workers use multiple skills to perform a given task, for the purposes of our quantification, we identified the main skill used.[117] For example, in banking and insurance, we mapped "prepare business correspondence" and "prepare legal or investigatory documentation" to the skill "advanced literacy and writing," which is grouped in the category of higher cognitive skills. In retail, we classified "stock products or parts" into gross motor skills and strength in the category of physical and manual skills, while "greeting customers, patrons, or visitors" is mapped to basic communication skills, in the basic cognitive category.

To quantify skills, we then looked at the number of hours that workers spend performing the activities mapped to that skill. To allocate a specific number of hours to each activity, we combined data on the frequency of each activity in O*NET with the overall number of hours worked in a given occupation. As the number of hours in each activity (by country and by sector) changes with automation and future job growth, so does the number of hours spent exercising different skills.

Since our approach ties each individual activity to a single skill, only pure IT activities such as operating a computer were tagged under "basic digital skills." This understates the importance of this group of skills, as workers' aptitude at working with digital technologies has increasingly become a core part of many jobs that are not typically thought of as "IT" jobs, for example designers today need to be able to work with computer-based design software, and their fluency with digital is a pre-requisite. We consequently applied a digital refinement to correct for the digital component of work not being fully reflected in the activities associated with most jobs. We re-allocated a portion of hours from activities requiring non-technological skills to basic digital skills, to account for their digital requirements. For example, professional driving now often requires the use of GPS and thus some basic digital skills. To determine the magnitude of this reallocation appropriate for each occupation, we use the digital score devised by Mark Muro and colleagues at the Brookings Institution. We relate the digital score to a job's digital content by extrapolating

[117] Our other ongoing research, for example in Sweden, suggests that primary skills account for 50 percent of hours worked, while secondary skills are used less than 20 percent of the time. This suggests that our methodology is robust.

the relationship we identified among the top 50 most common occupations in the ICT sector where the digital component is captured more explicitly. We also assume a continued digitization trend in line with the shift observed in the 2002 to 2016 period.

MODELING SKILL SHIFTS TO 2030

To model skill shifts in the period 2016 to 2030, we quantified net job changes resulting from automation and other macroeconomic trends using an employment model for the period. We also looked at the impact of automation on individual tasks within a given job. This model has four drivers of job loss and gain from both AI and non-AI factors:

- **Job loss due to automation.** We applied automation adoption rates leveraging an automation adoption rate by activity, job, industry, and geography, based on previous MGI research. For this, we assessed the technical potential for automation and then modeled different scenarios for its adoption based on technical and economic feasibility, and adoption and deployment scenarios. Our base case assumes job displacement using midpoint automation adoption rates by 2030 as a percentage of 2016 employment (24 percent for Western Europe, and 25 percent for the United States), defined as an average of rates from our latest and earliest scenarios (respectively 3 and 45 percent for Western Europe, and 4 and 46 percent for the United States).

- **Job loss due to non-AI productivity gains.** We assume that the historical effect of productivity gains on employment of the pre-automation era remains unchanged. As productivity increases, the employment necessary to generate equivalent levels of output decreases, leading to a reduction in total hours worked at constant GDP. Hours worked over real GDP was observed for at least the past ten years, for the United States (-1.2 percent per year) and Western European countries (-0.7 percent per year, where the range is from -0.9 percent for Germany to 0 percent for Italy). These productivity gains are assumed equal going forward.

- **Direct job gain from automation.** We assume half of the job loss due to automation in each sector results in direct job gains in the same sector, which come from innovation generated by the application of AI in new products and services. This accounts for both new technology jobs and other innovative jobs that enable and support AI. We first calculate total job gain in the sector, then assume a percentage of this gain is in tech jobs that follow the distribution of occupations in the ICT sector, which we consider as more advanced. We consider the remaining percentage gain comes from innovative jobs distributed based on an average between the ICT sector and the given sector's occupation distribution.[118]

- **Job gain due to macroeconomic drivers**, including indirect effects from automation. We leverage MGI modeling from previous work on the future of employment, adjusted to our 2030 employment estimates (based on historical and projected productivity gains and employment data). We reflect the micro-modeled impact of the seven job growth drivers previously introduced in our December 2017 *Jobs lost, jobs gained* report. The seven are: rising incomes; aging population; education retraining; investment in technology; domestic services; investment in infrastructure; investment in buildings; and energy transitions. These gains include the indirect productivity gains from automation that will be reinvested in the economy by 2030.

[118] We define ICT as a subset of the NAICS Information sector, comprising telecommunications, data processing and hosting services, and other services including Internet publishing and web search portals.

We then quantified skill shifts implied by the net change in work activities. Because we mapped hours spent on work activities to skills, we can calculate the shift between skills needed today and those needed in the future as a combination of the net change in the distribution of jobs in each sector and the changing mix of activities that constitute each individual job. For each skill, we primarily looked at the relative change between 2016 and 2030 to capture significant increases even among skills that are comparably less common today. This analysis allows us to see a shift in the skills needed to perform a specific occupation as well as to analyze the aggregate trends on an industry or country level.

This methodology has several limitations that we fully acknowledge. First, we used US data from O*NET on the activities within each occupation and assumed that workers in other countries spend similar amounts of time on each activity. Second, our mapping of activities to skills was simplified, as in reality workers may use multiple skills while performing a specific task. Third, we assumed that the skills we assigned to work activities in our mapping remain unchanged. Finally, we could not observe the true skill set of each worker and thus were unable to observe latent skills they may possess but not deploy. Indeed, as noted in the paper, surveys of worker sentiment reveal that large portions of the workforce believe they have more skills than are used.

OUR SURVEY ON THE IMPACT OF AUTOMATION AND AI ON ORGANIZATIONS, WORKERS, AND SKILLS

The survey of companies we quote in this paper was conducted by London-based ResearchNow in March 2018. The sample covered 14 specific sectors of the economy in seven countries: Canada, France, Germany, Italy, Spain, the United Kingdom, and the United States. Companies surveyed had workforces ranging from 30 to more than 1,000 employees and described their level of automation and AI adoption that enabled us to characterize them as limited, moderate, or extensive adopters. We categorized companies that have adopted automation and AI technologies in most of their business processes or throughout their entire operating model as extensive adopters. Limited adopters were classified as those that have not yet adopted automation and AI technologies or only adopted them in some minor business processes. We used quotas for countries, industries (especially the five focus industries of this report), and levels of automation and AI adoption to ensure significant sample sizes per segment (Exhibit A1).

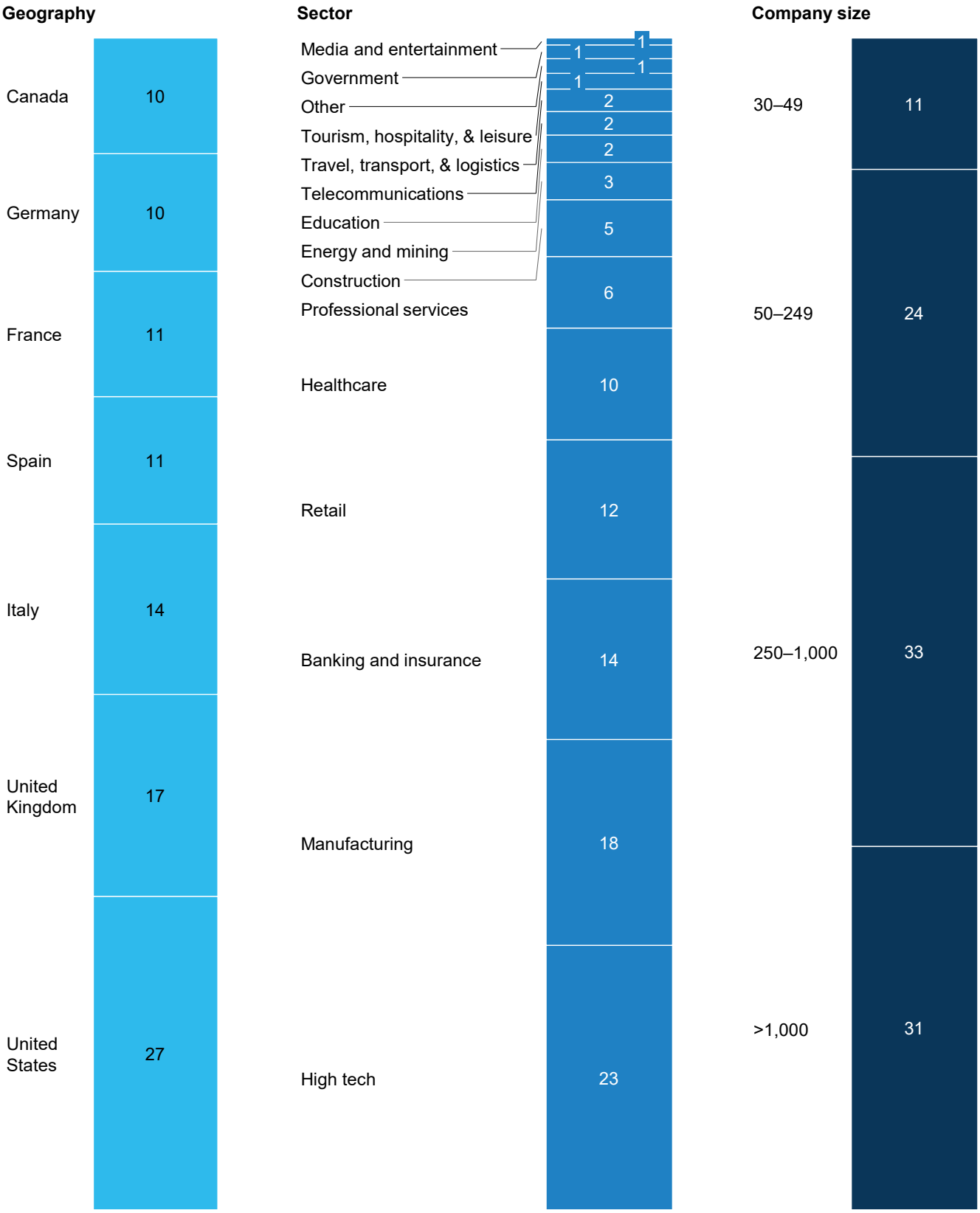
The final survey sample after quality checks and data cleansing consisted of respondents from 3,031 companies. The survey targeted C-level executives from organizations familiar with at least one automation, AI, or advanced digital technology and its application in business from the following list: big data and advanced analytics, machine learning/artificial intelligence algorithms, autonomous vehicles, image recognition, robotic process automation, virtual agents, back-office process automation, wearables, internet of things, personalized pricing and promotions, 3D printing, and blockchain and distributed ledger.

The survey consisted of three sets of questions in addition to basic information about the company and the respondent. The first set asked respondents about the use of automation and AI in their organization, and their attitude towards automation and AI. The second set inquired about how much the adoption of automation and AI is affecting their organization, their structural design, and their workforces. The third set of questions asked how much the adoption of automation and AI has affected the composition of skills in their organization, whether it has created any potential skill mismatches and, if so, among which types of workers. It also asked how organizations plan to address such skill mismatches.

Exhibit A1

Overview of MGI survey on the impact of automation and AI on organizations, workers, and skills.

% of respondents (n = 3,031)



NOTE: Based on results of March 2018 survey of 3,031 business leaders in Canada, France, Germany, Italy, Spain, United Kingdom, and the United States. Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute workforce skills executive survey, March 2018; McKinsey Global Institute analysis

Results were weighted by level of AI adoption, industry, and country. Level of adoption weights were based on an AI intensity score by industry based on the diffusion of AI per sector such that the results reflect the relative representation of different levels of adoption in each sector. Industry weights were based on the number of employees per sector in the different countries such that the results reflect the relative economic importance of sector employment on a national level. Country weights were based on the total number of employees per country such that the results reflect relative economic importance of national workforce sizes. The reported results were tested for statistical significance at the 95 percent confidence level.

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This report contributes to MGI's mission to help business and policy leaders understand the forces transforming the global economy, identify strategic locations, and prepare for the next wave of growth. As with all MGI research, this work is independent and has not been commissioned or sponsored in any way by any business, government, or other institution. While we are grateful for all the input we have received, the report and views expressed here are ours alone. We welcome your comments on this research at **MGI@mckinsey.com**.

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