THE FUTURE OF WORK

How Might New Technologies Affect H-1B Industries and Occupations?

INTRODUCTION

The term “future of work” (FoW) has been used quite frequently over the past several years and has a multitude of implications. In most scenarios, it refers to the rapid changes in the economy and workforce due to automation, new technologies and other trends, including the growth in contingent workers. Evidence suggests the effects on jobs could be significant, though there doesn’t seem to be agreement yet on the details. While there is a dearth of resources for workforce development professionals who wish to stay ahead of these economic shifts, there are still actions that can be taken to prepare.

H-1B industries and occupations could be impacted, requiring individuals to obtain new skills and competencies in their respective industries and occupations in order to be competitive. It is critical for workforce development programs to track shifts in technology and consider how training can be adapted to meet these needs now and into the future, ensuring individuals are receiving the necessary skills to be placed in H-1B occupations and industries. This brief broadly covers some of the new technologies that are changing the workforce, including industrial automation, artificial intelligence (AI) and machine learning (ML), and the Internet of Things (IoT). The section following this introduction focuses on how these technologies may be affecting particular H-1B industries and how programs can adapt training to meet these changes within their target H-1B industries and occupations. With the right approach and some updated practices, workforce development programs can position themselves to help their target populations navigate the FoW landscape successfully.

FoW: TECHNOLOGICAL CONCEPTS

While the FoW is being shaped by many forces—social, cultural, legal, and political—technological advancement is clearly a pivotal one. Some of the tech

nological concepts described in this section are not new—industrial automation, for instance, has been in widespread use for decades, while AI and ML have only recently become more widely used. The third advancement, the IoT, is new compared with automation and AI. Each will be described in turn with a discussion of how they are changing jobs.

Industrial Automation

Going back to the 1960s, early forms of automation such as programmable logic controllers (PLCs) automated areas from simple industrial processes such as controlling lighting and safety mechanisms to more complex ones such as assembly of components. Although PLCs may have replaced some activities originally performed by humans, they still required human labor to program, and at least early on, they did not automate entire industrial production processes—usually only parts of them. PLCs then became part of more sophisticated systems called supervisory control and data acquisition (SCADA) systems, which include a network of devices and machinery that manage full operations across a factory floor or even a large geographical area.[1,2]

In parallel to these developments in systems automation, the use of robotics also became more common.[3] In just the past decade, demand for industrial robots has accelerated, with an average annual growth rate of 15 percent in the supply of new robots in the United States, according to the International Federation of Robotics (IFR) (see Figure 1).[4] IFR also notes that the total number of robots in operation around the world will exceed 3 million by 2020—a figure equivalent to the current population of the state of Arkansas.[5,6] While the share of robots used in the automotive industry is still by far the largest, the electronical and electronics industry is seeing fast growth and the food and beverage industry has seen steady growth as well.[7] Robotics are becoming more widely used in other industries as well, such as healthcare, where there is currently about $40 billion of annual value in robot-assisted surgery (orthopedics).[8]

Figure 1

Estimated annual shipments of multipurpose industrial robots in selected countries. Number of units

Country	2015	2016	2017*	2018*	2019*	2020*	2017/ 2016	CAGR 2018 - 2020
America	38,134	41,295	48,000	50,900	58,200	73,300	16%	15%
North America	36,444	39,671	46,000	48,500	55,000	69,000	16%	14%
- United States	27,504	31,404	36,000	38,000	45,000	55,000	15%	15%
- Canada	3,474	2,334	3,500	4,500	3,000	5,000	50%	13%
- Mexico	5,466	5,933	6,500	6,000	7,000	9,000	10%	11%
Brazil	1,407	1,207	1,500	1,800	2,500	3,500	24%	33%
Rest of South America	283	417	500	600	700	800	20%	17%

Source: IFR

AI and Machine Learning

Related to automation, AI and ML are also growing across H-1B industries and occupations. Although closely related, they are distinct concepts—AI is a more general term for programs that are capable of learning, independent decision-making, and adapting to novel situations. Machine learning is a newer branch of AI, a process by which an AI system can learn by processing massive volumes of data to derive insight as opposed to learning rules or processes for decision-making.[9,10] ML has been very effective—90 percent of today's digital data was created in the past two years and the accuracy of algorithms has improved 10- to 100-fold in the past two decades.[11] These advancements are indicative of how much smarter and capable the current generation of machines and programs are compared with previous smaller scale innovations.

There are multiple ways AI and ML are being applied in H-1B industries. For example:

- AI is being used to track the supply chain for manufacturing companies, looking for issues and making decisions in real time. For example, in one instance, an AI supply chain management system anticipated a sharp price increase due partly to an unforeseen disaster at a supplier and moved to secure the supply needed ahead of the price increase.[12]
- An AI system called Dreamcatcher uses ML techniques to analyze thousands of design prototypes in the cloud to determine the optimal design based on goals and constraints of the desired project.[13] In healthcare, it has been applied to design optimal facial implants to accelerate healing.[14]
- In the field of transportation and logistics, driverless cars logged hundreds of thousands of miles on the road in 2017 alone.[15] The automation of truck driving and other jobs in logistics is likely not far behind.

It's not hard to imagine how easily AI and ML technologies can be used for other occupations, including help desk and quality assurance in the ICT field, solving technical problems in an efficient and even personable way (think Siri and Alexa).

Internet of Things

A third technological concept that has wide-reaching implications for H-1B industries and occupations is IoT. Cisco has calculated that there will be more than 30 billion connected devices by the year 2020.[16] These devices make up the IoT and include components such as security systems, thermostats, sensors, and scanners. IoT is beginning to pervade every industry, changing necessary jobs skills at a rapid pace. It may even create a new industry with jobs that specialize in networked devices in residential and commercial settings.

In the agriculture business, major strawberry producer Driscoll's utilizes a system of radio frequency identification (RFID) to track its products from farm to stores. Each box of strawberries has an RFID tag that is scanned by readers at many different points in the supply chain, collecting data on temperature, how long travel through each part of the supply process takes, when and where there are problems or losses, etc.[17] With this data, it can pinpoint issues in the process and address them quickly and efficiently.

In advanced manufacturing, Stanley Black & Decker operates a large tool manufacturing plant that produces jigsaws, planers, cordless drills, floodlights, and screwdrivers among other

products. A case study by Cisco describes a "real-time location system" using RFID tags on materials and parts, similar to the Driscoll's example cited above.[18] It allows managers to closely track the location of parts at every stage of the manufacturing process in real time, allowing them to see which processes are running properly and which ones require troubleshooting to meet production targets. The plant increased its overall equipment effectiveness on the router production line by 24 percent, leading to cost savings as a result.[19]

PREPARING FOR THE FUTURE

The Data

What does all of this mean for jobs now and into the future? Even though automation has been around for decades, as have sensors and controls within industrial settings, humans were always the connective tissue. Machines didn't learn new things, adapt to novel situations, and make complex decisions. This has all changed with the three technologies described above, which are allowing machines to do more with less need for human labor and oversight as they become intertwined. The IoT is allowing us to connect robotics and other automated systems to networks of devices and sensors spread out over vast distances, all controlled by an AI system.

Using a unique approach that analyzed individual job activities as opposed to full jobs, McKinsey & Company found that as much as 50 percent of time spent on activities across all sectors could be automated with *current* technology.[20] Overall, the research shows that jobs that have highly repetitive physical tasks, require less expertise, and are more limited in interpersonal communication—such as food services, manufacturing, and transportation—are at the highest risk for being eliminated or significantly reduced by automation. In other industries, such as healthcare, the news is better: Jobs for nurses, physician assistants, pharmacists, health aides, and health support workers are projected to grow between 25 to 49 percent by 2030 as a result of automation.[21] (See Appendix A for an overview by McKinsey on automation's projected impact on employment by occupation.)

Automation may also have more devastating impacts in low-wage metro areas and for underrepresented workers. The Institute for Spatial Economic Analysis (ISEA) published a study combining data from Oxford on the likelihood of particular occupations being automated and compared it with Bureau of Labor Analysis (BLS) data on jobs common to specific regions.[22] For example, Las Vegas; El Paso, Texas; and Riverside-San Bernardino, California, top the list for the largest share of automatable jobs, while high-tech centers such as Boston, New York, and San Francisco have a smaller risk. Using a similar approach, the Kellogg School of Management at Northwestern University had comparable results.[23] The ISEA also found that compared with white people, Latino workers are 25 percent more likely to lose their job due to automation and African Americans are 13 percent more likely.[24]

RECOMMENDED APPROACHES FOR TECHHIRE PROGRAMS

1. Consider adding new data sources for forecasting employment

Traditional forms of labor market information (LMI) may no longer be enough on their own. Because the changes to the economy and workforce are happening so rapidly, by the time

trends related to advancements in automation technologies show up in traditional sources, the jobs and skills required have often already changed significantly.

New sources of information on job automation, including the McKinsey and ISEA studies referenced here, can be coupled with traditional LMI to form a better understanding of where to target workforce development programs. For example, if your local LMI data show a particular occupation is growing, consider checking the chart in Appendix A (or the full McKinsey report) to determine the risk of job loss due to automation. Although there are not yet sources developing this type of information on a regular basis, some LMI vendors (for example, Burning Glass Technologies) are incorporating existing data from McKinsey and others into their analyses.

2. Include future-proof skills in your training

A large share of occupations across industries could experience significant shifts in the types of activities workers perform. To help workers enter and build careers in this new economy, they must be equipped with "future-proof" skills—skills that protect them against constantly shifting job requirements and demands. They include 21st century and/or employability skills such as **adaptability, problem-solving, collaboration, interpersonal communication, empathy, an entrepreneurial mindset, and self-awareness**. Most of these are skills machines don't have and are not likely to acquire in the near future.

Fortunately, the business world is starting to recognize these shifts in the skills their workers will need. LinkedIn found that 57 percent of the managers it surveyed in 2018 thought "soft" skills were more important than "hard" skills. They prioritized **adaptability, culture fit, collaboration, leadership, growth potential, and prioritization**, in particular.[25,26]

Finally, incorporating "systems thinking" into training and curricula is something to explore. Businesses are expressing the need to have workers see the bigger picture, including how individual systems interact with one another, internally and externally (see the link for enterprise resource planning below). While it may be unrealistic for every TechHire participant to have the 30,000-foot view, even understanding some basics may add value to their work.

For more information about future-proof and employability skills, including definitions, curricula, and trainings, here are a few sources:

1. The National Network 's Common Employability Skills
2. MHA Labs' Skill Building Blocks
3. Framework for 21st Century Learning (P21)
4. Department of Education's Definition of Employability Skills
5. New World of Work's 21st Century Employability Skills
6. Center for Curriculum Redesign's Skills for the 21st Century

3. Work closely with businesses as they adopt new technology

Some have taken a scenario-planning approach to planning for the future of work. The Shift Commission used this approach with a panel of experts, and one of the possible future scenarios the experts describe is called the "Go Economy."[27] This approach highlights the fact that human and machine labor complement one another, whereby technology is seen as augmenting people, not replacing them. Roy Bahat of Bloomberg Beta, one of the commission's co-chairs, made the argument during a panel presentation that we all have a

role to play in how business adopts automation.[28] That is, if we would like to see a scenario like the Go Economy, we should not wait to see what happens in the business world and then react to it. Rather, we should have a direct influence on it.

Workforce development staff who engage businesses can rethink their roles, viewing themselves not just as partners or service providers but as *business advisers*. It's likely that your local business partners, particularly small to midsize ones, need help developing upskilling strategies to prepare their current workforce for the impact of automation and making decisions about the impacts of automation on their recruitment and retention as well. You and your team can be equipped to help in a way that benefits both businesses and workers.

One way to accomplish this is to arm yourself with a deeper understanding of these technologies and become problem-solvers for your business partners. This may just be a subtle change to the way staff present themselves to businesses after gaining new knowledge on the subjects below, or it could be a full overhaul of the organization's business services. The specific steps here will vary by situation but likely start with surveying your local business needs, followed by adjusting the engagement approach, including staff training and professional development.

A number of resources can help workforce development professionals learn more about current technologies and contingent workers. Here are a few places to start:

Automation

- McKinsey Global Institute conducted detailed research about how automation will affect specific sectors, jobs, and job activities in its report "Jobs Lost, Jobs Gained: Workforce Transitions in a Time of Change" (see excerpt in Appendix A).
- Harvard Business Review identifies an approach to analyzing automation needs within a workforce in its article "Thinking Through How Automation Will Affect Your Workforce."

IoT, enterprise resource planning, and AI

- IoT: Cisco lists several case studies on its IoT web page. It also offer a foundational course in IoT as part of the Cisco Networking Academy.
- Enterprise resource planning (ERP) systems and software packages are used by organizations to manage day-to-day business activities, such as accounting, procurement, project management, and manufacturing. Coursera offers a free course that covers the fundamentals of ERP.
- EdX (MIT) offers a free, self-paced introductory AI course.

4. Ensure your program incorporates work-based learning (WBL) experiences

The research presented here presents a case for a rapidly changing economy. In a more slowly changing economy like we've experienced thus far, there was room for program participants to focus entirely on academics without WBL experiences along the way. While many programs do already incorporate WBL, for the ones that don't, there's a potential danger in keeping the status quo, risking the competitiveness and relevancy of program graduates transitioning to work. The entry-level "on-ramps" that could be relied on for someone entering a new occupation may be disappearing.

To learn adaptability, have relevant skills, and compete, a program graduate needs regular exposure to the work world so they can apply their learning in novel situations during the education or training experience. WBL is more essential now than it ever was because it not only helps participants learn academic material, but also keep pace with the work world before they find themselves competing with others as they begin a career.

At a minimum, programs can include career awareness and exposure-type events, such as job shadows, industry-advised class projects, and workplace tours. More intensive and likely more impactful experiences include co-op programs, paid internships, and apprenticeships (see the first resource below for more detail).

Several work-based learning resources can assist education and workforce practitioners across systems:

- Making Work-Based Learning Work offers a broad overview of the topic, with specific examples of work-based learning in the field for both youth and adults. It presents the seven guiding principles according to our experience and work in the field.
- For postsecondary institutions, the Work-Based Courses Toolkit can assist in the design of courses that incorporate work-based learning.
- The Linked Learning Alliance offers examples and resources from Linked Learning programs across California.
- The National Skills Coalition completed a 50-state scan for policies that support work-based learning such as expansion initiatives and employer subsidies.
- For workforce intermediaries, Making Apprenticeship Work for Opportunity Youth offers some practical models for setting up an apprenticeship program that targets young adults with barriers to work and education.
- For even more resources, JFF's Center for Apprenticeship and Work-Based Learning is an extensive base of knowledge and tools for this subject.

CONCLUSION

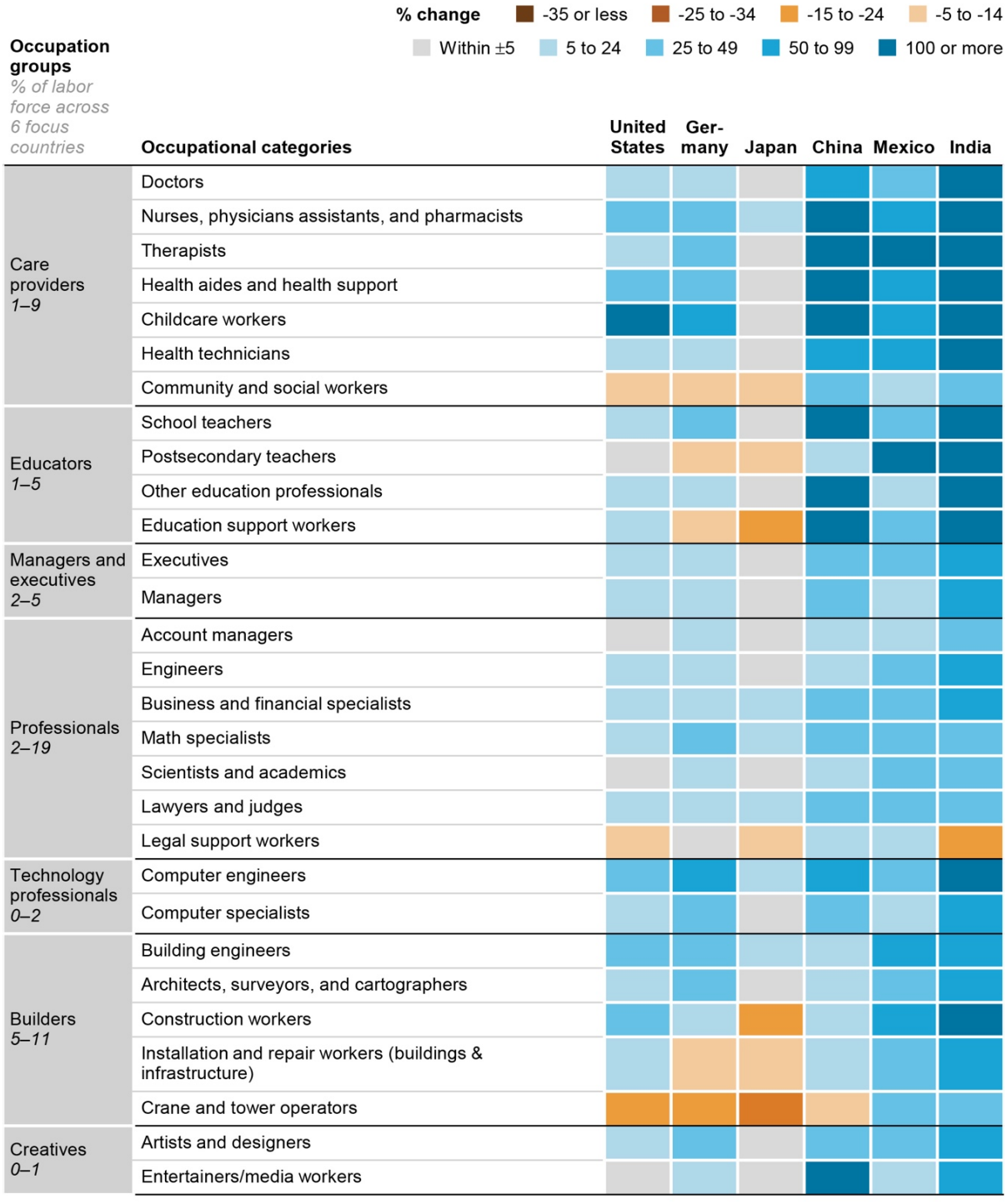
The future of work will incorporate new technology in industrial automation, artificial intelligence, machine learning, and the Internet of Things. In addition, it is likely that these technologies will begin to be used together more often, resulting in rapid changes in the economy. As described in this brief, these advancements have implications for H-1B industries and occupations as the technology spreads across industries. (See Appendix A, which highlights data from McKinsey & Company, offering a quick snapshot on the potential impacts of these technologies by occupation.)

Although the data on how these technologies will impact the workforce are still limited, there is plenty that can be done now to prepare. In this brief, we've described several recommended approaches for TechHire grantees to consider in their programming that can both protect against rapid and significant changes in the economy and put TechHire participants in a strong position for beginning new careers. It is also critical for workforce development programs to stay abreast of technology in their target industry and regularly consider updates to their training as necessary. The time is now to proactively plan for these coming advancements—before the impact on the workforce becomes severe and more difficult to address.

APPENDIX A: MCKINSEY ANALYSIS ON AUTOMATION IMPACTS

Jobs of the future: Employment growth and decline by occupation

Net impact of automation and seven catalysts of labor demand, 2016–30
% change (+/–), step-up labor demand, midpoint automation[1]



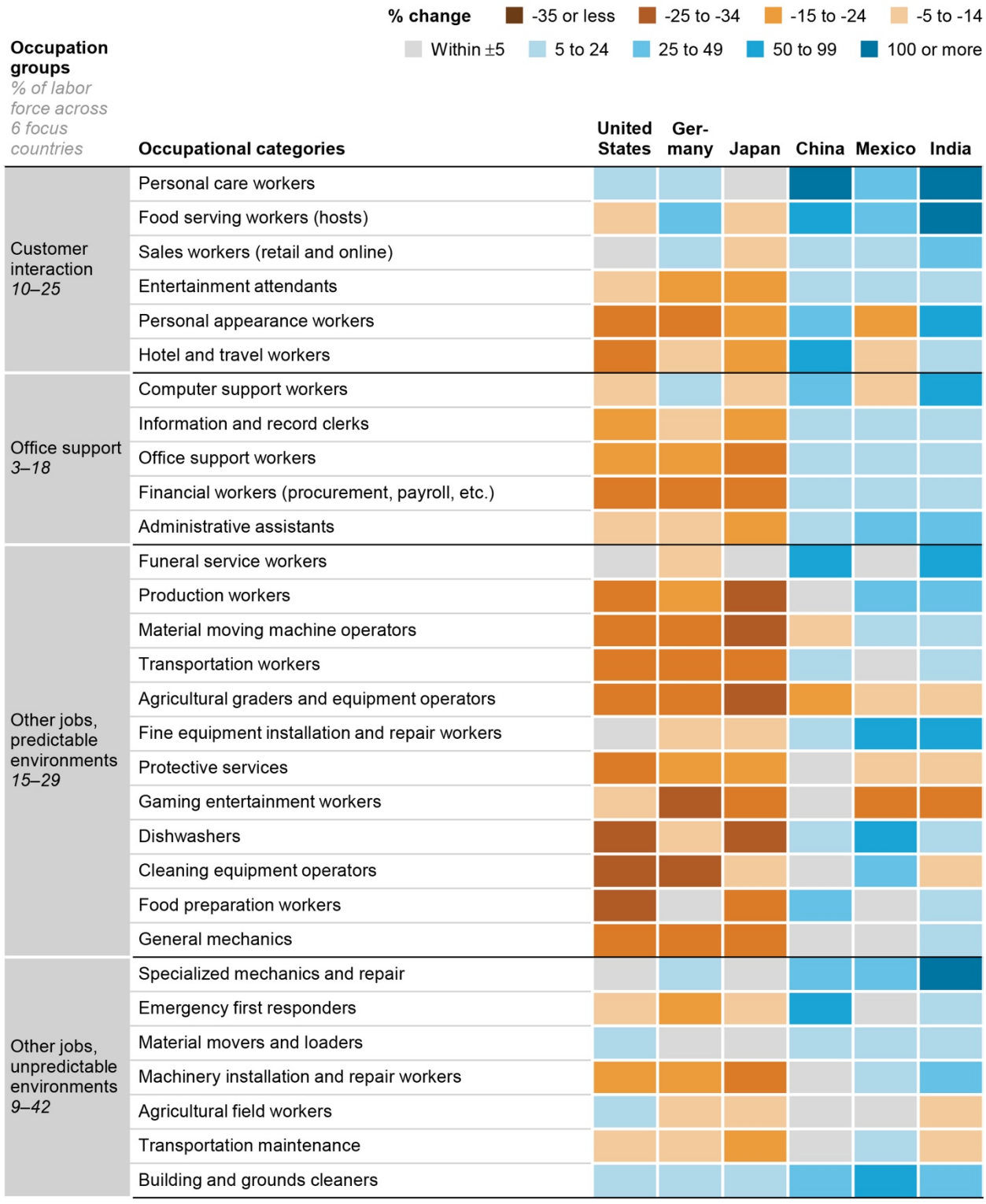
Occupation groups *% of labor force across 6 focus countries*	Occupational categories	United States	Germany	Japan	China	Mexico	India
Care providers *1–9*	Doctors	5 to 24	5 to 24	Within ±5	25 to 49	5 to 24	100 or more
	Nurses, physicians assistants, and pharmacists	25 to 49	25 to 49	5 to 24	50 to 99	25 to 49	100 or more
	Therapists	5 to 24	25 to 49	Within ±5	50 to 99	50 to 99	100 or more
	Health aides and health support	25 to 49	25 to 49	Within ±5	50 to 99	25 to 49	100 or more
	Childcare workers	100 or more	25 to 49	Within ±5	50 to 99	25 to 49	100 or more
	Health technicians	5 to 24	5 to 24	Within ±5	25 to 49	25 to 49	100 or more
	Community and social workers	-5 to -14	-5 to -14	-5 to -14	25 to 49	5 to 24	25 to 49
Educators *1–5*	School teachers	5 to 24	25 to 49	Within ±5	50 to 99	25 to 49	100 or more
	Postsecondary teachers	Within ±5	-5 to -14	-5 to -14	5 to 24	100 or more	100 or more
	Other education professionals	5 to 24	5 to 24	Within ±5	50 to 99	5 to 24	100 or more
	Education support workers	5 to 24	-5 to -14	-15 to -24	50 to 99	25 to 49	100 or more
Managers and executives *2–5*	Executives	5 to 24	5 to 24	Within ±5	25 to 49	25 to 49	50 to 99
	Managers	5 to 24	5 to 24	Within ±5	25 to 49	5 to 24	50 to 99
Professionals *2–19*	Account managers	Within ±5	5 to 24	Within ±5	5 to 24	5 to 24	25 to 49
	Engineers	5 to 24	5 to 24	Within ±5	5 to 24	25 to 49	50 to 99
	Business and financial specialists	5 to 24	5 to 24	5 to 24	25 to 49	25 to 49	50 to 99
	Math specialists	5 to 24	50 to 99	5 to 24	25 to 49	25 to 49	25 to 49
	Scientists and academics	Within ±5	5 to 24	Within ±5	5 to 24	25 to 49	25 to 49
	Lawyers and judges	5 to 24	5 to 24	5 to 24	25 to 49	25 to 49	25 to 49
	Legal support workers	-5 to -14	Within ±5	-5 to -14	5 to 24	5 to 24	-15 to -24
Technology professionals *0–2*	Computer engineers	25 to 49	50 to 99	5 to 24	50 to 99	25 to 49	100 or more
	Computer specialists	5 to 24	25 to 49	Within ±5	25 to 49	5 to 24	50 to 99
Builders *5–11*	Building engineers	25 to 49	25 to 49	5 to 24	5 to 24	50 to 99	25 to 49
	Architects, surveyors, and cartographers	5 to 24	25 to 49	Within ±5	5 to 24	25 to 49	50 to 99
	Construction workers	25 to 49	5 to 24	-15 to -24	5 to 24	50 to 99	100 or more
	Installation and repair workers (buildings & infrastructure)	5 to 24	-5 to -14	-5 to -14	5 to 24	25 to 49	50 to 99
	Crane and tower operators	-15 to -24	-15 to -24	-25 to -34	-5 to -14	25 to 49	5 to 24
Creatives *0–1*	Artists and designers	5 to 24	25 to 49	Within ±5	25 to 49	25 to 49	50 to 99
	Entertainers/media workers	Within ±5	5 to 24	Within ±5	100 or more	5 to 24	50 to 99

1 Midpoint of earliest and latest automation adoption in the "step-up" scenario (i.e., high job growth). Some occupational data projected into 2016 baseline from latest available 2014 data.

SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

Jobs of the future: Employment growth and decline by occupation (continued)

Net impact of automation and seven catalysts of labor demand, 2016–30
% change (+/–), step-up labor demand, midpoint automation[1]



Occupation groups *% of labor force across 6 focus countries*	Occupational categories	United States	Germany	Japan	China	Mexico	India
Customer interaction *10–25*	Personal care workers	-5 to -14	-5 to -14	Within ±5	100 or more	5 to 24	100 or more
	Food serving workers (hosts)	-15 to -24	25 to 49	-15 to -24	50 to 99	25 to 49	100 or more
	Sales workers (retail and online)	Within ±5	5 to 24	-15 to -24	5 to 24	5 to 24	25 to 49
	Entertainment attendants	-15 to -24	-25 to -34	-25 to -34	5 to 24	5 to 24	5 to 24
	Personal appearance workers	-25 to -34	-25 to -34	-15 to -24	25 to 49	-15 to -24	50 to 99
	Hotel and travel workers	-25 to -34	-15 to -24	-15 to -24	50 to 99	-15 to -24	5 to 24
Office support *3–18*	Computer support workers	-15 to -24	5 to 24	-15 to -24	25 to 49	-15 to -24	50 to 99
	Information and record clerks	-15 to -24	-15 to -24	-15 to -24	5 to 24	5 to 24	5 to 24
	Office support workers	-15 to -24	-15 to -24	-25 to -34	5 to 24	5 to 24	5 to 24
	Financial workers (procurement, payroll, etc.)	-25 to -34	-25 to -34	-25 to -34	5 to 24	5 to 24	5 to 24
	Administrative assistants	-15 to -24	-15 to -24	-15 to -24	5 to 24	25 to 49	25 to 49
Other jobs, predictable environments *15–29*	Funeral service workers	Within ±5	-15 to -24	Within ±5	50 to 99	Within ±5	50 to 99
	Production workers	-25 to -34	-15 to -24	-25 to -34	Within ±5	25 to 49	25 to 49
	Material moving machine operators	-25 to -34	-25 to -34	-25 to -34	-15 to -24	5 to 24	5 to 24
	Transportation workers	-25 to -34	-25 to -34	-25 to -34	5 to 24	Within ±5	5 to 24
	Agricultural graders and equipment operators	-25 to -34	-25 to -34	-25 to -34	-15 to -24	-15 to -24	-15 to -24
	Fine equipment installation and repair workers	Within ±5	-15 to -24	-15 to -24	5 to 24	50 to 99	50 to 99
	Protective services	-25 to -34	-15 to -24	-15 to -24	Within ±5	-15 to -24	-15 to -24
	Gaming entertainment workers	-15 to -24	-35 or less	-25 to -34	Within ±5	-25 to -34	-25 to -34
	Dishwashers	-35 or less	-15 to -24	-35 or less	5 to 24	50 to 99	5 to 24
	Cleaning equipment operators	-35 or less	-35 or less	-15 to -24	Within ±5	25 to 49	-15 to -24
	Food preparation workers	-35 or less	Within ±5	-25 to -34	25 to 49	Within ±5	5 to 24
	General mechanics	-25 to -34	-25 to -34	-25 to -34	Within ±5	Within ±5	5 to 24
Other jobs, unpredictable environments *9–42*	Specialized mechanics and repair	Within ±5	5 to 24	Within ±5	25 to 49	25 to 49	100 or more
	Emergency first responders	-15 to -24	-25 to -34	-15 to -24	50 to 99	Within ±5	5 to 24
	Material movers and loaders	5 to 24	Within ±5	Within ±5	5 to 24	5 to 24	5 to 24
	Machinery installation and repair workers	-25 to -34	-25 to -34	-25 to -34	Within ±5	5 to 24	25 to 49
	Agricultural field workers	5 to 24	-15 to -24	-15 to -24	Within ±5	Within ±5	-15 to -24
	Transportation maintenance	-15 to -24	-15 to -24	-25 to -34	Within ±5	5 to 24	-15 to -24
	Building and grounds cleaners	5 to 24	5 to 24	5 to 24	25 to 49	50 to 99	25 to 49

1 Midpoint of earliest and latest automation adoption in the "step-up" scenario (i.e., high job growth). Some occupational data projected into 2016 baseline from latest available 2014 data.

SOURCE: US Bureau of Labor Statistics; McKinsey Global Institute analysis

ENDNOTES

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