Assessing the Future of *Our* Work

AUTOMATION AND THE ROLE OF CITIES

About the National League of Cities

About the National League of Cities: The National League of Cities (NLC) is the nation's leading advocacy organization devoted to strengthening and promoting cities as centers of opportunity, leadership and governance. Through its membership and partnerships with state municipal leagues, NLC serves as a resource and advocate for more than 19,000 cities and towns and more than 218 million Americans. NLC's Center for City Solutions provides research and analysis on key topics and trends important to cities and creative solutions to improve the quality of life in communities.

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Acknowledgements

As president of the **National League of Cities**, my goal is to help city leaders build stronger communities. One of the biggest challenges – and greatest opportunities – that we have as local officials is preparing our cities for the future of work. And it requires us to take a comprehensive approach to workforce development in three key areas:

Technology and Innovation: We must grapple with the technological advancements, automation and artificial intelligence that you read about in the headlines — the "robots will take or change our jobs" narrative. That's true of the gig economy, as well, with more and more Americans working in one or more contract or temporary positions.

Pathways to Success: We must ensure our education systems and our career and technical training help citizens gain skills to succeed in the workforce and meet local demand. This starts with early childhood as well as K-12 education. Young people need to be exposed to a wide range of careers and future opportunities from an early age.

Equity and Inclusion in the Workforce: We must prioritize equity and special populations in terms of workforce development. There are millions of individuals who can be classified as "opportunity youth" — not in the workforce, not enrolled in school — along with countless adults who need to be reengaged in school, reconnected to the workforce, and given a chance to advance beyond low-wage jobs that can't cover the rent or put enough food on the table.

As city leaders, we need to be asking the right questions and bringing the right people together to address these three critical elements of the future of work. We don't know everything that the future will bring,
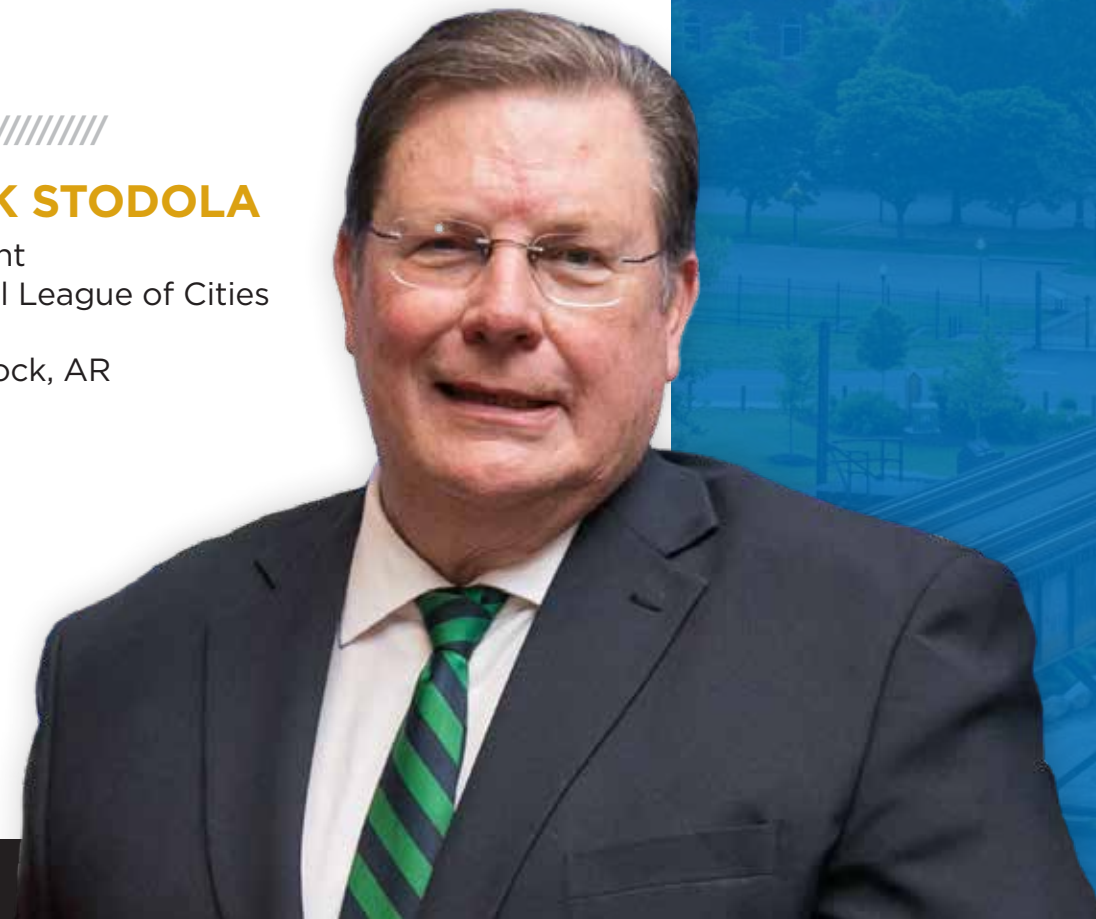
but we do know that our workforce and the jobs that are available to our residents are changing at a rapid pace. And that even without change, we have jobs today that need to be filled and a workforce that needs investment in their skills to take advantage of those opportunities.

The National League of Cities is dedicated to equipping city leaders with tools and information to respond to these shifts in the workforce. That is why we're proud to release our latest report on the future of work, focused on the skills that will be in demand for decades to come. It is our hope that this research will provide America's cities with a foundation for making decisions and crafting policies that respond to social and economic change. Because it is in cities where we find the leadership and innovation required to prepare our country for the future of work.

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MARK STODOLA
President
National League of Cities
Mayor
Little Rock, AR

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INTRODUCTION: SOLUTIONS FOR OUR FUTURE

The rise of new technologies has drastically changed the nature of work throughout history, both as a cause of and a response to massive historical shifts. Cities feel these shifts most acutely, serving as the places where these rapid movements are found, focused, and filtered into broader society. Knowledge sharing and new ideas form within a conglomeration of individuals as the density of people from all walks of life, cultures, and creeds create a dynamism that pushes us forward. This dynamism often leads to disruption—as well as great upheaval—as technology upends fundamental ways of being. As automation and robotics permeate great swaths of the workforce—hyper-charged by the advent of usable artificial intelligence—we currently find ourselves in just such a period in which large numbers of workers will be displaced as the new washes away the old.

No industry, job, or task is safe from automation. Displacement of existing jobs is a given, and the new kinds of jobs that will arise in their place remain unknown. Today, new technologies can optimize manual, automatic, routine, and non-routine tasks alike, making displacement difficult to quantify.[1] A 2013 Oxford study predicted that automation would replace 47% of American occupations in the next two decades.[2] Alternatively, a 2016 study by the Organization for Economic Co-operation and Development (OECD) using a task-based approach found that automation would eliminate only nine percent of American occupations.[3] Furthermore, McKinsey Global has estimated the U.S. labor force will hold 166 million workers by 2030, with anywhere between 39 – 73 million of this contingent displaced by automation. There are predictions that some 48-54 million people will need to change careers in this time frame.[4] Unfortunately, the incongruence and complexities do not end there. While fear of displacement lingers as a quantifiably ambiguous but certain force of change, cities must also grapple with the fact that currently 22.2 percent of the U.S. labor force is underutilized, meaning individuals are working beneath their skill sets, are underemployed, and/or are earning beneath their means.[5] [6]

Even the lowest estimates on automation mean that millions of Americans will be out of work, but cities can take strategic steps to prepare for this future. While cities can do little to prevent the elimination of jobs due to automation, they can prepare their local economies for prospective high-demand jobs that have low probabilities of being automated. They can also equip workers with those promising skill sets that will be in-demand in the future. This report identifies different categories of occupations and attempts to bridge the gaps between those with high and low automatability. We suggest the best skills and logical career crosswalks towards better opportunities and sustainable local economies. Finally, we present case examples from three American cities to display how they are supporting and scaling accessible pathways to employment, equity, and emerging industries.

OUR FOCUS

The National League of Cities' Center for City Solutions has analyzed occupations at three levels of automatability as well as the highest-ranking skills associated with those occupations. The goal of this report is to identify growing American occupations and their susceptibility to automation, ranking them with low, medium, or high automatability. Analyzing these rankings will help city leaders recognize trends in their own communities. It will also enable city leaders to identify occupations with the lowest educational barriers and the highest average incomes.

Automatability is categorized herein as low (30% or less), medium (30% - 70%), and high (70% or more). All methodology is borrowed from the Oxford Martin School. The higher the probability, the more likely the occupation's required tasks are to be optimized, not necessarily eliminated. By categorizing these growing occupations, it should become clear that workforce investment and development in the 21st century has shifted beyond securing jobs (job placement) and moved toward securing financially sustainable, long-lasting jobs.

Understanding the gap between jobs with high and low automatability can create more opportunity and help city leaders formulate their own strategic plans for the future. Unemployment in the U.S. sits around 4 percent, the lowest in a decade. Our federal statute on workforce development—the 2014 Workforce Innovation and Opportunity Act, or WIOA—currently incentivizes job placement, wages, and retention. While important, these incentives best fit the profile of a low-income, low-skilled worker and do not address the full profile of those who might be displaced by automation. Displacement will impact workers across income and skills brackets.

In addition to automation, there is also a 'skills gap' or mismatch. Currently, 44 million middle-skill jobs pay more than the national median income,[7] and while these jobs are expected to grow by 53 percent in the near future, only 43 percent of the U.S. labor force is prepared to occupy them.[8] [9] While examining levels of job automatability, this report also highlights existing pathways that can make occupations more accessible to U.S. workers. Seventy-four percent of American workers are willing to learn new skills to remain employable in the future, and through apprenticeships, work-based learning, career and technical education (CTE), associate degrees, and early college high school programs, cities can continue to create prosperity in their communities despite the uncertain future of work.[10] New America estimates that health care, construction, and professional services will add the most new workers by 2030.[11] Cities can prepare for this shift by investing in and equipping their workers with the appropriate skills to meet new needs.

Despite the misconception that automation poses a threat only to those in certain types of occupations, there is potential for displacement in every industry and sector, and at every skill level. This is why incentive structures should shift from mere placement to economic mobility, competitive wages, and long-term stability in the face of new 21st century challenges like workplace automation, underemployment, and the 'skills gap.' This report aims to help city leaders answer the following questions:

1 **What can we do to prepare for an uncertain future?**

2 **How can cities realize their strengths, maximize their agility, and enhance their economic mobility in local markets with global consequences?**

The following analysis will help city leaders assess high-demand occupations and help them to make the best workforce investments for the future of their local economies.

AUTOMATABILITY

Measuring the level of automatability allows us to focus on growing jobs with a higher likelihood of sustainability. According to the Oxford Martin School's *Future of Employment*, automatability has three rankings: high (70% or more), medium (30% to 70%), or low (30% or less). The higher the probability, the closer it is to overcoming the "engineering bottleneck", or the ability of technological applications or robotic assistants to take tasks over. The purpose of this analysis is to demonstrate the vulnerability to automation, not necessarily the likelihood of it happening.

Growth

The Bureau of Labor Statistics' categorizes '50,000 or more' new jobs in a decade as its highest level of occupation growth. Of the nearly 900 occupations that are tracked, 60 are projected to grow by 50,000 or more from 2016 to 2026. Growing occupations are of interest to every city and serve as the basis of our list of most new jobs from 2016-2026 (See Appendix I, Table 5).

Education for Entry & Median Income

Today, education beyond high school has become a prerequisite for success. The proportion of jobs that require 'some college' grew by 11 percent and those that require an Associate degree grew by 83 percent.[12] According to the OECD college-educated American workers earned 74 percent more than those with only a high school degree.[13][14]

Americans want jobs that can sustain their lifestyles, and the U.S. median income helps many to set this bar. City leaders must decide which occupations they consider most economically viable for their regions. The 2017 *Good Jobs That Pay without a BA* resource from Georgetown University's Center for Education and the Workforce chose a range of $35,000 to $45,000 as a minimum income and a median income of $55,000 as a self-sustaining salary.

TITLE

Occupations without automatability	Number (Thousands)	Median Income	Education for Entry
Nursing assistants	173.4	$26,590	Postsecondary nondegree award
Nurse practitioners	56.1	$100,910	Master's degree
Health specialties teachers, postsecondary	56.1	$99,360	Doctoral or professional degree

* Note: Three jobs were not represented with probabilities of computerizability by the Oxford Martin School. Our report considers the automatability of jobs and how to pursue more resilient jobs. We matched the computerizability of the American occupations producing the most new jobs in the next decade (2016-2026).

High Automatability Occupations (70% or higher)

Automatability is not synonymous with obsolescence but represents a higher likelihood of technology optimizing more tasks within that job. While many industries are represented in this category there are many low-paying, service-oriented, domestic, and food preparatory jobs presented here. The list has been arranged in a way that shows the lowest level of education attainment and highest median income (see Appendix I, Table 3 for full list).

Summary Findings

- **Nineteen of 60 occupations have high automatability.**

- **Physically demanding work.** Many of the jobs in this category tend to be very physically demanding, and many are not traditionally supported with benefits. These include occupations such as laborers, waiters, landscapers, and carpenters, among others.[15,16]

- **The downside of 'gig work,' hourly wages, and low barriers to entry.** While hourly and part-time work can be a choice, McKinsey and Co. found that 19 million Americans were part of the 'on-demand' or gig economy out of necessity. Either way, by opting into the gig economy workers often sacrifice full-time employee status and the associated benefits of retirement, paid time off, healthcare, worker's compensation, and unemployment insurance. Along with a lower status, workers in highly-automatable jobs may be underemployed or underutilized. The Bureau of Labor Statistics identified 80 million Americans working hourly-waged jobs in 2017. [17] Of the 19 jobs on this list, only three require a bachelor's degree.

- **The fastest-growing occupation is vulnerable.** The personal care aide is projected to add 777,700 new jobs to the American labor market before 2026. However, this job is vulnerable to automation.

TOP JOBS WITH HIGH AUTOMATABILITY

Automatability	Job Titles	New Jobs 2016-2026 (in thousands)	Education for Entry	Median Income
95%	Landscaping and grounds keeping workers	135.2	No formal educational credential	$26,320
85%	Laborers and freight, stock, and material movers	199.7	No formal educational credential	$25,980
92%	Combined food preparation and serving workers, including fast food	579.9	No formal educational credential	$19,440
96%	Cooks, restaurant	145.3	No formal educational credential	$24,140
87%	Food preparation workers	68.6	No formal educational credential	$21,440
94%	Waiters and waitresses	182.5	No formal educational credential	$19,990
85%	Sales representatives, wholesale and manufacturing, except technical and scientific products	76.4	High school diploma or equivalent	$57,140
72%	Carpenters	83.8	High school diploma or equivalent	$43,600
85%	Receptionists and information clerks	95.5	High school diploma or equivalent	$27,920
74%	Personal care aides	777.6	High school diploma or equivalent	$21,920
94%	Accountants and auditors	139.9	Bachelor's degree	$68,150

Source: Bureau of Labor Statistics & The Future of Employment, Oxford Martin

- **Food preparation and service.** By far, food workers make up the second-fastest growing group in this list after the Personal Care Aide.

- **The lowest paying occupations.** Fast food workers and waiters and waitresses both earn below $20,000.

- **Some occupations are not directly automatable.** While the category of waiters and waitresses has a high degree of automatability, the traditional function of the job itself requires a person. This vulnerability would likely be reflected in a shift toward kiosk ordering and fast-casual dining establishments.

Medium Automatability Occupations (30%-70%)

These represent the six highest-paying jobs for each education level. The most typical education required for entry is a high school diploma or general equivalency diploma (GED). For those jobs requiring 'no

Automatability	Job Titles	New Jobs 2016-2026 (in thousands)	Education for Entry	Median Income
66%	Janitors and cleaners, except maids and housekeeping cleaners	236.5	No formal educational credential	$24,190
39%	Home health aides	431.2	High School diploma or equivalent	$62,560
35%	Plumbers, pipefitters, and steamfitters	75.2	High school diploma or equivalent	$51,450
51%	Dental assistants	64.6	Postsecondary nondegree award	$36,940
56%	Teacher assistants	109.5	Some college, no degree	$ 25,410
64%	Elementary school teachers, except special education	104.1	Bachelor's degree	$ 55,800

Source: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

formal educational credential, maintenance occupations top the list (see Appendix I, Table 2 for full list).

Summary Findings

- **Thirteen of 60 occupations have medium automatability, the smallest category.**

- **The fourth-largest growing occupation.** We project the occupational category of home health aides to generate over 400,000 new jobs. The bachelor's degree requirement seems to immediately elevate the median income of these jobs.

- **Two fully-automatable jobs.** This group includes market research analysts, an occupation projected to generate 130,000 new jobs before 2026. Light truck or delivery services drivers are projected to generate over 62,000 new jobs before 2026. However, some other research suggests that these occupations are fully-automatable.

Low Automatability Occupations (0%-30%)

We found 28 jobs with low automatability (0-30%), meaning technology cannot easily replicate the skills needed to complete the tasks in these occupations. Occupations

Automatability	Job Titles	New Jobs 2016-2026 (in thousands)	Education for Entry	Median Income
17%	**First -line supervisor:** Construction trades and extraction workers	75.8	High school diploma or GED	$62,980
1%	**First -line supervisor:** Office and admin. support workers	51.2	High school diploma or GED	$54,340
28%	**First -line supervisor:** Retail sales workers	57.7	High school diploma or GED	$39,040
15%	Electricians	59.6	High school diploma or GED	$52,720
6%	Licensed practical and licensed vocationl nurses	88.9	Postsecondary nondegree award	$44,090
0%	Heavy tractor-trailer truck drivers	108.4	Postsecondary nondegree award	$41,340
1%	Preschool teachers, except special ed.	50.1	Associate degree	$28,790

Source: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

with a low automatability represented here are those growing by 50,000 or more jobs before 2026. The number of registered nurses will grow by more than 400,000 while preschool teachers will generate little more than 50,000 new jobs in the same time-period. The educational requirements for these jobs include a high school diploma or GED and/or a bachelor's degree. Our analysis of these low-risk jobs includes those that do not require a bachelor's degree (see Appendix I, Table 1.1 for full list) and those with a minimum requirement of a bachelor's degree (see Appendix I, Table 1.2 for full list). The top five jobs from each category

highlight jobs from each educational rank and those with the highest median income.

Summary Findings

- **Twenty-eight of 60 occupations have low automatability.**

- **Management roles.** The category Manager (all other) serves as a placeholder for four other managerial roles also on this list. Financial, general & operational, as well as medical & health managers all fetch median incomes between $69,000 and $121,000. Managers exhibit many

TOP 5 JOBS WITH LOW AUTOMATABILITY - BACHELOR'S DEGREE

Automatability	Job Titles	New Jobs 2016-2026 (in thousands)	Education for Entry	Median Income
25%	Manager, all other	79.5	Bachelor's Degree	$104,970
13%	Software developers, applications	255.4	Bachelor's Degree	$100,080
1%	Registered nurses	438.1	Bachelor's Degree	$68,450
0%	Nurse practitioners	56.1	Master's Degree	$100,910
13%	Management analysts	115.2	Bachelor's Degree	$81.330

Source: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

of the soft and analytical skills that are critical for future work.

- **First-line supervisor roles.** These jobs present the best median income for the lowest educational attainment. Interestingly, these jobs do not mandate training before occupancy.

- **Apprenticeships**. Electricians enter the workforce through an apprenticeship. This means nearly 60,000 Americans will become trained professionals through this proven career pathway. There is also great potential for apprenticeships to become more commonplace and help facilitate more on-the-job training and opportunities for workers to upskill.

- **Fastest-growing occupation with low automatability.** Registered nurses are projected to generate 430,000 new jobs before 2026.

- **Lowest median income.** Preschool teachers require the highest level of education on this list but are also the least compensated with a starting salary of $28,790. The job has a low likelihood of becoming automated.

The table on page 15 shows how U.S. workers can move from occupations with higher to lower automatability. It displays the objective paths determined by occupational code number.

City leaders can leverage strategic skills and career pathways to bridge the gap for their unemployed, displaced, or dissatisfied workers. In our analysis of the occupations with the most new job growth (see Appendix I, Table 5), not only did we categorize these

> " Fastest-growing occupation with low automatability: Registered nurses are projected to generate 430,000 new jobs before 2026.

BUILDING THE BRIDGE FROM HIGH TO LOW AUTOMATABILITY: ON-RAMPS & SKILLS

	HIGH		LOW	
39 - Personal Care and Service Occupations	Personal Care Aide	$21,920	Childcare Workers	$21,170
	Non-Farm Animal Caretaker	$21,990	Hairdressers	$24, 260
35 - Food Preparation and Serving Related Occupations	Combined Fast Food Workers	$19,440	First-line Food Prep (Medium)	$31,480
	Waiters	$19,990		
	Cooks (Restaurant)	$24,140		
	Food Prep Worker	$21,440		
43 - Office and Administrative Support Occupations	Billing Clerk	$36,150	Stock Clerk	$23,840
	Receptionist and info clerk	$27,920	First-line Admin.Support Worker	$54,340
53 - Transportation and Material Moving Occupations	Laborer & Freight	$25,980	Heavy & Tractor trailer Truck Driver	$41,340
47 - Construction and Extraction Occupations	Construction Laborer	$ 24,140	First-line Construction Supervisor	$62,980
	Carpenter	$43,600	Electrician	$52,700
41 - Sales and Related Occupations	Retail Salesperson	$22,680	Services Sales Representative	$62,490
	Wholesale Sales Rep.	$57,140	First-line Retail Supervisor	$39,040
13 – Business and Financial Operations Occupations	Accountants and Auditors	$68,150	Business Operations Specialis	$69,040
	Management Analyst	$81,330		
25 - Educational Instruction and Library Occupations	Teachers, all other	$30,110	Health Specialties Teachers	$99,360
			Secondary School Teachers	$58,030
			Self-Enrichment	$37,330
			Preschool Teachers	$28,790

occupations in terms of automatability, we also performed an analysis on the importance of their skills. The Occupational Information Network (O*NET) uses 'level' and 'importance' to rank the significance of 35 skills across six elements: basic skills, complex problem-solving skills, technical skills, systems skills, resource management skills, and social skills.[18] The skills with the highest level of importance amongst the occupations that will produce the most new jobs in the future include time management, judgement and decision making, operation monitoring, coordination, speaking, critical thinking, active listening, and material resource management.

These are all commonly regarded as soft professional skills, which many agree are highly valuable. The World Economic Forum's Global Agenda Council listed complex problem solving, creativity, critical thinking, and people management among their top 10 skills for 2020.[19] Ideally, further developing these kinds of interoperable skills that will be required in the workforce of the future will maximize outcomes.

City leaders can also leverage federal and local workforce development funding to promote inclusivity when considering workforce development programming and target audiences. Successful programs will help a wide array of workers beyond those who are unemployed and offer other support that will help all types of students in their careers.

In the following city profiles, each city supports accessible, responsive, and equitable workforce training programs. The Workforce Innovation and Opportunity Act (WIOA) defines career pathways as "a combination of rigorous and high-quality education, training, and other services." Seven broad guidelines follow, and it is up to city officials and workforce development professionals to decide how to best leverage the federal funds. The objective is for Americans to enter and advance in their chosen occupation. The National League of Cities encourages cities to support and scale career pathways that are accessible, promote equity, and encourage diversity.[20]

CITY PROFILES

Strategic leadership can support and scale pathways to equitable and accessible employment in cities. Technological advancement and optimization make the communication between employers and employees more important than ever. Just as some occupations are susceptible to automation, cities are vulnerable to the implications of automation.

The following section presents examples of cities that are relatively less-vulnerable to the forces and implication of automation. Using a metric in the report *Technology at Work* written by the Oxford Martin School and Citi GPS, we selected three cities for analysis: Boston, Richmond, and Minneapolis. A sample of cities in the aforementioned report have been assessed and assigned a percentage that indicates whether their existing workforces are most or least at-risk of high automatability. The percentages of cities least at-risk of high job automatability range between 38 percent and 41 percent. The percentages of cities most at-risk of high

job automatability range from 45 percent to 54 percent. The three cities we selected fall into the category of least at-risk.

These cities focus on accessible and equitable programs that purposefully target non-traditional students and assist with transformation, child care, and other useful work supports. This report also highlights how Boston, Richmond, and Minneapolis' use of the U.S. Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant program. TAACCCT grants—because of their investment in sector-focused community college workforce training programs—include support for nontraditional students. They tend to support and segue into responsive programs, which leverage local partnerships and industry knowledge to prepare students and workers for existing jobs in local economies.

The following cities present examples of promising practices in proactively preparing for and meeting new workforce challenges.[21]

Boston is one of America's oldest cities and Massachusetts' largest metropolis, with a population of 669,469. As an early American city, Boston leveraged its seaport to become an international commerce hub. Today, Boston remains a global city with strong traditions in higher education, tourism, finance, and innovation. Boston is home to 53 institutions of higher education, attracting a large number of students from around the globe. The city is also the core economic engine in the state.[22]

The median household income in the city is $58,263 and the top five industries (based on the percentage of city population working in them) include 1) health care and social assistance, 2) educational services, 3) professional, scientific, technical services, 4) accommodation, food services, and 5) retail trade. Of those residents who are age 25 or older, 15 percent have no high school diploma, 36.5 percent have a high school diploma, and 48.5 percent have a higher degree.[23]

In terms of automatability, 38.4 percent of Boston's jobs are highly susceptible to automation which, according to the Oxford/Citi report, classifies the city as low-risk. Multiple factors may account for this low-risk status, including the accessibility, variety, and quality of Boston's job market. For instance, Boston's leaders are aware that nearly half of all labor force participants and a quarter of all full-time workers earn less than $35,000. Thus, the city's Office of Workforce Development has committed to lowering the barriers to opportunity for disadvantaged workers regardless of age, race, gender, or educational attainment. Under the leadership of Mayor Marty Walsh, Boston's Office of Workforce Development

has an explicit plan to engage retirement-age workers. Boston also launched the Office of Resilience & Racial Equity which showcased the NLC's Center for Race, Equity, and Leadership (REAL) as part of the city's 2017 government-wide resilience strategy.

Career Pathways:

The City of Boston has eleven city-led workforce development initiatives including campaigns centered around a living wage, apprenticeships, and adult literacy.[24] With federal TAACCCT grant funding, Massachusetts has targeted its information technology, manufacturing, healthcare, and energy industries with a total of $56 million. This money is spread out over five grants supporting 191 programs with 19,589 participants. The programs have resulted in 6,468 credentials earned since 2014.

BOSTON, MA

As the capitol of Virginia, Richmond has long served as an important economic, political, and historical setting. Sitting at the nexus of the Piedmont and Tidewater regions of Virginia, a triple crossing of rail lines, and the intersection of two major interstates, the city has spent three centuries at the crossroads of regional commerce. Today, Richmond is home to 213,735 residents and eight Fortune 500 companies, including Dominion Resources, CarMax, and Altria Group (formerly Phillip Morris Companies), among others.[25] Law, finance and advertising have long been significant forces in the city's economy, which also counts biotechnology and pharmaceutical research as significant contributors via the Virginia Biotechnology Research Park, which opened in 1995.[26]

The median household income in the city is $40,758 and the top five industries (based on the percentage of city population working in them) include 1) health care and social aassistance, 2) educational services, 3) retail trade, 4) professional, scientific, technical services and 5) finance and insurance. Of those residents who are 25 or older, 18.5 percent have no high school diploma, 41.8 percent have a high school diploma, and 39.7 percent have a higher degree.[27]

In terms of automatability, 41.4 percent of Richmond's existing jobs are highly susceptible to automation which, according to the Oxford/Citi report, classifies the city as low-risk. There are several reasons why the city might not prove as highly susceptible to automation. Richmond's historical reputation as a city of headquarters and affiliates has established a strong industry backbone with 11 Fortune 1000, eight Fortune 500, and three Fortune

200 companies based there.[28] Richmond also hosts the state's largest university, Virginia Commonwealth University (VCU), home to more than 30,000 students. In addition to VCU, the city has many other major institutions of higher education, including the University of Richmond, Virginia Union University, Virginia College, South University–Richmond, Union Theological Seminary & Presbyterian School of Christian Education, the Baptist Theological Seminary, J. Sargeant Reynolds Community College, and John Tyler Community College, as well as vocational colleges like Fortis College and Bryant Stratton College.

Career Pathways

The city's workforce is supported by PluggedIn VA, a career pathway partnership with the Department of Education that prepares traditional and non-traditional students with adult education programs, post-secondary opportunities, and supplemental support. Private partnerships with the business world give students internship, shadowing, and interview experience. The accessibility to soft skills training and placement makes PluggedIn VA a valuable asset to the city's workforce.[29] Virginia's TAACCCT grant funding totals $51 million spread over nine grants, supporting 58 programs with over 4,000 participants. It has resulted in over 2,558 credentials earned since 2014.

RICHMOND, VA

The larger of the two Twin Cities, Minneapolis sits at the center of the second largest economic center in the Midwest.[30] Minneapolis is home to 422,331 residents and is the largest city in the state of Minnesota. Along with its metropolitan neighbor, Saint Paul, and the surrounding suburban communities, the Twin Cities metro area has approximately 3.6 million residents. Economically, Minneapolis is a formidable force in the global economy and contains five Fortune 500 companies.

The median household income in the city is $56,255 and the top five industries (based on the percentage of city population working in them) include 1) health care and social assistance, 2) educational services, 3) professional, scientific, technical services, 4) retail trade, and 5) accommodation and food services. Of those residents aged 25 or older, 11.7% have no high school diploma, 36% have a high school diploma, and 52.3% have a higher degree.[31]

In terms of automatability, 41.40% of Minneapolis's existing jobs are highly susceptible to automation which, according to the Oxford/Citi report, classifies the city as low-risk. Its highly diversified economy and highly skilled workforce likely contribute to its low-risk status. Fortune 500s headquartered in the city include Target, U.S. Bancorp, Xcel Energy, Ameriprise Financial, and Thrivent Financial.[32] The number of individuals in the workforce with advanced degrees exceeds the national average, and the city is becoming a Midwestern enclave of technological innovation. In 2005, the city was named a "top tech city" in the U.S.[33] Minneapolis also has a robust network of institutions of higher education. University of Minnesota's main campus is in Minneapolis, with more than 50,000 undergraduate,

graduate, and professional students enrolled. Other universities and institutions of higher education in the city include Augsburg University, Minneapolis College of Art and Design, North Central University, Minneapolis Community and Technical College, St. Mary's University of Minnesota, Metropolitan State University, and the University of St. Thomas.[34]

Career Pathways:

Hennepin Pathways is a county level program that supports workforce development and connects qualified candidates to jobs in the Twin Cities region. The program is proactive, identifying that by 2020 the "region will have 128,000 more jobs than people qualified to fill them." To narrow the gap between skills and jobs available, Hennepin Pathways has created 18 sector-based pathways that help residents get the skills they need to fill the region's jobs. The program emphasizes equity and prioritizes training individuals in marginalized communities for good, sustainable jobs with benefits in high demand fields. It breaks down some of the institutional and social barriers that keep talented candidates from gaining access to decent paying jobs. The program also ensures job seekers are trained for jobs in high-demand sectors with growth potential. It has a proven track record, with 90 percent of Pathways graduates achieving placement into sought-after jobs and 88 percent of Pathways graduates retaining employment with the same employer 12 months after hire.[35] Minnesota's TAACCCT grant funding totals $64 million spread over seven grants, supporting 71 programs with more than 8,000 participants. It has resulted in over 4,704 credentials earned since 2014.

MINNEAPOLIS, MN

TAKEAWAYS & RECOMMENDATIONS

Automation sets the U.S. economy on an uncertain path that will see significant disruption of our country's workforce. No industry, job or task is safe from automation; therefore, displacement will likely affect all types of workers. While automation does not necessarily mean obsolescence, it does mean there will be an inevitable shift in workplace tasks for most jobs. Ultimately, cities should try to minimize the suffering that is likely to accompany such a major economic transition. That means taking stock of what the federal programs do and do not do, filling in some of the gaps (e.g., entrepreneurship programs, social protections), and enhancing the ability for individuals to get work experience and exposure to technical jobs. The most critical and immediate challenge for cities will be confronting the problem of inequality not just from within workforce programs, but also at the social safety net level and/or through social protections as a whole. Success can no longer be tied to a job placement.

This report sets forth several takeaways and recommendations that might serve as starting points for cities' efforts as they set out to address the future of work. Summary takeaways from this report are as follows:

- Low automatability occupations (0%-30%) are mostly managerial and supervisory positions whereas high automatability occupations (70% or higher) are generally physically demanding, compensated hourly, and low-paying jobs.

- Cities labeled 'least at-risk' of being vulnerable to automation have strong connections to education, tend to leverage more federal funds, and invest in a diverse mix of occupations. Their economies tend to be well diversified, meaning they are less vulnerable when one industry changes or decelerates.

- The skills with the highest level of importance among the new jobs of the future include time management, judgement and decision making, operation monitoring, coordination, speaking, critical thinking, active listening, and material resource management.

- There are very few apprenticeship opportunities for occupations in high-demand.

Source: Scott Olson/Getty Images

—— RECOMMENDATIONS ——

1 **City leaders should look beyond job placement towards income mobility and economic stability.** They can start by assessing high-demand occupations for automatability, median income, and needed education level. They should also consider ways to position their local economies to attract new, stable industries. Instead of focusing on job placement, they should focus on attracting good and accessible jobs to their cities.

2 **Cities can draw on available federal resources** like TAACCCT, WIF, and CTE, to broaden training opportunities for employed, unemployed, and transitioning U.S. workers. These federal resources can help support local workforce and job pipeline initiatives.

3 **To avoid becoming 'at-risk' to automation**, cities should consider ways to match the demands of their local industries and the skillsets of their populations. Skills can bridge the gap between workers in need of opportunity and industries in need of capable workers.

4 **Cities will need to rethink education and workforce training programs to meet constantly changing employer needs**. Municipal leaders recognize that the strength of their cities are the people that live there. As cities prepare for the future of work, they must work with business leaders, educational institutions and community-based organizations to ensure that workforce needs are fulfilled by regional training and educational programs.

5 **Cities should work to create policies that build pathways between post-secondary education institutions and their business communities.** Investment in improving and increasing access to early childhood, K-12, and postsecondary educational opportunities will position cities to not only benefit from automation and other technology changes, but also ensure that the local workforce has the skills to contribute to and share in the gains.

6 **Cities will need to ensure that their business development programs consider equity.** Equity is an important dimension to consider when building a strategy for economic growth. Policies that promote equity often have positive effects on economic growth. Targeted investments in low-income neighborhoods often bring higher growth rates along with broader equity.

7 **Cities can begin to explore and implement programs and pilots that go beyond the traditional mix of workforce supports.** Policies like portable benefits and universal basic income are two examples that are currently being pursued and worth examining.

Appendix I

DISCLAIMER

The probabilities used in this paper are not predictive and have been used to facilitate a discussion about the growing jobs of our future. The percentage of computerizability or automatability provided by the Oxford Martin School does not represent the gradual and unpredictable nature and timeline of automation. The OECD projection of 9% is task-based and analyzes the several tasks that it takes to complete a job. This study provides a national probability rather than any occupation specific probabilities. The Oxford Martin School report *The Future of Employment: How Susceptible are Jobs* projections takes an occupation-based approach with probabilities across industry and for each occupation. Both approaches and their resulting probabilities should be approached with caution because of our limited ability to predict the role and integration of technology in the workplace. As we assess the low, medium, and high levels of automatability, keep in mind that this is a relative likelihood rather than an accurate prediction.

In the latter section of the paper we assess three cities and their collective risks. These cities have been assessed and assigned a percentage describing the risk of automatability of their existing jobs as identified by Oxford Martin School and Citi GPS: Global Perspectives & Solutions in Technology at Work (January 2016). The percentages of cities least at-risk of high job

TABLE 1.1 LOW AUTOMATABILITY - NO BACHELORS DEGREE REQUIRED

Occupation Titles	New Jobs (in thousands), 2016-2026	Automatability	Education for Entry	Median Income
First-line supervisors of construction trades and extraction workers	75.8	17%	High school diploma or GED	$ 62,980
First-line supervisors of office and administrative support workers	51.2	1%	High school diploma or GED	$ 54,340
Electricians	59.6	15%	High school diploma or GED	$ 52,720
Sales representatives, services, all other	94.9	19%	High school diploma or GED	$52,490
First-line supervisors of retail sales workers	57.7	28%	High school diploma or GED	$39,040
Self-enrichment education teachers	57.4	13%	High school diploma or GED	$ 37,330
Social and human service assistants	63.9	13%	High school diploma or GED	$ 31,810
Stock clerks and order fillers	100.9	13%	High school diploma or GED	$23,840
Childcare workers	84.3	8%	High school diploma or GED	$ 21,170
Licensed practical and licensed vocational nurses	88.9	6%	Postsecondary nondegree award	$44,090
Heavy and tractor-trailer truck drivers	108.4	0%	Postsecondary nondegree award	$ 41,340
Medical assistants	183.9	30%	Postsecondary nondegree award	$31,540
Nursing assistants	173.4	N/A	Postsecondary nondegree award	$ 26,590
Hairdressers, hairstylists, and cosmetologists	80.1	11%	Postsecondary nondegree award	$24,260
Preschool teachers, except special education	50.1	1%	Associate degree	$ 28,790

SOURCE: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

TABLE 1.2 LOW AUTOMATABILITY - BACHELOR'S DEGREE NEEDED

Occupation Titles	New Jobs (in thousands), 2016-2026	Automatability	Education for Entry	Median Income
Financial managers	108.6	7% (low)	Bachelor's degree	$121,750
Managers, all other	79.5	25% (low)	Bachelor's degree	$104,970
Software developers, applications	255.4	13% (low)	Bachelor's degree	$100,080
General and operations managers	205.2	16% (low)	Bachelor's degree	$ 99,310
Medical and health services managers	72.1	1% (low)	Bachelor's degree	$ 96,540
Computer systems analysts	54.4	1% (low)	Bachelor's degree	$ 87,220
Business operations specialists, all other	90.3	23% (low)	Bachelor's degree	$ 69,040
Registered nurses	438.1	1% (low)	Bachelor's degree	$ 68,450
Secondary school teachers, except special and career/technical education	76.8	1% (low)	Bachelor's degree	$ 58,030
Nurse practitioners	56.1	N/A	Master's degree	$100,910
Lawyers	65.0	4% (low)	Doctoral or professional degree	$118,160
Health specialties teachers, postsecondary	60.6	N/A	Doctoral or professional degree	$ 99,360
Physical therapists	67.1	2% (low)	Doctoral or professional degree	$ 85,400

SOURCE: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

automatability range between 38 percent and 41 percent. The percentages of cities most at-risk of high job automatability range from 45 percent to 54 percent. We used this list as our selection criteria for cities with high concentrations of the jobs we have identified as growing and automation-resistant.

TABLE 2 JOBS WITH MEDIUM AUTOMATABILITY

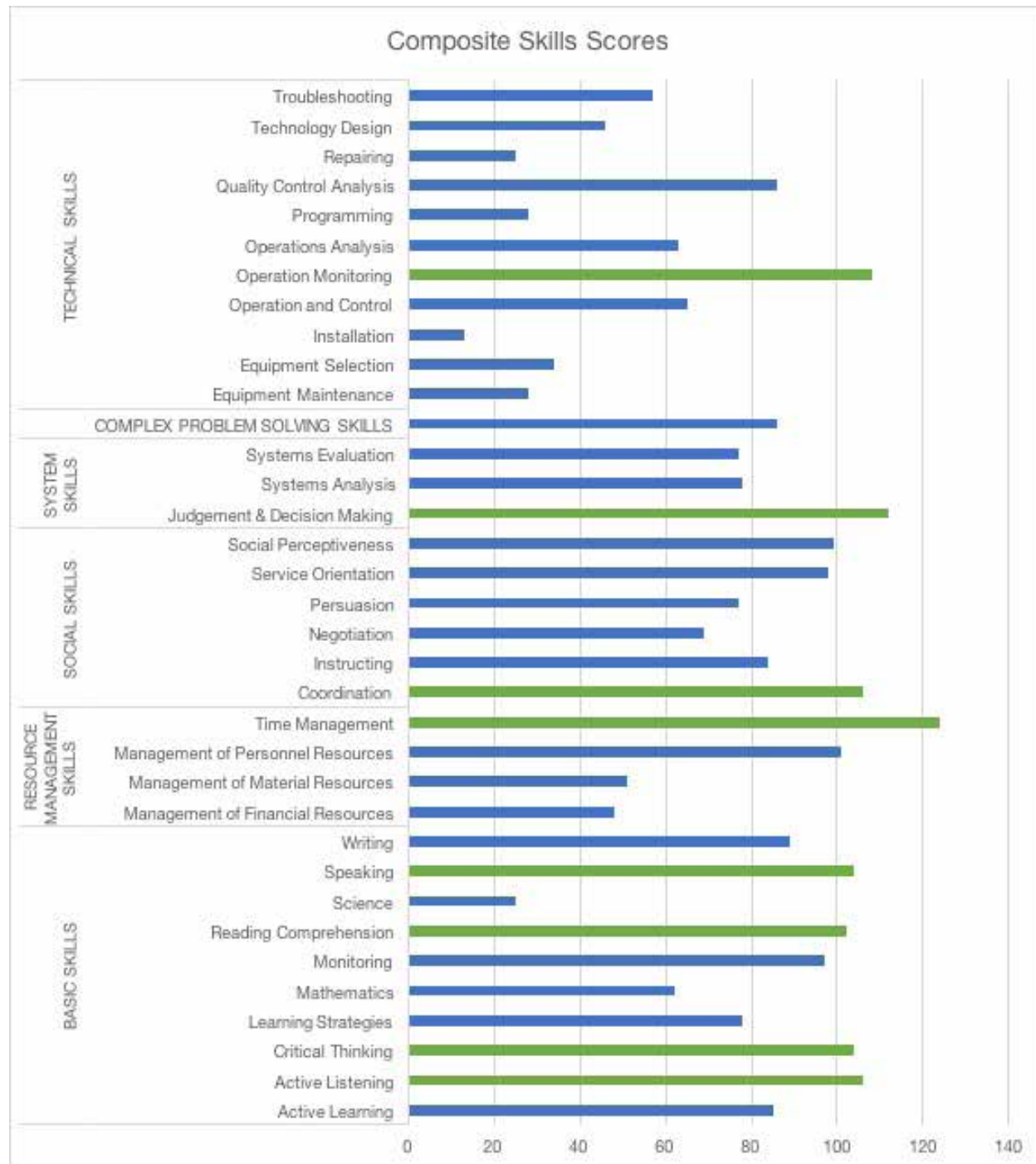| Occupation Titles	New Jobs (in thousands), 2016-2026	Automatability	Education for Entry	Median Income
Janitors and cleaners, except maids and housekeeping cleaners	236.5	66%	No formal educational credential	$24,190
Maids and housekeeping cleaners	87.9	69%	No formal educational credential	$21,820
Plumbers, pipefitters, and steamfitters	75.2	35%	High school diploma or equivalent	$51,450
Maintenance and repair workers, general	112.5	64%	High school diploma or equivalent	$36,940
Customer service representatives	136.3	61%	High school diploma or equivalent	$32,300
First-line supervisors of food preparation and serving workers	87.6	63%	High school diploma or equivalent	$31,480
Light truck or delivery services drivers	62.1	69%	High school diploma or equivalent	$ 30,580
Home health aides	431.2	39%	High school diploma or equivalent	$22,600
Dental assistants	64.6	51%	Postsecondary nondegree award	$36,940
Teacher assistants	109.5	56%	Some college, no degree	$ 25,410
Computer user support specialists	72.1	65%	Some college, no degree	$49,390
Market research analysts and marketing specialists	138.3	55%	Bachelor's degree	$62,560
Elementary school teachers, except special education	104.1	64%	Bachelor's degree	$ 55,800

SOURCE: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

TABLE 3 JOBS WITH HIGH AUTOMATABILITY

Occupation Titles	New Jobs (in thousands), 2016-2026	Automatability	Education for Entry	Median Income
Construction laborers	150.4	88%	$33,430	No formal educational credential
Landscaping and grounds keeping workers	135.2	81%	$26,320	No formal educational credential
Laborers and freight, stock, and material movers, hand	199.7	85%	$25,980	No formal educational credential
Cooks, restaurant	145.3	96%	$24,140	No formal educational credential
Retail salespersons	79.7	92%	$22,680	No formal educational credential
Food preparation workers	68.6	87%	$21,440	No formal educational credential
Waiters and waitresses	182.5	94%	$19,990	No formal educational credential
Combined food preparation and serving workers, including fast food	579.9	92%	$19,440	No formal educational credential
Sales representatives, wholesale and manufacturing, except technical and scientific products	76.4	85%	$57,140	High school diploma or equivalent
Carpenters	83.8	72%	$43,600	High school diploma or equivalent
Billing and posting clerks	70.7	96%	$36,150	High school diploma or equivalent
Medical secretaries	129.0	95%	$33,730	High school diploma or equivalent
Receptionists and information clerks	95.5	85%	$27,920	High school diploma or equivalent
Security guards	70.6	84%	$25,770	High school diploma or equivalent
Nonfarm animal caretakers	58.5	82%	$21,990	High school diploma or equivalent
Personal care aides	777.6	74%	$21,920	High school diploma or equivalent
Management analysts	115.2	79%	$81,330	Bachelor's degree
Accountants and auditors	139.9	94%	$68,150	Bachelor's degree
Teachers and instructors, all other	98.0	96%	$30,110	Bachelor's degree

SOURCE: Bureau of Labor Statistics, Table 1.7 & The Future of Employment, Oxford Martin

TABLE 4 COMPOSITE SKILLS SCORE

Composite Skills Scores

SOURCE: Bureau of Labor Statistics, Occupation Data, Table 1.7

Basic skills have ten elements: Active Learning (85), Active Listening (106), Critical Thinking (104), Learning Strategies (78), Mathematics (62), Monitoring (97), Reading Comprehension (102), Science (25), Speaking (104), and Writing (89).

Resource Management skills have four elements: Management of Financial Resources (48), Management of Material Resources (51), Management of Personnel Resources (101), and Time Management (124).

Social skills have six elements: Coordination (106), Instructing (84), Negotiation (69), Persuasion (77), Service Orientation (98), and Social Perceptiveness (99).

System skills have three elements: Judgement & Decision Making (112), Systems Analysis (78), and Systems Evaluation (77).

Complex problem-solving skills hold only one element and accumulated 86 points across the 30 occupations.

Technical skills have a combined eleven elements; however, the majority of level indicators are shown as Not Relevant or Not Applicable for our six occupations. Level estimate are labeled as N/R if less than 75 percent of respondents flag the item as "not important." Any element labeled as N/A is if its level of precision does not meet the minimum requirements. The National Center for O*NET Development keeps to these standards for minimal data collection for quality purposes.

The composite score was calculated by taking the level score for each element within a descriptor and using percent rank to assign a number of 1-5. These numbers are labeled as scores which are then summed across elements to give a comparable score between elements in a descriptor.

TABLE 5 TOP 60 GROWING

SOC	Occupations with Most New Growth	Number Change 2016-2026
39-9021	Personal care aides	777.6
35-3021	Combined food preparation and serving workers, including fast food	579.9
53-7062	Laborers and freight, stock, and material movers, hand	199.7
35-3031	Waiters and waitresses	182.5
47-2061	Construction laborers	150.4
35-2014	Cooks, restaurant	145.3
13-2011	Accountants and auditors	139.9
37-3011	Landscaping and groundskeeping workers	135.2
43-6013	Medical secretaries	129.0
13-1111	Management analysts	115.2
25-3099	Teachers and instructors, all other	98.0
43-4171	Receptionists and information clerks	95.5
47-2031	Carpenters	83.8
41-2031	Retail salespersons	79.7
41-4012	Sales representatives, wholesale and manufacturing, except technical and scientific products	76.4
43-3021	Billing and posting clerks	70.7
33-9032	Security guards	70.6
35-2021	Food preparation workers	68.6
39-2021	Nonfarm animal caretakers	58.5
29-1141	Registered nurses	438.1
15-1132	Software developers, applications	255.4
11-1021	General and operations managers	205.2
31-9092	Medical assistants	183.9
31-1014	Nursing assistants	173.4
11-3031	Financial managers	108.6
53-3032	Heavy and tractor-trailer truck drivers	108.4
43-5081	Stock clerks and order fillers	100.9
41-3099	Sales representatives, services, all other	94.9
13-1199	Business operations specialists, all other	90.3
29-2061	Licensed practical and licensed vocational nurses	88.9
39-9011	Childcare workers	84.3
39-5012	Hairdressers, hairstylists, and cosmetologists	80.1
11-9199	Managers, all other	79.5
25-2031	Secondary school teachers, except special and career/technical education	76.8
47-1011	First-line supervisors of construction trades and extraction workers	75.8
11-9111	Medical and health services managers	72.1
29-1123	Physical therapists	67.1
23-1011	Lawyers	65.0
21-1093	Social and human service assistants	63.9
25-1071	Health specialties teachers, postsecondary	60.8
47-2111	Electricians	59.6
41-1011	First-line supervisors of retail sales workers	57.7
25-3021	Self-enrichment education teachers	57.4
29-1171	Nurse practitioners	56.1
15-1121	Computer systems analysts	54.4
43-1011	First-line supervisors of office and administrative support workers	51.2
25-2011	Preschool teachers, except special education	50.1
31-1011	Home health aides	431.2
37-2011	Janitors and cleaners, except maids and housekeeping cleaners	236.5
13-1161	Market research analysts and marketing specialists	138.3
43-4051	Customer service representatives	136.3
49-9071	Maintenance and repair workers, general	112.5
25-9041	Teacher assistants	109.5
25-2021	Elementary school teachers, except special education	104.1
37-2012	Maids and housekeeping cleaners	87.9
35-1012	First-line supervisors of food preparation and serving workers	87.6
47-2152	Plumbers, pipefitters, and steamfitters	75.2
15-1151	Computer user support specialists	72.1
31-9091	Dental assistants	64.6
53-3033	Light truck or delivery services drivers	62.1

TABLE 5 TOP 60 GROWING (continued)

Computerisability	A.R. Level	Median Annual Income	Typical Education for Entry	Typical Training for occupancy
0.74	high	$ 21,920	High school diploma or equivalent	Short-term on-the-job training
0.92	high	$ 19,440	No formal educational credential	Short-term on-the-job training
0.85	high	$ 25,980	No formal educational credential	Short-term on-the-job training
0.94	high	$ 19,990	No formal educational credential	Short-term on-the-job training
0.88	high	$ 33,430	No formal educational credential	Short-term on-the-job training
0.96	high	$ 24,140	No formal educational credential	Moderate-term on-the-job training
0.94	high	$ 68,150	Bachelor's degree	None
0.81	high	$ 26,320	No formal educational credential	Short-term on-the-job training
0.95	high	$ 33,730	High school diploma or equivalent	Moderate-term on-the-job training
0.79	high	$ 81,330	Bachelor's degree	None
0.96	high	$ 30,110	Bachelor's degree	None
0.85	high	$ 27,920	High school diploma or equivalent	Short-term on-the-job training
0.72	high	$ 43,600	High school diploma or equivalent	Apprenticeship
0.92	high	$ 22,680	No formal educational credential	Short-term on-the-job training
0.85	high	$ 57,140	High school diploma or equivalent	Moderate-term on-the-job training
0.96	high	$ 36,150	High school diploma or equivalent	Moderate-term on-the-job training
0.84	high	$ 25,770	High school diploma or equivalent	Short-term on-the-job training
0.87	high	$ 21,440	No formal educational credential	None
0.82	high	$ 21,990	High school diploma or equivalent	Short-term on-the-job training
0.009	low	$ 68,450	Bachelor's degree	None
0.13	low	$ 100,080	Bachelor's degree	None
0.16	low	$ 99,310	Bachelor's degree	None
0.3	low	$ 31,540	Postsecondary nondegree award	None
	low	$ 26,590	Postsecondary nondegree award	None
0.069	low	$ 121,750	Bachelor's degree	None
0.0044	low	$ 41,340	Postsecondary nondegree award	Short-term on-the-job training
0.13	low	$ 23,840	High school diploma or equivalent	Short-term on-the-job training
0.19	low	$ 52,490	High school diploma or equivalent	Moderate-term on-the-job training
0.23	low	$ 69,040	Bachelor's degree	None
0.058	low	$ 44,090	Postsecondary nondegree award	None
0.084	low	$ 21,170	High school diploma or equivalent	Short-term on-the-job training
0.11	low	$ 24,260	Postsecondary nondegree award	None
0.25	low	$ 104,970	Bachelor's degree	None
0.0078	low	$ 58,030	Bachelor's degree	None
0.17	low	$ 62,980	High school diploma or equivalent	None
0.0073	low	$ 96,540	Bachelor's degree	None
0.021	low	$ 85,400	Doctoral or professional degree	None
0.035	low	$ 118,160	Doctoral or professional degree	None
0.13	low	$ 31,810	High school diploma or equivalent	Short-term on-the-job training
	low	$ 99,360	Doctoral or professional degree	None
0.15	low	$ 52,720	High school diploma or equivalent	Apprenticeship
0.28	low	$ 39,040	High school diploma or equivalent	None
0.13	low	$ 37,330	High school diploma or equivalent	None
	low	$ 100,910	Master's degree	None
0.0065	low	$ 87,220	Bachelor's degree	None
0.014	low	$ 54,340	High school diploma or equivalent	None
0.0074	low	$ 28,790	Associate's degree	None
0.39	medium	$ 22,600	High school diploma or equivalent	Short-term on-the-job training
0.66	medium	$ 24,190	No formal educational credential	Short-term on-the-job training
0.55	medium	$ 62,560	Bachelor's degree	None
0.61	medium	$ 32,300	High school diploma or equivalent	Short-term on-the-job training
0.64	medium	$ 36,940	High school diploma or equivalent	Moderate-term on-the-job training
0.56	medium	$ 25,410	Some college, no degree	None
0.64	medium	$ 55,800	Bachelor's degree	None
0.69	medium	$ 21,820	No formal educational credential	Short-term on-the-job training
0.63	medium	$ 31,480	High school diploma or equivalent	None
0.35	medium	$ 51,450	High school diploma or equivalent	Apprenticeship
0.65	medium	$ 49,390	Some college, no degree	None
0.51	medium	$ 36,940	Postsecondary nondegree award	None
0.69	medium	$ 30,580	High school diploma or equivalent	Short-term on-the-job training

Scale	Domains	Definition
Importance	Tasks 2, Knowledge, Skills, Abilities, Work Activities, and Work Styles	This rating indicates the degree of importance a particular descriptor is to the occupation. The possible ratings range from "Not Important" (1) to "Extremely Important" (5).
Level	Knowledge, Skills, Abilities, and Work Activities	This rating indicates the degree, or point along a continuum, to which a particular descriptor is required or needed to perform the occupation.

Appendix II: Methodology

1. All occupational data and classification comes from the Bureau of Labor Statistics, Employment Projections, Occupational projections and worker characteristics, Table 1.7 Occupational projections, 2016-26, and worker characteristics, 2016 (Number in thousands).

   GROWTH was determined by Table 1.7, Employment Change, 2016-26. Number, rather than Percent, is used to determine growth. U.S. Bureau of Labor Statistics, Occupational Outlook Handbook, Occupation Finder is an interactive database allowing a search and sort of all occupations by entry-level education, on-the-job training, projected number of jobs, projected growth rate, and 2016 median pay. Projected Number of new jobs has six categories that track "The projected numeric change in employment from 2016 to 2026": 50,000 or more, 10,000 to 49,999, 5,000 to 9,999, 1,000 to 4,999, 0 to 999, or Decline. Projected Growth Rate categories: Much faster than average, Faster than average, As fast as average, Slower than average, Little or no change, and Decline. Our selection of 50,000 or more in numeric change from 2016-26 aligns with the highest U.S. BLS "projected number of new jobs". This

category does not however, correlate to the highest projected growth rate of "much faster than average".

   - Growth 1: Top 60 Occupations projected to grow more than 50,000 (2016-2026). Line Items only, no Summary Items.

   - Growth 2: Top 60 BY Median Annual Income

   - Growth 1 (2): Top 102 with 30,000 or more in growth BY Median Annual Income BY Typical Education for Entry

2. AUTOMATABILITY: For each occupation, we sought to find the most automation resistant skills. Skills furthest from the "engineering bottleneck" explained in *The Future of Employment* report (understanding, of course that all skills are at risk but the more routinized and computerized, the higher the risk)

3. Education for Entry is a predetermined category from the Bureau of Labor Statistics, 'Occupations', Table 1.7

4. Median Income is a predetermined category from the Bureau of Labor Statistics, 'Occupations', Table 1.7

Composite Skills Analysis

The Bureau of Labor Statistics 2018 Standard Occupational Code Handbook holds the current industry classifications for American jobs. Both job incumbents and occupational experts rate the importance and level of a skill on a specific occupation. The Task Model was used to create the probabilities of computerizability from the Oxford Martin School report The Future of Employment: How Susceptible are Jobs.

Bureau of Labor Statistics. Occupation Table. Table 1.4 and Table 1.7 were used to compile the occupations used in this report.

O*NET Data. For the 30 fastest growing occupations, we paired each BLS occupation with an O*NET code. This was done to replicate the methods of the Oxford Martin white paper *The Future of Employment*. The related excel file, Future of Work Skills Data holds the O*NET code, BLS occupations, and O*NET skills by Level.

Each O*NET Online descriptor is "associated with a scale, such as Importance, Level, Relevance, Frequency, Occupational Interest, Extent of the activity and Content." Originally, we choose Importance as it includes the most domains, however the Oxford Martin white paper uses Level. To remain consistent, we also used Level as our variable for each of the skill elements collected. The difference between importance and level centers around performance. Importance indicates the relation of a descriptor to the occupation. Level indicates the degree to which a descriptor is needed to perform for the occupation. [36]

Using Level allows us to incorporate the probability of computerization in the Future of Employment report. "These variables were derived from the ONET survey, where the respondents are given multiple scales, with "importance" and "level" as the predominant pair. We rely on the "level" rating which corresponds to specific examples about the capabilities required of computer-controlled equipment to perform the tasks of an occupation. For instance, in relation to the attribute "Manual Dexterity", low (level) corresponds to "Screw a light bulb into a light socket"; medium (level) is exemplified by "Pack oranges in crates as quickly as possible"; high (level) is described as "Perform open-heart surgery with surgical instruments".[37]

"Skills – In the O*NET framework, Skills are capabilities of individuals that are acquired through experience and practice, and are used to facilitate knowledge acquisition (Mumford, Peterson, & Childs, 1999). The O*NET Skills contain both basic (e.g., active learning, mathematics) and cross functional elements, and the cross functional elements can be further described by five categories: (a) complex problem solving, (b) resource management, (c) social, (d) systems, and (e) technical. Within these categories, there are a total of 35 elements, rated on importance and level by trained independent O*NET analysts (Tsacoumis & Willison, 2010; Tsacoumis, Willison, & Wasko, 2010), rather than job incumbents." [38]

ENDNOTES

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12 Pew Research Center. The Rising Cost of Not Going To College. 2014, http://www.pewsocialtrends.org/2014/02/11/the-rising-cost-of-not-going-to-college/

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