AUTOMATION BRIEF REPORT 2020

Automated Labor: Workers and Jobs in an Automated Economy

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SALT LAKE COUNTY
ECONOMIC DEVELOPMENT

Technology is neither good nor bad; nor is it neutral. –Melvin Kranzberg

INTRODUCTION

In 1965, before he founded Intel, Gordon Moore wrote an article describing the rate of technological innovation, noting that the number of transistors that could fit on a circuit had doubled each year since 1959. In the article he described that if such doubling continued until 1975, the average circuit – which in 1959 had 30 transistors – would have 65,000 transistors, which would allow for portable communications equipment, home computing, and even automatic controls for vehicles. Such technological doubling became known as Moore's Law. At the time, Moore was looking a decade into the future and was astonished by what he saw. That the trend of doubling has lasted over half a century is nothing short of awesome.

Moore's prediction of portable and home computing came true decades ago. His prediction of autonomous vehicles is upon us to varying degrees. There are varying degrees to which people anticipate such doubling lasting into the future, with Nvidia's Chief Executive Officer Jensen Huang declaring the continuation of Moore's Law impossible in January 2019. Others, like Intel's Chief Technology Officer Michael Mayberry and MediaTek's Financial Chief David Ku, are more confident that innovations will continue at a rapid rate, even if the rate slows from its current pace. Still others see new technologies further increasing the speed of computing.

Whether or not computing speeds and efficiencies double at the rate predicted under Moore's Law, this progress has changed and will continue to change the way we live. Increases in computing power and affordability have made it not only possible but increasingly feasible to adopt technologies to automate tasks to varying degrees – from robotics to Artificial Intelligence (AI) systems.

Such advancements have been promised to help humans live longer, healthier, and more productive lives; to reduce the amount of human labor at home and at work; and to increase safety, reliability, and precision by relying on data to inform decisions and by taking humans out of the equation in cases where there is danger.

Because automation technologies have the potential to drastically alter the way humans think about and do work, they will have reverberating effects on economies throughout the world. The extent to which these advances in technology will impact the labor force is an open topic for debate. There are many, including Carl Frey and Michael Osborne of Oxford University, who raise concerns that automation technologies and AI threaten jobs and livelihoods. Given the rapid advancement of technologies into a wide range of industries, these concerns are justified. Coupled with these concerns is

an underlying fear of widespread unemployment, poverty, and increased income inequality, all of which lead to societal instability.

Others see historical evidence for economic resilience despite such disruptions. Alec Ross, a Distinguished Visiting Fellow at Johns Hopkins University, and James Bessen, at Boston University, have each argued that labor markets are resilient and that while automation technologies may displace some workers, such technologies will never fully replace human labor. Rather than machines replacing humans in the labor force, they argue that dynamic labor markets will adapt to accommodate workers displaced by automation.

Still others foresee a techno-utopia in which machines will fully replace the majority of humans in the labor force, leading to a post-work future of leisure and plenty. These individuals place hope in both technology and government institutions, seeing mass unemployment as an opportunity to embrace new governmental and societal forms as well as new types of living.

SITUATING THE PROBLEM: CRISES AND ADVANCEMENT

While the debates about technology have emerged from time to time, the debate around the impacts of automation is salient at the moment because of the circumstances which surround it. This report will focus on the situation in the United States (U.S.), though not all of these circumstances are unique to the U.S. Nationally, unemployment is at record lows, the baby boomer generation is in the process of aging out of the workforce, and the fertility rate is below the replacement rate. Amidst these challenges, globalization exerts pressure to continue expanding the economy and drive GDP growth and profits more generally.

This mixture of circumstances is troubling. Low unemployment puts upward pressure on wages, making hiring less affordable and slowing job growth. An ageing workforce and a fertility rate below the replacement rate will combine to increase the pressure on wages further as people age out of the workforce and are not replaced. Combine all of this with the pressure of global economic system and firms will be hard-pressed to meet output demand. In order to meet demands and continue growing, firms will be forced to either look elsewhere for more affordable labor, automate what they can, or a combination of both.

While automation technologies can be costly, in the long run a robotic or digital “employee” that does not demand wages or benefits and that can work around the clock without breaks in challenging conditions may become increasingly enticing to businesses struggling to meet labor demands. The point at which labor shortages and rising wages, along with productivity increases, outweigh the up-front costs of an automated system vary depending on the business, but automation technologies are impacting every industry and every occupation.

Currently routine, repeatable tasks are relatively easy to automate (i.e. packaging a bag of chips or lifting boxes) while tasks that require problem-solving or unique approaches and that are non-routine are more challenging to automate. These circumstances mean that certain tasks and jobs are more likely to be *automated* in the short-term – leading to displacement, while other tasks or jobs are more likely to be *augmented*, allowing for new skills to be learned and, perhaps, new opportunities for career advancement.

In this landscape, scholars approach the topic of automation and its impacts on the economy, particularly the labor force, arriving at different and contradictory conclusions. Two primary camps emerge from the literature (though this is over-simplistic): techno-optimists and techno-pessimists. Techno-optimists understand automation technologies as primarily beneficial. Machines, they argue, can replace humans in some jobs but will still require human input (for troubleshooting, guidance, and problem solving, for example) for most jobs. Techno-optimists generally make some form of the argument that labor which cannot be replaced by automation will be complemented by it,[1] leading to increased production and, therefore, decreased costs of goods and increased wages. While there will be some displacement, new jobs will emerge, and the economy will remain resilient.

Techno-pessimists, on the other hand have a fundamentally different view regarding autonomation technology and AI. They tend to see robots displacing, rather than augmenting, an increasing number of jobs. Their argument follows the logic that companies will continue to seek more and more efficient means of generating profits. In such an environment, human workers are bad for business – they are costly and generally less efficient than machines. As pressures for profit efficiencies increase, automation technologies become increasingly enticing for businesses. With mechanical or digital "employees" becoming increasingly affordable, increasingly capable, and increasingly efficient, more and more jobs will be replaced. In the new automated market, the techno-pessimists argue, the economy will not be able to absorb displaced workers: unemployment will skyrocket, inequality will increase, and society will be in crisis.

Evidence certainly suggests that automation is replacing human labor. Daron Acemoglu and Pascual Restrepo argue that automation in the manufacturing industry has directly replaced workers.[2] Acemoglu and Restrepo attribute a decrease in the employment-to-population ratio to the increase in manufacturing robots.[3] These findings are mirrored by findings in Germany that "Every robot destroys two manufacturing jobs."[4] Wolfgang Dauth and his team note that between 1994 and 2014, Germany saw a decrease of 23 percent in the number of manufacturing jobs, which correlates to 275,000

jobs over that period.[5] Such evidence from the manufacturing sector is bleak.

Despite the evidence that automation technologies are already replacing workers, the outcomes of such economic disruption are disputed. Alec Ross and James Bessen have each argued that advances in technology will create enough new jobs that the economy will be able to absorb the displaced workers and that technology will increase productivity, which will increase demand for products or services that, in turn, increase employment demand in the sector.[6,7] However, others, like Martin Ford and Andrew Yang, challenge the idea that the dynamic U.S. economy will be capable of generating sufficient higher-wage, higher-skill jobs to absorb all the newly displaced workers.[8,9]

For those who see technology displacing workers, there is disagreement regarding how broad the impacts on the labor market will be. Researchers at the McKinsey Global Institute suggest that "very few occupations - less than 5% - consist entirely of activities that can be fully automated,"[10] while Martin Ford cites research out of Oxford's Business School to argue that "nearly 50% of jobs will be susceptible to full automation."[11] Nuancing this argument, Dauth et al., who measured the impacts of automation and AI on the German manufacturing industry, found that job losses in manufacturing due to automation were fully offset by additional jobs in the service sector; finding that while automation does not cause net job losses, it does affect the composition of aggregate employment.[12]

Despite differing views on the ultimate impacts of automation technologies, such technologies will impact the labor force and the economy more broadly. In order to mitigate the potential negative impacts, individuals, businesses, educational institutions, and governments at all levels will need to work together moving forward.

A GREAT REARRANGEMENT

For most of human history, the majority of our ancestors farmed the land. As recently as 1850, the agricultural sector comprised a majority share of employment. With the industrial revolution, as tractors and other mechanized farming implements came online, agricultural production became less labor intensive, causing a largescale disruption in the labor force. As the agricultural sector was changing, people needed to find new ways of earning a living: they moved to cities and many joined the burgeoning manufacturing sector. Over 40 years between 1880 and 1920, the share of jobs in the United States devoted to agriculture decreased 25%, from nearly half of the workforce to merely a quarter of the workforce. Today, merely 2.5% of the American workforce is employed in agriculture, despite dramatic increases in agricultural production, with both trends largely due to increased use of farm equipment (See Figure 1).[13]

While the turn of the 20th century saw a rearrangement from agriculture to other sectors, the turn of the 21st century has seen a similar rearrangement. Technological innovations have increased productivity while minimizing human labor. Whereas the rearrangement during the early 20th century primarily impacted a single sector, however, the current rearrangement is much broader in its impacts, leaving no industry untouched. Just as in the prior rearrangement, however, contemporary technologies have not resulted in largescale unemployment. Instead, new jobs have emerged, and technologies have augmented others.

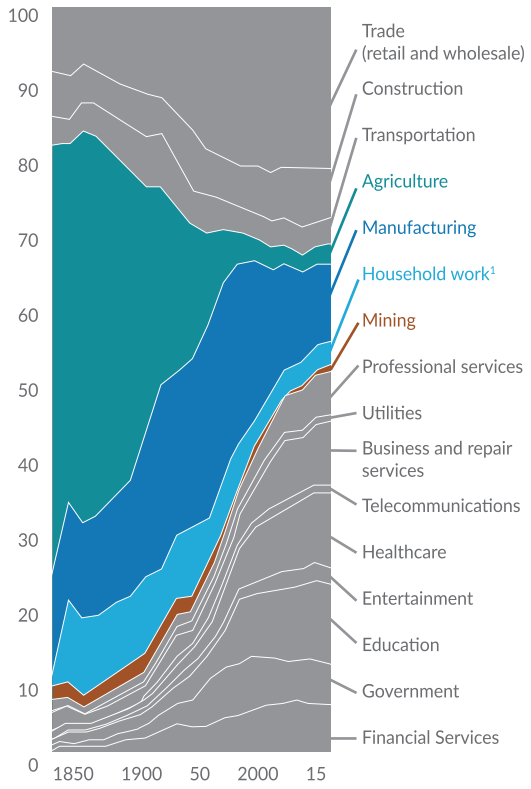

FIGURE 1. DECLINES IN SECTORAL UNEMPLOYMENT HAVE BEEN ABSORBED BY GROWTH IN OTHER SECTORS[16]

The banking industry is a useful example here. Bank tellers have been critical to bank operations since their inception. Many predicted that with the adoption of the Automated Teller Machine (ATM), the industry would see human tellers displaced by machines. Instead, the opposite has been the case: the number of bank tellers in the labor market has grown steadily since the advent and implementation of the first ATM in 1971. Use exploded with the early implementation of the ATM, with 42% of US families having an ATM card by 1984.[14] With nearly half of customers using ATMs for teller services, many forecast the demise of the teller as a profession. However, the reality was that while ATMs did decrease the amount of transactions a human teller was responsible for, it also decreased the cost of operating individual branches, which allowed banks to build more branches, each staffed with fewer people. This shift created fewer jobs per location, but more jobs overall. While tellers were processing fewer customer transactions, they were able to increase their customer service and shift their

focus to creating new products for clients (loans, investment opportunities, small business services, etc.). In this case, technological advancement (in the form of automation) contributed to an increase in employment in the sector immediately impacted by the technology. (Figure 2).

Another layer of nuance in the outcomes is based on the approach different researchers take. Carl Frey & Michael Osborne take an occupation-based approach, wherein they consider whole jobs that can be replaced by automation.[18] A research team at the Organisation for Economic Cooperation and Development (OECD), however, approaches the problem using a task-based approach.[19] Rather than looking at whole jobs that are likely to be replaced, they look at tasks within a given job that are most likely to be automated. This difference in approach

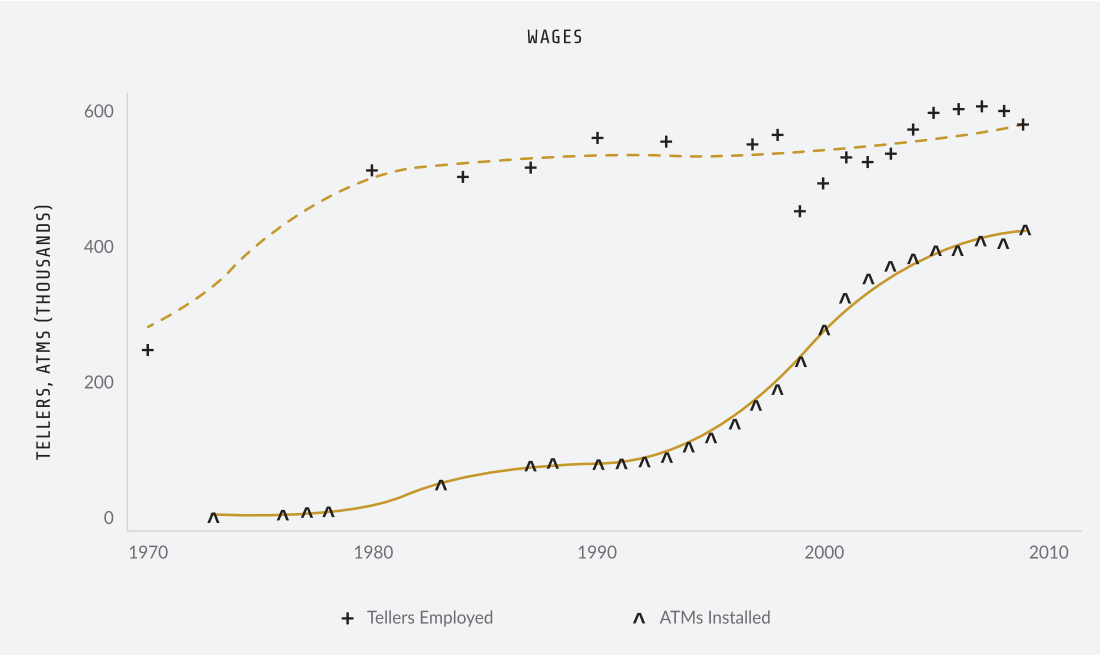

FIGURE 2. ATM ADOPTION AND TELLER JOBS OVER TIME[17]

is significant and is a factor in the way in which individuals understand the outcomes of automation.

Considering the automation problem from an occupation-based approach casts a wide net, expecting that robots and AI will be able to complete every single task in a given job title, displacing the human worker. The task-based approach, however, takes a conservative approach, considering that augmentation, rather than full displacement, is more likely as automation technologies would handle routine tasks while humans would be more available for increasingly abstract, creative, non-routine tasks. The ATM case cited earlier provides a good example of how a task-based approach lends itself to job augmentation as opposed to job displacement, actually increasing the number of jobs created through increasing capacity while cutting expenses.

LABOR AUTOMATION AND ITS IMPACTS ON WORKERS

While the full extent of automation technologies on the economy is debatable, there is consensus that routine and repeatable tasks are easiest to automate. With high automation potential, these jobs are the most likely to be displaced in the near term by automation technologies. This means that jobs in the trucking, manufacturing, food preparation, and warehousing sectors are likely to disappear or significantly change in the near term. And while these jobs are low-skill and low-wage, higher skill and wage jobs are not exempt from the disruption of automation. Forecasts also suggest, and evidence corroborates, that banking, finance, insurance, data analysis, and pharmacy jobs, among others, are also ripe for disruption.

Morgan Stanley estimates the savings of automated freight delivery to be a staggering $168 billion per year saved in fuel ($35 billion), reduced labor costs ($70 billion), fewer accidents ($36 billion), and increased productivity and equipment utilization ($27 billion), which would actually be enough to continue paying freight drivers $40,000-a-year salaries to stay home while saving tens of billions per year across the industry.[20] In Germany, a global leader in manufacturing, the average hourly cost (to a company) of a manufacturing worker is $49, in the United States the average hourly cost is $36; the hourly cost of a robot is $4 (see Figure 3).[21] Couple these cost disparities with the fact that machines can work around the clock making fewer mistakes, and the math is even more clear: employing robots to complete tasks and replace human laborers will save companies money. These are bad signs for workers across industries.

Many people in these industries many not even expect or foresee their jobs being automated, but experts warn that it is happening and could have particularly negative effects, in the short term, while the market tries to soak up all the newly displaced workers. Consider the transportation industry: driv-

ing a truck is the most popular job in 29 states and there are 3.5 million truck drivers nationwide.[22] Experts anticipate fully autonomous trucks arriving before fully autonomous personal vehicles because highway driving is easier to navigate than complicated city driving. While the number of potentially displaced truckers is staggering, there are twice as many workers supporting the trucking industry as there are drivers, many of whom live in rural communities. About 2,000 truck stops around the country serve as dedicated hotels, restaurants, stores, and entertainment for truckers daily - employing as many as 7.2 million workers.[23]

But truck drivers and their service providers are not the only professions that risk being displaced. The same concerns apply for floor traders on the New York Stock Exchange as well, where automated trading algorithms are responsible for between 50-70 percent of trades on Wall Street.[25] The finance industry, while requiring higher educational attainment than trucking, is set for disruption from auto-

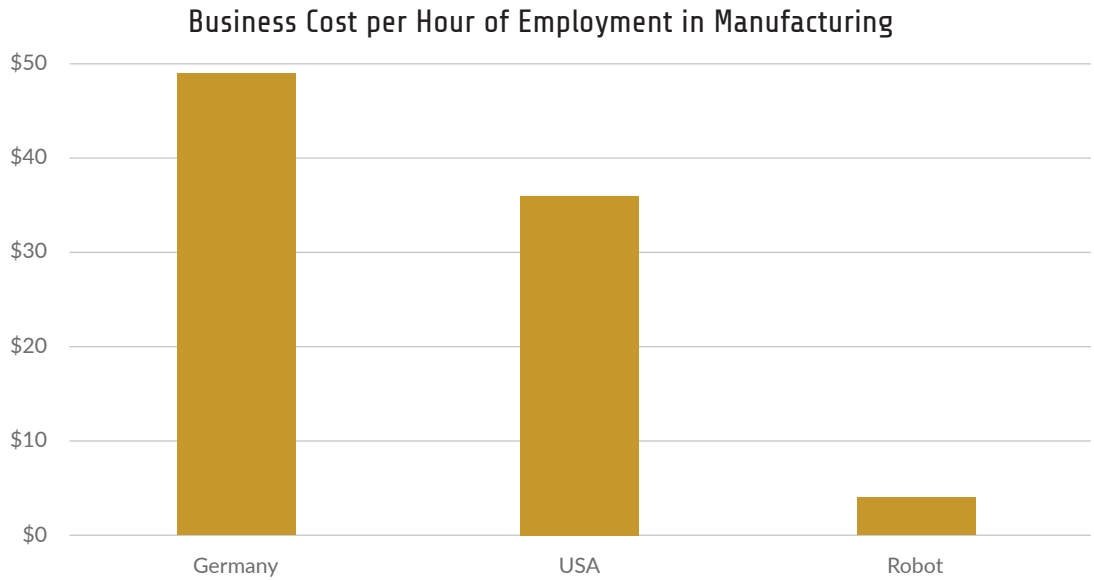

FIGURE 3. BUSINESS COSTS PER HOUR OF HUMAN EMPLOYEES VERSUS AUTOMATED TECHNOLOGIES IN MANUFACTURING[24]

mation as tasks are highly repetitive and rational, institutions have immense wealth concentration and are efficiency-minded, and culture is fueled by competition. The difference between truckers and investment bankers is that technology is already displacing investment bankers, while truck drivers will not be displaced for a few years, if not decades.

In 2016 *Bloomberg* published an article declaring that 2016 was the year of "peak human" for the finance industry and the industry would begin to progressively shed jobs, noting that algorithms would largely be rolled out to execute trades and analyze data.[26] The very same year, the president of State Street predicted that 20 percent of his 32,000 employees would be automated out of jobs in the next four years.[27]

Some of the forecasts for workers are bleak:

- Nearly a quarter of American jobs stand to be "heavily disrupted" by automation and AI technology in the coming decades.[28]
- Male workers are much more exposed to the negative impacts of automation and AI than women are, considering men's dominant presence in manufacturing, transportation, and basic construction occupations—job areas that are largely routine and repetitive. In contrast, industries typically dominated by women are relatively safe occupations, such as health care, personal services, and education.[29,30,31]
- Low-skill workers are likely to bear the brunt of the adjustment costs as the automatability of their jobs is higher compared to highly qualified workers.[32]

While these forecasts are bleak, it is important to note that many of the jobs most ripe for displacement by automation are tedious, unfulfilling, and do not pay a living wage. Even still, many people currently depend on these jobs to make ends meet. If such forecasts are correct, there will likely be an increase in the supply of low-skilled labor, which may put upward-wage pressure on high-skill labor, at least in the short-term. Alternately, increased productivity and increased profits realized by companies through the adoption of automation technologies may lead to the creation of new jobs doing new tasks that do not currently exist, similar to when computers revolutionized the modern office and created a host of new jobs and new tasks. Researchers at the McKinsey Institute suggest that technological advancement could create more jobs than it destroys, as it has throughout history.[33]

THE RISE OF NON-ROUTINE JOBS

While automation and AI technologies are incredibly good at replicating the same task or process over and over, they currently struggle with diverse arrays of tasks and chaotic environments. This is why autonomous personal vehicles are further down the road than autonomous long-haul trucks and why a single millimeter change in the place-

ment of shelves can disrupt warehouse operations for days. Because technology has not yet made diverse tasks and chaotic environments feasible for automation, humans are currently more efficient (and inexpensive) at completing non-routine tasks in changing environments. This is evidenced by a growth in employment of non-routine cognitive tasks in the United States over the past 30 years while routine job growth has stagnated, with declines more recently (Figure 4).[34]

Some estimates predict that if automation technology is adopted rapidly, 3-14 percent of the global workforce could need to switch occupational categories by 2030.[36] Because non-routine cognitive jobs are typically higher wage jobs, the least likely

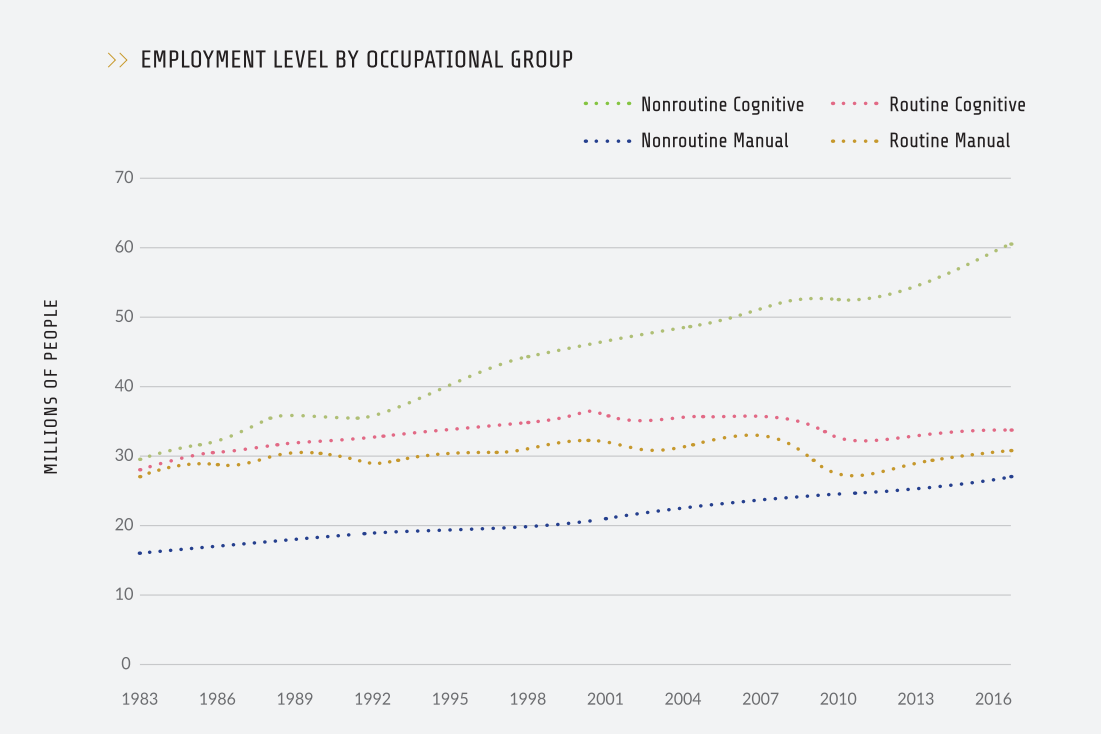

FIGURE 4. EMPLOYMENT LEVEL BY OCCUPATION GROUP[35]

to experience disruption or displacement will be those with higher levels of education that work in cognitive roles. Analyses by the Brookings Institution suggests that a bachelor's degree will provide stability to many workers, given that only about six percent of workers with such a credential face high automation threats in the coming decades.[37] Other experts note that the fastest rate of job growth will be for occupations currently requiring a college or advanced degree.[38] This provides hope and a realistic path forward for many workers concerned about the impacts of automation on their future earnings and jobs as education seems to provide some insulation, but it may lead to despair for individuals in low-skill, low-wage jobs, as they are likely to be left behind in a more automated economy unless there are significant interventions made.

Experts are acutely aware of which jobs are least likely to be automated and there are currently several labor markets in desperate need of cognitive non-routine work. The Bureau of Labor Statistics (BLS) publishes a comprehensive list of the jobs projected to be the fastest growing jobs over the next decade, and they include a wide range of non-routine cognitive roles: Speech-Language Pathology, Mathematics/Statistics, coding/software development, physical/occupational therapy, energy technology (solar & wind), and general health care fields, among others (Figure 5). All these fields are expected to grow, nationally, by over 20% in the next decade - with many of them paying between $50,000 and $100,000 annually, though the largest growth is anticipated in home health and personal care fields, which are low wage and dominated by immigrants and women.[39]

Many employers are desperate for non-automatable jobs in fields that do not require a bachelor's degree, as well. Consider the construction industry. Nationally there is a construction labor shortage that is seriously impacting housing prices.[40] Experts at the Harvard Joint Center for Housing Studies have attributed historical labor shortages in the housing construction industry since 2008 as part of the contributing cause of rising home prices. Local experts echo this very same point, noting a serious lack in construction labor in Utah.[41] This shortage extends beyond traditional construction jobs like framers, roofers, and drywallers, with more technical, higher-paying construction jobs like electricians, plumbers, and HVAC technicians in high demand as well. Construction and repair jobs are currently difficult to automate due to their non-routine nature. Construction presents a significant area for workers with lower educational attainment to obtain a middle-wage job.

While the BLS report suggests specific industries that are expected to grow significantly over the next decade, workers that master non-routine, cognitive skills in any field will be rewarded in the shifting labor market. Jobs that require face-to-face customer service and service provision will remain

FASTEST GROWING OCCUPATIONS

	Percent change, projected 2018-28	Employment change, projected 2018-28 (in thousands)	Median annual wages, May 2018
Solar Photovoltaic Installers	63.3%	6.1	$42,680
Wind Turbine Service Technicians	56.9%	3.8	$54,370
Home Health Aides	36.6%	304.8	$24,200
Personal Care Aides	36.4%	881.0	$24,020
Occupational Therapy Assistants	33.1%	14.5	$60,220
Information Security Analysts	31.6%	35.5	$98,350
Physician Assistants	31.1%	37.0	$108,610
Statisticians	30.7%	13.6	$87,780
Nurse Practitioners	28.2%	53.3	$107,030
Speech-Language Pathologist	27.3%	41.9	$77,510

FIGURE 5. FASTEST GROWING OCCUPATIONS, 2018-2028

for the foreseeable future, including jobs such as educators, managers, childcare workers, customer service positions, and Human Resources specialists.

While there are factors that will increase an employees' likelihood of getting a job in an increasingly autonomous economy, there are other factors working against automation's widespread takeover of the job market. These factors include the threat of hacking by bad actors, general societal discomfort with the prospect of a completely autonomous workforce, and a historical perspective of job creation despite technological advancement (see Figure 1). Hacking, specifically, provides an increasingly ubiquitous threat in an increasingly automated economy that could theoretically shut down an entire factory, production line, energy grid, or transportation system. To mitigate this threat, either the market for cybersecurity personnel will likely increase in proportion with automation technologies or businesses will continue to rely on human labor to offset the risk of total collapse following a cyber-attack, or some combination.

WAGE STAGNATION AND INEQUALITY

Automation technologies present challenges beyond technological unemployment. Wage stagnation is also a concern that needs to be addressed as it will likely have a more significant impact on human well-being than displacement. Historical economic data suggests that such stagnation is already a major concern and automation technologies only look to exacerbate its effects.

Over the past few decades, there has been a trend of wealth concentration to the highest earners. This largely stems from a polarized workforce. A major fear behind the threat of automation on the labor force is that incomes will continue to polarize and at an accelerated rate. Those at the high end of the income spectrum are growing and those at the lowest end of the income spectrum are growing, what results is a once-healthy middle class being hollowed out (Figure 6). Figure 6 shows that over the past 30 years, the share of jobs in the middle of the occupational spectrum has reduced each decade, resulting in a labor force that is increasingly polarized to high- and low-income earners with fewer in the middle. A large body of U.S. and international evidence confirms the presence of employment polarization at the level of industries, localities, and national labor markets. Many experts anticipate that income polarization will continue.

In addition to an increasingly polarized workforce, workers at the high end of the income spectrum are making most of the wage gains while workers at the low end of the income spectrum have seen nominal increases in their annual wages over the past 50 years.[43] Additionally, in the aftermath of the Great Recession, the wealth gap between upper-income families and everyone else is at the highest level recorded.[44] While productivity has historically

been coupled with wage gains, the data increasingly shows otherwise, with a notable deviation since the 1970s in U.S. employee's wages and productivity (Figure 7). The new norm is that employers expect more and reward less.

Consider the example of bank tellers mentioned earlier. While teller job growth has remained relatively stable in the face of increasing reliance on automated technology, wages have not fared the same outcome. While the impacts of automation on bank tellers' rate of employment was relatively mild, the impact on wages was significant in the face of new skill requirements: "Since the late 1980s, the median hourly pay of bank tellers has risen about 6 percent," leading to high rates of turnover as labor

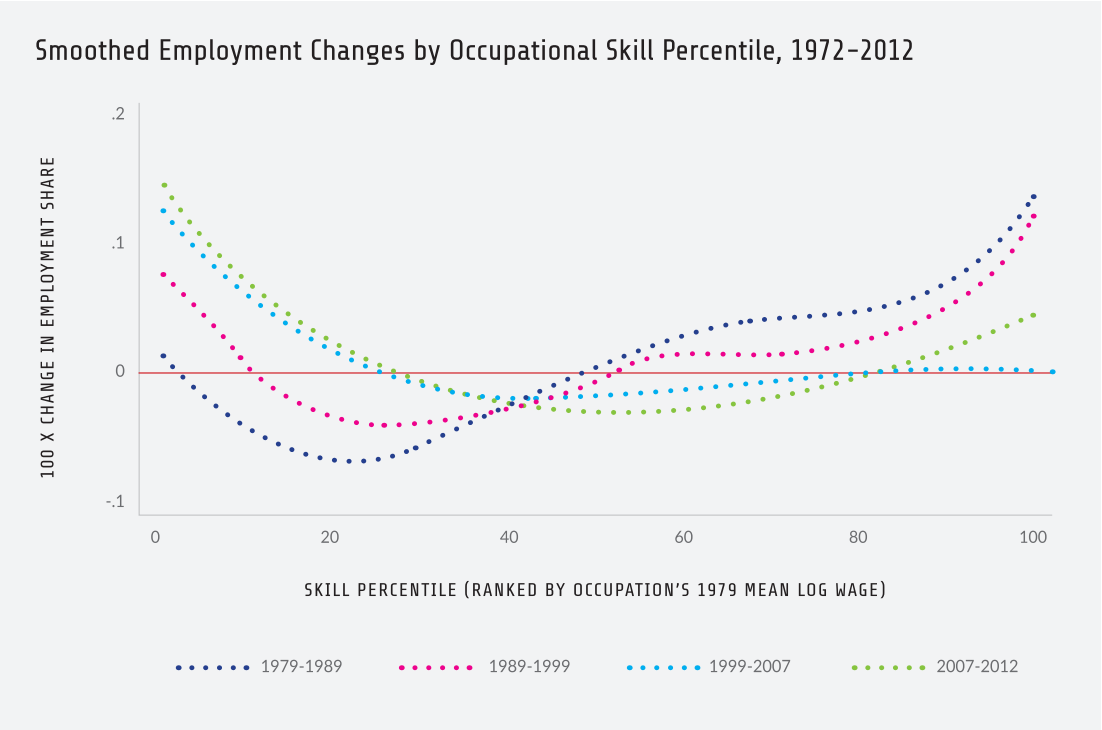

FIGURE 6. SMOOTHED EMPLOYMENT CHANGES BY OCCUPATIONAL SKILL PERCENTILE, 1972-2012[42]

markets have not compensated tellers well for their experience.[46] Such a decoupling of productivity and wages suggests that the advent of autonomous technology has placed downward pressure on wages.

Such a decoupling of wages and productivity is concerning for individual workers and their families but also for the broader economy. Increased wages are the largest driver on consumer spending growth. Consequently, consumer spending growth

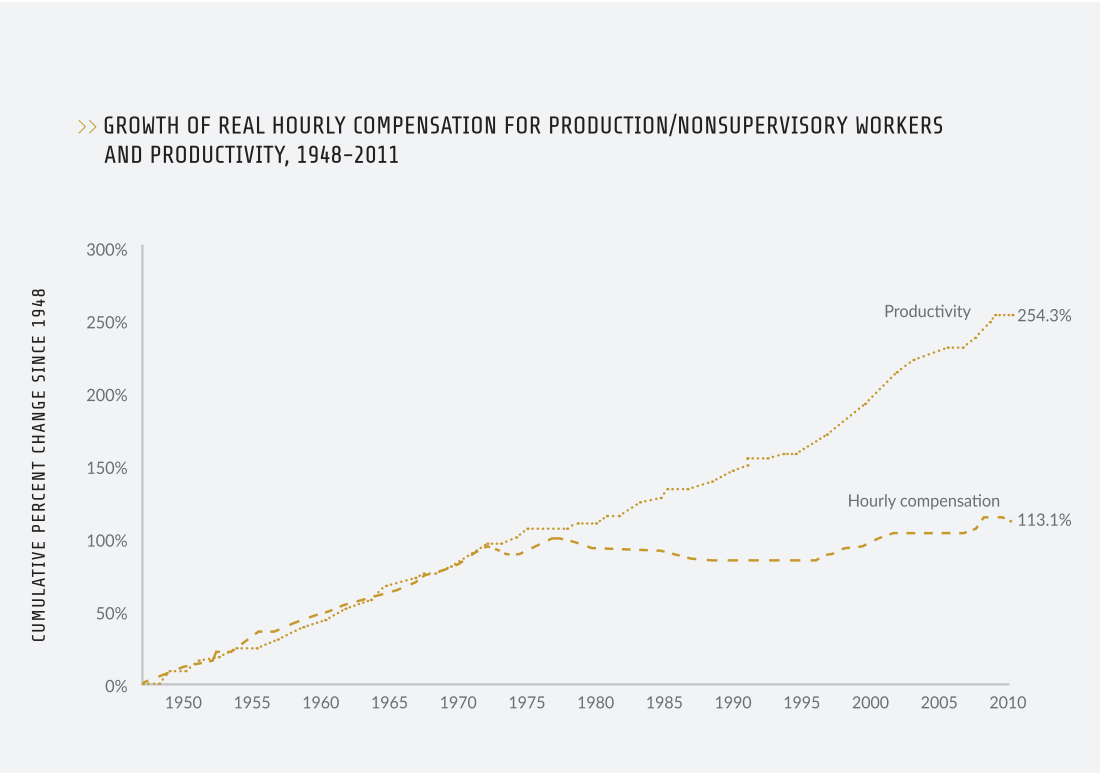

FIGURE 7. GROWTH OF REAL HOURLY COMPENSATION FOR PRODUCTION/NONSUPERVISORY WORKERS AND PRODUCTIVITY, 1948-2011[45]

is a major driver of U.S. gross domestic product (GDP) growth. The relationship between consumer demand, jobs, and growth is intricately linked (Figure 8). If wages continue to grow despite automation, meaning other industries grow to compensate for the new availability of labor, *and* wages increase in these new jobs, then the economy will transition relatively smoothly. However, if wages continue to stagnate or even decline, due to automation, the economy will face major challenges.

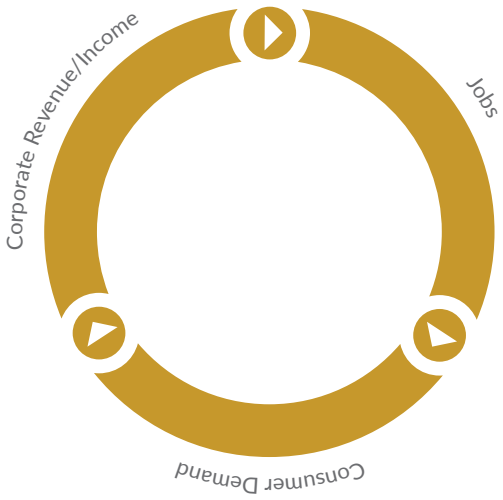

FIGURE 8. DEMAND AND PROFIT

Perhaps more than any other economic sector, the automotive industry has showcased the importance of the purchasing power of the middle class. When Henry Ford ramped up production of the Model T in 1914, he famously doubled wages to $5 per day, ensuring that his workers would be able to afford the cars they were building. From that genesis, the rise of the automotive industry would go on to become inextricably intertwined with the creation of a massive American middle class. But a decoupling is currently occurring as costs continue to increase even as wages stagnate, leading to consumer debt that has increased each quarter since the second quarter of 2013.[47]

Humans and governments are the only consumers in the economy. Robots do not consume goods or services; they only facilitate their production. While wealthy individuals have largely been able to increase spending to maintain GDP growth in the U.S. despite stagnating low- and middle-class wages, lately GDP growth has been nominal. If automation does impact jobs as the techno-pessimists fear, and re-employment is slow or non-existent, frictional unemployment will rise and wages will face further downward pressure. This is concerning because economies that are not expanding struggle to generate job and wage growth, leading to increased inequality, widespread unemployment, and deflation.

Deflation presents challenges for individuals, governments, and corporations as it makes debt unmanageable. In a deflationary economy, income may fall, property values may fall, and the stock market

may fall. Debts such as mortgages, car loans, and student loans, however, do not fall. Debts are fixed in nominal terms, so as incomes and asset values decline, borrowers have more difficulty repaying debts and have less discretionary income to spend. Governments likewise run into trouble because tax revenues plunge,[48] which has widespread ramifications as government spending from research and development to entitlement programs is cut and austerity policies are instituted.

ARE ROBOTS TAKING OUR JOBS?

While some caution automation's possible negative impacts on the economy and labor force, others caution that automation is being used as a scapegoat for other global economic problems. Trade, for

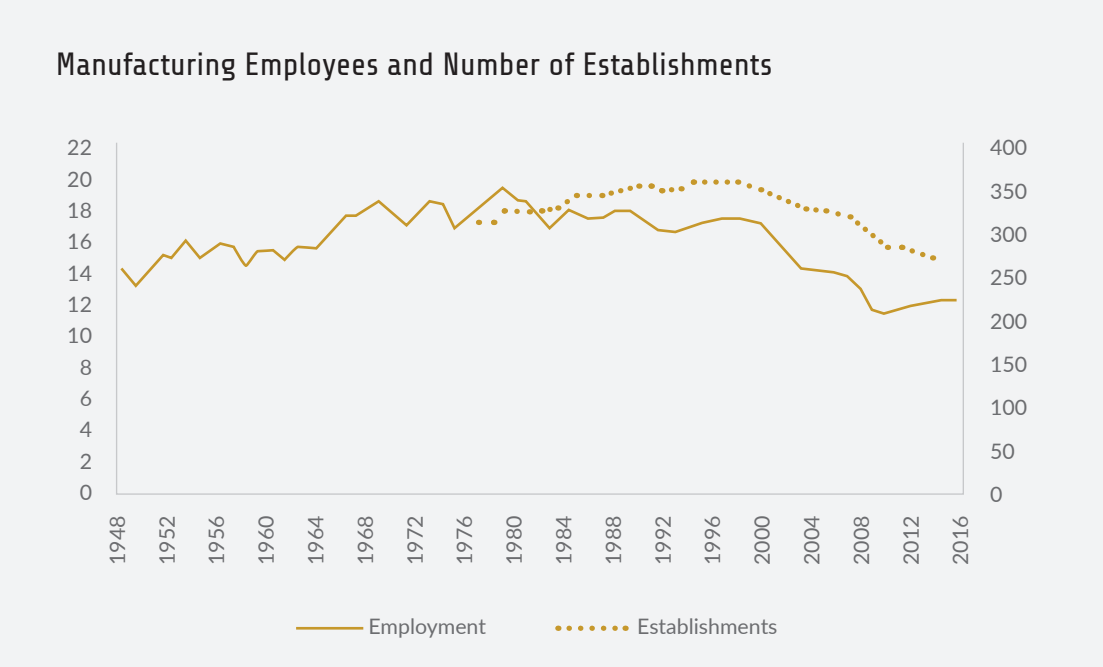

FIGURE 9. MANUFACTURING EMPLOYEES AND NUMBER OF ESTABLISHMENTS[50]

instance, has played a significant role in the collapse of U.S. manufacturing employment in the 2000s, but many techno-pessimists argue that automation is the leading factor. In contrast, research to date finds little support for the hypothesis that automation was responsible for the sudden decline in manufacturing employment since 2000 (Figure 9), though automation can have significant impacts on the number of jobs at manufacturing firms.[49]

Conventional wisdom is that US manufacturers are currently maintaining their historical levels of production with fewer employees and that robots are directly competing with US workers for jobs. Data, however, suggests that U.S. manufacturing is being outsourced to other countries, partly because of lesser environmental regulations and cheaper labor. This is evidenced by the general decline in U.S. manufacturing companies in line with the decline in manufacturing employees (Figure 9).

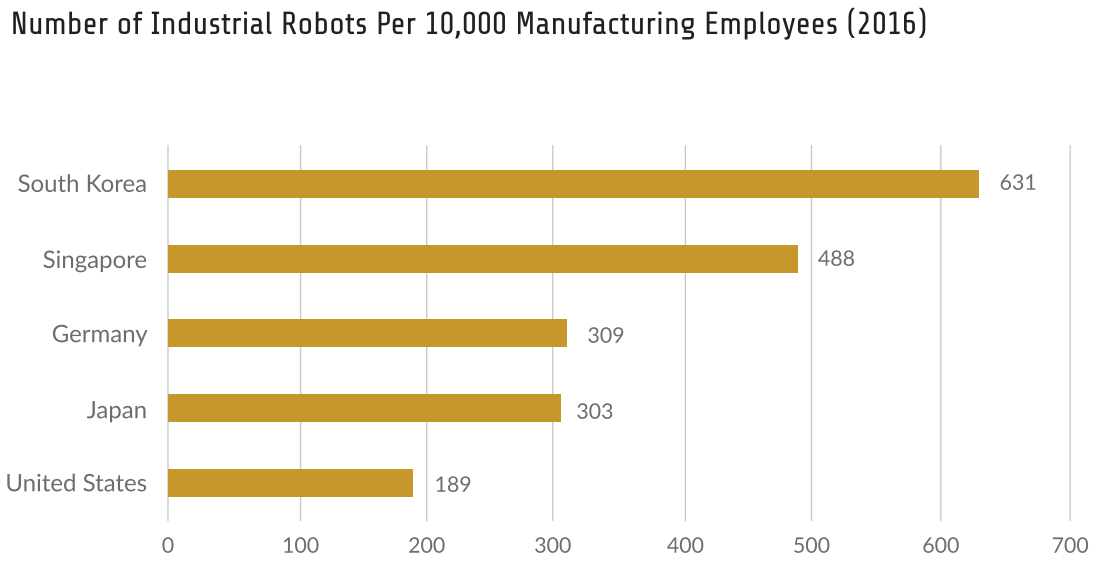

FIGURE 10. NUMBER OF INDUSTRIAL ROBOTS PER 10,000 MANUFACTURING EMPLOYEES (2016)

Additional evidence from other countries clarifies this point. Countries that excel in manufacturing (measured by percentage of population employed in manufacturing) also are the largest of adopters of industrial robots. Germany (19 percent of population employed in manufacturing), South Korea, and Japan (16.9 percent each) each have over 300 industrial robots per 10,000 manufacturing employees,[51] suggesting that automation alone is not leading to a decline in manufacturing (Figure 10).

Regardless of whether automation is the primary culprit of the U.S. manufacturing decline, it contributes to the challenges that manufacturing and other industries are facing and will face in the future. Furthermore, automation technologies have the potential to drastically change the way that individuals think about and perform work. A 2020 research report by James Bessen at the Brookings Institution suggests that the largest challenge of automation is not long-term, permanent unemployment but a greater level of worker transitions, which involve periods of unemployment and income loss.[52] These periods of un- and underemployment have been shown to have "non-negligible" impacts on worker pay, as workers at automating firms experience income losses of approximately 11 percent of one year's pay over the five years following an automation event.[53] And, as Economist Teresa Fort at Dartmouth College has said, "If we care about people's well-being, we should stop debating whether trade or technology led to the loss of certain jobs, and instead focus on how to recognize and facilitate the transition into new job opportunities."[54]

AUTOMATION IN SALT LAKE COUNTY

Despite expert predictions, things may not be as dire in Salt Lake County – at least in the short term. A research team at the Brookings Institution anticipates that of the 100 largest metropolitan areas in the nation, the Salt Lake City MSA is in the bottom third for automation potential, with a potential of 44.6 percent.[51] A diverse economy that is not reliant on a single sector helps, as does an educated workforce. Wages that are lower than in competing markets may contribute to local resilience in the short-term as there is less wage pressure to automate. Demographic homogeneity may also serve as a buffer because historical and current policies and hiring practices lead minority groups to be overrepresented in jobs with high automation potential.[56]

All of this is confounded slightly by data suggesting that young people and men are more at risk of displacement than older workers and women. In Salt Lake County, women comprise 45% of the workforce, earning a median annual wage that is 74 percent of what men earn. While males over the age of 16 participate in the labor force at rates of

79 percent, women only participate at 64 percent. Additionally, women work an average of five fewer hours per week and are slightly less educated than their male peers (Figure 11).[57]

Since women typically work in jobs that are less likely to be automated but also earn less than men, any disruption in the labor market that displaces large numbers of men could have a devastating impact on the local economy, as households (which are larger in Salt Lake County than at the national level) lose a primary breadwinner to technological unemployment and struggle to make ends meet. The median wage of women in Salt Lake County is $37,652[59]– roughly 60 percent of Area Median Income for a single individual[60] and below what a research team at the Massachusetts Institute of Technology (MIT) considers a "living wage" for anyone but a single individual living in the County.[61]

45%

WOMEN ARE 45% OF THE LABOR FORCE

LABOR FORCE PARTICIPATION RATE*

64%	79%
WOMEN	MEN

YEAR-ROUND, FULL-TIME ANNUAL MEDIAN EARNINGS

$37,552	$51,007
WOMEN	MEN

SHARE OF POPULATION WITH A BACHELOR'S DEGREE OR HIGHER

32%	35%
WOMEN	MEN

FIGURE 11. WOMEN IN THE WORKPLACE IN SALT LAKE COUNTY[58]

Furthermore, Hispanic individuals are considered the most likely to suffer displacement through automation.[62] As Salt Lake County's largest ethnic minority (18.6 percent of the population),[63] this is concerning and could have widespread effects on the local economy. Young Hispanic men, therefore, are triply targeted by automation technologies. Given that the gender wage gap for Hispanic women is more exaggerated than the wage gap for women generally,[64] a loss in income from a husband, partner, or father due to technological displacement for Hispanic families could prove devastating.

The data is concerning and suggestive of a potential crisis. Despite these broader macroeconomic concerns, however, local business practitioners do not see automation technologies having such a negative impact on their businesses or their employees. Rather, the consensus of local practitioners across multiple fields aligns with many of the techno-optimists: automation will *augment* more than it will *displace* and will create more jobs and increase productivity, as technology has historically done.

Additionally, local business sentiments seem to align with the larger trends in the literature: automation technologies may *displace* some workers, but it is not clear that automation and AI is currently *replacing* workers. While technology exists that reduces current human labor demand, making workers more productive because their work is augmented by technology, technologies that fully replace humans are often too expensive to be feasible or simply do not yet exist.

The optimism of local businesses may result from that fact that current adoption of automation technologies has increased efficiency and productivity and has not yet had a displacing effect. Automation technologies have allowed current employees to focus more attention on different areas of their jobs or to learn new skills. In some instances, this has resulted in wage increases commensurate with the new skills.

Businesses are hesitant to state that automation technologies have directly resulted in employee layoffs, but that may be a nature of the industries represented. Furthermore, while jobs may not immediately be replaced by automation technologies, such technologies may limit the new jobs that are created. A new warehouse that historically may have employed dozens of workers, if built with automation technologies in mind, may not hire nearly as many employees to begin with. Thus, a business may not replace existing jobs but has limited a future need – even while creating jobs.

Industry representatives did suggest that automation technologies have increased capacity, which has increased demand, leading, in some cases, to new jobs. These jobs, however, are typically not the same types of jobs that automation technologies have augmented. Rather, they are jobs in other occupations or roles entirely: manual labor or data entry may be replaced by finance, sales, IT, or cyber-security jobs, for instance. Some local companies work with their employees to upskill, but this is not universal.

Upskilling will be important moving forward. Recently Amazon announced that it will invest $700 million to retrain a third of its current workforce by 2025.[65] Such an investment is admirable and will hopefully help employees who take part gain skills that can increase their earning potential. However, such an approach may actually depress wages in the "in-demand" occupations as the number of individuals seeking those jobs increases because labor supply elasticity is implicated in lower wages.[66]

Such labor supply elasticity is apparent when looking into the national and state-level emphases to increase investment in Science, Technology, Engineering, and Math (STEM) education as a means of preparing students for future labor market needs. Evidence suggests that there is already an over-supply of individuals with degrees in STEM fields. Citing a 2004 government-sponsored report, David Berliner and Gene Glass write that, "Despite recurring concerns about potential shortages of STEM personnel in the U.S. workforce, particularly in engineering and information technology, we did not find evidence that such shortages have existed at least since 1990, nor are they on the horizon."[67]

More recently, *The New York Times* published an article citing research from both private businesses and academics outlining that there is an over-supply in all STEM fields except computer science, which sees supply and demand at near equilibrium.[68] Emphasizing STEM education has generated an oversupply in certain fields, which, in turn, has depressed the wages of those fields.

Depressing wages through increased labor supply concerning given that real (inflation-adjusted) wages within Salt Lake County have been stagnant since at least the 1980s, even as cost of living has increased.[69] Consumer Price Index data from August 2019 shows that since 1982, cost of living has increased 256 percent, and Salt Lake County is now less affordable than the national average.[70] The compressed wages within Salt Lake County are of particular concern given that the County has been at full employment (5 percent unemployment or lower) since mid-2012 and has seen unemployment rates consistently below 3.5 percent since September of 2014.[71]

While low unemployment can induce higher wagers, it also presents a real challenge to growth for local employers. Data from interviews with over 500 small and medium businesses (500 employees or less) conducted from 2017-2018 highlights the challenges that local businesses face to growth, with workforce challenges being cited more frequently than any others.[72] Low unemployment certainly contributes, but so too does the aging of the workforce. Despite Salt Lake County having a younger than average workforce, as members of the baby boomers age out of the workforce, additional pressure will be placed upon local businesses. Thus, automation may be necessary simply to maintain

current productivity levels – especially in the trades, which struggle attracting younger talent.

For those whose jobs are replaced or augmented by automation technologies, upskilling will be critical, but may lead to short-term discomfort. Asking individuals who are years – or even decades – into their careers to return to school (in some form, even if that form is an Amazon training program) is a tough ask. This is especially true if individuals are required to pay for upskilling on their own or take time outside of work to retrain.

There is hope in upskilling, however, as recent survey data from Salt Lake County Economic Development suggests. In a survey of over 1,000 people employed within the County that asked individuals to rank work values, the top five highest ranking work values were: a job that is interesting; a job that uses your skills and abilities – lets you do the things you do best; a job where you can learn new things/skills; a job that offers a predictable, secure future; and a job where you can see the results of what you do.[73] Within the top five, then, two values are related to skills and one is related to job security. This suggests that area residents are eager to learn and apply what they learn to their job. The nexus with job security suggests that learning new skills will increase the likelihood of being retained as automation technologies become more ubiquitous.

All of this suggests that, at least in the short term, automation offers opportunity for further economic growth: new technologies can increase efficiency and productivity while creating new jobs and augmenting others; decreases in consumer product prices as efficiency increases; the possibility of increased leisure time and better work-home balance; wage increases due to increases in productivity. None of this is guaranteed, however. Intentional interventions to ensure that the future is bright will be necessary because the possibility of displacement, increased unemployment, and increased poverty – along with increased income inequality – is ever-present. Furthermore, long-term predictions are highly speculative.

Because of the disagreement that exists on the impact automation technologies will have on labor markets, it is problematic to present hard numbers on how many jobs will be replaced by technologies as well as the timeline that such replacement might occur. If widespread technological unemployment were to occur, it is likely that the transition would be on the scale of decades rather than years. Regardless, it is important to understand what such impacts might look like locally.

To represent the impact that automation technologies might have on the local labor market, however speculative such predictions might be, turning to Frey and Osborne is useful. Applying Frey and Osborne's likelihood of computerization scale74 to the local labor market, it is clear that low-wage occupations

AUTOMATION PROBABILITY AND MEDIAN ANNUAL WAGE OF OCCUPATIONS

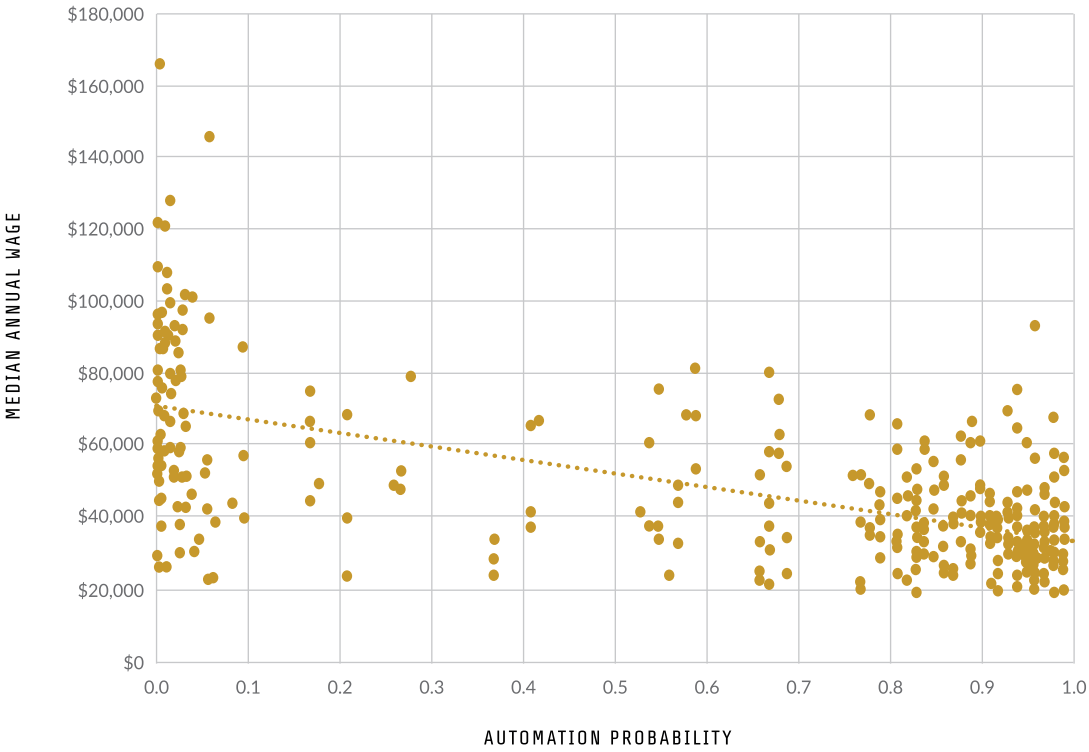

FIGURE 12. AUTOMATION PROBABILITY AND MEDIAN ANNUAL WAGE OF OCCUPATIONS IN SALT LAKE COUNTY

are more likely to be automated. While this model is from 2013, it is still a helpful tool. Figure 12 shows median annual wage on the y-axis and probability of automation on the x-axis. Note that applying Frey and Osborne's analysis suggests that 53 percent of all occupations in Salt Lake County have a probability greater than 0.8 of being automated while 27 percent of occupations have a probability less than 0.2. Viewed a different way, the data is telling in terms of the total impact that automation might have locally. Table 1 lists the top 15 occupations by total employment in Salt Lake County and the potential for such jobs to be automated. Of the top 15 occupations listed, eight have automation probabilities

OCCUPATION	Total Employment in Salt Lake County	Probability of Automation
Customer Service Representatives	30,290	0.550
Retail Salespersons	21,010	0.920
Combined Food Preparation and Serving Workers, Including Fast Food	17,120	0.920
Office Clerks, General	15,350	0.960
Laborers and Freight, Stock, and Material Movers, Handlers	14,300	0.850
Heavy and Tractor-Trailer Truck Drivers	12,790	0.790
Cashiers	12,310	0.970
Janitors and Cleaners, Except Maids and Housekeeping Cleaners	10,710	0.660
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	10,450	0.850
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	9,290	0.960
Waiters and Waitresses	8,180	0.940
Bookkeeping, Accounting, and Auditing Clerks	6,990	0.980
Teacher Assistants	6,810	0.560
Software Developers, Applications	6,060	0.042
Accountants and Auditors	5,190	0.940

TABLE 1. TOP OCCUPATIONS IN SALT LAKE COUNTY AND PROBABILITY OF AUTOMATION[75]

above 0.9, which is startling. If such probabilities prove correct, even within a ten percent margin of error, tens of thousands of individuals could be out of work. (For a full list of jobs and their automation potential, see Appendix 1.)

Table 2 looks at occupation groups, rather than individual occupations. While automation potential does not necessarily correlate perfectly to the number of jobs that could be replaced by automation, if it did, Table 2 would point toward mass unemployment, with 328,007 people without a job once the occupation was automated. This is a worst-case view and should be considered as such, but it is helpful to keep in mind. A more likely scenario would include job losses only in occupations with very high (0.85 or higher) automation probabilities with other occupations experiencing minimal displacement and augmentation commensurate with the automation probability.

In combination with Frey & Osborne's predictions, David Autor has outlined three key factors that nuance the impacts of automation: 1) Workers are more likely to benefit from automation if they perform tasks that can be augmented by automation, but not if they primarily perform tasks that are automatable; 2) Elastic labor supply can offset wage gains; 3) The output of elasticity demand combined with income elasticity can either dampen or amplify the gains associated with automation.[77] The first factor is intuitive but can be shown through the example of construction workers. An individual who knows how to operate an excavator can earn more than an individual who only knows how to use a shovel due to increased productivity. The second factor was articulated above in relation to STEM jobs. The third factor can be understood through the agricultural and healthcare sectors. In the case of agricultural products over the long run, spectacular productivity improvements have been accompanied by declines in the share of household income spent on food. In the case of healthcare, improvements in technology have led to ever-larger shares of income being spent on healthcare needs.

These factors, along with the probabilities of automation presented above, will certainly contribute to how automation technologies impact the local labor market in both the short and the long term. Growing pains in the short term can be mitigated through thoughtful public and private policies to address likely outcomes. In the long term, things become a little more difficult. If AI and robotics do advance to the levels that Martin Ford,[78] Andrew Yang,[79] or Aaron Bastani[80] predict, significant structural changes to the global economy as well as governments at all levels will be required to adapt to a world where humans are considered redundant in the labor force.

In order to mitigate the most disruptive and negative impacts of automation technologies on lives and livelihoods of area residents, it is important to

OCCUPATION GROUPS	Employment	Automation Potential
All Occupations	713,060	46%
Office and Administrative Support Occupations	127,730	60%
Sales and Related Occupations	70,010	43%
Management Occupations	55,310	23%
Transportation and Material Moving Occupations	50,660	55%
Food Preparation and Serving Related Occupations	47,710	81%
Business and Financial Operations Occupations	41,820	14%
Production Occupations	40,700	79%
Education, Training, and Library Occupations	37,660	18%
Healthcare Practitioners and Technical Occupations	36,720	33%
Construction and Extraction Occupations	33,620	50%
Computer and Mathematical Occupations	29,790	37%
Installation, Maintenance, and Repair Occupations	25,680	49%
Personal Care and Service Occupations	21,330	34%
Building and Grounds Cleaning and Maintenance Occupations	19,210	21%
Architecture and Engineering Occupations	14,740	19%
Healthcare Support Occupations	13,460	40%
Arts, Design, Entertainment, Sports, and Media Occupations	13,400	20%
Protective Service Occupations	11,590	36%
Community and Social Service Occupations	8,560	22%
Life, Physical, and Social Science Occupations	6,520	32%
Legal Occupations	6,440	38%
Farming, Fishing, and Forestry Occupations	400	56%

TABLE 2. OCCUPATION EMPLOYMENT AND AUTOMATION POTENTIAL[76]

begin thinking proactively about policies and partnerships. The following list of policies that have been proposed at some level to address the potential crisis that automation technologies could bring is a far from comprehensive but offers some useful starting points.

MITIGATING TECHNOLOGICAL UNEMPLOYMENT: POLICY RESPONSES

One thing is certain, rapid automation will likely create distributional challenges that invite broad policy responses.[81] Slower automation will be harder to measure but will create similar distributional challenges. For governments, the appropriate policy responses ought to focus more on mitigating the effects of automation on humans than on stopping or inhibiting automation in the first place. The likely challenge for the future lies in coping with rising inequality and ensuring sufficient (re-)training, especially for low-skilled workers.[82]

A dynamic economy requires that labor be mobile enough to move out of sectors in which technological progress has reduced the need for labor into sectors in which labor is in short supply. [83] This movement is not pleasant for those who are caught in it, since it is accompanied by some degree of unemployment or underemployment and is accompanied by income losses. There is also a great degree of uncertainty causing mental and physical discomfort to the people involved. For these reasons, both government and private sector responses to the rising challenges created by automation and AI are warranted. In this case, the report is limited to considering policies on the local, regional, and state level. The policies considered herein are policies that have been suggested or proposed elsewhere. Rather than being prescriptive, they are meant to provoke conversations about how to best limit individual and societal hardships that could result from automation.

1. **Create municipal, county, and state digital economy strategies.** Local, regional, and state governments should develop digital economy strategies for how they will help mitigate the transition to an increasingly automated economy. This should include considerations of where the digital economy is heading and how to prepare for it, including new job opportunities, shifting revenue streams to react to market shifts with flexible taxation, and staff retraining policies.[84]
2. **Create financial incentives for schools to create or maintain programs in top Bureau of Labor Statistics (BLS) or Department of Workforce Services (DWS) growth sectors.** The BLS posts the top growth sectors nationally[85] and the DWS posts a similar report at the state and county levels for both short- and long-term growth projections.[86,87] Incentivizing educational institutions to align educational priorities with high-demand employment sectors

could help ensure that individuals are prepared for the jobs that are available. These incentives could come from either the public or the private sector, or both.

3. **Create robust retraining programs for individuals at high risk for displacement.** Done at either the government or the industry level, or both, retraining programs for individuals at high risk for automation will be critical for a smooth transition into a more automated economy, and mid-career job training and continuing education will be essential to a healthy economy.[88] Amazon provides a useful example with their investment into retraining their workforce. Retraining programs should be free or highly affordable and should be "on the job" as much as possible.
4. **Create new and expand existing training and credentialing programs that offer efficient retraining options.** In addition to "on-the-job" training programs, technical and career colleges or other similar programs that offer quick, affordable retraining and credentialing should be created and expanded so that individuals can move into new jobs as quickly as possible.[89] Requiring a mid-career individual to attain a new 4-year degree is unfeasible. Programs that train in weeks rather than years should be prioritized for individuals deep into their careers. These programs should also be based long-term rather than short-term needs. While training individuals to be long-haul truckers is a short-term solution to a current labor need, truck driving is not a sustainable long-term solution as truck drivers will likely need retraining en masse as autonomous vehicles severely disrupt the industry.
5. **Expand government aid programs for individuals displaced by automation.** Expand existing programs to help unemployed individuals find and access training programs and new jobs.[90] The Utah DWS currently helps connect unemployed individuals with potential employment opportunities. With the prospect of increased unemployment, local and regional governments could assist in program deployment. Additionally, increased financial support for individuals displaced by automation could facilitate retraining that will help individuals find new and higher-wage work.[91]
6. **Create portable benefits that follow an individual despite the job they hold.** Benefits are heavy burdens on employers, especially with rising healthcare costs, and contribute to the cost of labor. Allowing benefits to follow an individual from job to job takes some of the financial burden from employers and ensures that individuals retain coverage if they lose their job to automation. For benefits to follow an individual, governments would need to step in to provide such benefits.[92]
7. **Large-scale public investment in infrastructure and buildings.** The construction industry is a difficult industry to automate because tasks

and environments are not standardized. Public investment in infrastructure simultaneously meets pressing needs such as housing affordability, affordable transportation, and air quality mitigation as well as creating living-wage jobs (trade laborers, architects, engineers, construction workers, machinery operators, and other lower-skill jobs). The McKinsey Global Institute estimates that the world needs to invest an average of $3.3 trillion annually to bridge infrastructure gaps.[93]

8. **Enact policies and increase public investment to facilitate renewable energy development and energy efficiency.** Along with the infrastructure investments listed above, investing in renewable energy infrastructure can create a significant amount of jobs. The Solar Foundation's 2018 Solar Jobs Census for Utah cited a net decrease in solar jobs due to the Public Service Commission's ruling to end statewide retail rate net energy metering. Despite this net decrease in jobs, the solar industry is poised for growth within the state as there is large capacity for solar energy.[94] Enacting policies and increasing public investment in transitioning to renewable energy sources as well as updating homes and buildings to be more energy efficient can simultaneously create jobs in various sectors (engineering, manufacturing, construction, and installation, etc.) as well as addressing air quality issues that face the region.[95]
9. **Reassess tax structures to preserve revenue streams.** If there comes a time when automation leads to wide-spread unemployment, the tax structure will need to change. While taxing labor makes sense currently, it may be unsustainable as fewer and fewer people work.
10. **Consider reducing the standard work week to 32 hours and implementing "job sharing".** As technology makes workers more productive and begins displacing individuals from their jobs, reducing the standard work week from 40 hours to 32 hours has the potential to play a mitigating factor. A recent experiment by Microsoft Japan found that reducing the workweek from 5 days to 4 (while maintaining the same level of pay) boosted productivity by 40% and cut electricity costs by 23%.[96] Similar per-employee productivity is found in Countries such as Norway and France that have implemented shorter work weeks. A 32-hour workweek also has the potential to create job-sharing opportunities where the tasks of one job are shared by multiple individuals, giving managers more flexibility in assigning duties. Such job sharing has the potential to lead to an increase in employment, allowing displaced workers the opportunity for jobs in new fields – all of this is compounded by increased productivity as well as effective and aggressive retraining programs. Senators in Washington have proposed legislation that would require a 32-hour work week to replace a 40-hour work week,[97] citing increased productivity and better health

outcomes and satisfaction of employees with work-hour reductions while maintaining current pay levels.

11. **Consider implementing Universal Basic Income (UBI) and Universal Basic Services (UBS).** Andrew Yang and Martin Ford advocate for a UBI. If automation causes mass unemployment, individuals will need some sort of "wage" to ensure purchasing power of residents. UBS ensures that residents have what they need to live comfortable: housing, energy, etc. While both are "worst-case" scenarios, they have been proposed as solutions to technological unemployment. The better-known UBI is controversial and its claims are untested. Some individuals have proposed doing UBI tests across the nation to get better data,[98] but even then, the policy would remain controversial. While not billed as such, the Alaska Permanent Fund (APF) pays out a dividend to residents of the state who have lived in Alaska for a full calendar year. The dividend from the APF is an annual payout, not a monthly payout, and has never exceeded $2,072. Nevertheless, it is a template upon which other UBI programs could be modeled, were there political will.[99]

APPENDIX 1: AUTOMATION POTENTIAL OF OCCUPATIONS IN SALT LAKE COUNTY

Occupation Title	Total Employment in Salt Lake County	Automation Probability	Median Annual Wage
Data Entry Keyers	2,610	0.9900	$33,680.00
Insurance Underwriters	430	0.9900	$52,520.00
Library Technicians	150	0.9900	$25,400.00
Photographic Process Workers and Processing Machine Operators	90	0.9900	$27,930.00
Sewers, Hand	200	0.9900	$19,430.00
Tax Preparers	230	0.9900	$56,260.00
Telemarketers	1,300	0.9900	$29,680.00
Title Examiners, Abstractors, and Searchers	640	0.9900	$37,430.00
Bookkeeping, Accounting, and Auditing Clerks	6,990	0.9800	$38,410.00
Brokerage Clerks	360	0.9800	$50,560.00
Claims Adjusters, Examiners, and Investigators	1,400	0.9800	$57,510.00
Credit Analysts	470	0.9800	$67,650.00
Driver/Sales Workers	1,080	0.9800	$30,590.00
Etchers and Engravers	70	0.9800	$28,200.00
Inspectors, Testers, Sorters, Samplers, and Weighers	3,060	0.9800	$37,630.00
Insurance Claims and Policy Processing Clerks	520	0.9800	$37,480.00
Legal Secretaries	930	0.9800	$39,320.00
Loan Officers	3,090	0.9800	$43,500.00
Order Clerks	440	0.9800	$32,800.00
Packaging and Filling Machine Operators and Tenders	1,420	0.9800	$29,780.00
Parts Salespersons	1,060	0.9800	$40,030.00
Procurement Clerks	350	0.9800	$38,160.00
Shipping, Receiving, and Traffic Clerks	4,200	0.9800	$29,970.00
Tellers	2,180	0.9800	$26,290.00
Umpires, Referees, and Other Sports Officials	130	0.9800	$18,760.00
Cashiers	12,310	0.9700	$22,610.00
Counter and Rental Clerks	1,350	0.9700	$28,550.00

Credit Authorizers, Checkers, and Clerks	150	0.9700	$35,690.00
Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	160	0.9700	$48,070.00
Dental Laboratory Technicians	470	0.9700	$40,000.00
File Clerks	1,120	0.9700	$31,150.00
Grinding and Polishing Workers, Hand	260	0.9700	$30,360.00
Hosts and Hostesses, Restaurant, Lounge, and Coffee Shop	1,280	0.9700	$22,770.00
Payroll and Timekeeping Clerks	690	0.9700	$46,110.00
Pesticide Handlers, Sprayers, and Applicators, Vegetation	30	0.9700	$32,760.00
Telephone Operators	50	0.9700	$36,470.00
Woodworking Machine Setters, Operators, and Tenders, Except Sawing	390	0.9700	$32,240.00
Billing and Posting Clerks	2,980	0.9600	$36,790.00
Compensation and Benefits Managers	190	0.9600	$93,070.00
Cooks, Restaurant	3,860	0.9600	$27,640.00
Counter Attendants, Cafeteria, Food Concession, and Coffee Shop	1,450	0.9600	$22,830.00
Dispatchers, Except Police, Fire, and Ambulance	1,000	0.9600	$41,840.00
Office Clerks, General	15,350	0.9600	$31,860.00
Receptionists and Information Clerks	4,810	0.9600	$28,700.00
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	9,290	0.9600	$35,260.00
Surveying and Mapping Technicians	190	0.9600	$56,280.00
Switchboard Operators, Including Answering Service	200	0.9600	$24,970.00
Ushers, Lobby Attendants, and Ticket Takers	1,190	0.9600	$20,230.00
Adhesive Bonding Machine Operators and Tenders	130	0.9500	$30,630.00
Bill and Account Collectors	3,860	0.9500	$32,780.00
Grinding, Lapping, Polishing, and Buffing Machine Tool Setters, Operators, and Tenders, Metal and Plastic	150	0.9500	$31,930.00
Landscaping and Groundskeeping Workers	3,880	0.9500	$29,750.00
Library Assistants, Clerical	320	0.9500	$24,560.00
Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	750	0.9500	$36,060.00

Operating Engineers and Other Construction Equipment Operators	1,190	0.9500	$47,070.00
Postal Service Clerks	190	0.9500	$60,090.00
Print Binding and Finishing Workers	560	0.9500	$29,280.00
Weighers, Measurers, Checkers, and Samplers, Recordkeeping	730	0.9500	$29,280.00
Accountants and Auditors	5,190	0.9400	$64,520.00
Budget Analysts	140	0.9400	$75,320.00
Cement Masons and Concrete Finishers	930	0.9400	$42,210.00
Couriers and Messengers	340	0.9400	$28,700.00
Excavating and Loading Machine and Dragline Operators	240	0.9400	$42,000.00
First-Line Supervisors of Housekeeping and Janitorial Workers	550	0.9400	$39,720.00
Hotel, Motel, and Resort Desk Clerks	1,750	0.9400	$23,430.00
Interviewers, Except Eligibility and Loan	680	0.9400	$30,650.00
Meat, Poultry, and Fish Cutters and Trimmers	40	0.9400	$28,980.00
Paralegals and Legal Assistants	2,100	0.9400	$46,870.00
Waiters and Waitresses	8,180	0.9400	$20,490.00
Welders, Cutters, Solderers, and Brazers	1,580	0.9400	$41,260.00
Butchers and Meat Cutters	520	0.9300	$32,500.00
Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders	220	0.9300	$40,710.00
Fiberglass Laminators and Fabricators	40	0.9300	$32,520.00
Industrial Truck and Tractor Operators	1,960	0.9300	$33,980.00
Outdoor Power Equipment and Other Small Engine Mechanics	60	0.9300	$39,850.00
Refuse and Recyclable Material Collectors	490	0.9300	$39,590.00
Tax Examiners and Collectors, and Revenue Agents	110	0.9300	$69,260.00
Cabinetmakers and Bench Carpenters	840	0.9200	$34,610.00
Combined Food Preparation and Serving Workers, Including Fast Food	17,120	0.9200	$19,570.00
Helpers--Carpenters	100	0.9200	$35,560.00
Insurance Sales Agents	2,820	0.9200	$38,810.00
Loan Interviewers and Clerks	1,610	0.9200	$39,630.00

Office Machine Operators, Except Computer	240	0.9200	$27,500.00
Pharmacy Technicians	2,020	0.9200	$37,410.00
Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	250	0.9200	$27,330.00
Retail Salespersons	21,010	0.9200	$24,180.00
Automotive Body and Related Repairers	620	0.9100	$37,960.00
Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	420	0.9100	$32,190.00
Dining Room and Cafeteria Attendants and Bartender Helpers	870	0.9100	$21,070.00
Geological and Petroleum Technicians	90	0.9100	$45,570.00
Medical Records and Health Information Technicians	1,360	0.9100	$39,990.00
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	1,000	0.9100	$39,830.00
Rail Yard Engineers, Dinkey Operators, and Hostlers	40	0.9100	$43,850.00
Appraisers and Assessors of Real Estate	180	0.9000	$48,360.00
Crane and Tower Operators	40	0.9000	$61,200.00
Human Resources Assistants, Except Payroll and Timekeeping	330	0.9000	$38,760.00
Molders, Shapers, and Casters, Except Metal and Plastic	330	0.9000	$35,590.00
Roofers	950	0.9000	$40,330.00
Traffic Technicians	30	0.9000	$48,180.00
Transportation Inspectors	260	0.9000	$38,360.00
Bakers	1,080	0.8900	$30,530.00
Bus Drivers, School or Special Client	660	0.8900	$40,090.00
Medical Transcriptionists	200	0.8900	$29,550.00
Sewing Machine Operators	520	0.8900	$27,800.00
Stationary Engineers and Boiler Operators	40	0.8900	$60,350.00
Taxi Drivers and Chauffeurs	890	0.8900	$26,780.00
Technical Writers	430	0.8900	$66,400.00
Cartographers and Photogrammetrists	80	0.8800	$62,270.00
Construction Laborers	4,990	0.8800	$33,310.00
Metal-Refining Furnace Operators and Tenders	450	0.8800	$55,730.00

Production, Planning, and Expediting Clerks	2,010	0.8800	$44,490.00
Rail Car Repairers	160	0.8800	$41,210.00
Food Preparation Workers	3,120	0.8700	$25,480.00
Highway Maintenance Workers	250	0.8700	$39,850.00
Parking Lot Attendants	640	0.8700	$23,370.00
Cutting and Slicing Machine Setters, Operators, and Tenders	260	0.8600	$31,930.00
Executive Secretaries and Executive Administrative Assistants	2,610	0.8600	$50,780.00
Food Servers, Non-restaurant	1,060	0.8600	$26,390.00
Maintenance Workers, Machinery	360	0.8600	$48,630.00
Sawing Machine Setters, Operators, and Tenders, Wood	30	0.8600	$25,200.00
Laborers and Freight, Stock, and Material Movers, Hand	14,300	0.8500	$28,780.00
Meter Readers, Utilities	150	0.8500	$47,530.00
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	10,450	0.8500	$54,730.00
Electrical and Electronics Engineering Technicians	720	0.8400	$58,680.00
Lathe and Turning Machine Tool Setters, Operators, and Tenders, Metal and Plastic	60	0.8400	$36,460.00
Parking Enforcement Workers	40	0.8400	$33,180.00
Security Guards	4,060	0.8400	$29,170.00
Tool and Die Makers	80	0.8400	$60,790.00
Automotive and Watercraft Service Attendants	1,000	0.8300	$25,220.00
Baggage Porters and Bellhops	140	0.8300	$18,980.00
Cooks, Institution and Cafeteria	1,720	0.8300	$28,140.00
Helpers--Brickmasons, Blockmasons, Stonemasons, and Tile and Marble Setters	150	0.8300	$30,180.00
Insulation Workers, Floor, Ceiling, and Wall	140	0.8300	$34,000.00
Mixing and Blending Machine Setters, Operators, and Tenders	340	0.8300	$40,520.00
Paving, Surfacing, and Tamping Equipment Operators	150	0.8300	$47,240.00
Printing Press Operators	790	0.8300	$37,070.00
Structural Iron and Steel Workers	610	0.8300	$53,350.00
Brickmasons and Blockmasons	690	0.8200	$39,940.00

Nonfarm Animal Caretakers	980	0.8200	$22,340.00
Security and Fire Alarm Systems Installers	540	0.8200	$50,570.00
Sheet Metal Workers	650	0.8200	$45,580.00
Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders	40	0.8100	$33,050.00
Cooks, Fast Food	1,800	0.8100	$24,160.00
Electrical and Electronics Drafters	190	0.8100	$65,890.00
Electro-Mechanical Technicians	80	0.8100	$58,450.00
Medical Secretaries	1,510	0.8100	$34,570.00
Pressers, Textile, Garment, and Related Materials	200	0.8100	$24,030.00
Property, Real Estate, and Community Association Managers	1,510	0.8100	$45,010.00
Word Processors and Typists	270	0.8100	$31,110.00
Aircraft Structure, Surfaces, Rigging, and Systems Assemblers	290	0.7900	$34,130.00
Drywall and Ceiling Tile Installers	1,930	0.7900	$39,230.00
Heavy and Tractor-Trailer Truck Drivers	12,790	0.7900	$43,360.00
Helpers--Installation, Maintenance, and Repair Workers	480	0.7900	$28,150.00
Postal Service Mail Sorters, Processors, and Processing Machine Operators	580	0.7900	$46,620.00
Computer Operators	90	0.7800	$49,360.00
Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	460	0.7800	$35,090.00
Gas Plant Operators	120	0.7800	$68,050.00
Medical Equipment Preparers	330	0.7800	$36,360.00
Bartenders	1,460	0.7700	$19,740.00
Dishwashers	1,740	0.7700	$21,750.00
Locksmiths and Safe Repairers	150	0.7700	$51,350.00
Civil Engineering Technicians	250	0.6900	$53,900.00
Light Truck or Delivery Services Drivers	4,570	0.6900	$34,130.00
Maids and Housekeeping Cleaners	3,170	0.6900	$24,240.00
Boilermakers	50	0.6800	$57,310.00
Dental Hygienists	1,270	0.6800	$72,090.00

Mechanical Drafters	210	0.6800	$62,870.00
Postal Service Mail Carriers	1,060	0.6800	$57,500.00
Atmospheric and Space Scientists	230	0.6700	$79,850.00
Bus Drivers, Transit and Intercity	550	0.6700	$37,280.00
Foundry Mold and Coremakers	100	0.6700	$43,480.00
Industrial Machinery Mechanics	1,560	0.6700	$58,190.00
Lifeguards, Ski Patrol, and Other Recreational Protective Service Workers	660	0.6700	$21,060.00
Helpers--Production Workers	1,790	0.6600	$24,670.00
Janitors and Cleaners, Except Maids and Housekeeping Cleaners	10,710	0.6600	$22,100.00
Pest Control Workers	220	0.6600	$33,290.00
Statistical Assistants	80	0.6600	$51,520.00
Market Research Analysts and Marketing Specialists	4,100	0.5900	$53,340.00
Transportation, Storage, and Distribution Managers	1,100	0.5900	$80,990.00
Personal Financial Advisors	890	0.5800	$68,140.00
Chemical Technicians	630	0.5700	$43,860.00
First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers	470	0.5700	$48,660.00
Teacher Assistants	6,810	0.5600	$23,600.00
Audio and Video Equipment Technicians	1,250	0.5500	$37,030.00
Commercial Pilots	240	0.5500	$75,420.00
Customer Service Representatives	30,290	0.5500	$33,630.00
Advertising Sales Agents	490	0.5400	$60,430.00
Massage Therapists	510	0.5400	$37,180.00
Hazardous Materials Removal Workers	280	0.5300	$41,490.00
Cost Estimators	1,300	0.4200	$66,010.00
Economists	40	0.4100	$65,160.00
Judicial Law Clerks	230	0.4100	$37,070.00
Structural Metal Fabricators and Fitters	700	0.4100	$41,340.00
Cleaners of Vehicles and Equipment	1,830	0.3700	$23,340.00

Helpers--Extraction Workers	40	0.3700	$33,610.00
Surveyors	240	0.2800	$78,920.00
Plumbers, Pipefitters, and Steamfitters	2,050	0.2700	$52,550.00
Zoologists and Wildlife Biologists	40	0.2700	$52,700.00
Athletes and Sports Competitors	160	0.2600	$48,670.00
Actuaries	90	0.2100	$67,960.00
Animal Control Workers	60	0.2100	$39,710.00
Concierges	130	0.2100	$23,540.00
Public Relations Specialists	1,260	0.1800	$48,880.00
Financial Examiners	540	0.1700	$60,630.00
Firefighters	640	0.1700	$44,190.00
First-Line Supervisors of Construction Trades and Extraction Workers	3,480	0.1700	$60,630.00
Middle School Teachers, Except Special and Career/Technical Education	3,370	0.1700	$66,150.00
Occupational Health and Safety Specialists	500	0.1700	$74,490.00
Travel Agents	450	0.0990	$39,560.00
Police and Sheriff's Patrol Officers	1,800	0.0980	$56,910.00
Electrical Power-Line Installers and Repairers	490	0.0970	$86,990.00
Fitness Trainers and Aerobics Instructors	1,390	0.0850	$43,960.00
Fashion Designers	50	0.0660	$38,630.00
Hairdressers, Hairstylists, and Cosmetologists	1,560	0.0640	$22,860.00
Electrical Engineers	1,130	0.0600	$95,080.00
Chefs and Head Cooks	310	0.0590	$41,860.00
Childcare Workers	2,910	0.0580	$22,060.00
Compliance Officers	2,000	0.0570	$55,850.00
Editors	550	0.0550	$52,090.00
Emergency Medical Technicians and Paramedics	1,060	0.0490	$33,830.00
Psychiatric Technicians	330	0.0430	$30,080.00
Fine Artists, Including Painters, Sculptors, and Illustrators	90	0.0420	$46,280.00

Software Developers, Applications	6,060	0.0420	$100,700.00
Clergy	140	0.0350	$50,770.00
Landscape Architects	80	0.0350	$65,230.00
Lawyers	3,170	0.0350	$101,270.00
Meeting, Convention, and Event Planners	630	0.0350	$42,750.00
Environmental Scientists and Specialists, Including Health	610	0.0330	$68,520.00
Database Administrators	660	0.0300	$97,450.00
Industrial Engineering Technicians	450	0.0300	$50,860.00
Industrial Production Managers	910	0.0300	$92,450.00
Network and Computer Systems Administrators	2,080	0.0300	$79,010.00
Purchasing Managers	210	0.0300	$91,660.00
Industrial Engineers	1,510	0.0290	$85,120.00
Veterinary Technologists and Technicians	580	0.0290	$29,900.00
Child, Family, and School Social Workers	1,060	0.0280	$37,730.00
Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	200	0.0280	$80,420.00
Occupational Therapy Assistants	130	0.0280	$58,580.00
Biochemists and Biophysicists	70	0.0270	$58,130.00
Chiropractors	180	0.0270	$42,410.00
Electronics Engineers, Except Computer	260	0.0250	$89,010.00
First-Line Supervisors of Correctional Officers	180	0.0250	$77,530.00
Art Directors	340	0.0230	$93,100.00
Interior Designers	350	0.0220	$52,590.00
Producers and Directors	680	0.0220	$51,040.00
Architects, Except Landscape and Naval	860	0.0180	$66,120.00
Environmental Engineers	270	0.0180	$73,880.00
Natural Sciences Managers	690	0.0180	$79,110.00
Physical Therapist Assistants	300	0.0180	$59,130.00
Aerospace Engineers	180	0.0170	$99,060.00

Chemical Engineers	60	0.0170	$90,250.00
Hydrologists	60	0.0140	$90,550.00
Marketing Managers	1,710	0.0140	$103,060.00
Coaches and Scouts	880	0.0130	$26,010.00
Sales Managers	2,630	0.0130	$107,400.00
Logisticians	790	0.0120	$68,060.00
Microbiologists	90	0.0120	$58,140.00
Pharmacists	1,370	0.0120	$120,160.00
Mechanical Engineers	1,350	0.0110	$87,900.00
Civil Engineers	1,620	0.0085	$75,660.00
Chief Executives	2,560	0.0081	$165,770.00
Education Administrators, Preschool and Childcare Center/Program	80	0.0081	$37,450.00
Marriage and Family Therapists	170	0.0078	$53,880.00
Medical and Health Services Managers	2,050	0.0073	$96,880.00
Athletic Trainers	100	0.0071	$44,710.00
Social and Community Service Managers	640	0.0067	$62,590.00
Computer Systems Analysts	2,350	0.0065	$76,830.00
Speech-Language Pathologists	510	0.0064	$85,700.00
Training and Development Managers	340	0.0063	$90,280.00
Recreation Workers	1,050	0.0061	$25,750.00
Human Resources Managers	850	0.0055	$96,180.00
Set and Exhibit Designers	50	0.0055	$44,480.00
Clinical, Counseling, and School Psychologists	530	0.0047	$69,560.00
Education Administrators, Elementary and Secondary School	900	0.0046	$93,330.00
Podiatrists	30	0.0046	$121,270.00
Medical Scientists, Except Epidemiologists	590	0.0045	$61,140.00
Dentists, General	780	0.0044	$121,520.00
Elementary School Teachers, Except Special Education	4,250	0.0044	$55,930.00

First-Line Supervisors of Police and Detectives	450	0.0044	$76,330.00
Psychologists, All Other	50	0.0043	$95,990.00
Instructional Coordinators	2,080	0.0042	$49,880.00
Sales Engineers	160	0.0041	$109,050.00
Dietitians and Nutritionists	370	0.0039	$58,630.00
Lodging Managers	130	0.0039	$54,320.00
First-Line Supervisors of Fire Fighting and Prevention Workers	340	0.0036	$72,780.00
Healthcare Social Workers	550	0.0035	$60,900.00
Occupational Therapists	410	0.0035	$80,780.00
Audiologists	50	0.0033	$76,970.00
Mental Health and Substance Abuse Social Workers	190	0.0031	$52,000.00
Emergency Management Directors	70	0.0030	$58,750.00
First-Line Supervisors of Mechanics, Installers, and Repairers	2,210	0.0030	$59,360.00
Preschool Teachers, Except Special Education	650	0.0028	$28,710.00

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