How Current Technology Affects Employment in America: An Emphasis on Manufacturing

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Abstract

We are surrounded by technology every day: at home, in the car, and especially at work. As technology advances, American businesses are taking hold of its power in order to compete in a global marketplace. This shift towards technology has changed America's perception of a traditional workforce and created a new way of thinking about how we do work. This article will explore the relationship between technology and American society, the definitions and theory of how technology will affect employment, a look at how companies and employees alike can mitigate these effects and include an emphasis on technology's impact on manufacturing.

Introduction

In our modern economy, worries about job security are a part of everyday life. The Great Recession of 2008 still casts doubt for some about the stability of the workplace, and globalization has led to the loss of 2 million to 2.4 million in America alone (Acemoglu, Autor, Dorn, & Hanson, 2014). This fear became reality in the current economic climate where the U.S. saw a surge of unemployment due to the COVID-19 global health pandemic. Those who were still employed became dependent on technology to work remotely, and technology firms leapt into action to support the increased demand created by this virtual workplace. These economic worries and other advancements in technology have always had Americans wondering, "When will a robot take my job?" Unfortunately, that time has come with many workers displaced from their jobs.

This study discusses the dynamics between technology and employment in America. How we as a society interact with technology greatly impacts our economy and defines how we treat technology when it comes to employment. We will also explore current definitions of the terms automation and augmentation, discuss the theory of the four intelligences, and demonstrate how AI and other technology could potentially replace humans in the workforce. We apply our thinking to the manufacturing industry, arguably one of the most affected by technology-driven job displacement and one which saw a decline in labor growth since 2000 (Acemoglu, Autor, Dorn, & Hanson, 2014). Finally, we discuss suggested practices companies and employees alike can use to help ensure they are protected from these circumstances.

Purpose

The purpose of this paper is to explore the literature on the effects of technology on employment in America and to explain the shifting relationship between jobs and technology. This problem has been reported by the Government Accountability Office (GAO) in a report titled "Better Data Needed to Assess and Plan for the Effects of Advanced Technologies on Jobs" (U.S. Government Accountability Office, 2019). Since this subject is broad, we will summarize the context of the current domestic situation, define the problem and current climate, and offer suggestions professionals have made based on their research. As we do this, we will provide industry context to the situation by interjecting applications and specifics in manufacturing, an industry largely disrupted by technology in terms of employment.

Technology and Employment in American Society

We cannot describe the problems surrounding technology and employment without first mentioning the context of technology in society and our personal lives right now. Technology surrounds the American people every day; According to the Pew Research Center, 28% of American adults reported that they are online "almost constantly" and 81% use the internet on a daily basis (Perrin, 2019). Age demographics also play a role in these statistics too: the same study says 48% of 18-29 year olds report that they are "online constantly" and 46% report they are online multiple times per day, compared to the 7% of those 65 and older that are "online almost constantly" and 35% that use the internet go online multiple times per day (Perrin, 2019).

Technology at Home and Work

Just as technology has affected the personal lives of Americans, it has changed the workplace as well. For those working in retail, e-commerce and online sales have dramatically shifted the retail environment. According to the US Census Bureau, electronic shopping made up $611.74 billion in 2018, or 11.6% of the total retail sales nationally. Because of this, stores have shifted from a "brick-and-mortar" style to a "brick-and-click" creating a multimedia experience for consumers with different preferences (Brynelson, 2017). While many retail spaces and employees are able to weather the storms of large on-line retailers (Bynelson, 2017), employees in American manufacturing industries are being displaced due to advancing technology.

Along with this displacement, we must also look at our cultural attitude towards technology and how this attitude transfers over to our view of tech in our workplace. Adam Saunders, from the University of British Columbia's Sauder School of Business, proposes a thought experiment based on Moore's law mixed with consumer economics:

> Let us consider the computing power we will have in our hands in twenty years if Moore's Law continues to hold... Suppose the cost of computing falls in half every 18 months. Then, a thousand dollars of computing power today (approximately the cost of an unlocked iPhone 8 Plus with 256GB memory in 2017) would cost less than ten cents by 2037. While that may seem astonishing, ask yourself how much would you pay for a cell phone made twenty years ago? (Saunders, 2018)

As the costs of consumer technology continue to increase, this ultimately leads to a faster rate of depreciation. The same consumer needing the best cell phone available in 2000 would likely pay next to nothing for the same technology in 2020. To consumers, technology is becoming less of an investment and more of a replaceable good.

According to a 2016 *New York Times* article, workers laid off and replaced by machines did not have access to retraining programs or simply did not want to change their skills to compete with younger workers who had grown up in tech culture (Miller, 2016). Stories like this have created a cultural fear that robots are coming for our jobs and could lead to mass unemployment for semi-skilled or unskilled labor (Cyert & Mowery, 1987). This has been a concern ever since we began to see technology enter our labor markets. Consider the following quote from a former Secretary of Labor on technology and employment:

> In the long run, new types of industries have always absorbed the workers displaced by machinery, but of late, we have been developing new machinery at a faster rate than we have been developing new industries…At the same time we must ask ourselves, is automatic machinery, driven by limitless power, going to leave on our hands a state of chronic and increasing unemployment? Is the machine that turns out wealth also to create poverty? Is it giving us a permanent jobless class? Is prosperity going to double back on itself and bring us social distress? (Atkinson, 2016)

The author of this quote, "Puddler" Jim J. Davis, asks several key questions about how labor and technology relate to one another. However, this quote is from 1927, just seven years shy of 100 years before this paper was written. Davis is right about one thing: we will see new types of industries, new jobs absorbing workers displaced by machinery. As for creating a jobless class and social distress, US unemployment was at an all-time low (3.5% in December of 2019[1]) before the COVID-19 pandemic and we have yet to see mass unemployment due to technology (BLS, 2020). The effects of how the global pandemic has changed the workplace are still being discovered.

National Initiatives

Several national initiatives have been birthed from the concept of increased technology in the workplace. Programs such as Science Technology Mathematics and Engineering Education (or S.T.E.M. Education) by the academic world and the "Creators Wanted" campaign by the National Association of Manufacturers are examples of forces shaping the labor market to adjust for this increase in technology and automation (Timmons, 2020). Programs like these, aim to create a renewed interest in technology across the country, especially with younger demographics with an interest in creating and integrating technology further into our culture. However, these programs do less for older demographics that are struggling to stay relevant in the age where proficiency with technology is everything. Companies such as Goodwill try and help teach basic computer skills to people who are at this disadvantage, but some believe it is "too little, too late" to compete with younger generations that grew up with the technology (Miller, 2016).

Academic Theory of Replacing Human Labor

Many scholars use the terms automation and augmentation to describe labor that has been changed by technology. It is important to note that these two concepts are very different in their respect to employees. According to Merriam-Webster (Merriam Webster's online dictionary, 2020), automation is defined as "automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labor." With respect to human workers, the automated process replaces the human labor that completed the process beforehand. However, it is hard for a process to be fully automated: humans still need to maintain and service the machine, assess its effectiveness, sell the machine, and so on.

Comparatively, Merriam Webster defines augmentation as "to supplement, something that completes or makes an addition." In terms of labor, automation replaces while augmentation brings additional resources and abilities to help complete a task. Examples of augmentation include personal assistants such as Siri and Alexa helping complete simple tasks, all the way up to medical teams controlling mechanical robots to perform surgeries on patients (Huang & Rust, 2018). These examples also could lead to a reduction in labor, but more likely a shift in type of labor from manual to knowledge work.

The Four Intelligences and Automation

At its most basic level, a job is made up of a general outline, tasks to complete to satisfy the outline, and conditions and inputs to shape these tasks. As humans we apply critical thinking, our experiences, situational awareness, and other factors to perform our jobs well and to the best of our abilities. As the complexity of these tasks and inputs become broader (such as managing other humans) and we have a greater range of inputs and conditions, a higher level of intelligence is needed to do well. The threat of automation comes because machines and software are being built to replicate these factors with the reliability and accuracy of computing power.

In *Artificial Intelligence in Service*, Huang and Rust (2018) detail their theory and research on how AI and other types of automation can replace human intelligences. The foundation of this theory is that humans have four types of intelligence: Mechanical, Analytical, Intuitive, and Emotional. Examples and definitions of each can be found below, but the general idea is that these four intelligences have a hierarchy starting with Mechanical as the lowest and Emotional as the highest; as a problem increases in complexity, you move up in the hierarchy. The higher intelligences revolve around solutions based on experience someone has gained over time.

Mechanical intelligence is defined as intelligence that needs a "minimal degree of learning or adaptation" (Huang and Rust, 2018). These skills require minimal training or education and need to be precise and efficient. Results of these jobs are usually explicit and have repetitive actions. Examples of these jobs include factory-line assemblers, ride share drivers, and retail workers. One thing to note is that a job can have 2 or more intelligences used in its daily functions, however these examples refer to core-job characteristics rather than the holistic view of the work. An example of AI using this intelligence includes online chatbots pre-loaded with responses to common questions, turning customer-service into self-help (Huang & Rust, 2018).

Analytical intelligence is about learning and adapting to situations, but in a systematic and logical way based on data (Huang & Rust, 2018). This kind of intelligence makes decisions, but only based on a set of logical and specific rules or parameters set beforehand. Jobs that use analytical intelligence can have a high degree of complexity, but the challenge is more about applying the rules in creative ways. A great example of this is a mechanic: with some experience, they have knowledge about how a car should run and have developed a set of "rules" to fix problems when a car doesn't run like it should. AI is extremely present in jobs that use analytical intelligence, including IBM's Watson helping H&R Block with tax preparation (Huang & Rust, 2018).

Intuitive intelligence "learns and adapts intuitively based on understanding" (Huang & Rust, 2018). Here, we start to see a deeper level of insight applied to situations defined by context rather than rules. Intuitive jobs require deep understanding to come up with solutions for problems that are not well defined. Intuitive intelligence is still bounded, but the boundaries are more theoretic and less specific. Examples of these jobs include lawyers, marketing professionals, or consultants. Employees who use intuitive intelligence in an analytical or mechanical job are perceived to have a good sense of their position. The Associated Press has created AI reporters to write reports on Minor League

baseball games, and many robots with simulated learning collect data to use as "experience" in games like chess or poker.

Finally, Emotional intelligence is defined as "learn[ing] or adapt[ing] empathetically based on experience" (Huang & Rust, 2018). This intelligence can recognize and adapt based an understanding of the emotions, not just the context of a problem. Social connections and good communication define a person with strong emotional intelligence. Jobs that use emotional intelligence include politicians, salespeople, or executive-level managers that benefit from connections to others in their industry. Emotional intelligence, also known as EI, is one of the most sought-out traits in new-hires in the business world today. However, AI has even disrupted these jobs with chatbots that can learn and perceive a customer's emotions and respond accordingly, or Hanson's Replica that can replace psychiatrists for psychological comfort (Huang & Rust, 2018).

Huang and Rust's research and theory demonstrate how tasks we believe are safe from robots (tasks that require intuitive and emotional intelligence) are currently being tested and replaced by AI. They even cite research by Young and Cormier (2014) demonstrating that in terms of management "a human experiment controller has more perceived authority" but "nearly 46% of the participants obey[ed] the robots" that were managing them. In medicine, AI has outperformed dermatologists for skin cancer diagnoses (Esteva et al, 2017). As we mentioned above, here are even chatbots that will not only respond to specific stimuli but use machine learning to mimic a client's texting style and personalize its responses to match its client (Huet 2016). These advances show how AI and other technology is reaching beyond our original expectations and into jobs we once thought were safe from automation.

Despite this rather grim outlook, there are some silver linings to these predictions. First, many of these higher intelligences are still in the early stages of development as of now, so jobs using more complex intelligences are not in immediate danger of computers taking over. Second, many of these advancements improve our overall quality of life and can make up for our own human errors in our occupations. Despite this, there are very real concerns about the ability for workers that use mechanical and analytical intelligences in their jobs who are replaced to find work again where they can use these skills. Someone who works at a manufacturing facility installing parts on a car is not exactly fit to be a computer programmer controlling the robot that replaces their job. This kind of displacement can lead workers to be undervalued and unfit for new jobs without changes in their skill sets.

Jobs in the Age of Technology (Emphasis in Manufacturing)

We can already see new markets emerging from these advances, more so in ways that are harder for AI and automation to compete. A good example of this is the Software as a Service (or S.a.a.S) industry, which has changed the way clients interact with software companies (Safari & Safari, 2015). S.a.a.S goes above the old model of buying software for a specific use and the software company providing basic IT support to the current model of software companies being problem solvers and the source of new advancement in specific industries. New jobs created by S.a.a.S. companies include

setting-up and maintaining complex cloud-based IT operations (Safari & Safari, 2015), sales positions, industry analysts, in-depth integration specialists and even educators to implement and train new clients on the software.

As a manufacturing scenario, a company that makes custom cabinets might not be able to find enough skilled labor to plan and draw the cabinets in a drawing software (including technical aspects like the size, material, hinge placement, etc) so they turn to a S.a.a.S software company that augments this technical but repeatable process. The software works by repeating the process with minimal input and change from an employee, and the company benefits with more accurate and repeatable drawings leading to less errors, cheaper labor, an increased capacity utilizing the same labor force, and stimulates the S.a.a.S. companies' employees who sold, trained, and maintained the software for them. This is a great example how the labor force is shifting from manual tasks that are easily automated to tasks that require higher levels of cognition and emotional intelligence (Huang & Rust, 2018). The number of jobs will not decline, but the labor market will see a shift in demand from mechanical skills to technological skills.

Despite these benefits, technology has already begun to negatively disrupt employment in some industries. Companies like Uber and Fed-Ex thrive because of the accessibility of technology in their business models, but classify their workers as non-employees and sometimes independent contractors for the company (Cunningham-Parameter, 2016). By doing so, these companies get out of providing basic employment rights such as overtime and antidiscrimination policies while maintaining control over their workforce (Cunningham-Parameter, 2016). Taking advantage of the availability of technology to increase the labor supply without basic employment rights and circumventing labor laws has the potential to be a bad practice many companies could adopt if certain safeguards are not put in place.

Ethics aside, companies who adopt emerging technologies tend to see growth because of the benefits it brings to the table. According to the book T*echnology and Employment: Innovation and Growth in the US Economy*, companies who use technology with the goal of reducing the costs of production in a competitive market will see an increase in demand for their product. From here, this demand increases production and thus more labor, offsetting the labor costs of technology while growing the company at the same time (Cyert & Mowery, 1987). With this growth comes more investment in the company, and eventually it expands into new markets requiring more jobs to fulfill the demand.

Will these changing dynamics mean that America will have less jobs? The short answer is no, but that does not mean the jobs will look the same as they did before.

Manufacturing and Skilled Labor

As companies adopt new technology that automates or augments processes once done by humans, there is an increasing distinction between low-skill jobs and high-skill jobs that is occurring in the US economy due to automation (Cheremukhin, 2014). For our purposes, we will define a low-skill job as work that would require under 3 months of training to be competent at, middle skill to be around 3 months to a year of training, and a high skill job as work that would require 1-2+ years of training and experience to be fully

competent. According to Cheremukhin, in every recession since 1970, the number of middle-skill jobs have declined. Middle-skill jobs have decreased from 14% in the US since 1981 while the number of low and high-skill jobs have increased in the same time period (Cheremukhin, 2014).

Manufacturing leaders see this decline in skilled labor and would argue automation is the solution to their problem, not the cause. In a 2019 survey done by the National Association of Manufacturers, 63.8% of the industry stated their primary business challenge is "attracting and retaining a quality workforce." (NAM, 2019). American manufacturers cannot find skilled labor, so they are turning to technology to keep up with rising demand and a falling labor force. This gap in the labor force has created a cycle for American manufacturers that perpetuates the problem: they adopt technology to replace workers because they can't find skilled employees, then require more skills for employees they retain to work with the technology, and adopt more technology to help, and so on to further expand the gap.

While the number of jobs will not decrease, academic leaders on the topic caution that these middle and low-skill jobs will not go directly into new markets created by increasing technology (Atkinson, 2016). A woodworker with 20 years of experience replaced by technology will not always be able to be the same person that is brought on to maintain and fix the machine that has replaced him. Instead, this worker might find themselves underemployed at a lower skilled job with reduced income if they don't make an effort to adapt with the changes in the job market. This model is what drives the cultural fear of a "robot takeover" of the US labor market, and the fear of a further separation of the middle class.

Suggestions to Mitigate Technology's Impact on Employment

While the idea of mass unemployment due to technology has been in our culture for some time (and to date, has yet to occur) there is a clear threat to those whose skills are replaced by automation or other technology. How we react to that threat will determine what employment will look like in the coming years.

As we talked about with Fed-Ex and Uber, their practice of classifying workers as independent contractors has led to the omission of basic employments rights such as overtime compensation and protections against discrimination (Cunningham-Parameter, 2016). The ambiguous nature of what it means to "employ" someone leads to companies like these to hide behind a contractor or subcontractor in employment law. If companies continue to exploit this and accelerate at the current rate while laws stay stagnant, many Americans will be left unprotected from these employers, and employment laws will be obsolete.

To react to this threat, corporations across the board could be incentivized to employ ethical practices and policies in regard to displaced workers. T*echnology and Employment: Innovation and Growth in the US Economy* gives several recommendations of Federal policy and private sector practices to help displaced workers and ultimately a healthier economy for both to do business in. These recommendations include broadening income support for displaced workers engaged in training and action to provide tax incentives for employers to give substantial advance notice of permanent

plant shutdowns and large permanent layoffs on the Federal side. Internally, companies could provide advance notice of and consult with workers about job redesign and technological change and benefits that include a joint insurance fund for skilled workers paid out if the firm goes bankrupt suddenly (Cyert and Mowery, 1987).

According to the Cyert and Mowery, somewhere between 20-30% of the American labor force lacks basic skills such as literacy, problem-solving, and numerical skills. Their research also suggests employment opportunities of workers who possess these basic skills will not be limited by technology, and if so, they spend less time unemployed as compared to workers with weak or no basic skills (Cyert & Mowery, 1987). Profits realized by applying new technology in these settings could create demand and additional income, and when reinvested in a company's employees could lead to a stronger, healthier business that grows to meet the new demand with the same people as before. An emphasis on public and private policies that improve the basic skills of workers will allow the labor market to work with growing technology, not against it.

More so than changing public and private policy, the best way for an individual to stay viable in the market is continuous lifelong learning (Foster, 2016). It is likely that our cultural attitude and legislation will react to this problem at the very last minute or in an insufficient way, so depending on someone else to take action could lead to bad results (Foster, 2016). This does not mean that people should depend on ethical companies and government responsibility for jobs. The best way to improve an individual's situation is to always be open to learning and adapting to the environment.

Conclusion

Technology surrounds American lives every day: online retailers are taking up market share from brick-and-mortar retailers (Brynelson, 2017), workers are being displaced by automation (Miller, 2016), and the tremendous economic value we put on our technology is depreciating greatly as new and more exciting tech takes its place (Saunders, 2018). Industries like travel and healthcare are using technology to perform and create profit like never before.

As technology makes our lives easier and automates everything from personal tasks to specific manufacturing processes, its implications will shift jobs from mechanical tasks to things that require intuitive and emotional skills. The number of jobs will be the same, but how well we adapt to our growing environment will depend on our legislative response as well as our corporate ethics towards displaced workers. Remember, this issue is nothing new to the economy, and the best course of action is to correct practices now before they get out of hand. Change can be hard to navigate, but we need innovation now more than ever if America is to compete in the globalizing marketplace.

[1]It is worth mentioning that at the time this article was written, U.S. unemployment skyrocketed due to the COVID-19 pandemic in 2020. The statistics provided are slightly outdated so the pandemic would not skew the content of this paper. New peer research on how COVID-19, technology and employment are related was not available at the time of writing this article.

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