Automation's Negative Effects on the Common Workers

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Jarod Johnson

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

Joshua Earle, Department of Engineering and Society

STS Research Paper

I. Introduction

In November of 1811, a group of men with covered faces and a variety of weapons marched into a textile factory and destroyed a majority of weaving frames which were used by a relatively new machine called the 'gig mill' (Thompson, 2017). These men were former workers of the factory, but were replaced with a new machine as it allowed a weaver to produce stockings at a much faster rate. This group of men came to be known as the *Luddites*, and they would later burn down the factory owner's home. The Luddite movement spread to many towns and other factories who also indulged in this new technology. As time went on, the Luddites grew in numbers and became more violent. They assassinated factory owners in broad daylight and even raided the homes of everyday citizens for weapons and supplies. Eventually, the government started to crack down on the Luddites and create new laws that prevented destruction of machinery. Around 100 Luddites were either sent to prison, or hung publicly. There have been countless protests and riots similar to the Luddites in the past, all of them stemming from sudden surges in unemployment in a company or industry. Automation has played a major role in making people replaceable with technology.

What is Automation

Automation can be defined as a " the use of technology to perform tasks with where human input is minimized." (*"What is Robotic Process Automation (RPA)?", n.d.*). Automation has a long history, dating back to the earliest forms of machinery, but in recent years, advancements in technology have led to an exponential increase in automation across many different industries.

At its core, automation involves using machines, algorithms, and software to perform tasks that would normally require human effort. There are several different types of automation currently in use, including process automation, which automates repetitive manual tasks, and cognitive automation, which uses artificial intelligence to make decisions and perform tasks. In addition, there is robotic process automation, which uses software robots to automate manual, rules-based tasks, and AI-powered automation, which uses AI algorithms to automate complex, non-routine tasks (*"What is Robotic Process Automation (RPA)?", n.d.*). Across different industries, automation is being used to increase efficiency, reduce costs, and improve the quality of products and services. For example, in manufacturing, automation is being used to streamline production processes and improve product quality, while in the financial services industry, it is being used to automate manual, time-consuming tasks, such as data entry and reconciliation. Healthcare and retail industries actively utilize automation to enhance the efficiency of administrative duties and optimize supply chain processes, respectively.Automation has the potential for many economic benefits including "increased profit, increased throughput and productivity, improved safety, and higher quality" (Manyika et al., 2017).

In the next section of this paper I give a brief overview of what is both known and predicted about the negative effects of automation on the working class. In the following section, I explain how this paper will utilize the Social Construction of technology framework to analyze the sources used in my research. I then dissect these sources to come to a conclusion of how automation technology has negatively impacted our society, and what can be done to remedy the side effects of worker displacement.

II. Problem Definition

What is Known

The rise of automation and the increasing use of robots in manufacturing, construction, and other industries have brought many benefits, including increased efficiency, productivity, and quality of output. However, these advancements have also had negative effects on employment. A study conducted between 1990 and 2007 found that the "increase in robots in a zone reduced the average employment-to-population ratio by 0.39 percentage points and average wages by 0.77%. This means that adding just one robot to an area reduces employment in that area by about six workers" (Brown, 2020). Even if this number is slightly off, the amount of workers displaced by factory robots is in the millions. This is supported by the International Federation of Robotics' estimation of 2.7 million factory robots currently operating around the world (IFR International Federation of Robotics, n.d.) . This would indicate that a total of around *16 million* potential factory jobs have been stolen by robots internationally.

The negative effects of automation on employment are becoming increasingly apparent in many industries, including manufacturing, logistics, and customer service. As more tasks become automated, there is less need for human workers to perform them, resulting in job losses and increased competition for the remaining positions. Furthermore, the loss of jobs due to automation tends to have a disproportionate impact on low-skilled workers, who are more likely to be replaced by machines than high-skilled workers. This can lead to greater income inequality and social unrest, as workers feel they are being left behind in an increasingly automated world. The purpose of this paper is to find potential solutions to the problem at hand, and to determine if the technological advancements of automation are shaping our society. The solutions may come in the form of legislation that enables displaced workers to gain other skills or penetrate other industries for work.

What is Predicted

In their report, "The Future of Employment: How Susceptible are Jobs to Computerisation?", authors Frey and Osborne argue that while automation of jobs is not a new phenomenon, it is rapidly accelerating due to recent advancements in AI and robotics. The authors predict that jobs involved in repetitive manual tasks and data processing are most at risk of being automated in the near future. On the other hand, jobs that require high levels of creativity, problem-solving, and social intelligence are less likely to be automated. The report estimates that approximately 47% of total US employment is at risk of automation within the next two decades, but the impact of automation will not be evenly distributed across different occupations and skill levels, with low-skilled workers being most affected. To address the challenges posed by automation, such as job displacement and wage stagnation, the authors suggest that policy makers need to start thinking about how to provide support for retraining and job placement programs, and there is an urgent need for workers to acquire new skills. (Frey & Osborne, 2013)

III. Methods

In order to better understand the root of the problem, I employ the Social Construction of Technology (SCOT) STS Framework. This method argues that technology can influence society, and also be influenced by society. This idea fuels a way of thinking that can be useful for understanding the motivations behind the increase in prevalence of automation. The technological trajectory of our society is dependent on social norms and values, and vice versa. Using literary analysis, I will find historical examples of automation implementation in different

industries. Each analysis will focus on the different actors that either contributed or were affected by automation. There are two important aspects of the SCOT framework that I will use throughout this paper: relevant social groups, and interpretive flexibility (Bijker et al., 2012).

SCOT states that technologies are influenced by various social groups who may have different interests, values, and expectations. These groups may include engineers, users, manufacturers, policymakers, and other stakeholders. Each group can shape technology in different ways, leading to a variety of technological trajectories. The framework also argues that technologies can have different meanings and uses for different social groups. A single artifact can be perceived and utilized differently, depending on the social context and users' interpretations. These two concepts will allow for a better understanding of the cause and effect relationship of this specific issue with automation (Bijker et al., 2012).

IV. Results

The Causes and Effects of Automation in Capitalism

"Capitalist production, therefore, develops technology, and the combining together of various processes into a social whole, only by sapping the original sources of all wealth—the soil and the labourer" (Marx et al., 2019). Marx argues that the capitalist system, by its very nature, is constantly developing and using new technologies and methods of production to increase efficiency and productivity. However, he also argues that this drive for automation and efficiency ultimately leads to the exploitation of workers and the depletion of natural resources. Marx contends that while capitalists may benefit from the increased profits that result from automation, workers and the environment suffer as a result.

Effects on the Automotive Industry

The impact of automation on jobs in the automotive industry has been significant over the past few decades. With advancements in technology, robots and other forms of automation have become more prevalent in automotive manufacturing. As a result, the number of human workers required to produce a car has decreased, which has led to job losses. Between 2005 and 2017, approximately 85,000 jobs were lost in the United States automotive industry due to automation. This is a significant number, and it highlights the extent to which automation has reshaped the automotive industry. ("The Impact of Automation on Jobs in the Automotive Industry.", 2019). The jobs that were most affected by automation were those involved in assembly line work such as installing components, welding, and painting. On the other hand, jobs that are more involved in designing and engineering cars were mostly unaffected.

Effects on the Banking Industry

The introduction of ATMs has transformed the banking industry by providing customers with the convenience of accessing their accounts anytime and anywhere. While this technological innovation has simplified banking procedures for customers, it has also led to significant changes in the labor market. According to a study by the National Bureau of Economic Research, the widespread use of ATMs has caused a decline in bank teller employment by approximately 20%. This has been due to the reduced need for human tellers to process transactions that customers can now carry out through machines (Beraja et al., 2018). With online banking and crypto currencies in the modern world, we are becoming less dependent on physical banks, and therefore, less dependent on the employees at those banks.

Effects on the Farming Industry

According to the USDA, the number of people employed in the agricultural sector in the United States has steadily decreased over the past century, due to technological advancements and efficiency improvements. The widespread adoption of farm machinery has greatly reduced the need for manual labor, allowing farmers to produce more crops with fewer workers. In fact, the USDA reports that today, less than 2% of the US population is directly employed in farming and ranching. While the use of machinery has increased productivity and efficiency, it has also contributed to the consolidation of farms and the loss of small family farms. Larger farms can afford to invest in expensive equipment, while smaller farms struggle to compete. As a result, the number of farms in the US has declined dramatically over the past century, from 6.4 million in 1935 to just over 2 million today, according to the USDA. However, despite the decline in the number of farmers, the amount of food produced in the US has continued to increase. The USDA reports that between 1948 and 2019, the total value of US agricultural production increased from $74 billion to $416 billion, thanks in part to advances in technology and genetic engineering. The use of farm machinery has had both positive and negative effects on the agricultural sector in the United States, leading to increased productivity and efficiency, but also contributing to consolidation and the loss of small family farms. (*"Productivity growth in U.S. agriculture (1948-2019)", n.d.*)

During the 20th century, the state of California was a large agricultural producer of tomatoes. In the 1940s, the mechanical tomato harvester was invented, allowing for much more efficient seasonal harvests.

> "*By their very size and cost, more than $50,000 each to purchase, the machines are compatible only with a highly concentrated form of tomato growing. With the introduction of this new method of harvesting, the number of tomato growers declined from approximately four thousand in the early 1960s to about six hundred in 1973, yet with a substantial increase in tons of tomatoes produced. By the late 1970s an estimated thirty-two thousand jobs in the tomato industry had been eliminated as a direct consequence of mechanization. Thus, a jump in productivity to the benefit of very large growers has occurred at a sacrifice to other rural agricultural communities"* - (Winner, 1980, p. 126)

Winner concludes that only the larger farms that were able to invest in these machines were able to outperform the other farms lacking this technology who would eventually die out. Regardless, the tomato industry witnessed significant surges in productivity. A lawsuit was eventually filed against the university that paid for the research that birthed this new harvesting machine. The organization that filed it argued that it "[benefited] a handful of private interests to the detriment of farmworkers" (Winner, 1980, p. 126).

V. Analysis

Relevant Social Groups and Interpretive Flexibility

Many different social groups push for widespread adoption of automation technology, and they can all be seen in the aforementioned industries that have been affected. The relevant social groups that want this change include the manufacturers, the stakeholders, and especially, the consumers. Each of these groups of people in every situation will be benefiting from the replacement of human workers by machine workers. Interpretive flexibility shows how

automation technology is viewed differently depending on the individual. The worker will see the technology as a replacement for them. Its ability to work more efficiently than the individual would not bring any benefits directly to the worker. On the other hand, the capitalist or the owner of automation technologies sees it as a way to increase productivity, and therefore, profit as well. The reason we have seen the widespread adoption of the previously mentioned technologies is simply because the capitalist, like Marx has stated, holds all of the power.

Who is at Risk

In most of the instances above, the affected workers were employed in positions that didn't require any higher education or special training. Although technological advancements have allowed automation to replace workers that perform repetitive and menial tasks, it is not yet capable of performing high skill and creative tasks. This means that in the near future, these jobs are much more secure. However, as automation becomes more complex, jobs of all types become susceptible to displacement. This is supported by Frey and Osbornes' estimations that jobs of different types across different industries all have a non-zero chance of being replaced by automation at some point in the next few decades.

Even though a large number of jobs across different industries will soon become obsolete, some argue that overall job creation will equal or outpace job loss. "The job loss in the applying sectors is limited, while the potential for job creation is substantial, both in directly related (new) sectors as well as in the spillover sectors" (Vermeulen et al., 2018). Using empirical evidence and economic theory, Ben Vermeulen and collaborators conclude their research with the notion that automation creates enough jobs in the areas that directly deal with the design and creation of the automated systems, and do the same in unrelated industries.

However, these new opportunities do not become available to the displaced workers immediately after their termination. Not only does it take time for these new jobs to become established, but they likely require certain skills that the newly unemployed simply lack.

> *"Automated occupations become less labor intensive, which displaces workers but increases output as labor reallocates to non-automated occupations. Displaced workers face reallocation frictions: they receive random opportunities to move between occupations, experience a temporary period of unemployment or retraining when they do so, and incur a productivity loss due to the specificity of their skills. Workers also face financial frictions: they are not insured against the risk that their occupation is automated and face borrowing constraints."* - (Beraja et al., 2022, p. 2)

Once a worker is displaced, they are unable to find a means to contribute to a good production or relevant service until they acquire new, in demand skills. This ultimately causes this temporary 'friction' referring to the difficulties of finding new employment and the financial burden that comes with this transition.

Current Efforts to Help with Worker Displacement

Despite the issues surrounding displacement from advancing technologies, there has yet to be any legislation in the United State to acknowledge and help solve them. So far, there has only been a proposed bill, *The AI Bill of Rights,* which outlines some protections from Artificial Intelligence. The conceptual bill includes protections from privacy invasion, algorithmic discrimination, and unsafe systems. However, it does not specifically identify any protections for workers who can potentially be replaced by automated systems. They do touch on the necessity for human alternatives to some automated systems that people need access to should they prefer

it, but this does not truly guarantee the safety of employees as many areas have no need for human alternatives (The United States Government, 2022).

Solutions to the main issues surrounding automation have been discussed by entrepreneurs such as Bill Gates and Elon Musk. The first being the “robot tax”, which would require companies that are benefitting from automation to pay a hefty tax. This would accomplish two things: it would slow down the overall adoption of automated systems across all industries, and more importantly, it would help fund those who were displaced and are struggling financially. Secondly, some argue for a universal basic income (UBI), a form of wealth redistribution. UBI would ensure that everyone has access to resources needed to maintain a particular living standard, thus alleviating poverty. These proposals do have some merit, but are ultimately unsustainable. Both solutions focus on financially supporting the displaced employees without helping them find other means of employment. To put it simply, they aim to remedy the side effects rather than fix the root of the problem (Vermeulen et al., 2018).

A more efficient solution that focuses on the needs of the workers is one that prioritizes their ability to find other jobs. Ben Vermeulen and collaborators outline a rough plan which involves a combination of the previously mentioned solutions and new worker upskilling ideas. This plan would involve a program promoting “adequate training to facilitate sustainable, upward mobility” at the same rate at which they are laid off (Vermeulen et al., 2018). In addition to a training program, it also called for the implementation of contractual arrangements to entice and encourage employers to hire low-skilled employees. The plan also emphasizes the need to enhance the education system to develop a labor force that works in more technical fields, complementing the advancing automation technology. The authors also suggest that UBI could also be used as a type of stipend for workers that are going through this employment transition.

Are We Ready for a Solution

Following a 2018 report from McKinsey Global Institute which stated that roughly 14% of the global workforce may need to switch to more modern technological occupations, the company conducted a survey on close to 300 executives working at companies with $100 million or more in revenue. The purpose of this survey was to gauge how these companies plan to acquire workers with skills more relevant to the digital age. About 66% of companies that responded to the survey classify the reskilling of workers as a top ten priority within the company, and a majority consensus that corporations should take the lead in retraining workers as opposed to government programs. This makes sense as retraining employees gives a competitive advantage in the corporate world, giving companies incentive to create a training plan for workers. However, only 16% of executives said their companies are "very prepared" to address skill gaps and start retraining internally. One of the main barriers for a retraining program is the lack of direction; many workers are put into training programs without an end goal position or career path. (Illanes, et al., 2018)

VI. Discussion

Due to the difficulties surrounding the transition for displaced workers, a concrete plan is needed to ensure the safety and future of these victims of automation. Not only will they need financial support due to their lack of ability to make money during the transition, but also opportunities presented to them for a brighter future. I believe that a concrete plan involves collaboration between the government and private corporations. Similar to the school system, with private and public means of education, it would be wise to have federal training programs

along with private training programs. A “robot tax” would be instituted in order to fund the federal programs, but having a qualifying private training program would allow for partial or full exemption from this tax as they are using their own resources for retraining and financially supporting the trainees. The “robot tax” would also support a universal basic income specifically for those who are currently training or still l in between jobs. There are many small details that need to be ironed out, such as potential partnerships between companies and the federal government, or how to implement the “robot tax”. However, if successful, a plan like this could smoothen the brutal employment transition for workers who have been displaced by automation.

References:

"The Impact of Automation on Jobs in the Automotive Industry." (2019). Center for Automotive Research. Retrieved from: www.cargroup.org/wp-content/uploads/2019/05/Impact-of-Automation-on-Jobs-in-the-Automotive-Industry.pdf.

Beraja, M & Zorzi, N. (2022). "Inefficient Automation" Working Paper, National Bureau of Economic Research.

Beraja, Martin, et al. (2018). "Consumer Spending and the ATM Revolution." National Bureau of Economic Research, Working Paper No. 25374. Retrieved from: www.nber.org/paper/w25374

Bijker W. E., Hughes T. P., Pinch T. J., & Douglas D. G., (2012). *The social construction of Technological Systems New Directions in the sociology and history of technology*. Cambridge, MA: MIT Press.

Brown, S. (2020, July 29). *A new study measures the actual impact of robots on jobs. it's significant.* MIT Sloan. Retrieved March 7, 2023, from https://mitsloan.mit.edu/ideas-made-to-matter/a-new-study-measures-actual-impact-robots-jobs-its-significant

Frey, C. B., & Osborne, M. (2013). The Future of Employment. Oxford Martin Programme On Technology and Employment, Cambridge, working paper.

IBM. (n.d.). What is Robotic Process Automation (RPA)? IBM. Retrieved from https://www.ibm.com/

IFR International Federation of Robotics. (n.d.). IFR presents World robotics report 2020. IFR International Federation of Robotics. Retrieved from https://ifr.org/ifr-press-releases/news/record-2.7-million-robots-work-in-factories-around-the-globe

Illanes, P., Lund, S., Mourshed, M., Rutherford, S., & Tyreman, M. (2018, January 22). *Retraining and reskilling workers in the age of automation*. McKinsey & Company. Retrieved March 7, 2023, from https://www.mckinsey.com/featured-insights/future-of-work/retraining-and-reskilling-workers-in-the-age-of-automation

Manyika, J., Chui, M., Miremadi, M., Bughin, J., George, K., Wilmott, P., & Dewhurst, M. (2017). *A future that works: Automation, employment, and Productivity*. McKinsey Global Institutte.

Marx, K., Moore, S., Aveling, E. B., & Engels, F. (2019). *Capital: Volume One*. Dover Publications, Inc.

USDA ERS. (n.d.). Productivity growth in U.S. agriculture (1948-2019). Retrieved from https://www.ers.usda.gov/data-products/agricultural-productivity-in-the-u-s/productivity-growth-in-u-s-agriculture-1948-2019/

The United States Government. (2022, October 4). *Blueprint for an AI bill of rights*. The White House. Retrieved November 19, 2022, from https://www.whitehouse.gov/ostp/ai-bill-of-rights/

Thompson, C. (2017, January 1). When robots take all of our jobs, remember the Luddites. Smithsonian.com. https://www.smithsonianmag.com/innovation/when-robots-take-jobs-remember-luddites-180961423/

Vermeulen, B., Kesselhut, J., Pyka, A., & Saviotti, P. (2018). The Impact of Automation on Employment: Just the Usual Structural Change? *Sustainability*, *10*(5), 1661. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su10051661

Winner, L. (1980). *Do artifacts have politics?* The MIT Press.