

Hero or Villain: A Sociotechnical Analysis of Automation in the United States

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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

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Introduction

Since the 1950s, computational efficiency has increased by a factor of 100,000 (Roser et. al. 2022). With this increase in computational efficiency, the world economy has seen an unprecedented rate of progress. Raw materials and crops have decreased in price, renewable energy has become accessible, and medical technology has been transformed by new discoveries on DNA and diseases (Roser et. al. 2022). Technology and automation have revolutionized nearly every facet of human life in the 21st century — computers are now ubiquitous in every industry. However, while technological progress has increased, social progress has remained stagnant. In the US, the federal minimum wage has not increased since July 24th, 2009 (Department of Labor, n.d.). The average life expectancy in the country started decreasing in recent years and has gone backwards from where it was 25 years ago (Reamer, 2022).

The discourse surrounding societal “progress” is often intertwined with that of technological advancement, and is most often understood within the framework of the benefits of economic development. Yet, despite being more “connected” than ever through technology, the world has become more disconnected from what technological advancement should really be about – improving quality of life for all human beings. As technological advancements continue to abound in the future, society must redefine the goals with which it fights for these advancements. Today, societal progress may be intertwined with that of technological advancement. However, it is increasingly clear that societal progress is an inherent consequence of technological advancement. I invite you—as a reader and member of society—to delve into

this gray area of progress together with me and ask, “Is this advancement an improvement for *society*, or simply a *technological* advancement for the sake of profit?”

This paper will examine how the continued pursuit of advancement in automation reveals critical gaps in the United States’ federal policy to address the concerns of workers whose jobs are impacted by these increasingly prevalent and pervasive technological changes.

First, I will reveal how the current understandings of societal progress offer a misleading view at the impact of technological advancement in the United States. To do so, this paper analyzes the interplay of automation and labor rights in the US, focusing on the shifting nature of societal progress and the implications for various social strata. The report argues that while technological advancement has brought about undeniable societal progression, this does not necessarily translate into improved quality of life, especially for the working class. Through the examination of historical socio-economic phenomena this paper emphasizes the need for an inclusive, socially responsible approach to technological innovation and proposes tangible policy solutions.

Next, sections II and III of this paper will examine the impact of automation of labor and the response of the labor movement. Here, I will address historical trends in the automation of labor. Over time, an increasing variety of industries have been adapted to trends in automation, which has galvanized new industries to organize around demands for protections from job displacement and assistance in the event of job loss.

Methods:

The analysis employs Sheila Jasanoff's theory of co-production to examine the interplay between automation and quality of life. This framework is applied to documentary research, which is used to trace the evolution of societal definitions of quality of life and their relationship with technological developments (Tight, 2019) from the 20th century to the present. We are also able to look at statistical sources in the documentary context to help understand the evolution of the definition quality of life—we can consider information about the presence and power of unions at different times in conjunction with development and happiness indices to further understand the factors that impact both this definition and, as a result, the quality of life of the population.

As defined by the New Economics Foundation, “Co-production is an approach to decision-making and service design rather than a specific method. It stems from the recognition that if organizations are to deliver successful services, they must understand the needs of their users and engage them closely in the design and delivery of those services” (New Economics Foundation, 2011). Initially posed by Sheila Jasanoff, she coins the instruments of co-production as making identities, making institutions, making discourses, and making representations. These instruments refer to ways technology influences other spheres of life which is uniquely important when assessing the intersection of automation on quality of life (Jasanoff, 2004). As a theoretical approach, co-production is not without its critics. Durose states, “One prominent critique within academic work is, unsurprisingly, that co-production (as with many other concepts) is a messy and unclear concept.” (Durose, 2022) but goes on to differentiate it from the standard academic practice of being highly scientific. Durose refers to this framework as “clarification” and says it is “achieved by reducing excess meaning.” In an effort to be highly scientific and precise,

clarification misses out on an intersectional understanding of how complicated the way automation has affected society might be—that excess meaning is important, and it’s not necessarily through traditional analytical approaches that we can make sense of it.

Section I: The Marxist Perspective: Profit, Invention, and Society

To innovate is to create new value. As leaders in technological innovation, the United States has long purported the value of the capitalistic system as a motivator for innovation. The techno-optimist would hold hope that the innovation of new technologies benefits society, that profit-driven innovation and social prosperity reinforce one another, and that the material realities for most individuals in the United States have increased as a result of the effects of hyper-capitalism. However, increasing social upheaval in the form of labor protests and growing class struggles have revealed that even the United States’ professed drive to innovate for human welfare has not been able to compensate for the fact that technological innovation under capitalism produces deleterious effects on society.

To understand the interrelation of technology and society in the United States, it is helpful to re-read Marx’s exploration of the relationship between machinery and labor, class struggle, and legislation. Contesting the notion that automation reduces the burden on the worker, Marx summarizes the effects of machinery in the hands of capital thus,

“machinery, by annexing the labour of women and children, augments the number of human beings who form the material for capitalistic exploitation, how it confiscates the whole of the workman’s disposable time, by immoderate extension of the hours of labour, and how finally its progress, which allows of enormous increase of production, in shorter and shorter periods, serves as a means of systematic getting more done in a shorter time, or of exploiting labour-power more intensely” (Marx, 2019, p. 458).

The labor movement's origins in the 19th century were responses to the harsh realities of the Industrial Revolution. Brutal working conditions, child labor, long hours, and paltry wages sparked labor protests, with workers and burgeoning labor unions demanding safer working conditions, shorter hours, and better wages. These early battles against industrial capitalism and its accompanying machinery—initially in industries like the textile industry and later in manufacturing and transportation—shaped modern labor rights and further inflamed class tensions as workers saw their skills become superfluous.

Marx emphasizes that technology behaves in a capitalistic society to increase the means by which capitalists are able to exploit the labor of humans and causes the specialized skill of laborers to vanish.

“The worker’s activity, reduced to a mere abstraction of an activity, is determined and regulated on all sides by the movement of the machinery, not the opposite. The science which compels the inanimate limbs of the machinery, by their construction to act purposefully, as an automation, does not exist in the worker’s consciousness, but rather acts upon him through the machine as an alien power, as the power of the machine itself” (Marx, 1973a, p. 693).

In this way, Marx introduces the concept of "alienation" in the labor process, wherein workers in a capitalist economy find themselves estranged from the products they produce, the labor process, their fellow workers, and their own human potential. This alienation often manifests in a reduced quality of life, contrary to the outward appearance of prosperity that economic growth might suggest. Marx's critique extends to the realm of technology, where he argues that technological innovations could increase production efficiency and profit for capitalists but also leads to worker displacement and deskilling, thereby exacerbating worker alienation.

Under the pressures of profit motives, Marx writes that the pursuit of invention is transformed into a means of generating unceasing profits. Marx explains,

“Invention then becomes a business, and the application of science to direct production itself becomes a prospect which determines and solicits it. But this is not the road along which machinery, by and large, arose and even less the road on which it progresses in detail. This road is, rather, dissection [Analyse] – through the division of labor, which gradually transforms the workers’ operations into more and more mechanical ones, so that at a certain point a mechanism can step into their places” (Marx, 1973, p. 704).

Here, Marx explains that the continuous innovation which occurs under capitalism is geared towards the end goal of reducing the human labor needed in production, cheapening commodities, and increasing profits. The ever-present need for more profit drives continuous innovation.

According to Joseph Schumpeter, the capitalist system is characterized by a process of "creative destruction," where new innovations persistently displace older technologies, engendering economic growth. Thus, at the heart of capitalism, Schumpeter identifies the pursuit of growth necessitating continuous innovation. This innovation is sparked by consumer demand, itself stimulated by the pervasive force of advertising, a central pillar of modern capitalism. Advertising fuels the consumer's appetite for better and newer products, in turn driving technological advancements and growth. In Schumpeter's view, the role of advertising in shaping consumption patterns makes it an integral part of the innovation process (Schumpeter, 2009).

Although the constant cycle of innovation, driven by advertising-induced consumption, may enhance the quality of life in the short term, it risks resource depletion and environmental fallout in the long run. We see this playing out right now with the effects of global warming—

capitalism requires constant economic growth that disregards the environmental effects that are leading to imminent loss of resources and quality of life in the future. Schumpeter's critique, therefore, exposes the dual-edged sword of capitalism, embodying both the promise of progress and the specter of self-destruction.

By extending this Marxist critique to the realm of technological revolutions, we find that profit-driven technological advancements, while contributing to efficiency and prosperity for some (the bourgeoisie), often come at the expense of many (the proletariat). Marx's early critique of capitalism has proved to be no less relevant in the 21st century, and aptly predicted the effects of the dot-com boom of the 2000s. This period saw enormous technological advancements in the form of information technology and internet services, leading to significant economic growth. However, it also exacerbated income inequality and resulted in job displacement due to automation and digitization.

Hence, Marx's theories offer a pertinent lens to critically interrogate the relationship between profit, technological advancement, and the quality of life across different technological revolutions. They remind us that while technology can undoubtedly lead to significant societal shifts, the broader economic systems and profit motives driving these changes may not necessarily align with the overall improvement in societal well-being. They thus play a critical role in challenging conventional narratives about the role of profit as a driver for invention, stimulating a deeper conversation about the interplay between technology, economic systems, and societal outcomes.

Section II: The Impact of Automation on Labor

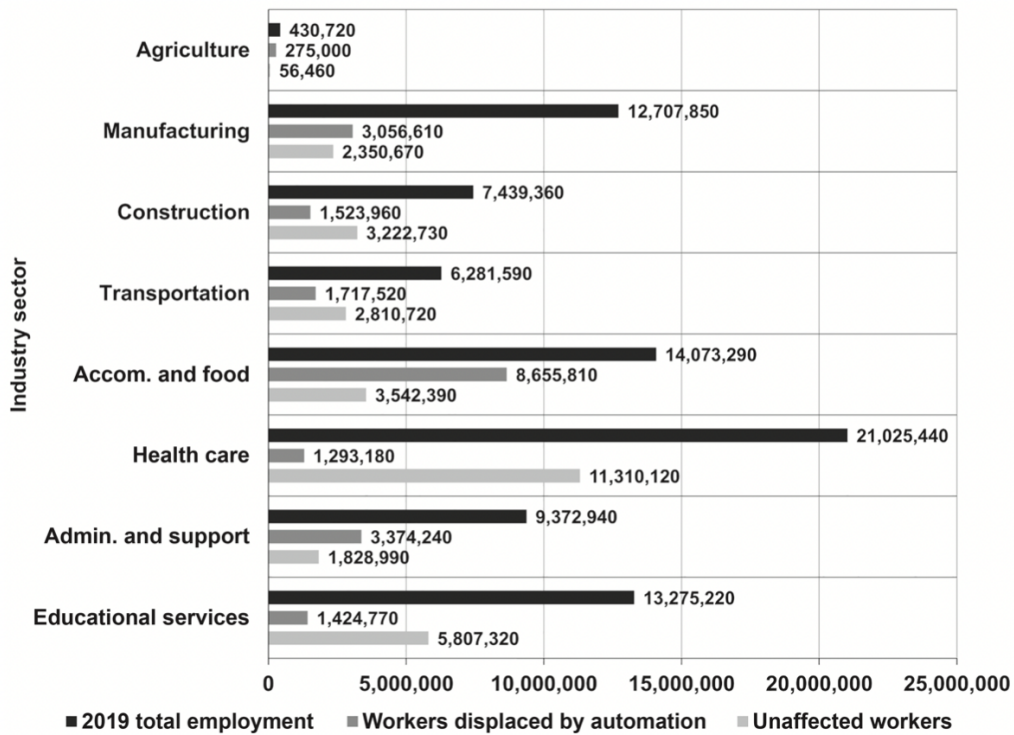
As automation expanded in the 20th and 21st century, shifts in labor demands have led to the displacement of workers from traditional industries affected by automation and led to a restructuring of labor and leisure for workers in United States industries. As technological innovation in machinery has reduced the need for high-skilled labor and reduced the cost of production, the labor of the human workman has been devalued, displaced, and deskilled.

The assembly line's introduction by Henry Ford in the early 20th century marked a transformative moment in industrial history. This innovation drastically changed work's organization, notably improving productivity and reducing production costs. Ford's Model T, manufactured at remarkable rates, brought car ownership within reach for the average American (Ingrassia, 2008). This development amplified consumerism and expanded personal freedom and mobility, seemingly enhancing the quality of life. However, this leap forward also triggered significant shifts in labor dynamics. Work was divided into smaller, repetitive tasks, increasing efficiency but simultaneously deskilling workers. Jobs required less skill and knowledge, possibly decreasing job satisfaction and workers' sense of achievement. The long-term implications of this shift on the quality of life remain complex and debatable, reflecting a trade-off between efficiency, affordability, and job satisfaction. Workers protested the assembly line's dehumanizing effects and the erosion of skilled jobs. The Flint Sit-Down Strike in 1936-37 is an emblematic instance of labor's resistance to the automation of work and the struggle for a fair share of the wealth these technological advancements produced (Tuncer 2022).

Decades later, workers continue to be displaced across a variety of industries impacted by automation. According to 2019 survey data from the Bureau of Labor Statistics, a total number of 21.3 million workers faced displacement as a result of business automation (Figure 1).

Figure 1

Worker Displacement Due to Automation Across Eight Industries



From *Business Automation and its Effect on the Labor Force* (Page 148), analysis based on a 2019 survey data from the Bureau of Labor Statistics. (Uechi, 2022)

Today, the rise of artificial intelligence is sparking a new wave of automation that extends beyond manufacturing and into white-collar jobs, including sectors such as law,

medicine, and journalism. According to a report by McKinsey Global Institute, automation could displace up to one-third of the US workforce by 2030 (Manyika 2017). While AI promises improved productivity, service quality, potentially lower costs, and reduced human error, it also threatens job displacement on a scale not previously seen, even widening the income inequality gap (O'Grady, 2017). If unchecked, these shifts could exacerbate social disparities and jeopardize individual quality of life.

Interestingly, the US response to job losses varies considerably depending on the source of job displacement. International trade-induced job losses attract substantial political attention and are often met with support measures, such as the Trade Adjustment Assistance program, which had provided financial aid and retraining for affected workers through 2022. In stark contrast, no comparable program exists for job losses due to automation, despite automation contributing more significantly to job displacement. This policy inconsistency can intensify the challenges faced by workers displaced due to automation, posing significant societal concerns. Left unaddressed, this job displacement, accompanied by insufficient safety nets, can lead to increased income inequality, social instability, and a decline in the overall quality of life.

Section III: Class Struggles, Labor Protests, and Automation

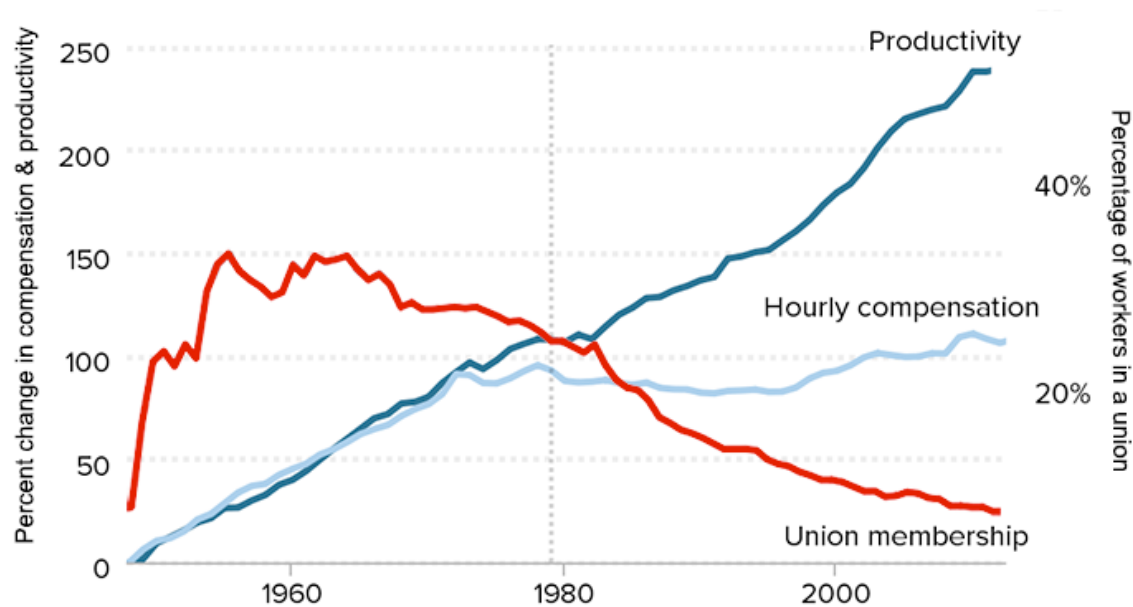
The implications for automation for employment and earnings across computer numerical control machinery, industrial machinery, and artificial intelligence have brought about both widespread job displacement and the growth of new labor demands. While the previous section looked to understand class struggle by focusing on the shifting role of human labor as a result of industrial automation, this section seeks to examine how collective actions in the 21st century labor movement have sought to gain decision-making power regarding the implementation of

automated processes. In this way, this section investigates how strategic interactions between workers and capital owners have sought to reduce automation risk by increasing the control rights of workers more broadly.

Recent decades in United States history have seen increasing wealth disparity between the working class and the top ten percent. The early 2000s saw an increasingly apparent correlation between wage stagnation, declining union membership, and rising automation. Meanwhile, the share of income going to the top 10% rose 1917–2017 according to data from the Economic Policy Institute (Jacobin 2021). As union membership plummeted from its peak of 28.3% in 1954 to a mere 10.3% in 2019, the median weekly earnings of full-time wage and salary workers have remained relatively unchanged, adjusting for inflation. In other words, gains from growth in automation have allowed capital owners to accrue more capital at the expense of the working class. The direct impact of the drop in union membership is made obvious by an inflection point at around 1980, shown in Figure 2, which illustrates the accelerating decline in union membership rates while wages stagnate and productivity continues to skyrocket.

Figure 2

Worker Productivity, Compensation, and Union Membership from 1948 to 2017



Source: <https://www.epi.org/publication/top-charts-2019/> and <https://www.epi.org/productivity-pay-gap/>

In the absence of adequate wealth redistribution, unions and worker cooperatives have spearheaded the organization of labor and the accumulation of collective bargaining power to negotiate higher earnings and improve working conditions (Parolin, 2021). Labor protests in the 21st century, such as the ‘Fight for \$15’ movement, reflect concerns about automation displacing low-wage jobs in fast food and retail. A similar trend occurred in the logistic industry. With the rise of e-commerce giants like Amazon, automated warehouses became the norm. Industrial robots and artificial intelligence have become integral in sorting, packaging, and shipping goods. This widespread automation led to job losses and sparked protests. Workers' concerns extend beyond job security to include grueling productivity standards set by automated systems, with reports of Amazon warehouse employees having to urinate in bottles due to strict quotas, highlighting how automation can intensify workplace pressures (Klippenstein, 2021). The resistance from those with capital to resist ideas favoring their employees such as a minimum wage increase or a four day work week, despite evidence of gains for employers (Campbell,

2023), represents a confirmation that the struggles of the proletariat against the bourgeoisie have not ceased despite progress in labor rights.

Automation has come to the forefront of labor protests across entirely new industries in the 21st century. As the advancement of machine learning has expanded the types of tasks that can be automated, automation threatens to replace workers across a never-before-seen variety of industries — from manufacturing and tech workers to visual and performing arts creatives. The potential for Artificial intelligence to displace intellectual and creative labor as well as manual labor has galvanized a new subset of the labor movement to demand protections from their employers in the absence of federal or state protections. Within this job-threatening climate, it has risen to the priority list of many mobilized workers to demand assurance from their employers that their jobs will not be replaced by AI Technology. For instance, the Writers Guild of America, has gone on strike, the first Hollywood strike in 15 years, to demand safeguards against the usage of AI technology which is posed to replace the work of screenwriters to complete unfinished screenplays and to generate original scripts (Minsky, 2023).

One of many examples, the writer strike attests to a more generalizable trend across industries affected by automation: a greater awareness of technological changes present in worker demands. Rather than simply demanding higher wages and better working conditions, union demands have been organized around protections and training resources for workers affected by automation. These movements underscore an important shift in the nature of labor protests, indicating a growing awareness of the role of automation in shaping the labor market. The federal government has a crucial role in mitigating the adverse effects of automation through policies such as retraining programs, income support for displaced workers, and fostering conditions for job creation in emerging industries. However, the most effective means of

addressing automation risk continues to be emboldening worker power—workplace governance and the democratic representation of worker demands have the ability to determine the future of work in order to protect the design of jobs which provide adequate compensation, benefits, and job loss security.

Discussion

The growth of the United States economy comes at the expense of social progress as the perpetual pursuit of economic growth drives a need to generate a profit, demanding that technological innovation is focused on meeting the demands of capitalist production. Thus, innovative engineering under capitalism is directed towards profit incentives, which runs counter to technological development for the betterment of society and enhancing the quality of life for all. Within the profit-driven incentives of capitalism, the automation of an industry does not ease the work for the worker, rather, it displaces their work in the pursuit of reducing labor costs and increasing profits, while workers become increasingly alienated and estranged from their labor.

Workers do not have power over the production of technology. The power to make decisions over the production of technology is restricted to few: executives, trustees, shareholders, and to a more limited extent, engineers, academics, and other members of the educated elite. Without decision making power, technological innovation has been designed for and by capital owners. It is no wonder that technological innovation has not been able to meet the basic needs of society, despite its advanced degree of excellence and rate of development, since it does not afford decision-making power or capital to most people in society.

When workers decide what technology to produce, the design, execution, implementation, and maintenance of that technology will be better aligned with what is best for everyone because the working class is who makes up a huge majority of that population. Thus,

labor action to lay claim to greater decision making power is precisely what co-production would argue for, workers can make choices about the production of technology, thereby putting the needs of society at the center of its aims rather than the profit-incentives of industrial capitalists.

While the United States government alone cannot legislate away the problem without fully untangling itself with the capitalist bourgeoisie, it can mitigate the negative consequences of automation by enacting policies which assist displaced workers with retraining, income support, and by fostering conditions to generate new job opportunities. In the absence of effective legislative action or incentives to reduce the exploitation of workers and prevent the elimination of many jobs replacing automation, the best way forward to improving the quality of life is to enable the mobilization of militant unions. That means redistributing the power back to workers—ensuring a federal jobs guarantee, a four-day, 32-hour work week with no reduction in wages or benefits, the raising of the federal minimum wage, and by guaranteeing the legal right to a union and to strike action for all.

References

- Campbell, T. T. (2023). The four-Day work week: A chronological, systematic review of the academic literature. *Management Review Quarterly*, 1–17. <https://doi.org/10.1007/s11301-023-00347-3>
- Ingrassia, P. (2008, September 28). *This Car Changed America*. The Wall Street Journal. <https://www.wsj.com/articles/SB122246777029780525>
- Klippenstein, K. (2021, March 26). *Documents show Amazon is aware drivers pee in bottles and even defecate en route, despite company denial*. The Intercept. <https://theintercept.com/2021/03/25/amazon-drivers-pee-bottles-union/>
- Marx, K. (1973). The Fragment on Machines. In *Grundrisse, etc* (pp. 690–712). essay, Penguin Books in association with New Left Review.
- Marx, K., Engels, F., Moore, S., & Aveling, E. B. (2019). Machinery and Modern Industry: 4 The Factory. In *Capital. A Critique of political economy* (pp. 457–465). essay, Dover Publications, Inc.
- Minimum wage*. DOL. (n.d.). <https://www.dol.gov/agencies/whd/minimum-wage>
- Minsky, A. (2023, July 1). What's at Stake for Hollywood and TV? The Writers Guild Strike. *Against the Current*, 38(3), 13 - 16.
- New Economics Foundation (2011, July 8). *Stories of Co-Production* [Video]. Youtube. https://www.youtube.com/watch?v=aKATrzUV2YI&ab_channel=NewEconomicsFoundation.
- O'Grady, F. (2021, September 17). The trade union's role in automation: AI has tremendous potential in the workplace--but we need to make sure we put people first. *New Statesman*, 150(5637), S4.

Parolin, Z. (2021). Automation, Occupational Earnings Trends, and the Moderating Role of Organized Labor. *Social Forces*, 99(3), 921–946. <https://doi-org.proxy.uchicago.edu/10.1093/sf/soaa032>

Reamer, A. (2022, August 24). *NCHS: U.S. life expectancy fell from 78.8 yrs 2019 to 76.1 yrs 2021 (8.31.22), State Variation 2020 (8.24.22)*. Economics Forum. <https://www.aeaweb.org/forum/2994/nchs-life-expectancy-fell-from-2019-2021-state-variation-2020>

Schumpeter, J. A. (2009). *Capitalism, socialism and democracy*. Harperperennial.

Tight. (2019). *Documentary research in the social sciences*. Sage Publications.

Tuncer, E. (2022, December 30). *Research guides: This Month in business history: The Flint, Michigan, sit-down strike*. The Flint, Michigan, Sit-Down Strike - This Month in Business History - Research Guides at Library of Congress. <https://guides.loc.gov/this-month-in-business-history/february/flint-michigan-sit-down-strike>

Uechi, E. (2022). The Effect of Automation on the Labor Force. In *Business Automation and its effect on the labor force: A practical guide for preparing organizations for the Fourth Industrial Revolution* (pp. 148–148). essay, Productivity Press.