Robots for the Rich:

A Socioeconomic Impact Analysis of the Development of Robotic Technology

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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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STS Research Paper

Introduction

Robots are taking over the world but not in the apocalyptic sense; at least not yet. Since the first appearance of the word "robot" in Rossum's Universal Robots (originally Rossumovi Univerzální Roboti) by Karel Čapek (Flatow, 2011), robotic technology has pervaded many facets of life, from industrial labor to performing household chores. As the future and the shape of its society comes ever clearer into view, robots are often an integral part of it, as in *The Jetsons* (Hanna et. al, 1962), where Rosie the robot maid essentially runs the house: cooking, cleaning, and watching over the children. Many of the uses of robots, current and envisioned, have changed, or will change, the way society operates and the daily rhythms of life, but do the time and money put into their development match the gravity of the issues that they address? Moreover, how have developments in robotic technology historically impacted the socioeconomically marginalized? The following analysis answers this question by tracing the trajectory of the development of robots from their inception to the present, utilizing the framework of technological momentum to explicate its interactions with the surrounding society, and then extrapolating that trajectory to envision how the technology might continue to shape and be shaped by society in the future.

Research Question and Methods

Research Question: How have developments in robotic technology historically impacted the socioeconomically marginalized?

To examine the momentum gained and maintained by robotic technology, this paper utilizes Literature Review and Discourse Analysis methodologies to explore the chronological development of robotic technology up to the present and its imagined future. First, this paper

explores the inception of robots and their introduction into society, especially how those in power in the society in which they were born shaped their development. Literature review involves gathering secondary sources related to a topic, summarizing them, and synthesizing them (Labaree, n.d.). Utilizing this methodology, this paper analyzes the early examples of robots in society and the problems that they were constructed to solve. Subsequently, this paper follows the development of robotics, the influences on it, and the impacts it had on the surrounding society of the time up to the present. Finally, utilizing discourse analysis, this paper provides glimpses at the imagined future of robotics based on the current public sentiment towards robots and their uses, drawing from sources similar to those in the literature review, but also some more non-traditional sources that more broadly represent the general population. Thus, this paper creates a timeline for the development of the technological momentum accrued by robotic technology, how it was influenced by the society of its time, and how it influenced or will come to influence the society it inhabits.

A Brief Introduction to Robotics

Robots, or at least machines formally called robots, first began in the minds of science fiction writers like the aforementioned Capek and the infamous Isaac Asimov as servants of man. Capek envisioned them as rebellious mechanical factory workers while Asimov depicted them as helpful servants bound by "laws" now known as Asimov's "Three Laws of Robotics" which read:

1. "A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law." (Pa, n.d.).

The tangible counterparts to the fictional robots also began primarily in industrial settings as in Rossum's Universal Robots. Unimate developed by George Devol was the first prototype industrial robot arm originally used by General Motors to handle extremely hot car parts (Sharma, 2013, p.1). With this introduction came a strong desire to have precise manufacturing and replace jobs that could be hazardous to a human worker. Since then, robots have found their way, not fully autonomously, out of factories and into many other fields including healthcare and even the home. These robots that operate inside the home are commonly called domestic robots.

In the current world of domestic robots, robot vacuums, colloquially known as Roombas, have found their way into 40 million homes worldwide as of 2021, only counting those sold by the original company, iRobot (iRobot, n.d.). Some of these devices sell for up to $1000 (iRobot, n.d.), begging the question, who can actually access the technological solution they provide? The high cost associated with creating these technologies means that the primary developers are the wealthy, and the subsequent high price when the technologies reach the market means that the wealthy are also the primary consumers.

Technological Momentum as an Analytical Framework

To answer the research question, this paper follows technology historian Thomas P. Hughes' framework of technological momentum. This theory posits that the influence that technology has on society is time dependent: early in the life of a new technology, it is much more susceptible to the influences of society and culture, but as it matures and becomes more established, the technology becomes increasingly independent and has its own influence on society. Technological momentum is intricately linked with the frameworks of the social

construction of technology (SCOT) and technological determinism. SCOT claims that technology is a product of the society it is created in and given its shape by the social constructs in place (Klein & Kleinman, 2002). In contrast, technological determinism argues that technology and its changes are some of, if not the greatest, influences on societies (Smith, 1994). In Hughes' words, "The social constructivists have a key to understanding the behavior of young systems; technical determinists come into their own with the mature ones. Technological momentum, however, provides a more flexible mode of interpretation and one that is in accord with the history of large systems" (1994, p. 112). Critics of the framework claim that technological momentum should not be considered a standalone framework as it amalgamates SCOT and technological determinism, or that it is simply a reframing of technological determinism (Colarossi, n.d.). While it certainly incorporates the main aspects of both, the primary helpful contribution is the linkage of the two frameworks with a time dependent relationship and the demonstration of how the deterministic nature of a technology can develop throughout its lifetime.

This method of analyzing a technology throughout the span of its life is especially useful for technologies still in their relative infancies. For example, autonomous vehicles (AVs) have long been in the minds of dreamers, engineers, and inventors, but only recently have they begun to emerge as a reality. In an undergraduate research paper addressing how AVs could have socioeconomic impacts, Christopher Fitzpatrick examines the potential development of AVs as public goods in light of the historical case study of a Boston commuter rail, the Fairmount Line (Fitzpatrick, 2020). The author utilizes technological momentum in the case of the Fairmount Line to draw connections between those in charge of planning the rail and the social impact of its development, and then compares this process to the current birth of autonomous vehicles saying,

"The dichotomy of who shapes versus is shaped by a public good carries massive insights for AVs as a public good" (p. 13). Similarly, robots are a relatively new technology in the grand scheme of the world, but the social constructs surrounding their creation and development have greatly influenced their development. This paper follows the momentum the technology has gained to see the current ways that it shapes society and how that momentum may need to be redirected to serve different needs and people than they were originally constructed to meet.

Results and Discussion

Overview

The development of robots has disadvantaged the socioeconomically marginalized throughout its history. From the beginning, the technology was socially constructed to benefit a specific subsection of society without regard for those it might harm. It gained momentum with the arrival of robots into increasingly complex fields, made possible by advances in sensing and feedback for their control, displacing workers in the process. Finally, in the forecasted future, there must be drastic changes to the current trajectory to prevent technological determinism from creating a society characterized by the injustices and implicit biases of those in power. The following analysis will elucidate precisely how robotic technology has reached this point, some of the effects it has had thus far, and what it might cause in the future if left unaddressed.

Past Construction

Robots moved from a science fiction dream to a reality in the early 1950s. The first of note was dubbed Unimate, an invention by George Devol shown in Figure 1, which was the first programmable robot. Robots broke onto the industrial scene as manufacturing assistants when General Motors (GM) bought Unimate from Devol, taking over jobs that were often too

dangerous for humans to handle (*The Robot Hall of Fame*, n.d.). For example, in one of its first uses, the arm handled and stacked hot pieces of die-cast metal (Mickle, n.d.). Robots like this were developed by researchers and academics but the direction of development was determined by those with the power and wealth to fund the research or present their problem as worth solving. Unimate, for instance, was bought for the automobile industry which primarily fueled and funded its development.

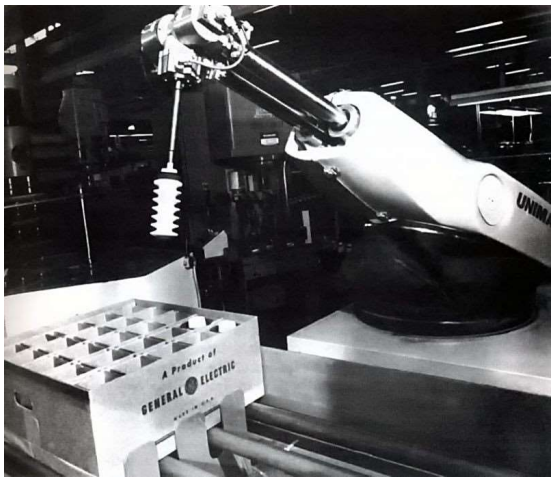

*Figure 1: Unimate in an industrial setting. (*AI & Robotics | Timeline of Computer History | Computer History Museum*, n.d.)*

In this way, the technological momentum of robots began to build as they were socially constructed by the industry that required them. Only a select group of people could afford automobiles in this time period, meaning that the stakeholders for this technology, and thereby the ones influencing the development, were the wealthy industry executives serving that group. As a journal paper asserted in 1963, "Nonwhite persons, persons aged 65 or over, and those with no liquid assets appear to show disproportionately low car ownership, even after removing the effect of the three major variables [income, stage in the family life cycle, and area of residence and city size]" (Kreinin & Lininger, 1963). The United States, in particular, has a long history of socio-economic inequality, especially in relation to race, the breadth and depth of which fall

outside the scope of this paper, but this disparity exemplifies how the automobile industry, and subsequently the robots developed for it, revolved around the wealthy majority. The automobile industry's inequitable influence is further exemplified in the example of the Rancho Arm developed by Rancho Los Amigos Hospital in Downey, California. The robotic manipulator was originally designed to be used by handicapped people and was acquired by Stanford University in 1963. At its new home, the arm was in part used by Victor Scheinman to eventually develop the "Stanford Arm" which became a tool to assemble Ford Model T water pumps, moving the technology away from helping those in need and towards creating profit. Victor Scheinman himself went on to sell his design to Unimation, the company that spawned from Devol's Unimate and worked with General Motors to develop the Programmable Universal Machine for Assembly (PUMA) that would be used for automobile assembly (Asaro & Šabanović, 2020). These robots were relatively simple compared to today's technology as they were primarily human-controlled or pre-programmed for specific tasks and entirely stationary. They did not sense their environment or make any autonomous decisions. The first mobile robot utilizing sensors was Stanford's "Shakey" in 1970 (*AI & Robotics | Timeline of Computer History | Computer History Museum*, n.d.). Since that time, robots have been desired for increasingly complex tasks, requiring them to become "smarter," more "human." To this end, robots were given sensors and cameras so they could understand their actions and environments to provide feedback and achieve more autonomy, further reducing the need for human involvement.

Present Momentum

As robots become more similar in capabilities to humans, they have begun to replace people in a wide variety of industries. As seen in Figure 2, even in the relatively short time span from 1960 to 2005, robots have stepped into a plethora of fields. However, as these robots have

begun to enter the same workspaces as humans and perform the same jobs that humans do, they have often made the previous human workers unnecessary, leaving them without jobs, contributing to "technological unemployment."

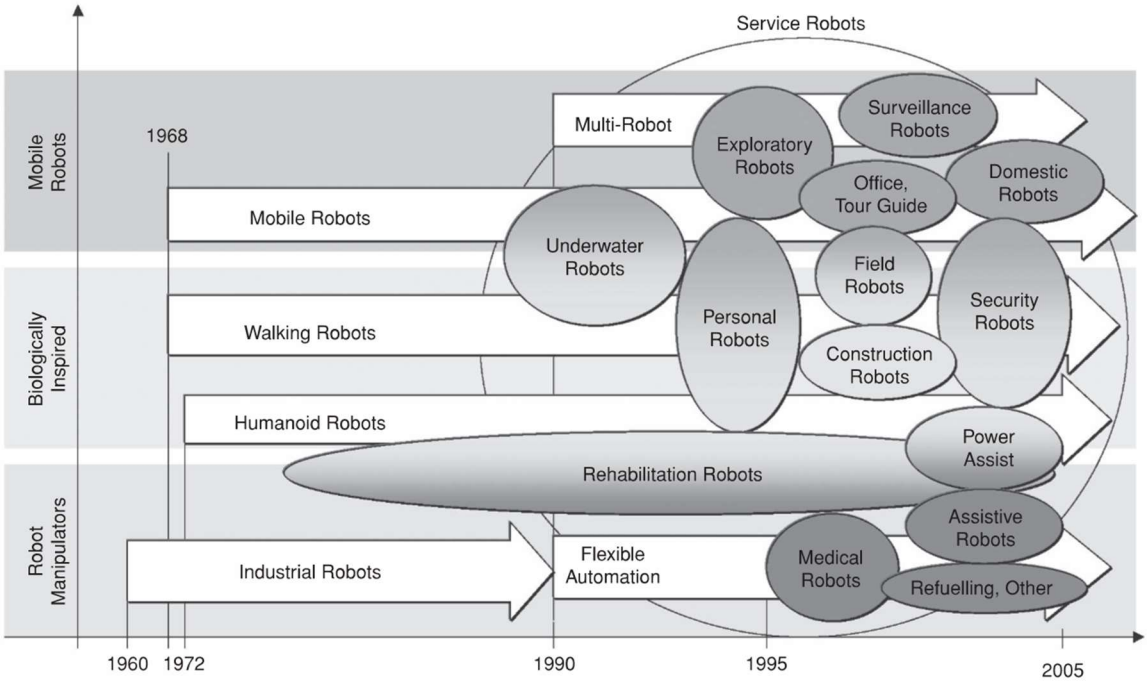

Figure 2: Time evolution of the robotics research towards service robots (Garcia et al., 2007)

A 2020 study of labor economics using data spanning 2005-2015 from 19 industries in 37 different countries, both high-income and emerging, concluded that increased usage of robots raised the employment share of non-routine analytic jobs but lowered the share of routine manual jobs (de Vries et al., 2020). The thrust of their argument is to disprove the notion that the inclusion of robots in the workplace decrease the overall number of jobs and rather demonstrate that the total number of jobs does not decrease, but the number of jobs focused on routine tasks, generally involving unskilled or lower-skilled labor fell. This study primarily focused on industrial workplaces, but the authors posit at the conclusion of their paper that this trend of disruption will only increase as robots enter service roles like medical care. The rampant

disruption is becoming increasingly more harmful to the socioeconomically marginalized as their livelihoods often depend on those routine jobs. If and when they become displaced, it is also more challenging for these groups of people to recover due to the lower social and economic mobility that accompanies their status. The lack of mobility that plagues these groups inhibits the ability to learn or relearn skills that are more in demand as a result of technological unemployment as the poor and otherwise marginalized have less access to education and resources, or their social position prevents them from taking advantage of them. This trend demonstrates the growth of the technological momentum of robots as efficiency and profit are placed over the needs and livelihoods of those in need. The more capable that robots become, the more complex the tasks are that they can take over from their human counterparts, thereby increasing the number of people that can be displaced by robots.

Future Determinism

Moving to the ever-approaching future, in order to work in the same fields as humans, robots need to be as smart as humans. The quest for robotic autonomy has manifested itself through the research fields of artificial intelligence and machine learning. At best, these pursuits could lead to a vision of human flourishing where society is freed from the menial tasks required by everyday life and industry. John Danaher posits a world where robots take over the tasks that make up the tedium of life, that which humans must do to survive and function, leaving the humans to do that which we can do to thrive, through art, music, and those pursuits that people are passionate about (2017). Though Danaher's vision would be a beautiful picture of human-robot harmony in utopia, unless society at large changes to uplift the poor, it will remain an ideal, which Danaher lightly addresses by assuming progress is made toward systems of equality like

universal basic income and “the assumption that people won’t be suffering from great hardship due to the lack of an income” (2017).

Unfortunately, more likely, is the pessimistic view which is at best inaccessible to the socioeconomically marginalized, and at worst racist, sexist, and classist. The documentary *Coded Bias* explores the technological momentum of artificial intelligence (AI) more specifically, though not explicitly using the framework. *Coded Bias* follows several activists raising awareness for the ways that AI is not, in fact, neutral and objective but reflects the bias of those who create it, and the data sets it is trained upon. One of the main focuses of the film is the discrimination that is present in current facial recognition. Joy Buolamwini, a researcher in the MIT Media Lab, discovered, through the course of her own project using facial recognition, that the open-source code she was trying to use could not detect her face, but it could detect a white mask. The course of the documentary explores several modern-day applications of facial recognition, like concrete examples of how people are already being discriminated against for their race by police surveillance, but also broadens it to how AI promotes unjust decisions in scenarios like recidivism decisions, job hirings, and credit cards. Viewing this documentary through the framework of technological momentum, the filmmakers expose the ways that AI has been socially constructed by its developers, largely white men, and the deterministic effects that that construction currently has and might have on the society at large. As Buolamwini says in the film, “People who have been marginalized will be further marginalized if we’re not looking at ways of making sure the technology we’re creating doesn’t propagate bias” (Kantayya, 2020). This film focuses primarily on machine learning and AI from a pure software perspective, but these algorithms are the same kind of technologies being developed to control physical robots. Thus, the same issues of justice and equity must be considered. If the current momentum of AI

were to continue and be implemented in physical, mobile robots, the consequences could be of science-fictional proportions. If our society continues to develop robots without thought for how they might displace the poor, or reflect the biases of their homogeneous developers, the chasm that separates those of different socioeconomic classes will only widen as the deterministic nature of the technology strengthens from its momentum. Issues of wealth are also intimately tied with race, as they are sadly woven into this society's systems of justice. As Ruha Benjamin writes "[I]n the face of discriminatory effects, if those with the power to design differently choose business as usual, then they are perpetuating a racist system whether or not they are card-carrying members of their local chapter of Black Lives Matter" (Benjamin, 2019, p.60). In the spirit of business as unusual, the book *Robotics, AI, and Humanity: Science, Ethics, and Policy*, and especially its chapter "AI/Robotics and the Poor" seeks actionable answers on how this disparity should be addressed through policy, visualizing how action might be taken to address the different areas impacted by AI and robotics as seen in Figure 3.

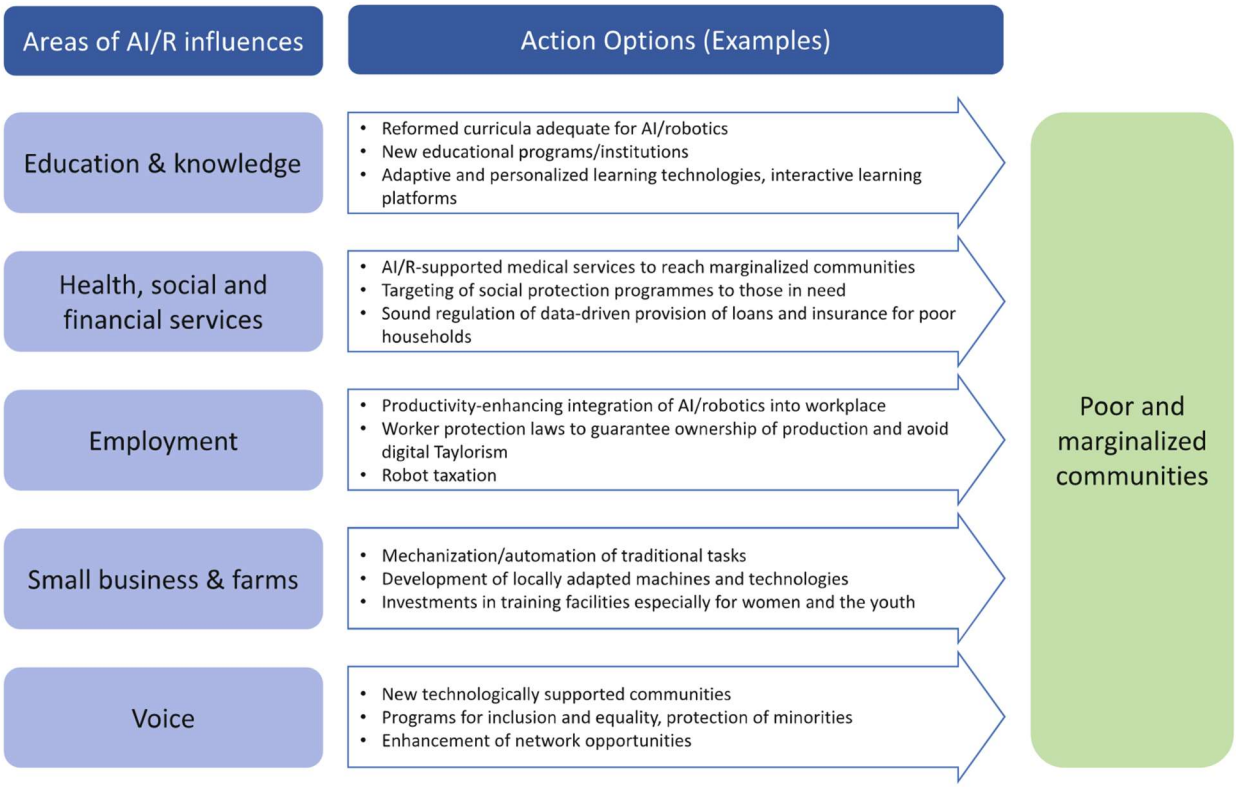

Figure 3: Policy action options for pro-poor AI/R [artificial intelligence/robotics] (von Braun et al., 2021)

These changes seek to assuage the failings of a society that causes marginalization. In society, those in power decide who benefits and who suffers, consciously or unconsciously, through their actions. As Cathy O'Neil says in an interview included in *Coded Bias* "We punish poor people, and we elevate rich people in this country [the USA]. That's just the way we act as a society. But data science makes that automated" (Kantayya, 2020). O'Neil believes that the propensity to create inequality is a defining quality of American society. If this society, and others globally, is to progress for all people, the well-off and the marginalized alike, this inequity must be combatted systematically.

Limitations and Future Work

This analysis primarily focuses on tracing the development of robotic technology through time and examining how it was shaped by those in control of its creation to produce its impacts,

intended or otherwise, on the larger society as a whole. Thus, this work is largely qualitative in nature. For future work or research on this subject matter, the argument could be fleshed out with quantitative data. For example, one limitation of this analysis is its omission of the assessment of the economic "market share" of each field of robotic research. Research in this area could demonstrate how much money is being poured into the various fields and thereby where the value of those in power is being placed. This would add more analytical substance to the argument of this work or at least provide nuance if the data contradicts the thrust of the argument. This analysis also pulls on many papers discussing the direct links between the development of robots and its effect on the marginalized, but more depth would be added by analyzing the broad societal structures that have produced the unjust and unequal systems that exacerbate this issue and create marginalization in the first place.

Conclusion

Robots have consistently brought harm to the poor and socioeconomically marginalized in society. In their infancy, the technology was shaped by those with power, like the automobile industry, to serve themselves and their wealthy customers. As the technology has progressed, and robots have become increasingly able to accomplish complex tasks, little thought has been given to those displaced by the jobs being taken over by robots, most often disproportionately disadvantaging the poor who have lower social and economic mobility. As ChatGPT, one of the most looming AI threats to current society, responds when asked to summarize how developments in robotics affect the poor, "Overall, the impact of developments in robotics on the poor is highly dependent on how these technologies are implemented and the policies put in place to manage their effects. It is important for policymakers to consider the potential impacts on low-skilled workers and take steps to ensure that the benefits of automation are shared more

equally" (*ChatGPT*, n.d.). Ultimately, in order to prevent a future with racist robots and a cavernous wealth gap, there must be sweeping policy changes to both develop robots and the systems informing their intelligence responsibly and inclusively and utilize those systems to actively uplift the poor.

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