How Can We Best Navigate an Automated Future?

Assessing the Effectiveness of Geels' Multi-Level Perspective for Analyzing Socio-Technical Transitions to Automation

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Fall, 2023

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

As self-driving cars roam our streets and artificial intelligence curates our news feeds, the line between human and machine labor blurs, raising urgent questions about the societal implications of automation. A 2017 study authored by Oxford professors Frey and Osborne revealed that a staggering “47% of total U.S. employment is in the high-risk category,” meaning that the job “could be automated relatively soon, perhaps in the next decade or two”, underscoring the profound uncertainties that future potential automation technologies bring (Frey, 2017, p. 44). Despite these alarming projections, there is currently no established framework for analyzing future potential socio-technical transitions to automation. This analytical gap poses serious challenges for policymakers and organizations, potentially exacerbating unemployment rates, income inequality, and other societal challenges. This paper uses Geels’ Multi-Level Perspective (MLP) to analyze past and current examples of socio-technical transitions to Automation to analyze the effectiveness of the framework for analyzing future potential socio-technical transitions to automation. Understanding the effectiveness of Geels' MLP in this context is crucial for equipping policymakers, organizations, and researchers with a reliable tool for preparing for and mitigating the societal impacts of future potential automation technologies.

In this paper, I argue that while Geels' Multi-Level Perspective is effective in analyzing past and current socio-technical transitions to automation, its modeling capabilities are inherently limited by uncertainties in future landscape-level pressures.

The first supporting argument offers a comprehensive problem definition through historical and current instances of automation, highlighting societal effects from the industrial revolution to autonomous vehicles. The second supporting argument delves into the basis for the paper's research approach, Frank W. Geels' article on socio-technical transitions to sustainability. Lastly, the third supporting argument will analyze two current examples of automation: AI script writing and autonomous vehicle technology.

Problem Definition: Highlighting Societal Effects of Automation

Automation has already been a transformative force across multiple sectors for several decades. This transformation can be identified as a socio-technical transition, which is defined as changes in the way society functions specifically in areas like "technology, policy, markets, consumer practices, infrastructure, cultural meaning, and scientific knowledge" (Geels, 2011, p. 24). One of the most well-known examples of a socio-technical transition to automation is the industrial revolution, which shifted societies from an economy focused on agriculture to an economy focused on manufacturing. Adoption of automation technologies in industries like agriculture and weaving "led to dramatic increases in output" (Groshen, 2019, p. 13), causing societal effects like migration from rural to urban areas, a division of labor, deplorable working conditions, and much more. The industrial revolution is a perfect example of the type of socio-technical transition that we could potentially be facing in the future, and the many negative societal effects caused by industrial revolution show why we need to understand any future socio-technical transition that our society may undergo.

Another interesting past case that shows the complexities of automation is the automated teller machine (ATM) in banking. Contrary to popular belief that ATMs would replace bank tellers, James Bessen notes, "The number of fulltime equivalent bank tellers has grown since ATMs were widely deployed during the late 1990s and early 2000s. Indeed, since 2000, the number of fulltime equivalent bank tellers has increased 2.0% per annum, substantially faster than the entire labor force" (Bessen, 2016, p. 6). This information can be seen below in Figure 1, which shows a graph of ATMs/bank tellers vs. time.

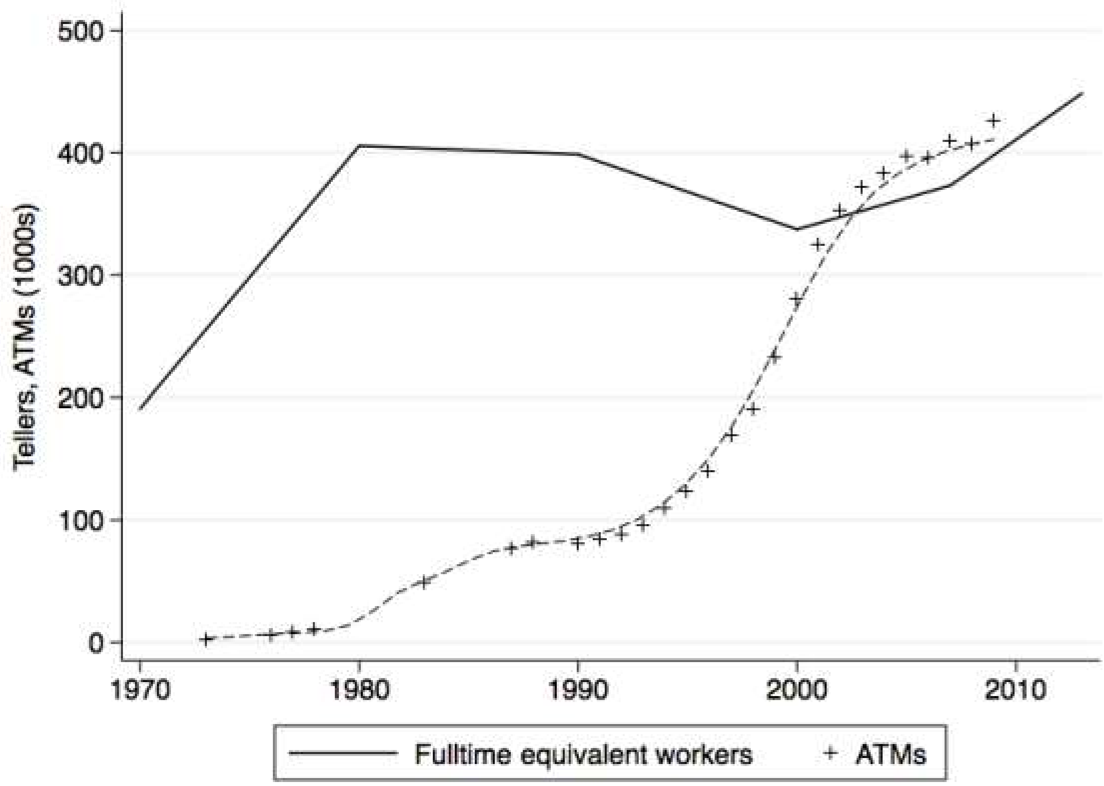

Figure 1 Bank Tellers and Automated Teller Machines. The figure shows an increase in fulltime bank tellers even with the introduction of over 400,000 ATMs. (Bessen, 2016, p. 43)

The invention of ATM technology actually led banks to open more branches due to reduced operating costs, offsetting the potential loss in teller jobs, and resulted in societal effects like an increase in "people served and services offered" (Groshen, 2019, p. 17).

Shifting focus to the present day, the rise of autonomous vehicles stands as a compelling example of a current socio-technical transition driven by automation. Both tech giants like Tesla and startups are pouring resources into perfecting self-driving technology. This has the potential to revolutionize transportation, making it safer and more efficient. Notably, three of the leading causes of traffic fatalities – drunk driving, distracted driving, and speeding (National Highway

Traffic Safety Administration, 2023)– are issues specifically attributed to human error, all of which autonomous technology will not be prone to. However, it also raises new ethical and regulatory dilemmas, and casts a shadow of uncertainty for over 2 million heavy duty truck drivers and over 1.5 million delivery truck drivers (Bureau of Labor Statistics, 2022). As autonomous vehicle technology is still in its initial stages, its full impact on society remains an open question, echoing the complexities highlighted by past instances of automation.

While we have a wealth of historical and current examples that help us understand the transformative power of automation, we do not understand the socio-technical effects of the many more automation technologies to come. One such uncertainty is the unpredictable trajectory of job displacement and creation. One attempt to predict these effects comes from James Manyika, who estimates that "between 400 and 800 million individuals could be displaced by automation and need to find new jobs by 2030 around the world" (Manyika, 2017). Even though many jobs may disappear, many jobs will be evolved and created by automation technology. This uncertainty makes it challenging to form a cohesive understanding of automation's future impact on employment, and further complicates our understanding of the socio-technical effects of potential massive changes in the employment landscape.

Furthermore, while we have made strides in understanding the economic dimensions of automation, its broader societal impacts remain a complex and largely uncharted territory. For instance, a recent study on AI applications in Chinese firms found that the technology had a 'positive effect on a firm's employment of nonacademically-trained workers and its overall employment but a negative effect on academically-trained workers' (Xue, 2022, p. 2). This suggests a 'technology deskilling effect of AI,' where the benefits and drawbacks of automation are not uniformly distributed across educational lines. A potential interpretation of the societal effect of this phenomenon could be fewer people going to college, but at the moment, not enough research has been done into the societal effect of automation on people with varying levels of education to make a definitive conclusion.

Similarly, research indicates that 'rural communities seem significantly more exposed to the automation of current-task content than larger ones' (Muro, 2019), and that 'Men, youth, and less educated workers, along with underrepresented groups all appear likely to face significantly more acute challenges from automation in the coming years'(Muro, 2019). Though this study has a different viewpoint on the effect of automation on uneducated workers, it brings up a good point: automation's varying levels of impact across different demographics, like rural vs. urban, could cause a significant societal impact. For example, a potential interpretation could be: if a larger percentage of jobs in rural communities are automated compared to urban, this could cause a migration from rural to urban areas, like the industrial revolution. The diverse ways in which automation could reshape society—across regions, demographics, and industries—make it difficult to form a unified understanding of its impending impact.

The collective uncertainty of the societal impact of future potential automation technologies forms a significant destabilizing condition, challenging our ability to make straightforward predictions or preparations for future socio-technical transitions to automation.

Automation's potential societal impacts are not mere academic curiosities; they carry real-world implications that could potentially be dire. The inability to understand potential job displacement and creation reliably leaves policymakers and organizations handicapped in preparing for future labor market shifts. This lack of foresight could exacerbate unemployment, widen income inequality, and strain social welfare systems, particularly if Frey and Osbourne's prediction of "47% of total US employment being at high risk" comes to fruition. If we had a better understanding of automation's impact on labor, we could prepare for it by implementing solutions such as retraining, universal basic income, and enhancing earned income tax credit (Mann, 2019, p. 31).

Moreover, the unbalanced impact of automation on different sectors of society could compound existing socio-economic divides. For instance, the 'technology deskilling effect of AI' could lead to a decrease in college attendance and an increase in vocational training, thereby changing the educational landscape and potentially diminishing the value of formal education. At the same time, the disproportionate effects on rural versus urban communities could result in mass migrations to urban centers, leading to urban overcrowding and exacerbating regional inequalities. Both educational and geographical imbalances in automation's impact could amplify social discord and economic disparity, however, these effects may be prevented if proper research into solutions is done.

Given the many uncertainties and potentially severe societal repercussions detailed above, it becomes abundantly clear that understanding potential socio-technical transitions to automation is of paramount importance. We have numerous studies and forecasts attempting to dissect automation's impact on employment, education, and demographics, but what is glaringly absent is an analysis of the frameworks that could be used to study future potential socio-technical transitions to automation. Specifically, there is a notable gap in the research concerning the effectiveness of Geels' Multi-Level Perspective for analyzing potential transitions to automation. Whereas the MLP analytical framework that Geels outlines is built for analyzing a socio-technical transition we need to take, automation is a potential socio-technical transition that we are being driven towards, so an analysis needs to be done to see if Geels' MLP is still effective.

Basis for Research Approach: Geels' Multi-Level Perspective

If our society can better understand future potential socio-technical transitions to automation, we will be better able to prepare solutions to the challenges that may arise. While a comprehensive analysis of future potential socio-technical transitions to automation is beyond the scope of this study, the focus here is to investigate the most effective methodologies for such an analysis. The analytical approach I will be analyzing the effectiveness of is Frank W. Geels' multi-level perspective (MLP) (2019). As a basis for my research approach, I will use Geels' article on socio-technical transitions to sustainability, The multi-level perspective on sustainability transitions: responses to seven criticisms. Geels' MLP is generally applied to socio-technical transitions toward sustainability, which are driven by the imperative to mitigate climate change. However, its effectiveness in analyzing transitions driven by emerging technologies, such as automation, remains untested. To ascertain the applicability of Geels' MLP in this context, I will use it to analyze past and current examples of socio-technical transitions to automation. Through this analysis, I aim to draw conclusions on the effectiveness of Geels' MLP for analyzing future potential socio-technical transitions to automation.

MLP combines concepts from a variety of fields such as evolutionary economics and neo-institutional theory to create a comprehensive analytical framework for studying socio-technical transitions. MLP identifies three analytical levels that interact to shape socio-technical transitions: socio-technical regime, niches, and socio-technical landscape.

1. The socio-technical regime is the "deep structure" [27] that represents the established practices, rules, and structures that stabilize existing socio-technical systems. For example, in automation, the socio-technical regime would include societal norms regarding employment,

regulations and safety standards for automation, and economic systems structured around labor-intensive industries.

2. Niches are “protected spaces” [27] where innovative ideas and technologies emerge that “deviate from existing regimes” [27]. For instance, niches in automation would include research laboratories such as OpenAI, startups such as Scale AI, and niche markets such as autonomous vehicles.
3. The socio-technical landscape is the broader societal context and external factors encompassing “demographical trends, political ideologies, societal values, and macro-economic patterns” [28]. In the case of automation, the socio-technical landscape would include an aging population that affects labor supply and demand, global economic trends and competition, and the differing effect of automation depending on level of education.

Furthermore, MLP shows that socio-technical transitions are “nonlinear processes” [26] that result from the interplay and interdisciplinary interaction of these three analytical levels. In addition, MLP emphasizes that the causality and interactions between the levels are circular and involve multiple processes across multiple dimensions. For example, the Socio-Technical Landscape influences both the existing regime to create windows of opportunity, and niches via expectations. The niche provides the “seeds for systemic change” [27] and enters the window of opportunity in the regime, which in turn influences the landscape. This idea is hard to describe, and Geels includes a figure to visualize these interactions:

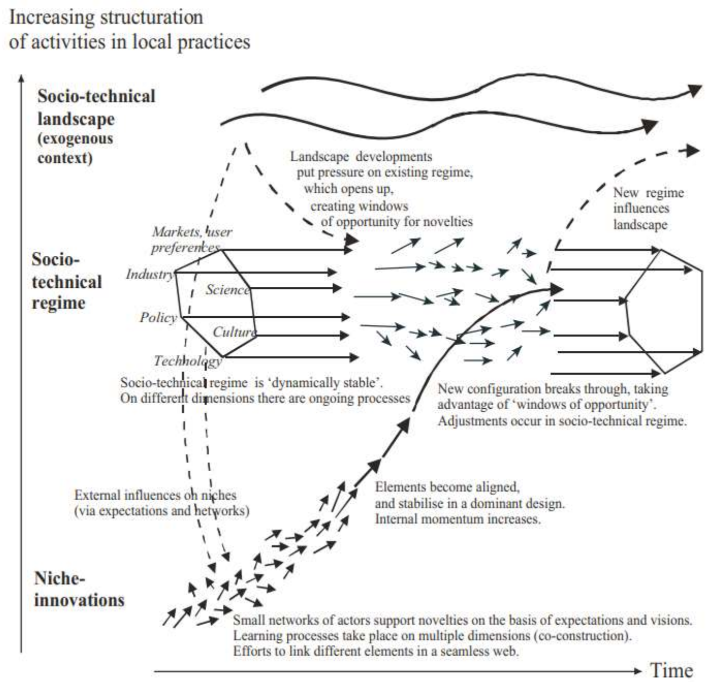

Figure 2 Multi-level perspective on transitions. Shows the circular interactions between levels. (Geels, 2019, p. 28)

MLP's focus on interdisciplinary interactions allows for a multitude of evidence to be gathered, analyzed, and connected across the analytical levels to bring about a greater understanding of a socio-technical transition.

As mentioned, I will analyze two instances of automation as a socio-technical transition using MLP: the 2023 Hollywood Writers Strike and autonomous vehicles.

1. The recent 148-day strike by the Writers Guild of America serves as a compelling case study in the complex interplay between labor and automation technologies, particularly artificial intelligence (AI). Although compensation remained the "most crucial issue" (Koblin, 2023) for the writers, the role of AI in scriptwriting became a pivotal point in the negotiations. This strike, one of the first significant labor disputes over generative AI, shifted the discussion from merely economic considerations to an existential human-versus-machine clash that could have ramifications across multiple industries. The

resulting tentative agreement mandates transparency from studios about the involvement of AI in creative processes and imposes limitations on AI-generated content, such as restricting AI's role in writing and rewriting "literary material."(Coyle, 2023). However, it does not outright ban the use of owned scripts for training AI systems, leaving room for future legal and ethical debates.

2. The rise of autonomous vehicles (AVs) offers a pertinent example of a socio-technical transition driven by automation. On the technological front, advancements in sensors, machine learning algorithms, and high-powered computing have enabled vehicles to perform increasingly complex tasks without human intervention. The societal implications are also profound and multifaceted. Autonomous vehicles have the potential to significantly impact public safety. In 2021, 31% of all traffic crash fatalities in the United States were caused by drunk driving, resulting in 13,384 preventable deaths (National Highway Traffic Safety Administration, 2023). Speeding was a factor in 29% of all traffic fatalities, leading to 12,330 deaths (National Highway Traffic Safety Administration, 2023). Additionally, distracted driving accounted for 8% of fatal crashes and an estimated 362,415 injuries (National Highway Traffic Safety Administration, 2023). Autonomous vehicles, which are not susceptible to human impairments like intoxication or distraction, could drastically reduce these figures. However, they also pose significant challenges to employment, particularly for professional drivers in sectors such as trucking and taxi services. Moreover, there are ethical dilemmas related to programming decision-making algorithms for emergency situations and concerns about data privacy and cybersecurity.

Analyzing these instances through the lens of Geels' Multi-Level Perspective allows for a nuanced understanding of the complex interrelationships between technological innovation and societal change. By dissecting past and current real-world examples of automation using MLP, I will bring about a greater understanding of the effectiveness of MLP for analyzing future potential socio-technical transitions to automation.

Evaluating Geels' Multi-Level Perspective in the Context of Automation Transitions

First, I will define the three levels (regime, landscape, and niche) as it relates to the 2023 Writers Guild of America strike. Second, I will delve into the interactions between the levels to understand the dynamics of the transition. Third, I will draw conclusions about the effectiveness of Geels' MLP based on my analysis of this situation.

Analysis of Writers Guild of America Strike using MLP

1. Socio-technical Regime:

The prevailing socio-technical regime in the case of the Writers Guild strike is the established Hollywood system, which includes the major studios, production companies, and the traditional roles and workflows involved in scriptwriting. Established norms, such as the reliance on human creativity for scriptwriting and the associated compensation structures, are part of this regime. The existing labor laws and guild agreements also come under this regime. One important economic issue for the regime is the significant industry shift towards streaming services, which was accelerated by the COVID-19 pandemic. Andrew Scott describes this shift in an article for the New York Times: “As a business and a cultural pursuit, the movies are in a state of chaos that has been growing year by year, as the disruptive force of streaming has rewritten the script. With so many options available at home, the pull of the multiplex and the art house isn't as strong as it used to be. We make our choices differently, according to patterns and preferences that aren't yet fully established" (Sorkin, 2022).

2. Niches:

The niches in this context are startups that are producing generative artificial intelligence technologies that can be used for screenwriting. Startup OpenAI's ChatGPT is the most well-known example of generative AI. Whereas ChatGPT is more of a general purpose tool, startups such as Squibler (www.squibler.io) and NolanAI (www.nolanai.app) are being started that are specifically trained to write scripts.

3. Socio-technical Landscape:

The socio-technical landscape consists of broader societal, political, demographical, and economic trends affecting this case. One piece of this landscape is the current rapid development of AI technology across a wide array of fields like healthcare, transportation, and much more. A second important piece of this landscape is growing concerns about automation technologies displacing jobs, sparking societal debates. A third crucial piece of this landscape is the current cost of living crisis, brought on by "a combination of climate shocks and the pandemic" which has "disrupted food and energy production and distribution" (International Monetary Fund, 2023).

Interactions

1. Previous automation technologies like factory automation and computer-aided design software have set precedents in the landscape, reshaping public opinion and policy towards automation.

2. The landscape, characterized by rapid advancements in automation technologies, creates fertile ground for the emergence of a niche specifically focused on AI-driven scriptwriting, as seen with startups like Squibler and NolanAI.
3. The socio-technical landscape, characterized by rapid development of automation technologies and an ongoing cost of living crisis, is exerting pressure on the existing Hollywood regime.
4. The regime, already grappling with economic shifts caused by the rapid transitions to streaming services, starts to see the possibility of employing AI for scriptwriting. Automating some of the scriptwriting tasks would allow the regime to employ less writers and pay writers less.
5. These pressures cause a destabilization of the regime, forming a “window of opportunity” (Geels, 2011, p. 29) in the regime for niche innovations like AI scriptwriting to gain traction and potentially become a mainstream practice in the regime.
6. Just as AI-driven scriptwriting starts to gain traction within the destabilized regime, the Writers Guild strike occurs. The strike can be seen as a response to these landscape-level pressures. This labor action serves as a counterforce, halting the niche innovation of AI scriptwriting from becoming mainstream and challenging the regime's inclination toward automation.
7. After a prolonged 148-day strike, a three-year agreement was reached stating that AI cannot "write or rewrite literary material" (Coyle, 2023). Despite this, the agreement does not prohibit studios from using their owned scripts to train AI systems, potentially paving the way for renewed debates and negotiations when the contract term concludes in 2026.

The application of MLP to the analysis of the 2023 Writers Guild strike proved to be highly effective in capturing the intricate dynamics at play between labor and automation technologies, specifically artificial intelligence. This multi-dimensional approach illuminated not only the pressures each level exerted on the others but also the interactions between them. For instance, the framework effectively captured how landscape-level pressures like rapid advancements in AI technology influenced both the existing Hollywood regime and the emergence of niche innovations. It also helped identify 'windows of opportunity' for change, as well as resistance points, such as the strike itself. Importantly, this analysis demonstrates that Geels' MLP, originally designed for studying socio-technical transitions to sustainability, is also effective for examining socio-technical transitions to automation, showing its versatility and broad applicability.

However, there is still the question of MLP's effectiveness for analyzing **future** potential socio-technical transitions to automation. The COVID-19 pandemic and the cost-of-living crisis served as significant factors that intensified the existing pressures on the Hollywood socio-technical regime, adding another layer of complexity to the Writers Guild strike. This poses a challenge for MLP, as it requires an understanding of the future landscape to accurately gauge the pressures that will impact the existing regime. While MLP effectively captured the significance of the strike as a countermeasure against the adoption of AI in scriptwriting, the framework's limitations become apparent when considering the unpredictability of future public sentiment toward automation technologies. Due to this uncertainty, MLP's effectiveness is diminished as it cannot correctly integrate this vital information that could result in similar labor actions or regulations being passed.

After examining the complexities surrounding the 2023 Writers Guild of America strike, my analysis shifts focus to another pivotal case of socio-technical transition: autonomous vehicle technology. Similar to the previous case, this section defines the three core levels of MLP—regime, niches, and landscape—to better understand the forces and interactions shaping the future of transportation.

Analysis of Autonomous Vehicle Technology using MLP

1. Socio-Technical Regime:

The socio-technical regime for autonomous vehicles consists of the existing automotive industry, including traditional car manufacturers, supply chain logistics, and the regulatory frameworks that govern vehicle safety and emissions. Established norms in this regime include human-operated vehicles, driver licensing requirements, and the economic models built around car ownership and public transportation.

2. Niches:

Niches in the context of autonomous vehicles are companies and research entities focusing on developing self-driving technology. These include well-known tech companies like Waymo, Tesla, Cruise, and startups specializing in various aspects of autonomous driving such as lidar technology, mapping, and AI-driven decision-making algorithms.

3. Socio-technical Landscape:

The landscape encompasses broader societal factors affecting autonomous vehicles, such as public opinion about safety and job displacement, and current rapid development of automation technology.

To deepen the understanding of the transition dynamics in the realm of autonomous vehicle technology, the next segment explores the interactions among the socio-technical regime, niches, and landscape.

Interactions

1. Previous automation technologies in other sectors have already influenced public opinion and regulatory stances, setting the stage for the acceptance or rejection of autonomous vehicles.
2. Rapid advancements in AI algorithms, machine learning, and sensor technologies in the landscape act as a catalyst for niche innovations in autonomous driving.
3. In 2021, the U.S. reported that 31% of all traffic fatalities were caused by drunk driving and 29% were related to speeding (National Highway Traffic Safety Administration, 2023). These grim statistics apply pressure on the existing regime to look for safer alternatives.
4. The automotive industry, already destabilized due to pressure from the landscape to transition to electric vehicles, has more pressure put for more safety, and to keep up with evolving (automation) technology.
5. These shifts and pressures create a "window of opportunity" (Geels, 2011, p. 29) for the adoption of autonomous vehicle technology, potentially transforming it from a niche innovation to mainstream technology.
6. As autonomous vehicles begin to gain traction, they face regulatory hurdles and public skepticism, which can slow down or alter their path from niche to regime.

7. While some states have begun to allow limited use of autonomous vehicles, comprehensive regulatory frameworks are still under development, leaving room for future debates and refinements (National Conference of State Legislatures, 2020).
8. In 2018, an Uber self-driving car was involved in a fatal accident, marking the first known fatality involving an autonomous vehicle. The safety driver, who was supposed to intervene in case of software failure, was found guilty of endangerment as she was watching TV on her phone when the crash happened. The National Transportation Safety Board's 2019 investigation found that the fatal accident involving an Uber self-driving car was "avoidable" and pointed to an "inadequate safety culture at Uber" (Riess, 2023), however, Uber faced no criminal charges from the incident. This fatal accident and its subsequent legal ramifications have influenced the existing transportation regime, increasing public skepticism and regulatory scrutiny, and altered the socio-technical landscape in which autonomous vehicle technology operates.
9. Despite significant advancements, no company has yet perfected fully autonomous vehicle technology. Issues like sensor reliability, decision-making in complex driving environments, and safety concerns remain unresolved. This technological uncertainty adds another layer of complexity to the regime's decision-making process and may delay or alter the trajectory of autonomous vehicles from niche to mainstream.

While MLP offers a robust framework for understanding the complex interactions between the socio-technical regime, niches, and landscape, its analytic capabilities are inherently limited by the uncertainty surrounding future landscape-level pressures. In both analyzed situations, the landscape level pressures such as the pandemic and economic situations were incredibly influential in the model, but many of these pressures are unknown for future potential socio-technical systems. For instance, the impact of evolving public opinion, technological breakthroughs, or unforeseen events like pandemics can alter the trajectory of a socio-technical transition in ways that are difficult to anticipate. This makes it challenging for MLP to effectively model future niche innovations or the future stability of existing regimes. Despite these limitations, MLP's strength lies in its ability to provide a nuanced understanding of the multi-dimensional forces at play. Thus, if one were to possess an accurate understanding of future landscape-level pressures, I believe that MLP would serve as an effective tool for analyzing future potential socio-technical transitions to automation. Therefore, although MLP is not equipped to forecast the future with certainty, I contend that conducting an analysis of potential future socio-technical transitions—based on certain plausible assumptions about the future landscape—would yield insightful and effective results.

Conclusion

The first supporting argument provided a historical context by examining the societal impacts of automation from the industrial revolution to present day. By tracing the socio-technical shifts in employment, industry, and societal norms, this argument established the complexity and multifaceted nature of transitions to automation. The second supporting argument scrutinized the research methodology, specifically the application of Geels' MLP, as a potential analytical framework. The Multi-Level Perspective offers a nuanced approach that captures the interplay among the socio-technical regime, niches, and landscape. However, its application to future scenarios is hampered by its inability to account for unforeseen landscape-level pressures, as evidenced in both case studies.

While MLP proved useful in understanding past and present socio-technical transitions to automation, it's important to acknowledge its limitations. Its predictive capabilities are inherently constrained by uncertainties in future landscape-level pressures. In summary, this research argues for the effectiveness of Geels' MLP in analyzing past and current socio-technical transitions to automation, while also emphasizing its limitations in predicting future transitions. As automation technologies continue to evolve, equipping policymakers, organizations, and researchers with effective analytical tools becomes increasingly crucial. The research conducted within this paper shows that MLP can only be an effective analytical tool for these groups to use if it is paired plausible assumptions about future landscape level pressures. While MLP presents a promising start, the quest for more predictive and adaptable frameworks remains an essential endeavor for future research.

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