From Drivers to Monitors: The Impact of Autonomy and Platooning on Truckers and the Trucking Industry

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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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The trucking industry is the backbone of the U.S. economy, moving over 70% of the nation's freight (USDOT, Bureau of Transportation Statistics, 2023). Yet, critical challenges threaten its stability: driver shortages, rising fuel costs, and supply chain disruptions (Hasiri & Kermanshah, 2024). The most promising solution to these issues is the development of autonomous truck platooning. Autonomous truck platooning allows multiple trucks to travel closely together in a coordinated convoy, with the lead vehicle setting the pace while others follow using automated driving technology, adjusting speeds to maintain close following distances. By relying on vehicle-to-vehicle (V2V) communication, these convoys can reduce fuel consumption, improve traffic flow, and enhance safety (Jacob, 2018). The shift to more autonomous systems could help alleviate driver shortages by shifting the role of truckers from active pilots to system supervisors. However, as autonomy is adopted in the industry, it raises critical questions about labor displacement, job satisfaction, regulatory barriers, and safety concerns.

This paper explores the broader impacts of integrating AI-driven automation into trucking, focusing on the research question: What are the socioeconomic consequences of introducing autonomous vehicles into the trucking industry? Specifically, it will examine how truck drivers, who are at the center of these technological shifts, will be affected. Will automation alleviate the driver shortage, or displace workers and undermine job satisfaction? How will driver trust and acceptance influence adoption rates? Addressing these questions requires an analysis through the lens of Actor-Network Theory (ANT), which considers the relationships between technology, drivers, businesses, policymakers, and public perception (Latour, 2005).

Through the ANT framework, this paper argues the importance of non-technical actors in the development and integration of autonomous truck platooning. The active involvement and consideration of driver concerns and inputs within the development and policy-making process are critical; neglecting to do so risks undermining the acceptance and smooth integration of truck platooning, foregoing the potential benefits. Examining the network of actors and their roles and relationships provides insights into the consequences of restructuring the network around truck platooning.

Background

The trucking industry is a cornerstone of the nation's economy, responsible for moving over 70% of the nation's freight (USDOT, Bureau of Transportation Statistics, 2023). Beyond its role in the transportation of goods, the industry provides well-paying job opportunities, particularly for high school graduates, filling a vital niche in the job market (U.S. Census Bureau, 2019). The continued operation of the industry is essential both for economic growth and stability in the U.S. However, the industry is facing numerous obstacles to continued operation, including driver shortages, rising fuel costs, and recurring supply chain disruptions.

Challenges in the Trucking Industry

Driver shortages have plagued the trucking industry for years. Although, the shortage has fluctuated with the economic influences–falling in 2008 due to the recession–the lack of drivers has only worsened. With the aging population of current truck drivers, over 50% of the demand for new drivers will replace those who retire (Costello, 2019). It's important to mention that the lack of drivers is not due to a lack of applicants, but a lack of *qualified* applicants. According to the same report, 88% of trucking companies received enough applications but were unable to fill

the roles because of the lack of qualifications. The report notes hiring underqualified drivers increases insurance premiums and accidents.

Fuel prices have fluctuated over the years, but the steady price increase has remained. The rising and volatile prices of fuel further strain the trucking industry. The price of fuel is heavily impacted by the economic climate and geopolitical issues. Prices hit an all-time high after the Russian invasion of Ukraine, and although prices are beginning to stabilize, price continues to increase year over year (Leslie & Murray, 2023). This volatility increases operational costs for trucking companies, potentially limiting their expansion, investments in new technology, or ability to maintain staffing, further exacerbating industry challenges.

The trucking industry is heavily reliant on the nation's economic climate. In 2020, during the COVID-19 pandemic, many truck drivers lost their jobs due to decreased demand for goods, as businesses shut down, the need for truckers fell (Reagan & Saphores, 2020). However, in the years following, businesses reopened and demand for drivers increased again, worsening the driver shortage.

Finally, the most important challenge facing the industry, and drivers specifically, is the poor working conditions. Many drivers are paid by the mile, not by the hour, meaning that stops due to poor weather conditions or hazards go unpaid. In addition, almost 50% of truckers work more than 40-hour weeks. Although truckers are less likely to be unemployed than other workers, they are also less likely to have health insurance through their employers. These poor working conditions and lack of benefits make trucking undesirable for new workers and decrease the overall retention of drivers (U.S. Census Bureau, 2019).

Autonomous Truck Platooning

These issues necessitate change in the industry; one promising innovation is the advent of autonomous truck platooning. Unlike conventional trucking, where each driver independently controls their vehicle, platooning enables a networked system where trucks maintain close proximity, reducing drag and fuel consumption. The lead vehicle sets the pace while the following trucks maintain optimal spacing using advanced automated driving systems. However, numerous obstacles and questions must be answered as the technology continues to develop and integration continues.

One of the primary benefits of truck platooning is the reduced fuel consumption. Currently, commercial trucks consume the most gas in the U.S. by vehicle type. The May 2024 report from the U.S. Department of Energy estimates the average truck consumes 10,745 gasoline gallon equivalents (GGE), representing the quantity of fuel with the same amount of energy contained in a gallon of gasoline, 25 times the consumption rate of the average car, which consumes 433 GGE (2024). Cooperative adaptive cruise control (CACC) in platoons allows trucks to coordinate speed changes in real-time, as opposed to a driver reacting to a change in speed, allowing the following distances to reduce dramatically (Federal Highway Administration, 2017). The Federal Motor Carrier Safety Administration recommends leaving at least a three-second gap between vehicles, but for large trucks, recommends leaving "at least one-second gap for every 10 feet of vehicle length." For trucks, this is typically four seconds, they also recommend an additional second of space when traveling over 40 mph (2015). At 40 mph, five seconds of space is around 88 meters.

However, with the help of autonomous systems, reducing this distance improves fuel efficiency by decreasing the air resistance on the following trucks. A study found that at a

distance of 20 meters in a three-truck platoon (one leader and two followers), the fuel savings of the middle truck were 17%. The study tested several following distances and found that the benefits of shortening the following distance increase as the distance decreases. In other words, the fuel benefits from following at 80 meters compared to 85 meters is much less than the benefits of following at 15 meters compared to 20 meters. This study found that with a distance of 87 meters, there is still an overall fuel saving of 4.5% (McAuliffe et al., 2018).

Trucks are responsible for 25% of climate emissions from road transportation in Europe. However, trucks only account for 2% of the vehicles on the road (*Trucks*, 2024). The increase in fuel efficiency is an important factor in truck platooning; using less energy, trucks will reduce their large environmental impact. In addition, by utilizing truck platooning, we can move against the call for larger trucks, which only increases fuel consumption rates and leads to more total miles driven (Coalition Against Bigger Trucks, 2020).

While truck platooning offers significant benefits, such as fuel savings and efficiency, its success ultimately relies on driver and industry acceptance, as well as regulatory adaptation. Truckers may benefit from reduced workloads and improved working conditions, but concerns about safety, job security, and shifting responsibility remain. Understanding these factors requires the examination of the socioeconomic impact through a framework that accounts for both human and technological actors.

Methodology

This study will utilize the insights gained from a literature review of the state of development and ideals surrounding autonomous trucks using the ANT framework. ANT provides a framework to analyze the relationships between human and non-human actors in a network (Latour, 2005). This approach helps unpack the multi-dimensional development of this

technology and fully understand the pressures and motivations across each layer of the network onto the other actors (e.g., engineers, drivers, policy-makers, trucks, sensors, algorithms, etc.). The sociotechnical impacts of autonomous trucks are complex and diverse, involving autonomous technologies and integration on both micro and macro levels. The acceptance of current drivers is vital for the technology's success and further development, and the support of governmental bodies, in the form of laws and infrastructure, is also critical for widespread adoption.

The first step in this study involved the collection and analysis of the literature surrounding autonomous trucks. This review covers technological advancements, regulatory obstacles, safety concerns, environmental impacts, and social perspectives. Using a collection of sources analyzing the spectrum of actors influencing autonomous trucks will shape a holistic understanding of the dynamics in the network. This review includes sources from academic journals, government publications, and case studies.

Building on the findings in the literature review, ANT will piece these actors together and describe the relationships surrounding autonomous trucks. By analyzing the technical developmental research, sources containing interviews, and reviews of case studies, ANT provides the ideology that combines these ideas into a more coherent picture that is present and necessary to understand. Examining the trucking industry as a network allows the examination of the impacts of technology on drivers and the driver impact on technology. Additionally, this framework provides insights into the relationships between industry leaders, policy-makers, and drivers. Knowledge about the strength of connections and impacts between actors is necessary in understanding the consequences of reconfiguring the network around autonomous platooning.

Discussion and Analysis

Introducing autonomous platooning into the trucking industry presents a variety of complex socioeconomic consequences, especially for truck drivers, who are at the center of the technological shifts. Automation has the potential to alleviate the continued driver shortage by making trucking more accessible and efficient. However, it also raises critical concerns about job displacement, increased monitoring, and erosion of the traditional sense of trucking as a profession, built on independence, the open road, and the freedom that attracted many drivers to the industry. Drivers have a nuanced relationship with automation, stemming from trust and unwillingness to give up control. Innovation has consistently removed independence from drivers, as new technology is often coupled with increased industry monitoring. Understanding the dynamics technology creates within the profession is critical for understanding driver acceptance. Public policy connects drivers and industry leaders; driver-centric policy decisions can help alleviate driver concerns while encouraging or hindering the progress of truck platooning integration.

Driver's Perspective

Autonomous truck platooning introduces a fundamental change in the profession, shifting from traditional notions of autonomy, skill, and job satisfaction. Despite the promises of automation increasing efficiency and safety, drivers are concerned about their role in the industry. While assistive systems for trucks, like adaptive cruise control (ACC), have been introduced in the past, the reception from drivers has been mixed, and similar apprehension surrounds the systems that enable truck platooning. Beyond the perception of assistive

technology, platooning introduces a more human challenge: the reliance on other drivers. Many truck drivers find this difficult, considering their traditional role within the truck. This resistance is deepened by the history of technological innovation in the industry, consistently eroding drivers' autonomy and expertise. Properly addressing these hesitations through training, exposure, and policy intervention will expedite the adoption of platooning and ease the push-back from drivers.

Perception of Assistive Technology

Driver assistive technologies have become more prolific within trucking, however, their adoption has been slow. Modern trucks have access to lane centering, automatic emergency braking, cruise control, and more (Federal Motor Carrier Safety Administration, 2021). While these assistive technologies have been shown to reduce the number of truck accidents by up to 20% and positively impact driving behavior, adopting this technology is slow (Chiarenza et al., 2018; Wu et al., 2023). The Center for Automotive Research identifies several key factors for the slow adoption rates, including doubts surrounding safety and effectiveness (Naseeb Souweidane & Brett Smith, 2022). Despite evidence of reduced crashes, consumers continue to view assistive technologies as unsafe. Driver interviews provide insights into the struggles surrounding the use of ACC, one driver stating, "*I always turn off adapted cruise control. It is perilous. If a car cuts in in front of you, it fully brakes - you really need to pay attention,*" (Trösterer et al., 2017). This hesitancy is rooted in issues beyond technical performance, drivers see these systems as unpredictable, challenging their sense of control.

Ignoring the pattern of rejection drivers have for assistive technology will only perpetuate the negative opinions towards innovations. Shifting the discussion from inevitable skepticism to focusing on training, transparency, and real-world demonstration can help bridge the gap

between perception and reality. From an ANT perspective, drivers are not passive adopters of technology, but active actors whose perceptions and actions influence the success and failure of systems. The introduction of assistive technologies, like ACC, disrupts the traditional role of drivers, causing unrest and resistance as drivers negotiate their role within the truck. Many drivers struggle to find their place in this network, feeling that the technology is stripping their control. If platooning is to be widely accepted, the core relationship between driver and truck must be preserved but adapted–shifted from hands-on, direct control to a network where control is maintained through transparency and clear technological boundaries.

Perception of Reliance on Other Drivers

Driving in a platoon requires another dimension of trust, drivers must trust both the assistive systems and their fellow drivers. In platooning, the lead truck sets the speed and is responsible for recognizing, handling, and avoiding hazardous situations. Following trucks will have less time to react and reduced line of sight, due to the close following distances. This additional element of trust only escalates the loss of control drivers feel, one driver stating, "Then you have to put your trust completely in the front driver. I have some trouble with that," expressing their mistrust and desire for control (Bhoopalam et al., 2023). Where truckers were once loosely coupled through a shared interest in technological developments, industry, and policies, platooning creates a direct, real-time link between them. This change in the network fundamentally changes the role of drivers, from independence and self-reliance to a profession that requires mutual trust and coordination among drivers.

This shift in driver relationships marks a significant deviation from the traditional idea of truck driving, where autonomy and independence are paramount. Instead of operating as loosely coupled independent actors only interacting through industry standards and shared experiences,

drivers in a platoon are directly and continuously linked, where the actions of one driver directly and instantly affect others. Platooning fundamentally changes the structure of the network, increasing the dependence and interactions of drivers from solely their truck to other drivers. The restructuring of the network forces drivers to negotiate their role in the platoon and the profession, balancing trust in technology and their human counterparts. Many drivers struggle with this shift, as it directly undermines the traditional idea of trucking that was initially so attractive

Perception of Innovation

While truck platooning offers improvements to environmental impact, fuel savings, and highway efficiency, drivers remain skeptical about the benefits. Instead of viewing platooning as an improvement, they see it as a threat to their jobs. One driver expressed this skepticism, stating, “Well great fuel savings I don't believe in at all,” questioning the reality of benefit claims. Another driver shared the sentiment, stating, “Why do they develop something like this? Is it only because of the environment? Or to save fuel costs? Or just because later you can employ people who are not qualified as truck drivers?” (Castritius et al., 2020). For many drivers, innovations like platooning are not seen as improvements or tools to further the industry, but as attempts to undermine their expertise, or replace the role of truck driving altogether.

This perception of platooning as a threat rather than an enhancement shapes the pushback against platooning. A critical element in overcoming this skepticism is the demonstration of benefits. Exposing drivers to the technology, illustrating the shift in driver roles rather than the removal, is critical in the adoption of platooning. The doubt in industry motives stems from the increasing use of monitoring systems, like the tachograph, which tracks driver behavior and time spent on the road. The pervasiveness of monitoring makes drivers feel their autonomy is being

threatened, only reinforcing their mistrust of innovations and the consequences to their profession.

Monitoring and Loss of Autonomy

As technological advancements like platooning gain traction, they are often accompanied by increased surveillance and monitoring of drivers. A key example is the tachograph, which tracks and records driver speeds, rest, and working hours. While tachographs were introduced to ensure compliance with regulatory policies surrounding driver work hours, preventing drowsy driving due to overworking, they have become a symbol of increased industry oversight (Furgel & Lemke, 2006). Before the integration of the tachograph, drivers were only contacted at fixed locations contributing to the traditional sense of independence. However, with increased monitoring, as one driver says, "*everything is planned,*" which adds more pressure on drivers to be on time. The tachograph has also reduced the human interaction drivers have on the job; previously, drivers would check in at pick-up or drop-off locations and interact with the staff on-site. However, with the increased monitoring, this connection is lost; instead, drivers check in electronically, *"Now we no longer communicate [with people at drop-off location]. It is just click and press, we are no longer in contact. We don't really talk to each other anymore at the terminal. This [use the tachograph] is really all I do. This is the only time [during the interview] this whole week that I talk to someone,"* (Bhoopalam et al., 2023). With this shift in how drivers are monitored and the reduction of interactions, the dynamics of their role in the industry are changing.

In the past, drivers had more control over their schedules and interactions. Upon arriving at a location, they would interact with personnel, negotiate loading times, and exercise flexibility within their schedule. However, following the introduction of real-time monitoring, drivers are

stripped of that autonomy, instead being expected at specific times, finding everything ready to go without direct interaction. Constant monitoring and timely expectations make drivers feel less in control of their routine, instead, like a cog in a machine. The history of technology encroaching upon driver independence is a critical root of their mistrust in innovation. Rather than simply removing the notion of autonomy, it is essential to shift the responsibilities and role of the driver thoughtfully. Failing to do so will only further alienate driver perceptions of innovation. One driver captures this sentiment, *"No, then it will be a very long and boring day. Then you have nothing to do,"* expressing concerns that platooning may transform driving into a monotonous, unfulfilling profession (Bhoopalam et al., 2023). Truck drivers view driving not only as a profession, but also as a hobby, and removing their direct interaction, without sufficient replacement, will be met with further resistance.

Public Perception and Policy

As the development of autonomous truck platooning continues, various public policies have been implemented or adapted to either support or hinder its adoption. These policies are critical in shaping the adoption and deployment of platooning as they provide the framework that operators and manufacturers must abide by. One area of focus is driver qualifications and presence. There are divergent ideas surrounding platooning; some states, like Tennessee and Arkansas, have taken encouraging approaches, proposing and implementing the requirements of platoon drivers. In contrast, California requires a human safety operator to be present in all trucks within the platoon (Goble, 2023).

Public policy is a critical connection within the network, connecting trucking companies, truck drivers, manufacturers, and the general public. Policies can slow or expedite the adoption of truck platooning, and careful consideration must be taken moving forward. Several fleet

operators have already expressed concerns surrounding international customs procedures with autonomous trucks (Mahajan et al., 2024). Without clear operating procedures in place for processing and clearing international shipments, the integration of platooning will lag. Additionally, concerns from the general public surround the driving conditions imposed by truck platoons. For example, concerns about the site distance of cars trying to pass on a two-lane highway, where there is no median, and one lane of traffic in each direction. These highways often have passing areas, where the field of vision of oncoming traffic is unobstructed, allowing following vehicles to transition into the oncoming traffic and overtake the lead vehicle. However, if a platoon is driving on this road, a following car may not be aware of the number of vehicles in the platoon, nor have sufficient line of sight to safely overtake the platoon (Chowdhury et al., 2024). A study investigating the effectiveness of communicating platoon size to drivers found that drivers preferred when the number of vehicles in the platoon is explicitly displayed, so they can make an informed decision about the time needed to successfully overtake the platoon (Carlos Sun et al., 2021).

As the integration of autonomous truck platooning advances, public policy will remain a decisive factor in shaping its trajectory. While some states have taken progressive steps to accommodate platooning technologies, others maintain stricter regulations, slowing the pace of adoption. The success of platooning hinges upon the cooperative interactions between policymakers, stakeholders, and the general public to address concerns around safety and implementation. Without clear, standardized policies, the technology will continue to face resistance in implementation. As a necessary connection, public policy must negotiate with these actors surrounding safety, driver roles, driver training, and public education.

Conclusion

The integration of truck platooning offers both significant opportunities and challenges for the trucking industry. While it promises fuel efficiency, reduced environmental impact, and potentially alleviating the driver shortage by making driving more attractive, it also disrupts the network the industry has maintained, raising numerous socioeconomic issues. Driver trust and acceptance of evolving technology are necessary for its adoption. However, more impactful is driver perception of their evolving role within the profession. Many drivers view platooning as a threat to their livelihood, stemming from increased monitoring tactics, mistrust in the efficacy of platooning, worries about job displacement, and dissatisfaction.

The successful adoption of truck platooning requires careful consideration of the human actors within the network. Carelessly rearranging the trucking network, removing drivers from the center will incite unrest and further alienate the sparse driver community. Instead, fleet operators and manufacturers must work with drivers, addressing their concerns through exposure, education, and training. Additionally, public policy will serve as a critical actor within the network from which communication between the industry and the general public will take place. The long-term success of truck platooning will not only depend on the technological safety, benefits, and reliability but more so on the careful navigation and restructuring of the social, regulatory, and human dynamics at play.

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