How do different social groups influence the development and adoption of the Ford F-150 Lightning, and how does the vehicle address or fail to address the specific needs and problems of these groups?

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

Oliver Mu

Spring 2024

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

Advisor

Joshua Earle, Department of Engineering and Society

STS Research Paper

Introduction

In 2022, Ford introduced the F-150 Lightning, the electric version of the F-150. Ford's executive chair, Bill Ford, describes the vehicle as the "Model T moment for the 21st Century," suggesting a significant step forward in electrifying mainstream, high-demand vehicles (Sozzi, 2022). With over 200,000 reservations before its release, the F-150 Lightning shows strong consumer interest and possible market success.

The F-150 Lightning is more than just another electric vehicle; it is a powerful machine built to fulfill the demanding needs of pickup truck drivers. It has a 320-mile range on a single charge, can tow up to 10,000 pounds, and has 563 horsepower, capable of sprinting from 0 to 60 mph in just 4.4 seconds. These specifications are designed to reassure traditional truck buyers that switching to an EV does not mean compromising performance. To achieve the ambitious goal of producing 2 million EVs by 2026, Ford has formed two distinct internal teams: Ford Blue, which focuses on gas-powered vehicles and managing profits, and Ford Model E, which focuses on electric vehicles (Sozzi, 2022). This strategic move demonstrates Ford's adaptability to the evolving automotive industry and commitment to leading the way in the electric vehicle industry.

The significance of the F-150 Lightning goes beyond its technological capabilities. It reflects an increasing shift in the automobile industry and is essential to meeting sustainability. The truck's launch is consistent with President Biden's vision of an innovative, environmentally responsible America, and it comes amid a more significant industry challenge to substantially boost EV sales to achieve net-zero emissions by 2050 (Domonoske, 2021). The F-150 Lightning

is ideally positioned to appeal to traditional pickup purchasers by providing characteristics similar to gas-powered vehicles while also giving the benefits of electric technology.

Social Construction of Technology (SCOT)

The Social Construction of Technology (SCOT) offers the perspective on technical breakthroughs. In the framework, human behavior and societal forces shape technology just as much as technology shapes society. Technologies are created and modified through interactions between different social groups with different objectives and purposes. Understanding how different groups influence technological progress is critical for understanding the more significant implications of new technology (Bijker, 2015). Through this framework, I want to ask, "How do different social groups influence the development and adoption of the Ford F-150 Lightning, and how does the vehicle address or fail to address the specific needs and problems of these groups?" The question is important because it allows us to look into how the interactions of numerous stakeholders, such as consumers, environmentalists, industry workers, and legislators, shape the development and adoption of the F-150 Lightning. Analyzing the F-150 Lightning through the SCOT framework can help to understand the artifact’s technological features and the societal factors that influence its market adoption and success.

Methods

The primary research method will be centered on the perspectives and influences of various social groups: environmentalists, truck users, car industry workers, policymakers, technology advocates, and shareholders. I will evaluate each group's relationship with the F-150 Lightning to determine how their demands, concerns, and actions contribute to the artifact's

future market position and broader social implications.

For environmentalists, the analysis will focus on their attitude toward electric vehicles' potential to reduce carbon footprints and concerns regarding battery production. I will also evaluate truck users' opinions on their expectations for performance, such as horsepower, torque, and towing capability, as well as their skepticism about the practicality of EVs in certain conditions. The research will also consider the impact of the change to electric car production on auto industry workers; this includes potential job retraining, displacement, and security. Regarding policymakers, I will focus on how the adoption of EVs, especially the F-150 Lightning, fits into the existing environmental regulations. Technology advocates will also play a critical part in evaluating the Ford F-150 Lightning. Their opinions can determine if the technology fits the industry standards and consumer expectations, influencing the vehicle's reception. Similarly, understanding the F-150 Lightning's economic viability requires the involvement of the company’s shareholders. Their priority on market response, sales, and strategic positioning in the EV market provides insights into F150-Lightning's potential for financial success and market penetration.

Environmentalists

Nations worldwide are working together to address climate change by lowering carbon emissions. The transportation sector, which is expected to account for more than 30% of total greenhouse gas emissions in the future, is a significant factor in this case. Alarmingly, the global vehicle fleet is expected to double by 2050, with low- and middle-income nations accounting for more than 90% of the increase. In response, the electric vehicles (EVs) are viewed as the answer. EVs provide a sustainable solution that has an environmental impact by lowering dependency on

fossil fuels and emissions. (Supporting the global shift to electric mobility).

The Ford F-150 Lightning is considered Ford's effort to join this initiative. Bruce Logan, the Director of the Institute of Energy and the Environment at Penn State, stated that when adjusted for energy losses in electricity production, F-150 Lightning's electric model can achieve an energy efficiency of 23 miles per gallon equivalent (mpgeE), compared to its gasoline counterpart of 22 miles per gallon (mpg). In addition, the F-150 lightning emits 40% less CO2 than the gasoline version when driven on the U.S. annual average of 13,500 miles—reducing from 33 pounds of CO2 per day to 20 pounds (Logan, 2022).

However, the F-150 Lightning also has certain limitations in environmental efficiency, particularly when compared to smaller electric vehicles (EVs). In her article "Just How Good for the Planet Is That Big Electric Pickup Truck?" New York Times reporter Elena Shao emphasized that the F-150 Lightning's larger size and heavier weight require larger batteries and more energy consumption, resulting in higher emissions than smaller electric variants. While the F-150 Lightning helps to reduce emissions, it does so at a much lower efficiency than more compact electric vehicles (EVs), which are more energy-efficient because of their lighter weight and smaller size. Furthermore, the production of the F-150 Lightning creates concerns regarding the mining of raw resources such as lithium, cobalt, and other rare earth metals. Mining these resources can result in environmental damage, affecting biodiversity, water sources, and residents negatively. These issues become severe as the need for such materials rises due to the popularity of EVs such as the F-150 Lightning. Without substantial improvements in battery recycling and reduction in overall vehicle dependency, the environmental benefits of large electric trucks like the F-150 Lightning may be outweighed by the negative effects of their production (Shao, 2023).

Truck Users

In an NPR market analysis, around one-third of traditional pickup owners are interested in adopting electric pickups; many are considered less wealthy, less liberal, and less concerned about the environment. According to Alexander Edwards of market research firm Strategic Vision, car buyers prioritize performance and handling, but just a small percentage (7%) are willing to invest significantly extra for the environment. Additionally, potential electric truck customers are mainly GenZ and millennials, who may face financial difficulties due to the higher upfront prices of electric vehicles (Domonoske, 2020).

In a review of the Ford F-150 Lightning, Quebec resident Michael Laroche talks about his story on the electric pickup's operational efficiency. Laroche noticed a significant decrease in operational costs after switching from a regular gasoline F-150 to the electric version, with monthly fuel costs reducing from around $450 to an electric bill of $350, including household and car charging. On the other hand, the F-150 Lightning sometimes requires longer charging, mainly for heavy duties like towing, which severely drains the battery (Dubey, 2023).

By 2024, a survey shows a significant gap in consumer interest in various types of electric vehicles. While 43% of respondents were still interested in electric vehicles and 42% in SUVs/crossovers, only 10% considered electric trucks. More importantly, 47% of consumers want an EV purchase below $40,000. This drop in interest in electric trucks highlights the limitations of the electric truck market, despite the availability of models from major manufacturers such as Rivian (R1T), Ford (F-150 Lightning), and impending releases from Chevrolet and GMC (Caldwell, 2024).

Due to low interest in the electric truck market, Ford has decided to reduce the manufacturing of its electric F-150 Lightning in 2024. Initially, Ford planned to produce 150,000

F-150 Lightning per year to fulfill significantly higher demand. Due to slower-than-expected growth and a re-evaluation of the market, Ford reduced the target to 1,600 trucks per week in 2024, almost half of its original goal (Boudette, 2023).

Auto Industry Workers

The early increase in consumer demand for the F-150 Lightning led Ford to change its workers to satisfy production requirements. Jaylin Jones, an assembly line worker at Ford's Rouge Electric Vehicle Center, is an example of the significant trend of workers shifting from traditional gas-powered vehicle production to electric versions. Jones, who previously worked on the gas-powered F-150, has been retrained to assemble the electric version, stating, "High demand, so we have to put them out." In November 2022, Ford implemented a third production shift and increased its workforce from 500 to approximately 750 employees (Wayland & Rosevear, 2022). However, the transition to electric car manufacturing has its challenges. Michelle Krebs, an executive analyst at Cox Automotive, emphasizes the imminent industry-wide impact: "There will be layoffs because different types of workers are required," she says. The emphasis on software engineering over traditional automotive skills changes labor demands, as "software engineers are hugely important in EVs" (Rezvani, 2022).

In 2024, over a year after Ford decided to increase production and add more personnel to focus on the F-150 Lightning, the company faced a significant change due to lower electric pickup sales. Approximately 1,400 workers at Ford's Michigan factory, which builds the F-150 Lightning, will either have to transfer to new positions or accept retirement offers. This revision comes after a slower-than-expected growth in electric vehicle sales, forcing the company to lower its manufacturing plans. As part of this transition, 700 workers will be moved to the

Michigan Assembly Plant to work on the Bronco and Ranger models. At the same time, another 700 will be offered retirement packages from last year's labor negotiations. Those who do not opt for retirement will be moved to other Ford operations in southeast Michigan (About 1,400 workers at Ford electric pickup plant to transfer or take retirement offers next week, 2024).

Technology Advocates

In a review on the MKBHD YouTube channel, the renowned technology reviewer Marques Brownlee referred to the Ford F-150 Lightning as "the iPhone of pickup trucks." He begins by placing the F-150 Lightning in the larger context of the American automotive scene, where the traditional Ford F-150 has dominated the market as the best-selling vehicle for more than three decades. According to Brownlee, one of the main attractions of Lightning is its appeal to current F-150 owners, who are known for their brand loyalty. He compares F-150 owners to iPhone users who constantly upgrade to the latest model without considering alternatives. This characteristic makes the Lightning particularly significant; it is not only an electric truck but an electric version of America's best-selling truck. The familiarity could make the transfer easier for regular truck owners who are skeptical about EVs. He also emphasized that the Lightning retains the solid and high-performance features expected of an F-150 but also brings upgrades that take advantage of electric technology. The quiet electric motor and seamless driving experience provide a new level of comfort and efficiency. The truck is praised for retaining a traditional feel while increasing the driving experience with these modern features. Marcus believes that the F-150 Lightning raises the bar for upcoming electric trucks from competitors such as Ram and Toyota and shows Ford's commitment to leading the truck industry's electrification (Brownlee, 2022).

Policy Makers

The U.S. Department of Transportation's initiatives and policies are critical in accelerating the adoption of electric vehicles (EVs), particularly in underserved rural communities. The federal government focuses on integrating EVs into America's larger transportation network, providing equal access to the technology. One of the goals of the federal government is to have half of all new vehicles sold in the U.S. by 2030 be zero-emissions vehicles, which is supported by developing a comprehensive network of 500,000 EV charging stations nationwide to make electric vehicles a feasible alternative for local and long-distance travel (Electric Vehicles & Rural Transportation).

During his visit to Ford's Michigan plan, President Joe Biden showed his support for the electric vehicle (EV) industry. The visit was a political statement of his ambitious $2 trillion infrastructure proposal, of which $174 billion is set aside to promote the adoption of electric vehicles (EVs) like the F-150 Lightning. This initiative aims to maintain American leadership in the worldwide competition for electric vehicle production technology, especially in the face of competitors such as China. In his speech, the president emphasized the necessity of boosting domestic manufacturing, including semiconductor chips and EV batteries, to prevent shortages that could affect the auto sector. He reiterated his vision for the future with a decisive statement: "The future of the auto industry is electric." In addition to his speech, the President also took the opportunity to test drive the F-150 Lightning. He told the reporter, "This sucker's quick," as he demonstrated the vehicle's capabilities, including its acceleration from 0 to 60 mph in 4.4 seconds (Wayland, 2021).

Investors and Shareholders

According to Ford's 2023 financial report, the Ford company has committed to investing more than $50 billion in electric vehicles and related battery technology between 2022 and 2026. This notable financial commitment aims to maintain a competitive position in the fast-growing EV market and demonstrates the company's dedication to moving to a carbon-neutral future. Part of the plan is to increase EV production capacity, with an annual production rate of 600,000 EVs by the end of 2023 and a target of 2 million EVs by late 2026. This production increase will help fulfill the increasing global demand for electric vehicles, positioning Ford as a vital player in the industry's transition from fossil fuels (Integrated Sustainability and Financial Report 2023, 2023). In 2023, Ford postponed their $12 billion investment in EV manufacturing due to low customer interest. It disrupted the company's plan to increase production, as many are unwilling to pay the premium on electric vehicles. Ford's EV business, Model E, revealed a loss of $4.7 Billion from the year 2023. John Lawler, the company's CFO, expects an increase in profit in the EV business "sooner rather than later." The company has to re-evaluate its position and consider hybrid vehicles and trucks for the near future, as the sales of hybrid vehicles are expected to increase by about 40% in 2024 (Wayland, 2024).

Discussion

Ford's electrification of its best-selling truck represents the corporation's recognition of the environmental need. However, converting larger vehicles like the F-150 to electric models can have both environmental benefits and drawbacks. Despite its lower emissions than its gasoline version, the F-150 Lightning has the trade-offs that come with larger electric cars. Its size needs larger batteries to increase the vehicle's overall energy usage. As a result, even though

the truck transition cuts emissions, it does so less efficiently than smaller electric vehicles(EVs). In addition, the environmental impact of EV manufacturing, especially for large vehicles, goes beyond emissions. The demand for raw minerals like lithium and cobalt in batteries poses significant environmental and ethical concerns. Mining for these resources can cause severe ecological damage, affecting wildlife and local communities. As a result, while the F-150 Lightning helps reduce emissions, the overall environmental costs of its production are significant. In summary, a comprehensive approach is necessary beyond just lowering emissions to address the environmental effects of manufacturing and operation. The plan must include increasing the efficiency and sustainability of all EVs, regardless of size, and optimizing practices in material sourcing. A balanced strategy will be key to achieving the full environmental benefits of electric vehicles.

Regarding truck users, accepting electric trucks such as the Ford F-150 Lightning poses challenges due to demographic preferences and economic constraints. Traditional truck users, who are less concerned about environmental issues and more focused on vehicle performance and cost-effectiveness, are hesitant to switch to electric vehicles. This demographic's reluctance is caused by an unwillingness to pay a premium for the truck's environmental benefits. The financial aspect is pivotal, particularly for Generation Z and millennials. The younger generations are interested in electric vehicles but are deterred by the high upfront costs, which directly contradicts the idea of widespread adoption of electric vehicles. On top of that, operational weaknesses such as longer charging times and lower efficiency in tasks towing minimize electric vehicles' appeal for traditional consumers who value utility and convenience. Despite the initial enthusiasm for electric trucks and the expected environmental and operational

cost savings, consumer interest has yet to match projections. This gap between anticipated and actual market demand shows that Ford may need to rethink their EV strategies.

Ford's electrification of the F-150 Lightning significantly impacts automotive workers in terms of opportunities and challenges. This change happens in the production lines and represents an unprecedented shift in the workforce and the skills required. Initially, the increase in demand for the F-150 Lightning prompted Ford to expand its workforce and add shifts. Growing interest in electric vehicles has a positive effect on employment. Workers like Jaylin Jones, who switched from gasoline-powered vehicle assembly to electric assembly, represent the trend of retraining to adapt to new production demands. This retraining is essential for keeping jobs and providing workers with more relevant skills to fit in the rapidly changing auto industry. However, the transition to electric vehicles requires workers experienced in software engineering rather than traditional mechanical skills. This could result in job displacement for people with traditional vehicle production experience. Moreover, the drop in production due to slower-than-expected sales of the F-150 Lightning poses the risk and unpredictability of this new technology. The reduction affects the workforce, with some employees being relocated to other projects while others face retirement or reassignment. The situation exemplifies the nature of innovation in the car industry: while it can lead to growth, it also brings instability and uncertainty for the workers.

On the positive side, technology advocates like Marques Brownlee praised the Ford F-150 Lightning as a crucial innovation in the automobile sector, noting its potential to transform the pickup truck industry as Apple did with the smartphone industry. However, technology advocates often focus on innovative features and integrating new technology; these

characteristics may only partially resonate with traditional truck users who value practicality and reliability more.

The Ford F-150 Lightning is integral to the Biden administration's strategy of establishing the United States as a leader in the electric vehicle market. The truck represents the potential for EVs to enter the mainstream automotive market. President Biden's visit to Ford's Michigan plant and public test drive of the Lightning were not just supporting gestures but purposeful measures to show the viability and performance of EVs to a broad audience. This engagement illustrates the administration's commitment to modernizing the United States auto industry by supporting the domestic production of electric vehicles. By showcasing a popular model such as the F-150, the administration wants to promote consumer and investor confidence in the EV sector, aligning with the goal of a zero-emission transportation future.

Ford's investment in the F-150 Lightning and electric vehicles reflects an ambitious move to lead in a rapidly growing sector. Still, the mismatch between customer interest and business expectation reveals their strategic failure. The delay of a significant investment due to low consumer demand reveals the difficulties in estimating EV adoption rates. This adjustment affects the F-150 Lightning's growth and questions the EV market's long-term prospects. Ford's decision to look into hybrids suggests the need for a safer approach to convince consumers to switch from traditional to electric vehicles.

Conclusion

The Ford F-150 Lightning is a technological innovation intended to meet government goals for environmental sustainability. Nevertheless, this technology has faced many challenges, including the complexity of incorporating such innovations into the current market and society.

The mismatch between customer interest and production has prompted a reconsideration of the company's market approach, which resulted in scaled-back production and layoffs. Additionally, criticisms of the F-150 Lightning, particularly its efficiency compared to smaller EVs and the cost of materials for batteries, indicate that it may not be the most sustainable option. These factors led to the reality of the F-150 Lightning's contribution to combating climate change, where its larger environmental impact somewhat offsets its benefits. Despite these challenges, the F-150 Lightning's story is far from over. Its ability to improve and adapt remains tremendous. As Ford continues to innovate and respond to consumer needs and environmental concerns, the F-150 Lightning has the potential to develop into a more universally beneficial technology. By addressing these initial flaws and refining its approach to meet the diverse needs of various social groups, the F-150 Lightning can still fulfill its promise as a transformative technology in the automotive industry.

References

AP News. (2024, March 28). *About 1,400 workers at Ford electric pickup plant to transfer or take retirement offers next week*. AP News. https://apnews.com/article/ford-jobs-electric-vehicles-f150-lightning-5f0e062efcd63f2d974221438dcd86a5

Bijker, W. E. (2015). Technology, social construction of. *International Encyclopedia of the Social & Behavioral Sciences*, 135–140. https://doi.org/10.1016/b978-0-08-097086-8.85038-2

Boudette, N. E. (2023, December 12). *Ford will cut planned electric F-150 production as demand slows*. The New York Times. https://www.nytimes.com/2023/12/12/business/ford-f150-lightning-ev.html

Brownlee, M. (2022, June 24). *Ford F150 lightning is the iphone of pickup trucks!*. YouTube. https://www.youtube.com/watch?v=CkoquiSnqbk

Caldwell, J. (2024, March 26). *EV survey: Consumer Expectations clash with market realities*. Edmunds. https://www.edmunds.com/car-news/consumer-expectations-of-evs-clash-with-market-realities.html?

Domonoske, C. (2020, December 16). *All the oomph, minus the vroom? electric pickups take aim at American market*. NPR. https://www.npr.org/2020/12/16/945626639/all-the-oomph-minus-the-vroom-electric-pickups-take-aim-at-american-market

Domonoske, C. (2021, May 19). *Why Ford unveiling an electric F-150 is a big deal*. NPR. https://www.npr.org/2021/05/19/998205598/can-a-battery-powered-f-150-truck-persuade-americans-to-embrace-electric-vehicle

Dubey, R. (2023, December 29). *Electric pickups need a big charge, but owners might still save money | financial post*. Financial Post. https://financialpost.com/commodities/energy/electric-vehicles/electric-pickups-big-charge-owners-save-money

Electric Vehicles & Rural Transportation. U.S. Department of Transportation. (n.d.). https://www.transportation.gov/rural/ev

Ford. (2023). Integrated Sustainability and Financial Report 2023. https://corporate.ford.com/content/dam/corporate/us/en-us/documents/reports/2023-integrated-sustainability-and-financial-report.pdf

Logan, B. (2022, June 21). *Will buying a new electric Ford F-150 lightning help save the world from climate change?*. Institute of Energy and the Environment. https://iee.psu.edu/news/blog/will-buying-new-electric-ford-f-150-lightning-help-save-world-climate-change

Rezvani, A. (2022, October 1). *Auto companies are racing to meet an electric future, and transforming the workforce*. NPR. https://www.npr.org/2022/10/01/1126079120/auto-companies-are-racing-to-meet-an-electric-future-and-transforming-the-workfo

Shao, E. (2023, February 18). *Just how good for the planet is that Big Electric Pickup truck?*. The New York Times. https://www.nytimes.com/interactive/2023/02/17/climate/electric-vehicle-emissions-truck-suv.html

Sozzi, B. (2022, April 26). *Ford begins production of the Electric F-150 Lightning*. Yahoo! Finance. https://finance.yahoo.com/news/ford-begins-production-of-the-f-150-lightning-100052545.html

Supporting the global shift to electric mobility. UNEP. (n.d.). https://www.unep.org/topics/transport/electric-mobility/supporting-global-shift-electric-mobility-0

Wayland, M. (2021, May 24). *Ford reveals new electric F-150 lightning pickup during Biden's visit to Michigan plant*. CNBC. https://www.cnbc.com/2021/05/18/ford-reveals-new-electric-f-150-lightning-pickup-.html

Wayland, M. (2024, February 7). *Ford is reassessing its EV plans, including Vertical Battery Integration*. CNBC. https://www.cnbc.com/2024/02/06/ford-reassessing-ev-plans-including-vertical-battery-integration.html

Wayland, M., & Rosevear, J. (2022, December 13). *Ford boosts production of electric F-150 Lightning Pickup truck*. CNBC.

https://www.cnbc.com/2022/12/13/ford-moves-to-boost-production-of-electric-f-150-lightning-pickup-truck.html