SOLAR CAR SUSPENSION SYSTEM
THE INDIVIDUAL IDENTITY IN AUTOMOTIVE ELECTRIFICATION

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

Transportation technology stands at a critical inflection point in human history. The transition from walking to horseback riding to the bicycle was a crucial progression in the mechanical assistance of everyday motion, but it was the invention of the automobile that fundamentally transformed society's relationship with mobility (McShane & Tarr, 2007). Today, society faces a similar transformative moment as the world shifts toward electric vehicles (EVs). This transition reveals complex sociotechnical relationships that warrant deeper examination, particularly in how technological solutions often create unforeseen challenges (Hughes, 2012).

The environmental impact of transportation has become a central concern in the 21st century, with the transportation sector accounting for approximately 29% of greenhouse gas emissions in the United States (EPA, 2021). While electric vehicles have emerged as an apparent solution, their adoption introduces new complications. For example, heavy metal extraction in lithium battery production leads to soil and water contamination. Further, Carbon dioxide emissions are rampant during vehicle production. Alongside that, there are power grid infrastructure challenges that concern individuals' everyday availability to electricity. This creates a sociotechnical shift known as technological momentum – where society's investment in a particular technological system makes it increasingly difficult to change course from the use of that technology (Hughes 1994). In the case of technology gaining momentum, society has control over technology early on in its life. However, as time proceeds, and the technological system grows further, we see that the system evolves to grasp control over society.

This research explores two interconnected aspects of transportation's technological evolution: the development of advanced sustainable racing technology and the broader socio technical implications of transportation system evolution. The technical portion focuses on developing a uniquely optimized suspension system that is lighter weight and more effective in shock absorption for solar-powered racing vehicles, while the STS research investigates how technological momentum has shaped Chevy's bumpy transition to electric vehicles. I will draw on the STS framework of technological momentum to investigate how a societal dependency on automobiles influenced a sense of identity and within vehicle choice, leading to greater difficulty to change the system much like one's own ability to change their image. This research will illuminate how technological advancement both shapes and is shaped by societal needs and constraints.

Technical Project Proposal

In universities throughout the world, solar car programs exist to develop solar technology as it relates to vehicles and as an opportunity for engineering students to gain hands-on experience. At the University of Virginia, the Solar Car Team is dedicated to designing, manufacturing, and testing a solar powered electric formula car to race in an intercollegiate competition. With the goal of optimizing the efficiency of the solar vehicle, the team strives to improve each of the primary systems: the chassis, energy harvesting, energy storage, aeroshell, and suspension. In particular, the suspension system is a critical component as stabilizes and controls the vehicle, making it easier to handle bumps and dips in the road. Additionally, an effective suspension protects the fragile solar technology components from the harsh forces encountered while the vehicle is driving in competition. In the previous model of the UVA solar car, the suspension system was an overly simplified double wishbone system. It consisted of a clunky aluminum upright, two aluminum wishbones, and a spring mounted directly to the bottom wishbone. The upright and control arms were heavy, mating joints were comprised of metal-on-metal contact, and the shock absorber was incorrectly rated. The culmination of these factors resulted in an overdamped suspension that inhibited the travel around corners, and produced extreme forces and strain in the tires. This led to an unsafe ride for the driver due to excessive vibrations and a lack of steering control (Singh, 2023).

The aim of this technical project is to design a new suspension system that efficiently transfers and damps shock impulses and works seamlessly with the steering and braking systems to improve handling of the car. The system will be constructed such that weight is minimized through thoughtful material selection and methodical geometry. Additionally, every joint within the system will be crafted using SAE-grade hardware to allow for a smooth transfer of forces. Lastly, the shock absorber will be carefully selected such that it critically damps the transferred forces and creates a smooth ride.

There are four major tasks the team will undertake in redesigning the solar car suspension system: designing, prototyping, manufacturing, and testing. First, the task of designing will be to create detailed engineering drawings and designs of our approach using geometric dimensioning and tolerancing. To analyze potential designs, the team will utilize computer-aided design (CAD) and finite element analysis (FEA) software, such as SolidWorks and Ansys, respectively. The final design will adhere to a set of strict boundary conditions and limitations set out by the American Solar Challenge as well as the dimensional constraints of the current chassis (American Solar Challenge, 2024). Next, the prototyping task will be to iteratively prototype the design components using fused deposition modeling (FDM) and scaled models to test joint fittings and other mating tolerances (Shahrubudin, N., Lee, T. C., & Ramlan, R., 2019). The team will use an Instron machine to perform a compression test on the shock absorber to ensure that it is an optimal selection for the car (Instron, 2024). The manufacturing task will consist of the following: machining the uprights from stock aluminum, cutting and welding one inch diameter steel tubing into a “V” shape for the wishbones, creating mounts and tabs out of steel sheet metal to mount individual components together, and assembling all the components together onto the chassis of the car. The fourth and final task will be to test the system to verify the suspension accomplishes its intended goal and to adjust as needed.

Initial design data for the system will be obtained from scholarly articles pertaining to the construction of suspension systems as well as models of existing systems such as Formula 1 race cars. As the proposed system develops through an iterative design approach, each iteration will supply more information and understanding for further development of the system. As for demonstrating the system's value, a test will be performed when the suspension system is finalized and mounted to the car's chassis. This will prove that our design accomplishes its intended goal of sufficiently mitigating impacts and facilitating efficient movement of the vehicle.

STS Project Proposal

In August 2021, Chevrolet announced the third recall of the Bolt EV, covering all 141,000 models, and later confirmed that 16 cars had caught fire (Berman 2021). This was not the first time an EV battery pack caught fire, but other car manufacturers such as BMW, Ford, Chrysler, Hyundai, Mitsubishi, and the flagship EV company Tesla have all had recalls for similar problems. This crisis shows that, although the push towards cleaner mobility is necessary, there are many deeper engineering and psychological barriers holding back the average consumer from the initiative. The transition to electric vehicles (EVs) represents a pivotal technological transformation in transportation, challenging deeply entrenched systems of automotive design, energy production, and consumer mobility. Since the early 2000s, EVs have evolved from niche experimental technologies to increasingly mainstream transportation alternatives, driven by environmental concerns, technological innovations, and shifting global energy policies. While internal combustion engine (ICE) vehicles are what most people typically associate with the first automobile, the electric car has existed since 1834, long before gasoline engines. William Morrison, a chemist who lived in Des Moines, Iowa created a six-passenger electric vehicle that went up to 14 miles per hour (Energy.gov 2014). Since the beginning, the adoption of electric vehicles has faced the same hurdles it does today: limited driving range and a lack of charging infrastructure (Valdes-Dapena and Sherman, 2019). Even in this period, Henry Ford and Thomas Edison were working together to create longer range batteries for the emergence of a new electric vehicle. However, Ford's Model-T endeavors were at the forefront of his agenda. This capitalistic mindset and new assembly line manufacturing technique squashed the early adoption of EVs.

Researchers typically focus on technical specifications, market adoption rates, and environmental benefits, treating EVs as isolated technological artifacts. Studies by automotive historians and technology analysts have primarily described EV development as a straightforward progression of improved battery technologies, increased range, and declining production costs. These existing perspectives fundamentally misunderstand the complex socio-technical networks that shape technological innovation. By treating electric vehicles as purely technological objects, current approaches overlook the intricate interactions between human and non-human influences that mediate technological change. Previous writers have examined EV development through narrow technological or economic frameworks, but they have not adequately addressed the complex network of interactions that truly drives a societal shift to technology gaining momentum.

I argue that the electric vehicle transition is not merely a technological shift but a complex negotiation of technological momentum, involving multiple nodes whose interactions simultaneously construct and are constructed by the emerging EV ecosystem. The momentum of electric vehicle technology emerges not from inherent technological superiority, but from the intricate network of human and non-human identities that collaboratively produce and transform the technological system. All over the world we see specific cases where countries are pushing the shift towards electrifying the automotive industry, so why isn't the United States? Unlike other countries where policy and groupthink have a large effect over the population, we often see that individuality and public appearance govern many actions of US citizens. This mindset carries forward in one's selection of automotive transportation, where small cars and electric vehicles give off the appearance of being "weak" and larger vehicles show a sense of power.

This research will employ Thomas Hughes's technological momentum theory, which conceptualizes technological systems as dynamic networks where technological and social factors are deeply intertwined. Drawing on Hughes's work, the analysis will examine how momentum accumulates through complex interactions between technological artifacts, institutional structures, and human actors (Hughes, 1983).

Conclusion

This research combines technical innovation in sustainable racing technology with critically examining transportation's technological momentum. The technical project will deliver an optimized suspension system that advances solar racing capability, while the STS research provides crucial insights into how technological systems evolve and create societal dependencies. Together, these projects contribute to understanding how our society can advance sustainable transportation while remaining mindful of sociotechnical implications. The technical portion of solar powered racing technology shows the beginning of a societal shift towards a cleaner energy approach to everyday jobs and entertainment. Students act as the workforce that facilitates the production and competition underlying the entertainment concept of racing as a sport. Rules and regulations by the American Solar Challenge act as policy and the law regarding the specifications and limitations of the vehicles. Further, universities and sponsors act as a pseudo government where there are public and private sponsors heading the development of this technology. The science technology and societal analysis of this issue is explored in the case of the Chevy Bolt EV. Although the push towards cleaner mobility is necessary, there are still engineering and psychological barriers holding back the average consumer from the initiative. The insights gained from studying technological momentum in transportation will inform the technical design process, helping to anticipate and address potential issues before they become embedded in the system. This integrated approach demonstrates how technical innovation can benefit from social science perspectives, potentially leading to more sustainable and socially conscious technological development.

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