Thesis Project Portfolio

Optimized Suspension System for a Solar Powered Electric Formula Car

(Technical Report)

Analysis of Hyundai Motor Company Electric Vehicle Recalls

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Introduction

This thesis portfolio explores the innovations and challenges behind the development of sustainable transportation in society. My technical capstone project focused on the design, manufacturing, and testing of a suspension system for the UVA Solar Car Team. This work contributed to the development of a more efficient and reliable solar car, with the goal of optimizing the performance in competitive racing environments and furthering the viability of solar-powered transportation. In parallel, my STS research project investigates structural challenges facing the solar car industry, using Hyundai's recent recall of electric vehicles (EVs) as a case study. This research paper argues that engineering timelines of EVs should be dictated by technical readiness, rather than external influences. Although distinct in method and scope, both projects are related by the common purpose to critically assess and improve the technological foundations of renewable transportation.

Technical Report

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. Among the primary systems of the car, the suspension system is a critical component as it facilitates the efficient movement of the vehicle. Additionally, an effective suspension protects the fragile solar technology components from the harsh forces encountered while the vehicle is driving in competition. For our technical project, my team and I designed a new suspension system that efficiently transferred and dampened shock impulses and worked seamlessly with the steering and braking systems to maximize handling of the car. There were four major tasks our team had to undertake in redesigning the solar car suspension system:

designing, prototyping, manufacturing, and testing. The suspension was designed and manufactured in a way that catered to the needs of the solar car and specifically addressed the requirements of the competition. As a whole, my capstone project improved the technology of the UVA solar car team and contributed to ongoing research on solar vehicle technology.

STS Project

My STS research paper investigates the sociotechnical factors that contribute to the challenges currently facing EV manufacturers, with a specific focus on how external pressures can compromise engineering outcomes. Using a case study approach, I analyzed Hyundai's EV recall that occurred in 2024 due to failures in the Integrated Charging Control Unit (ICCU). This case highlights how increasing public demand for EVs and government incentives aimed at accelerating EV adoption can lead to engineering decisions that prioritize speed over technical reliability. In analyzing the Hyundai EV recalls, I apply the science, technology, and society (STS) concept of actor-network theory (ANT), which provides a lens to explore how technical outcomes are the result of complex interactions among both human and non-human actors. In Hyundai's case, I conducted an analysis of how engineers, government policies, corporate strategies, public opinion, and EV technologies themselves interact within fluid and interdependent actor-networks. This method of analysis offers broad insights into the interconnected actor-networks that define the electric vehicle industry as a whole. Additionally, my research paper aims to highlight the importance of addressing the challenges that limit the transition towards sustainable transportation, particularly as it relates to efforts to combat climate change.

Conclusion

Working on both the technical capstone project and STS research paper concurrently provided a valuable opportunity to explore the relationship between engineering practice and the broader social systems in which it operates. My work with the solar car suspension system was centered around rigorous technical analysis and hands-on problem solving, while the STS research challenged me to think critically about the societal forces that shape engineering decisions. My work on the STS research paper encouraged me to approach the capstone project with a greater awareness of the importance of testing, validation, and long-term reliability. At the same time, the hands-on engineering experience of building a mechanical system deepened my understanding of the extensive work and analysis that must be done when developing a new technology. My capstone project required a significant amount of research and experimentation, and this was just for a single sub-system of the vehicle. This gave me insight into the immense amount of work and factors to consider when developing a new EV model, especially when decisions have the potential to affect public adoption and trust in the technology. Together, these projects reinforced the idea that technical development must be accompanied by a deep understanding of the social context in which the engineering takes place.