Thesis Portfolio

Robotic Solutions for Mobility: How Robots Can Enhance Transportation Systems

(Technical Report)

The Struggle over the Future of Combustion-Engine Vehicles in California

(STS Research Paper)

An Undergraduate Thesis

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By

Ekow Daniels

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Department of Mechanical Engineering

Table of Contents

Sociotechnical Synthesis

Technological innovation has a significant role in advancing sustainability, both in transportation and in the tools that support them. My STS paper examines how advocacy groups influenced California's adoption of sustainable vehicle alternatives in response to climate change and emissions concerns. Meanwhile, my technical project focused on designing and building a sustainable humanoid robot for the US Navy. These projects intersect in their shared challenge of scaling sustainable, affordable technology that meets environmental and operational standards

Despite current advancements in the robotics industry with the development of sophisticated robots, such as the Boston Dynamics Atlas and the Shipboard Autonomous FireFighting Robot (SAFFIR), their lack of sustainability, reusability, and high cost emphasize the need for better solutions. The goal of my technical project was to design, build, and test a lightweight, cost-effective humanoid robot capable of navigating complex terrain of U.S. Navy ships. This robot presents itself as a viable alternative, to ensure scalability in deployment throughout the world. The motivation for this project is to reduce the reliance of humans operating in hazardous environments by developing a robot that can conduct the same tasks safely and efficiently. This supports the broader goal of enhancing general operations while promoting sustainability and energy efficiency. To meet the strict weight and cost requirements, all components of the robot were manufactured using 3D-printed ABS plastic, a lightweight and durable material. The mobility of the robot was powered by Dynamixel Motors due to their high compatibility with robots, and their force outputs. During the first semester, our team focused on developing the structure of the robot using Computer Aided Design (CAD) software and optimized it using Finite Element Analysis (FEA) to ensure its reliability in worst case scenarios.

During the second semester, our team transitioned to building the robot, integrating electronics, and programming mobility logic using Robotic Operating Systems (ROS). While my capstone focused on building a sustainable robot for enhanced area mobility, my STS research paper examined how large-scale sustainability efforts, particularly in California's transportation sector, are shared through policy and advocacy.

California has emerged as a leader in transportation reform, particularly in its efforts to promote sustainability through the electrification of motor vehicles. In 2020, the state introduced a transportation reform policy, Executive Order N-79-20, which aimed to phase out the sale of Internal Combustion Engine Vehicles (ICEVs) by 2035 and promote the adoption of sustainable alternatives such as Battery Electric Vehicles (BEVs). The passing of this reform policy emphasizes a broader shift toward sustainable mobility and a need to reduce transportation related emissions. Current research emphasizes the negative environmental and health impacts of ICEVs and their high carbon emissions. In addition, studies have also shown these emissions disproportionately affect marginalized communities that live closer to highways and interstates. Despite this, there is limited research explaining the methodology of BEV advocates in influencing policy at this scale. My paper addresses this gap by analyzing the strategies employed by BEV advocacy groups to ensure the passage of the transporating reform policy, Executive Order N-79-20. I use the Advocacy Coalition Framework, to examine how coalitions of actors with shared beliefs engage in long-term policy struggles to shape legislation and public opinion. In addition, I conducted a comparative case study of three historical advocacy moments. These include, the American Cancer Society's and their use of empirical evidence against the tobacco industry in the 1950s, the California Smoking Ban in 1995 and the usage of media

campaigns, and the coalition building efforts throughout the apartheid movement in South Africa. In the context of BEV advocacy, groups such as the California Air Resources Board (CARB) and the Electric For all Coalition used similar strategies. CARB's Annual Air Quality Trends Report provided scientific evidence that highlights pollution levels and their impact on health across California. This evidence underscored CARB's efforts to establish scientific credibility. The Electric For all Coalition launched their own campaign to debunk misconception regarding the affordability, accessibility, and long-term economic benefits of BEVS. In addition, BEV advocacy groups participated in the International Zero Emission Vehicle Mandate (ZEV), a transnational collaboration that helped California align its goals with other governments committed to decarbonizing transportation. While these cases are topically unrelated, they reveal recurring advocacy patterns. Understanding how these strategies were used historically and in relation to the BEV advocacy moments provides a valuable framework for future transportation reforms and environmental policymaking in similar complex political environments

Working on both projects simultaneously gave me a deeper appreciation for the relationship between technological innovation and policy making. While my technical project improved my skills in Mechanical Engineering, my STS research encouraged me to think critically about the broader social implication of that technological innovation on society. Studying how advocacy efforts influence BEV adoption, provided an insightful foundation to better understand the integration of new technology into society. It also made me more aware of the importance of communication and stakeholder engagement in shaping technological transitions. Previously, I perceived sustainability primarily as a technical challenge, however,

working on both projects has given me a better understanding of the social and political dynamics of the topic.