Thesis Project Portfolio

The WorkSafe Monitor: A Comprehensive Wearable Personal Safety Monitor for Manufacturing and Construction Workers

(Technical Report)

An Electric Future: Developing Optimal EV Infrastructure in Urban Areas

(STS Research Paper)

An Undergraduate Thesis

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Kamil Urbanowski

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Department of Electrical and Computer Engineering

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Sociotechnical Synthesis

As part of our technical project, my team and I developed the WorkSafe Monitor to help construction workers and their employers identify worksite hazards in real-time and implement appropriate safety measures. The device is a wearable designed for fall detection, sound level monitoring, and the identification of hazardous gases and particulate matter. My STS research focused on the increasing prevalence of electric vehicles (EVs) and the infrastructural challenges they pose, especially in dense urban environments.

The Occupational Health and Safety Administration (OSHA) reports that one-fifth of all fatal work injuries happen in the construction sector, primarily due to falls. Additionally, exposure to dangerous chemicals contributes to over 190,000 illnesses and 50,000 deaths annually, including those related to cancer and various other conditions. The WorkSafe Monitor is engineered to mitigate these risks by continuously monitoring a variety of environmental variables using a multi-sensor configuration, and wirelessly transmitting data in real-time to a website for improved safety oversight. The device is composed of three subsystems: a sensor-equipped printed circuit board (along with a lithium-ion battery), the NI myRIO microcontroller for data collection and transmission, and a Flask-based web application for dynamic data visualization and alerts. This website uses a SQLite database and a JavaScript/HTML interface to present live data, featuring advanced algorithms that quickly analyze data for potential falls, excessive noise exposure, and dangerous concentrations of gases or particulate matter. All potentially hazardous events are recorded in a separate history database to promote in-depth auditing and continued safety improvements. The technical report discusses the rationale behind our engineering design choices and details the strategies used to overcome the major challenges we encountered, both on the hardware and software ends.

For my STS research project, I performed extensive literature review to answer the question of how cities can develop an equitable, efficient, and low-cost EV infrastructure to support growing demand. It's undeniable that EVs have many advantages over internal combustion engine vehicles: they're more environmentally friendly, have lower fuel costs, require less maintenance, and provide better performance, among other benefits. In fact, the Tesla Model Y ranked as the 5th best-selling car in the US in 2023, demonstrating a growth of over 50% from the previous year. Bloomberg projections show that by 2030, over half of passenger vehicles sold in the US will be electric. However, the surge in EVs, particularly in urban settings, necessitates significant changes and investments in infrastructure. To accommodate this influx, the number of charging stations in public spaces will have to increase, allowing drivers to charge their vehicles quickly and easily. Given that station installation is expensive, cities need to strategically determine their placement for maximum effectiveness. Additionally, EV charging places high pressure on power grids. As a result, government officials will have to not only begin larger grid improvement projects but also figure out how to meet short-term demand. Finally, a future in sustainable transportation requires that EVs and charging facilities are available to everyone. My research reveals the existing inequities within the EV industry affecting underprivileged communities and outlines what we can do to ensure inclusivity as we transition to electric cars. In performing the analysis of literature, I use Actor-Network Theory to examine the complex network of both human and non-human actors that are key to my research question. This STS framework helps identify how certain stakeholders can collaborate to simplify the development of infrastructure while also fulfilling their individual objectives. My findings suggest initiatives that policymakers, automobile manufacturers, and invested third parties can adopt to address the problem of limited EV infrastructure. These

strategies revolve around balancing costs, implementing smart and sustainable designs, and promoting social equity.