Thesis Project Portfolio

Optimizing Routes for UVA's Facilities Management Fleet: Enhancing Sustainability and Pedestrian Safety

(Technical Report)

Whose Body Is It? The Ethical Dilemma of Monitoring in Competitive Sports

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Mary Katherine McKay

Spring, 2025

Department of Systems and Information Engineering

Table of Contents

Sociotechnical Synthesis

Data collection technologies are rapidly reshaping how decisions are made in everyday life, the workplace, and how people define success. While these tools are often promoted as solutions for improving optimization and efficiency in contexts such as university operations and sports team performance, they can also create power imbalances that prioritize metrics over human input and well-being. The sociotechnical problem uniting my two thesis projects is that organizations increasingly use data-driven technologies to improve outcomes, but often fail to consider the ethical consequences of how that data is collected, interpreted, and used. This becomes a problem when decisions are made based on metrics alone, disregarding the perspectives of the people most affected. Without intentional regulations, these systems risk reinforcing power imbalances, limiting individual agency, and prioritizing institutional goals over human well-being. My technical project demonstrates how data collection technologies can produce tangible operational benefits, while my STS research highlights the ethical risks and human consequences that occur when these technologies are used without proper oversight or consent.

The UVA Facilities Management (FM) fleet includes around 300 vehicles that frequently pass through high-pedestrian zones like McCormick Road, raising concerns about safety, emissions, and congestion. This road is a central pathway for students, and frequent FM traffic through it creates unnecessary risk and disruption in a student-centered area. To address this problem, my technical research focused on identifying optimal travel routes for the FM fleet to support more efficient operations and progress toward UVA's carbon neutrality goals. Using telematics data from the Geotab platform, I analyzed over 60,000 vehicle trips across three distinct time periods before, during, and after a McCormick Road closure. From this, I identified key origin-destination hotspots and mapped out the most commonly used routes. I then provided both time-based recommendations for when to avoid McCormick Road and identified an alternative route that bypasses it entirely, offering a more sustainable and less disruptive option. This project demonstrates how data collection technologies, such as telematics, can be used to improve operational efficiency while reducing impact on student-centered areas of Grounds.

My STS research explored the ethical consequences of using data collection technologies in a very different context, focusing on athlete surveillance. Athlete monitoring technologies, while designed to enhance performance, are increasingly used in ways that compromise athlete autonomy, mental health, and free will in favor of institutional success. I examined how biometric tracking technologies in professional and collegiate sports impact athlete autonomy, mental health, and free will. Although these tools are often introduced as ways to enhance performance, they are frequently used to control behavior, enforce expectations, and make decisions without meaningful athlete input. I applied Actor-Network Theory to

analyze how various actors, including coaches, contracts, tracking devices, and media, work together to shape a system where athletes are reduced to data points. Without strong consent mechanisms or adequate data protections, athletes have limited control over how their information is collected, interpreted, and used. This research demonstrates that when ethical oversight is lacking, data collection technologies can shift power away from individuals and create systems that prioritize institutional interests over athlete well-being.

My work contributed to addressing this broader sociotechnical issue in two ways. In the technical project, I provided time-based recommendations for using a high-traffic campus road more safely and efficiently, while also advising an alternative route that avoids it altogether to better align with sustainability and safety goals. In my STS research, I called for stronger protections to ensure athletes have a voice in how their data is used and understood. Although my research targets only two very specific areas, these examples emphasize the need to design monitoring tools that prioritize the agency of those being tracked. Future researchers should build on this work by exploring clearer data regulations and how inclusive feedback strategies can be incorporated in data collection to ensure these systems serve, without controlling, the people within them.

I would like to thank my technical advisor, Professor Brian Park, for his guidance throughout my technical data analysis. I'm also incredibly grateful to Professor Caitlyn Wylie, whose insights in STS helped me think critically about the ethical implications of technology and gave me the tools to articulate them. Thank you to the UVA Facilities Management team for your collaboration and support. Finally, I appreciate the encouragement and feedback from my peers, family, and mentors who helped me throughout this thesis journey.