Thesis Project Portfolio

A Design Concept for Improving Local Transportation Systems & A Device to Reduce the Spread of Hospital-Acquired Infections

(Technical Report)

Investigating the Inertia in the Regulation of Vehicle Cybersecurity by Applying a Nontraditional Methodology

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Identifying and Rectifying Faults in the Management of Both Transportation Systems and Hospital-Acquired Infections

Transportation systems have served the public interest for millennia but modern iterations have flaws that endanger the safety of both humans and the environment. Vehicle cybersecurity is an area of interest due to the increased cyber risk associated with the computerization of onboard systems. Additionally, environmental impacts of automobiles must be reduced because of their deleterious effects thus far and the increasing achievability of the widespread adoption of environmentally friendly technologies. Thus, my STS work sought to investigate the human role in regulating cybersecurity and the first half of my technical work explored potential eco-friendly improvements that could be made to transportation systems in the Charlottesville area. Investigating safety from cybersecurity and environmental perspectives made obvious the nuanced nature of transportation systems. Due to unavoidable circumstances, I could not complete my technical work and joined another capstone group that worked to reduce hospital-acquired infections arising from wastewater sources, which is relevant to my STS topic in that both seek to guarantee the protection of humans.

In my STS research, I identified and applied frameworks not traditionally associated with vehicle cybersecurity with the intention of making unapparent discoveries. These frameworks included routine activity theory (RAT), risk assessment, and a literature synthesis on cybersecurity in general. Tying these frameworks together yielded the first steps to establishing strategies for the governance of computerized vehicles. RAT theorizes that the presence of a capable guardian is a necessity and that such a guardian must use various strategies to eliminate risk. My assessment of risk indicated that risk-prevention strategies will likely be more effective than strategies that try to control or tolerate risk or strategies that involve adapting reactively or

inaction. Given that current strategies appear to follow the latter in the United States, top-down action is needed to ensure that guardians are fulfilling their responsibilities. My analysis of cybersecurity literature pointed towards the facilitation and encouragement of the sharing of valuable information between stakeholder entities as a step towards risk prevention.

The technical portion of my thesis ultimately produced a design concept for sustainable transport in the Charlottesville area and the design for a device that reduces the spread of hospital-acquired infections from wastewater sources, specifically sinks. As mentioned previously, my technical work was divided into two parts. The first part of my work related to improving sustainability in transportation in the Charlottesville area and produced a replicable design concept for future project groups. This concept presented the framework for a sustainable transportation plan that aims to reduce Albemarle County emissions by 45% (compared to 2010 levels) by 2030 and help the University of Virginia reach its goals of carbon neutrality by 2030 and being 100% fossil fuel free by 2050. The three pillars of this plan include a marketing campaign, countywide electric bus implementation, and bus rerouting. The second part of my work entailed the construction and testing of the prototype of a device that would use ultraviolet germicidal irradiation to kill or inactivate bacteria in plumbing traps. The main feature of the device is a quartz glass that filters ultraviolet C radiation at the bottommost part of the U-bend to irradiate bacteria in the wastewater there.

Both projects complemented each other as the STS work and first part of my technical work illustrated the far-reaching impacts of transportation systems. Transportation is essential for the functioning of society but it is important to recognize that maintaining the status quo with regard to environmental or cybersecurity standards is imprudent. Even the second part of my technical work indicated that the hospital, a place where people go to recuperate, is susceptible to

hospital-acquired infections, which are failures that are the result of human activity. Given that the combined body of work developed solutions for problems that were ultimately created out of the solutions to prior problems, there is a need for more consequential thinking in engineering ethics.