Thesis Project Portfolio

Rock-Slide: Developing an Indoor Climbing Volume with a Linearly Actuating Hold

(Technical Report)

The Disproportionate Effect of Traffic Related Pollution on the Black Residents of Richmond Virginia

(STS Research Paper)

An Undergraduate Thesis

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Ethan Gregory Whitt

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Department of Mechanical and Aerospace Engineering

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Sociotechnical Synthesis

My STS paper explores the correlation between race and traffic related pollutant exposure. It is a well-established fact that race and socioeconomic status are tied heavily with this type of pollutant exposure in urban areas. Specifically, majority Black and Latino populations are exposed to higher levels of NO2 and PM2.5, pollutants with harmful effects on the respiratory system, than majority White populations. This is due to the trend of these populations living in close proximity to highly trafficked roadways, airports, and other infrastructure with large amounts of vehicle emissions, which serves as the largest emission source for NO2 and PM2.5.

Knowing this, my paper specifically examines the correlation between majority Black neighborhoods in Richmond Virginia and NO2 and PM2.5 exposure as a result of living in close proximity to the interstates and highways in the city. Put simply the question is: Is the Black population in Richmond Virginia disproportionately exposed to these pollutants? Additionally, my paper seeks to identify the contributing factors, the actors at fault, and possible solutions to mitigate disproportionate exposure.

To do this my paper first details the historical context of roadway construction through the city. This provides a greater understanding for what neighborhoods were most impacted by the introduction of major roadways and subsequently were exposed to heightened levels of traffic related pollutants. Next, I employed ANT analysis to build an actor network and examine the power structure of the system. This also allows for insight into how possible solutions could influence the system as a whole. From this it was clear that the state and national government in tandem with the EPA should be targeted to enact legislation to mitigate disproportionate exposure as they have the largest influence over the system.

By overlaying racial density maps of the city with VDOT's traffic volume maps, I found that 59.04% of roadways with over 50,000 vehicles per day bisected neighborhoods with the majority of residents being Black, who make up only 30% of the population of the city. With this finding I concluded that the Black population is disproportionately impacted by traffic related pollution. Additionally, I found that this level of exposure may be detrimental to resident's health by comparing the results of a study done in Montreal with similar traffic volume as is present along sections of I-64 in Richmond. Following this the paper discusses potential solutions which focus around reducing emission quantities, ensuring equal access to public transportation, and utilizing legislation that calls for equal access to clean air and establishes legal grounds to hold governmental bodies responsible when equal treatment is not met.

My technical project is a product that seeks to add novelty and creativity to the growing sport of indoor rock climbing. The current model for climbing route creation in an indoor gym is limited and remained largely unchanged since the origin of the sport. Climbing hold locations are constrained to a fixed grid of nuts that are drilled in to the wall. Additionally, once placed the holds are stationary. The Rock-Slide is a product that eliminates these constraints.

Knowing the limitations of the current model, the Rock-Slide was designed to meet a number of design requirements. It must contain a hold that moves linearly and continuously across the wall, reversing the direction when the limit of its actuation is reached. Additionally, the hold must be able to lock in place at any point along its path. By doing this, the Rock-Slide brings novelty and a greater range of creativity to rock climbing by introducing a moving hold to the climbing route creator's toolbox. With the option to lock the position of the hold at any point in its path the route creator also has the option of placing a hold in a position that would otherwise be inaccessible to the fixed grid of nuts.

To create a versatile and easily usable product a few more requirements needed to be met. Firstly, the product needed to have a small enough footprint and have the ability to be mounted anywhere on a standard climbing wall. Secondly, the linear actuator would need to produce enough torque to move the weight of a human hanging on the hold. Finally, the Rock-Slide would need to function entirely on batteries to avoid the need for a wall outlet. The details of how these limitations are met, the technical design of the product, and the challenges my team encountered are explained in the technical report.