

## **Thesis Portfolio**

### **The Smithinator: Recumbent Vehicle Design and Entry for the 2020 ASME Human-Powered Vehicle Challenge**

(Technical Report)

### **The Constraints on Bicycle Life in the United States**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia

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Bradley Mahaffey  
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Department of Mechanical and Aerospace Engineering

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## **Sociotechnical Synthesis**

### Introduction

For this thesis, the constraints of bicycling life in the US were, and were compared with the more successful systems of Amsterdam, or the Netherlands as a whole. Fittingly, the engineering capstone for this essay was to re-design the human powered vehicle and compete against other universities in the speed, endurance, and overall design of the vehicle. In the fall, designs were drafted and simulations were carried out, while in the spring manufacturing of the vehicle and competing was the main goal. In the STS analysis, it was stated that some changes would be necessary if America were to attempt to achieve a similar system to that of the Dutch. Often, the first solutions proposed are policies or regulations that force or highly encourage a population to use a new technology. However, as engineers, it is our job to make technology more appealing and efficient. We set out to make our design more favorable to the consumer, and hopefully make cycling options a more feasible reality for more Americans that rely on cars for transportation.

### Technical Topic Summary

When developing a human powered vehicle for the American population, our team of mechanical engineers first anticipated that comfort and ease of use is paramount for the average American. By surveying approximately one-hundred individuals, it became clear that Americans look for comfort, ease of use, and speed when considering the purchase of a bicycle. We took these results into account when choosing major aspects in our design. Our research team determined that a recumbent bicycle, complete with a fairing for weather protection, would be best for the longer, less congested roads with bike lanes in the US. The frame of the bike

included a roll-over protection system (RPS) if the vehicle was knocked over, along with including a safety harness which the rider would wear in the seat for additional safety. The drivetrain is a single derailleur, single chain with rear wheel driving. A chain gobbler is ideal to adjust for different heights and sizes of riders, allowing the seat to be welded into place onto the frame. Due to the front two wheel tadpole design, a steering system is necessary. Direct connections with both wheels to two handle bars were made, and using ackerman steering, we reduced the steering and slipping of the tires on sharp turns. This system utilizes a trapezoidal design to turn wheels at a separate rate from each other, keeping both perpendicular to a central turning point, and not parallel with each other.

## STS Summary

Constraints on cycling in the US stem from political, cultural, physical, and environmental factors. When compared to successful cycling cultures in Europe, or specifically Amsterdam, it is clear that the physical landscape and overall environment/climate is incredibly different than many areas in the US. These factors like warmer or colder climates, greater spreads of cities or towns, or different geographical barriers, make the US cycling issue all the more difficult to solve. Politically, there are actually many feasible solutions that the US can implement that are similar to the Dutch. The Netherlands have made multiple advancements in public policy and infrastructure by creating tax breaks, other cash incentives, and “bike highways”. All of these policies could easily be enacted in similar ways in US cities. Lastly, and possibly the most difficult challenge, is American culture and its view on the bicycle. Americans, through individualist and consumerist aspects of culture, don’t seem to recognize the benefit of carbon neutral transportation, or road-space rationing, and prefer to buy more comfortable

transportation like cars or use taxi/ride-share services. American cities and the suburb are deeply engrained into the culture, making distances between one's work and one's home practically dozens of miles away. These factors discussed are the key agents in inhibiting cycling from becoming prominent in the US.

## Reflection

While working on both of these topics throughout the year, it was interesting to see how much work needed to be done on a social level if our vehicle was to become the next iteration of cycling in the US. While learning how to manufacture metal pieces, weld, and assemble bike pieces, it became increasingly difficult to find necessary bike pieces we wanted. One of our goals was to make the bike cost efficient, but we quickly realized that many of the pieces that we needed were simply too difficult to find or expensive to purchase alone. We found ourselves working every day on machining new parts, or making sure that parts ordered from different companies could work together. Most recumbent bikes cost around three thousand dollars, while our custom built design with a carbon fiber fairing cost around five and a half thousand. We also realized that there were very few locations that sold recumbents for us to analyze in person. These factors showed us that if there was a company that began selling our design, the demand from the American people wouldn't necessarily be there, and make our hopes for changing cycling culture economically impossible.