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

(Technical Paper)

The Constraints on Bicycle Life in the United States

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

For many people all over the world, a bicycle is all that they need to travel on it. While many other cultures remain dependent on the bicycle as a means of transportation, cars have become a necessity in American life. As global emissions increase, finding forms of transportation that cut down on fuel consumption is paramount. In 2019, I worked in a team with thirteen other mechanical engineers, tasked with creating a human powered vehicle for the national ASME competition. We wanted to focus on creating a bicycle or tricycle that would get consumers interested in switching to a more environmentally friendly method of transportation. Our design is made to make cycling more comfortable and more applicable to the American commute and lifestyle. However, the STS research focuses on and analyzes what roadblocks are preventing bicycle culture from coming to the US, and determine what it would take to compete with other bicycle capitals of the world. These roadblocks range from social to geographic strains, which may have been solved in other bicycling cultures, specifically in Europe and Asia. Ideally, the STS paper will seek to highlight the largest problems preventing mainstream bicycle use in the US.

Technical Topic

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.

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 vehicle will have three wheels, allowing the user to not worry about balance and allow for easy stop and go traffic if one were commuting on a main road with cars. Recumbent bicycles and tricycles allow the rider to sit in a reclined position and pedal with the most efficiency and ease, compared to regular bikes. A tadpole design, meaning two front wheels, (Figure 1.1) was chosen due to its greater stability at the expense of a smaller turning radius. Ideally, our team wanted to implement a 70-30 front to back weight distribution as recommended through various research sources, mainly citing . 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. The constant location of the seat on the frame allowed a relatively constant

center of gravity despite rider height. The crankset and cassette allows eleven gear options for different inclines, with the lowest gear producing a max speed of approximately 25 miles per hour.

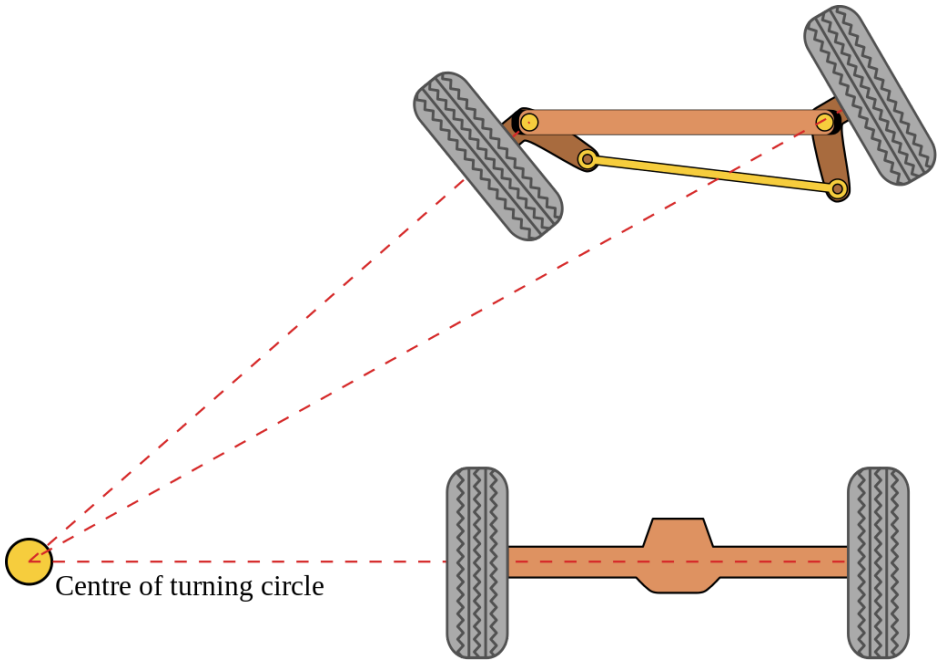

Figure 1.2: Ackerman Steering System, showing trapezoidal design and wheel rotation compared to a central turning point

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 (Figure 1.2), 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. The underseat steering allowed the rider to get in and out of the vehicle easily and allowed for better visibility.

Innovation and sustainability are the final two components we wanted to address in our design. We planned to make the vehicle using primarily old bicycling parts, and recycling scrap metal. Recycling parts allows the vehicle to be truly carbon neutral. Next, we did extensive

testing in a motion capture biomechanics lab, creating measurements for an ideal efficiency for cycling over an extended period. Force loads on pedals and strain on muscles were analyzed and body orientation was perfected as much as possible on the constructed frame. Lastly, the vehicle was designed to have brake charged lights for braking, to allow cars and other bikes to be more aware of the vehicle.

With each of the above parts and ideas implemented in our design, we believe that this vehicle will be efficient, consumer-friendly, and comfortable. Ideally, the product will be a stepping stone to increasing cycling commute in the US, and allow for a more sustainable, environmentally friendly US commute system.

STS Topic

Throughout the twentieth century, the US has demonstrated a strong connection with the automobile, but seems to have forgotten the usefulness of the bicycle. The average US family owns 2.28 cars, and seventy six percent of commuters drive alone to work each day. Why is the car so necessary in the US? Why is it favored over the bicycle?

One could argue that the US is much more spread out compared to that of Europe, particularly Amsterdam (Oosterhuis). The average American drives a thirty minute commute to his or her work each day, and the american suburb is most likely to thank for this lengthy commute. Americans have always enjoyed the luxury of having a large house, a plot of land, and more privacy than Europeans. Despite the boom of suburbia in the 1950's, the 1980's and 90's saw greater rates of return to the cities, as they become safer and better run (Wray). This created a spike in cycling commute to the American populous, mainly because when living in a city,

benefits of owning a car are scarce to that of owning a bike. But even if we were able to change the social ideology of Americans living in a cookie cutter home an hour out from their work, and allowed them to move closer together, what would American cities and towns need to do to catch up to the European counterparts?

Firstly, to make a city safer would mean a significant cutdown of crime and poverty, allowing citizens to feel safe driving exposed cycles to work, and leaving their bikes chained to outside bike racks. Many European cities have socialized welfare and support systems for the poor, and the population is well-educated enough to find stable employment easily through public or private industry. The likelihood of America to transfer to European socialism is very low, and its merely presented as a notable difference and ideal solution. Even with the idyllic cycling lifestyle of Amsterdam, which continues to be described as the perfect system, is showing signs of failure with the migrant influx, creations of private schooling, and private healthcare to compete with public versions, and more. It is necessary to keep in mind that there is no perfect solution, only drawing possible recommendations from research. Many American cities lack biking lanes, bike racks, rentals, and policies that allow for cycling to flourish.

Another aspect constraining the US to accepting bicycle culture may be a mental one. The US tends to keep an association between adolescence and cycling (Sigurdardottir). Not owning a car is a peculiarity in the US, especially in the suburbs. Americans view cycling as cheap, and juvenile. Perhaps if a person does not own a car, they are unable to deal with the responsibilities that come with owning one. This is most likely linked to a larger statement on the concept of consumerism that is so commonly associated with American culture, and these are concepts that many Americans should be aware of.

Americans, in general, are individualistic and capitalistic than their European counterparts. Thus, Americans are less likely to choose a more difficult, expensive, or uncomfortable method if it is for a greater communal good (Norcliffe). For any technology to succeed in the US, without the populous itself changing its culture, it needs to coact with these values. The bicycle may be redesigned to fit American needs, if we are to cut down on global emissions. Showing Americans improvements to the human powered vehicle on comfort, efficiency, cost and ease of use to the common car amy push them to switch.

Lastly, it is important to analyze some limiting factors that there is no possible solution to. One of these limiting factors is weather and climate. American cities experience a diverse set of temperatures and weather throughout the year. Many cities, such as Los Angeles or Dallas, maintain incredibly high temperatures, while cities like Boston and Chicago experience incredibly low temperatures and snow hazards. These conditions can be amplified in thousands of other towns and suburbs throughout the US, and makes the idea of non-air-conditioned commute seem more unappealing (Nankervis). Much of Europe has a constant climate, especially mediterrean areas.

Despite all of these issues blocking cycling from flourishing in the US, most of which can be circumvented through education and adjustments to American mindsets. All of the physical and social barriers in this problem can be referred to as actors in a network preventing widespread bicycle use in American life. Thus, actor network theory is the optimal STS theory of explaining this topic. The American heartland will always favor cars over human powered vehicles, and the American highway will most likely continue to be dominated by cars, but the

one hope is that the American commute will be changed to a more sustainable, healthy system with the bicycle.

Research Methods

When asked "What are the constraints of cycling culture in American society?", several research methods are available. Firstly, historical case studies help contextualize the development of the American commute structure. Second, policy analysis can be used to research the systems in place supporting bike culture in the Netherlands, while contrasting those of the US. Next, discourse analysis can provide broader perspectives on the general view of bike culture in the US, and can be combined with network analysis to examine the relationships between american social institutions and its general discordance with cycling.

Conclusion

In the ASME HPVC project, we sought to improve the American commute by constructing a more user-friendly human powered vehicle that could apply itself more specifically to the American system. The implementation of each section of the bike was designed to maximize efficiency, ease of use, and comfortable. It is important to investigate the general social and physical barriers blocking greater bike use in the US. Much of the discourse comes from American social norms, in that much of America live further away from their European counterparts, and tend to prioritize individual luxury over efficiency and sustainability. American social structures favor automobile transport, and much of this can hopefully be solved by presenting research and information in support of transition to a more bicycle friendly culture.

In total, we hope that our machine design can serve as a prototype for future companies and industry to create a bicycle to shorten the discourse between American culture and cycling, while presenting that the reasons for this discord are not as permanent as one may think.

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