Thesis Project Portfolio

Human Powered Vehicle

(Technical Report)

How Consideration of Disability Improves Interactive Innovation in Engineering Education

(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

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Department of Mechanical Engineering

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Sociotechnical Synthesis

My sociotechnical engineering projects this past year have focused on an overarching topic of designing inclusively for all potential users. Due to the fairly rigid structure of my technical project, I was able to explore more openly the problem of engineering products that are usable for people of all skill levels and all levels of disability. While I started with designing for a competition, research and new skills showed how engineering design can be ethical and provide social good.

My technical project resulted in a complete design for a three-wheeled human powered vehicle (also called a trike), fully modeled in SolidWorks. All of the parts had been ordered and the trike was far along in the building process when the pandemic forced us to halt production. We would have competed in the American Society for Mechanical Engineering (ASME) endurance races that our trike would have participated in had they not been cancelled. The primary considerations in our design were stability and rider safety, followed by the efficiency of pedaling by the rider. Our design featured a required rollover protection system (RPS) that ensured the rider's head would be safe in case of a crash, and the three-wheeled design in a tadpole configuration (two wheels in the front, one wheel in the back) meant that the bike was far less likely to tip or turn over than a two-wheeled version, while maintaining superior aerodynamics over a four-wheeled vehicle. Other major design decisions on the frame of the vehicle included recumbent seating (lying-down position), for lower center of gravity and better ergonomics, and steel tubing as the material due to the low cost and ease of bending and welding. In addition to the virtual model and partially-complete finished product, the team wrote a detailed report that was submitted to ASME for judgement, specifying all design choices, rationales, and testing processes, such as the welding tests performed to provide the factor of

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Finally, if you have changed any of the fonts, make sure they are at least consistent across all titles and text.

Commented [MOU3]: Not sure what you are getting at the phrase that begins this sentence. What was the significance of the rigidity? Did it make the need for inclusive design clearer or did it mean that you could only really explore inclusivity in your STS research?

safety in the frame. Due to the national quarantine, this report was the only aspect judged for the competition, and the results will be released soon announcing the winners.

Commented [MOU4]: I hope your team wins. UVA engineering teams have often been compliemented for the quality of their reporting ☺.

My STS research paper focuses on the relevance of disability in engineering design, and how to include disability in engineering education. I was inspired to change my topic for the STS research paper away from my technical project when I became injured early this semester, and began to notice how challenging many things become once your mobility is limited. For the education portion of the research paper, I discussed how disability should be more of a focus in design processes when being taught to engineering students. Often the technology for disabled people comes separately after the standard engineering product is released, as engineers design towards a standard user. I also discussed how engineering education is taught to disabled students, and how to engage those students better in order to have their perspective in STEM industries. Going off of this, I suggested that engineering students should be taught to better view all perspectives in their designs, both to broaden the use of their final products to more people and to allow for disabled people to gain the same benefits as able-bodied people.

Commented [MOU5]: A really good point.

My STS research paper informed my thinking on the human powered vehicle (HPV) competition by making me realize how difficult it would be for a disabled person to use most human powered travel - despite wheelchairs being one of the most common forms. In the initial stages of research for the ASME competition, we looked through examples of past HPV designs, including one that used the mechanics of a rowing machine instead of foot pedals. Looking back now, after having done research, this design actually had a much more significant appeal. Given that this vehicle was powered by the upper body, it could provide a method for those who have lost strength and mobility in their legs to join races or could be an alternative to bicycles. My research proved to me that by placing limits on your project, such as by taking away leg power

from a bicycle, engineers come up with much more creative and inspired choices. This alone should be evidence of why including disability in design is a worthwhile endeavor for all engineers, and makes me more confident in my STS research.

Commented [MOU6]: Nice coherence overall and really good insights at the end.