Thesis Portfolio

Soft Robotic Exoskeleton for Elbow Assistance
(Technical Report)

Effect of User Groups on Co-Production Cycle of Wearable Exoskeleton Technology
(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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Spring, 2022

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Sociotechnical Synthesis

The STS thesis was centered around the question, with the commercialization of wearable robotic exoskeleton technology, how will the needs of user groups affect the co-production cycle of this technology? Wearable robotic exoskeletons are a means for those with muscular disorders to regain some of their mobility and independence. They must be designed with the goal of meeting all the needs of the user. What was concluded from this paper is that engineers have to rethink how they conduct testing, introduce the technology to the user, and then introduce the technology to society. They have to be aware of how they pose their ideas, especially in the context of disability, where ableism becomes a relevant issue. The user needs to be present in all aspects of the design process so that the design can be more widely accepted by users.

The goal of my Technical thesis was to design and create a prototype upper limb wearable robotic exoskeleton. I worked with a group of 14 others to create the entirety of the exoskeleton, but worked with a sub-team of four others to develop the degrees of freedom for the elbow joint. We chose soft actuators, more specifically McKibben artificial muscles, instead of a rigid frame so that it would be more flexible and physically comfortable for the user. During the design process we tested multiple tube designs to discern which one would produce the greatest amount of force. We initially planned to use thin McKibbens, which we would put together to make a multifilament muscle, but closing off the ends of all the tubes to one air source resulted in too many leaks. Instead, we chose a tube that was significantly larger, but provided enough force with just one filament and could be easily closed off to prevent leakage.

My STS and Technical thesis are very closely intertwined, both dealing with the overarching subject of wearable robotic exoskeleton technology. In the case of my technical thesis, my technical group requires testing and feedback in order to determine what needs to be changed in the design to improve it. Once a prototype is complete we will have user groups test the device and then use their feedback. This is similar to the conclusion of my STS thesis which examines the way in which users affect the way exoskeletons are designed.

While conducting my technical thesis, I learned about the process of creating a wearable robotic exoskeleton and which aspects my team really focused on when trying to develop one. We focused a lot on force output, comfortability, and aesthetics. Sometimes we focused more on force output than anything else because our main goal ended up being to create something that works and could actually move a limb. It was an interesting comparison to see what my team prioritized versus what other people and exoskeletons I researched for my STS thesis prioritized. It showed me what I was likely to find when doing research. During the writing of my STS thesis I learned that my team for the Technical thesis did not focus on the societal impacts of our design. We didn't take into account that our overall project could be contributing to the stigma surrounding disability and how it would affect the user's interactions with society.

The implications of the two theses are fairly similar. The technical thesis shows first hand that larger societal issues may not seem initially relevant to engineers when beginning the process of designing a wearable robotic exoskeleton. The STS thesis confirms this with examples of other wearable robotic exoskeletons and explains what user needs have to be met for the technology to succeed. Overall, the two projects show that more of the user groups' needs have to be taken into account when designing.