

Thesis Project Portfolio

Upper Limb Exoskeleton for Shoulder Joint Control

(Technical Report)

A Double-Edged Sword: How the Prosthetics Industry Perpetuates Mental Health Disorders

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

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Research in the limb-prosthetics field has advanced exponentially in the last few decades by transitioning from wood and leather models to lightweight running blades. As a result of this advancement, the social interactions between these technologies and society have changed, directly shaping limb-different people's lives (UPMC Health). New technologies like 3D printing have been a catalyst for obtaining better shaped sockets, which attach to the user's limbs. However, there is still much work to be done in order to successfully meet the needs of all the end-users, physically and psychologically. This portfolio includes two different research papers that have wearable prosthesis as a common theme. For example, the technical research paper is about finding the best prototype for an upper limb exoskeleton using soft and flexible materials with the sole purpose of providing comfort and a larger range of motion to the end user. On a similar topic, the science, technology, and society (STS) paper addresses the psychological effects using a limb-prosthesis that does not match the users' physical appearance, more specifically on children. Both papers have a large emphasis on wearable electronics, and focusing on meeting specific user's needs. The technical research paper deliverable is a soft prototype for an upper limb exoskeleton; although, the final deliverable will not be implemented in this portfolio. The STS research paper focuses on finding a way to mitigate mental health issues from the early stages of life, using the following research question: how does the prosthetic industry's failure to consider body dysmorphic disorder in the prosthesis design process affect the psychological development of children with limb differences?

The arm is a powerful tool for the human race, taking into account the three degrees of freedom of the arm, the six degrees of freedom of the wrist, and the twenty-one degrees of

freedom of the hand. The upper body is essential for the everyday life, from eating, to driving, arms are an incredible source of power, balance and precision. Exoskeleton prosthetics are wearable robotic devices that are used mainly for rehabilitation. The technical research paper is mean to design a soft exoskeleton prosthetic to help people who have had arm injuries regain their strength through rehabilitation. There is a high need for soft, flexible upper-limb exoskeletons for patients with muscular dystrophy. Using pneumatic actuators our team will create a more comfortable design that achieves multiple degrees of freedom in the shoulder joint. This paper discusses the current literature on exoskeletons, the process used to design the current model consisting of a vest and various artificial muscles, and the materials needed to generate the prototype.

Close to 92% of limb-different people have body image disorder (Shue, 2020). There are different types of prosthesis most of which can be divided into the categories: cosmetic and functional. Cosmetic prostheses simulate the patient's limb as realistically as possible while functional prostheses are practical and prioritize helping patients achieve their goals. Body image disorders are enhanced by the prosthesis industry's failure to consider the patient's cosmetic needs in the design process. Additionally, prostheses are a technology that must adapt to their users, and even though relevant innovations towards this purpose have been developed, they are not available to the public. These problems are magnified by a lack of research into the effect prostheses have on children. This negligence by the prosthesis industry leads to a question of how not considering body dysmorphic disorder in the prosthesis design process affects the psychological development of children with limb differences. To answer this question, soft technological determinism is used to study the design processes of various prosthesis design companies. The expectation of this research is to find ways to improve the prosthetics industry

and their prosthesis design in order to directly help children in need of these cosmetic and functional prosthesis. This research paper uses soft technological determinism to study the different effects the prosthetics industry has on different people, specifically children, and the effect this community has on the industry itself.

Overall, this portfolio documents the many reasons why users end up not using their prosthesis, including how the prosthesis's price, how well they look and how they fit. Throughout the STS research paper, one can see and understand the different design processes there are in creating limb prosthesis, from when the users are fitted, through rehabilitation and the aftermath, once they've gotten used to them. Similarly, in the technical research paper, one can see the different approaches taken by the team in designing the exoskeleton prosthesis, how they took these processes and made sure to take into account how the final device looks, making sure it is not something extremely out of place that would be extremely noticeable and uncomfortable to wear. Both of these papers give a holistic view to the prosthesis design process and making sure to be inclusive when creating devices that will be part, not only of people's lives, but how they present themselves to the world. This portfolio documents the importance of taking people's opinion into account when designing medical devices that they have to wear in their daily life.

Works Cited

Shue, S., Wu-Fienberg, Y., & Chepla, K. J. (2020). Psychiatric disease after isolated traumatic upper extremity amputation. *Journal of Hand and Microsurgery*, *13*(02), 075–080.

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