Thesis Project Portfolio

3D Printed Stroke Rehabilitation Exoskeleton Design

(Technical Report)

Gender Disparity in Automotive Safety: A Care Ethics Analysis of the Design and Implementation of the Hybrid III 5th Percentile Female in Accident Simulations

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The technical paper and STS research paper both revolve around the concept of mechanical designs based on the human body and address the importance and complexity of designing systems that accurately reflect human anatomy. Representing the human body through physical models is important for many reasons: it allows safety features to be designed and also allows for better care to be given, because the technology facilitates an understanding of how a body would respond in a specific situation without putting a real human at risk. It also allows for accurate mimicry for physical therapy needs.

The technical project had a goal to create a rehabilitative exoskeleton for stroke patients. Those who suffer from strokes tend to lose partial muscle function if not becoming fully paralyzed in parts of their body. It has been shown that physical therapy can help mitigate these effects and assist in regaining motor function. The rehabilitative exoskeleton design is an attempt to monitor the range of motion for the patient and assist the patient in maintaining muscle strength. The design is specific to the right arm, but can be adjusted to fit various sized arms, both in length and thickness. The exoskeleton allows for three degrees of freedom: flexion/extension of the elbow and of the shoulder, and abduction/adduction of the shoulder.

This provides a variety of motions for a patient to diversify their physical therapy. The exoskeleton also provides partial assistance, so it will allow a patient to work the muscles that were weakened due to the stroke.

The STS research paper focused on gender inequality being perpetuated throughout automotive safety designs, analyzing the issue through a care ethics framework. The hybrid III crash test dummy family is a common model used in automotive safety studies to understand how the

human body may behave in a dangerous situation. Women are at a much higher risk to suffer severe or fatal injuries in automotive accidents, the main factor is due to the only female crash test model is for the 5th percentile female weighing only 110 pounds and having a height less than 5 feet tall. Further, the Hybrid III female model is equivalent to the male model, simply scaled down to the proportions of the 5th percentile female. Both of these design aspects were choices made by the design team that inadvertently or purposefully excluded the female population from receiving accurate safety restraints in motor vehicles. Therefore, the research concluded that underrepresentation as well as misrepresentation of women as crash test dummies was a result of unethical decisions made by the design team because it failed to provide adequate care.

Working on both projects simultaneously allowed me to thoroughly apply an ethics of care to the technical design. If each project was conducted independent of the other, I think it is less likely that I would have applied care ethics as intentionally to the design of the exoskeleton. Furthermore, I was able to learn about the difficulty of designing a product that has the potential to interact with a diverse population. It is difficult but necessary to ensure that proper care is available to users of products because without equal care, certain populations will be disproportionately and negatively affected.