Prosthesis Embodiment's Relationship to Prosthesis Functionality and Appearance

STS 4500 Prospectus

Biomedical Engineering

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The University of Virginia, Charlottesville

Name: Nolan Kata

Technical Advisor: N/A

STS Advisor: Alice Fox

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Overview:

My research will be focused on identifying the effects of different design considerations of limb prosthesis as they relate to prosthesis embodiment for the patient. As an undergraduate in the biomedical engineering department at the University of Virginia, interested in prosthetic design, the results of this research should reveal effective design parameters for those designing prosthetics to increase patient embodiment, prosthesis functionality, and societal acceptance. Utilizing Value Sensitive Design (VSD) methods including value oriented semi-structured interviews, value oriented mockup and prototype deployment, and value sensitive action reflection model during the co-design process illustrates how implicit and explicit stakeholders will view the technology in society as well as the effectiveness of the prosthetic as it relates to functionality and embodiment for patients. One major goal is to challenge society's view of disabled patients as "cyborgs", or superhuman to bring forth designs that increase societal acceptance and evidently patient embodiment. To do so, the design process must heavily involve implicit and explicit stakeholders to model design considerations to capture the views of society that will elicit prosthetic embodiment in society for the patients. Overall, what combination of materials, design, functionality, and aesthetics produce the most widely accepted model for limb prosthetic embodiment in patients and their integration into society.

Positionality:

My interest in researching innovative prosthetics stems from my upbringing. My mother is an avid runner and always has been. Throughout my childhood, I was always interested in joining her on runs until she could no longer keep up with me. Prior to my introduction to running, I found my love for engineering by watching informative science shows and documentaries on the television. In high school, my love for running and engineering blossomed as I was finally introduced to STEM courses in school and participated on the track team. At home, my parents have always encouraged me to do the right thing and also put 100% effort into whatever I do. Coming from a white middle class family in a very diverse Long Island community, my experiences have helped shape who I am today. A club called peer support in high school allowed me to listen to others and better understand myself and the world around me. It is important for me to realize that I am a healthy white, heterosexual, male and the privileges that are associated with my identity. In doing so, I have learned a tremendous amount about these privileges, which still exist, that help me critically consider mine and others thoughts and actions. While I realize these privileges it is still important to consider how these privileges might unknowingly affect my work. It is because of my privileges and ability that I would like to help people through my career in the future. Combining my interest in athletics and STEM with my love for helping others. By working on innovative prosthetics, I hope to bridge the gap of ableness and bring as much ability back into the lives of the disabled. My focus on prosthesis

embodiment stems from my desire for successfully functional prosthesis to be used by all those who may need them.

Problematization:

The relationship between prosthetic design aesthetics and functionality has been a topic of ongoing debate and research in the field of prosthetics. The main actors involved in this debate are the unique patients who require prosthetic limbs, prosthetists who design and fit the limbs, the perceived outlook from society, and insurance providers who may influence the design options available to patients based on cost considerations. Instead of focusing solely on patient feedback which lacks several important stakeholders relating to embodiment, the view of able bodied people must also be taken into consideration because today, many patients struggle with society's harsh view of the disabled community as “cyborgs” or less human due to technological assistance. The issue at hand is to determine the optimal balance between functional design and aesthetic appeal as they are perceived by the disabled and society to identify the design considerations that induce embodiment for the patients and reforms society's view of those with prosthetics as “cyborgs”.

Main Argument:

How does the balance between functionality and aesthetics in prosthetic design affect patient prosthetic embodiment and well-being in society?

Projected Outcomes:

This research aims to address the problem of conflicting priorities between prosthetic design aesthetics and functionality by utilizing an approach that values patient-centered outcomes and recognizes the role of power dynamics in shaping prosthetic design. By examining the impact of prosthetic appearance on patient embodiment and well-being, the research challenges dominant ways of thinking about prosthetics and prioritizes patient perspectives and experiences. The outcomes of this research have the potential to empower patients and improve the quality of life for those who require prosthetic limbs, by providing a deeper understanding of the relationship between prosthetic design and patient outcomes and its relation to society.

Technical Project Description:

Since there is currently no technical project created, below describes the anticipatory project idea. The project that will accompany this research will take results from a designed survey to form a patient's perceived embodiment scale and a modified version also be given to those without prosthetics to assess their views on the design considerations. By doing so, the views of prosthetic users and non-prosthetic users will be encapsulated to ensure that during the co-design process of new technology, the parameters that allow the patient to feel accepted by society and also accept the prosthetic as an extension of oneself will be identified and considered. The survey will ask patients about their background relating to why they need

prosthetics, their opinions of their prosthetics, and what they would like to see from new designs. Included also will be a portion to hear the thoughts of the public to ensure that any biases from the researcher are reduced. To create a scale of embodiment, questions will be given in both short answer format and through a numbered scale (1 Bad - 10 Good) to be compiled and analyzed for embodiment from prosthesis patients and acceptance for non-prosthetic patients. This technical project will ground the value sensitive design research by incorporating the views from groups associated with prosthetics and those who are not to effectively quantitatively identify the design parameters for increased prosthetic embodiment within patients and from the perception of the public.

Preliminary Literature Review & Findings:

After reviewing many published works on prosthetic embodiment, the direction of research is obvious. Other engineers are currently working to create prosthetic designs that elicit prosthetic embodiment by working to develop neural interfaces to provide improved control and somatosensory feedback from prosthetic limbs. Other STS researchers have taken a different route to look at the view of society on people with prosthetics and how it affects their embodiment. One example of STS research discusses considering cyborg bodies through the lens of transmobility to change the negative narrative of disabled bodies as the people to take pity on or look towards for inspiration and in turn view these bodies as imaginative, playful, and mobile (Nelson, M. K., Shew, A., & Stevens, B. 2019). Challenges with both of these methods arise when it is considered that every patient is different and their idea of embodiment may be different than the next. The approaches from these groups are limited in their ability to identify prosthetic embodiment since they are not being utilized together. To accurately identify the parameters that elicit prosthetic embodiment in patients, the patients and the people must be considered to ensure that the patient feels accepted in their own skin and by those around them.

STS Project Proposal:

STS is a field of study focused on evaluating the relationships between science, technology, and society which works to help us better understand how the world is interconnected. Patient embodiment is not only associated with personal feelings about the prosthetic but also how the prosthetic is perceived by the world. This research will be done from a disability focus, to encapsulate the perspectives of the disabled that will allow future prosthetic designs to be held under more scrutiny to not only achieve prosthetic functionality which has dominated design considerations but also increased prosthetic embodiment in patients and acceptance from society. To do so, clinical prior research done by respected professionals will be utilized as well as a combination of methods from Value Sensitive Design (VSD) to fully identify the connection between prosthetic embodiment and society. Comparably, the resources at my disposal dwarf those of professionals also researching this topic, as a result, these findings are incredibly useful to my research after undergoing scrutiny. VSD is a design approach that prioritizes ethical and value considerations in the design process which can be useful when

considering the uniqueness of each patient. In the context of this research project, VSD would involve considering the values and experiences of patients and the impact that prosthetic design has on their embodiment and well-being as related to society as well. Value oriented semi structured interviews will allow for open ended discussion of prosthetics and their perception from those who wear prosthetics and do not (Vermin, S., 2022). Then a value sensitive action reflection model allows for a co-design process with impacted stakeholders to implement the findings from the semistructured interviews (Yoo, Myongjee & Bai, Billy. (2013)). And lastly, value oriented mockup, prototype deployment will evaluate the effectiveness of the new prototypes as they relate to prosthetic embodiment in patients and society (Friedman, B., Hendry, D. G., & Borning, A. (2017)). VSD is important in this context as it recognizes the role of values and power dynamics in shaping prosthetic design and prioritizes patient perspectives and experiences which modifies outdated methods of prosthetic design limited to prosthetic functionality. This aligns with the STS perspective that values the agency of marginalized communities and recognizes the role of power dynamics in shaping knowledge and technology. By incorporating VSD into the research process, the aim is to co-produce research that is patient-centered and takes into account the impact of prosthetic design on patient embodiment and well-being. This will result in a deeper understanding of the relationship between prosthetic design aesthetics and functionality and provide recommendations for design that prioritizes patient outcomes and experiences. This will be accomplished through existing patient reflections of their experiences with prosthetics, discourse analysis, and interviews from prosthetic users and non-prosthetic users. The existing patient reflections of their experiences with prosthetics will provide insight on current prosthetic design aesthetics, functionality, worldly experiences, and their impact on patient embodiment and well-being. This will serve as a foundation for the research and provide a background on the topic. Interviews will be conducted with patients who have received prosthetics to gather additional information about their experiences and perspectives on prosthetic embodiment using a narrowed scope attainable from the analysis of the existing patient reflections. Interviews will also be conducted with groups that do not have prosthetics to assess their acceptance of the designs as well. These interviews will provide insight into how patients perceive the impact of prosthetic design on their embodiment and will also highlight important parameters for societal acceptance which can play a major role in the patients perceived embodiment. Analysis will provide insight into how these groups understand and make meaning of these concepts and the values that shape their perspectives. By using a combination of value sensitive design methods, the patient will be prioritized in the co-design process in such a way that changes traditional methods of designing prosthetics to bring forth expected increased prosthetic embodiment in patients and from the perspective of society. This research will allow for a comprehensive understanding of the relationship between prosthetic design aesthetics and functionality in society and the impact on patient embodiment and well-being to be considered for future prosthetic innovations.

Barriers & Boons:

The limitations regarding this research are found when looking at my current status. As an undergraduate student in the Biomedical Engineering Department at UVA, I have access to many medical journals that can be utilized but will differentiate from the research idea proposed. In addition, conducting interviews with prosthetic users and non-prosthetic users will be rather difficult to seek out in a magnitude that will allow for validity of results. Another potential limitation is financial barriers, which can limit access to resources and technology necessary for conducting research. Additionally, as an undergraduate student, I may have limited experience with certain research methods, which could affect the validity and reliability of the results. Time constraints may also be a limitation, as completing a research project can be a time-consuming process, and balancing school and research commitments can be challenging. This could affect the validity of findings, as well as the ability to effectively engage with and understand the perspectives of the community. To offset these limitations, it would be important to consult with more experienced researchers, attend training and workshops, and engage in reading and studying to gain a deeper understanding of the research methods and techniques. Additionally, seeking out collaboration with individuals from different backgrounds and experiences can help to ensure a more diverse and inclusive perspective is included in the research. Finally, involving and engaging with the community being studied, through methods such as interviews and surveys, can help to build rapport and ensure that their perspectives are accurately represented in the research findings.

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