Thesis Project Portfolio

The development of the one-handed knee aspiration mechanism to aid in arthrocentesis

(Technical Report)

The importance of users in prosthetics design process

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

Modern society continues to innovate and improve the future of medicine. The goal for modern medicine is to find new methods, techniques, and innovations that enhance medical care further and better the quality of life for patients. The following two theses explore ideas relating to the enhancement of modern medicine.

The technical thesis sought to develop a new medical device to assist physicians during arthrocentesis procedures conducted on knee joints. Arthrocentesis is a procedure that is performed by using a syringe to extract synovial fluid from a swollen joint. The procedure is most effective at removing the most synovial fluid if the physician can use a second hand to push the fluid towards the syringe needle, commonly known as “milking” the joint. The goal for this project was to develop a one-handed knee aspiration mechanism that allows a physician to pull back the syringe plunger with one hand, thus freeing the second hand to milk the knee. The thesis details this problem’s significance and the design process to develop the final device. The final product was primarily fabricated from ASA plastic via 3D printing and successfully tested by multiple physicians.

The STS thesis explores the modern-day prosthetics industry and how users assist in the prosthetic design process in order to develop the most optimal designs and products available. Several successful prosthetic companies and their associated devices are evaluated for how they collect user data and feedback in order to inspire or innovate new prosthetic devices. The prosthetic industry heads towards an even more personalized route that uses modern-day design and manufacturing methods. These products improve the functionality and the quality of life for amputees via users’ direct and indirect incorporation into the design process.

The capstone team developed the final iteration of the one-handed knee aspiration mechanism. Multiple physicians tested the device in a dry run trial that used a paired t-test to determine statistical significance of the device comfort and if the device made the procedure easier to perform. Upon final statistical analysis, the data from this trial showed to be statistically significant, thus proving that the mechanism increased comfort for the physicians and made the procedure easier to conduct. The next steps will be to continue gathering feedback from the clinical trials in order to produce more design iterations before pursuing a patent application. The STS research introduces a conversation about the importance of users in the design process for prosthetics devices. It explores the different manners medical device companies use in order to gather user feedback and data. This user feedback and incorporation into the design process produces the most optimal device for improving the users' quality of life.

Lastly, I would like to acknowledge my teammates Victoria Annen and Emma Woessner for their dedication to completing the capstone project. In addition, I would like to thank Dr. Ian Backlund, Dr. Mark Miller, Prof. Shannon Barker, Prof. Timothy Allen, and Prof. Sean Ferguson for their assistance and guidance throughout the creation of both theses.