

## **Thesis Project Portfolio**

### **Development of a Custom 3D-Printed Ankle Brace for Chronic Ankle Instability**

(Technical Report)

### **A Virtue Ethics Analysis of Biased Data in Medical Textbook Literature**

(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**

### Sociotechnical Synthesis: Custom 3D-Modeled Ankle Brace and Medical Education

My technical work and my STS research are connected because they are both important aspects to effective outcomes for people with chronic ankle instability (CAI). CAI is the residual damage of the ankle joints caused by previous trauma such as an ankle sprain and can cause long-term pain, swelling, and weakness of the ankle joint. Both my technical project and my research paper are important to CAI outcomes; however, they explore the problem from different angles. My technical project focuses on creating a custom, 3D-modeled ankle brace that can effectively treat CAI and help users heal their ankle, whereas my STS research focuses on the broader issue of racial disparities in visualizations of ailments in an orthopedic medical textbook and the effects this has on the ability of medical professionals to accurately diagnose orthopedic conditions such as CAI. Addressing both the social aspects that influence effective diagnosis of CAI and the technical aspects for effective treatment of CAI will ensure the most ideal outcomes for those who suffer from this condition.

My technical work explores a solution to the current shortcomings of the ankle brace market in treating CAI. The issues with current braces are that they are bulky, invasive, not adjustable, and are one-size-fits all. Therefore, the goal of my capstone project was to create an ankle brace that can more adequately address CAI. My capstone team specifically chose to address lateral ankle instability, which causes the ankle joint to be more susceptible to ankle inversion, because lateral ankle sprains are the most prevalent form of ankle sprains. To accomplish this goal, my capstone team designed and iterated a custom, 3D-modeled ankle brace that targets lateral instability and reduces the inversion angle of the ankle. This functional prototype includes adjustable stability, multi-axial control, and enhanced comfort and fit. These

specifications allow users to better manage their unique needs for their CAI and the brace is a cost-effective, customized option to treat lateral ankle injuries.

My STS research focuses on the drastic effects that racial disparities in textbook visualizations of ailments can have on the effective diagnosis and treatment of medical conditions such as CAI. I specifically focus on an orthopedic textbook used in the University of Virginia orthopedic residency program to educate medical professionals and I analyze qualitative data and two types of visuals found throughout the textbook. Aristotle's ethical framework of virtue ethics is employed to explain that the racial disparities in the textbook visualizations result in worse medical outcomes for those who are underrepresented and so this piece of medical education is not a virtuous work. My claim is that author Martin I. Boyer fails to practice the professional virtue of integrity and is therefore morally responsible for producing medical education material that is racially biased. The goal of this research is to educate individuals on the harmful impacts consuming racially biased medical education materials has on creating implicit biases in individuals so that medical professionals can more effectively diagnose medical conditions.

Working on these two projects simultaneously greatly benefited each work. My technical project and the research I did for it gave me a better understanding of the orthopedic bracing market and the importance of addressing each person's individual needs, which provided me context to the importance of inclusivity and representation for all individuals. In addition, the research I conducted for my STS paper showed me the broader implicit biases that are perpetrated from underrepresentation in technologies, which inspired me to engineer a more inclusive design. Collectively, working on both pieces of work together allowed me to explore the issues of effective patient outcomes from all angles which improved the quality of each work.