Thesis Project Portfolio

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

(Technical Report)

Creating Equitable Access to Orthopedic Devices & Treatment for Low-Income Populations

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

It is the duty of an engineer to invent, design, build, and test new devices that provide a benefit to society. However, this benefit is only captured if the device is also made accessible to those who truly need it. The goal of my biomedical engineering capstone project is to develop a custom 3D-printed ankle brace for people with chronic ankle instability (CAI). The design and iteration of this device is based on problems experienced by actual CAI patients, and ultimately it aims to address common issues that these patients have with current braces on the market. One of the biggest issues in bracing – and more broadly, orthopedic devices – is the lack of accessibility to low-income populations. This is where my STS and technical research projects overlap. By identifying and analyzing the ways in which low-income people are restricted access to adequate orthopedic treatment, I will be able to introduce a new perspective into the development, testing, manufacturing, and rollout of my ankle brace. Ideally this perspective will facilitate an increase in accessibility of this brace to low-income people who need it. The ultimate goal of my thesis is to provide groundwork for any engineer designing an orthopedic device to be more inclusive.

The technical portion of my project seeks to provide an engineered solution for people with chronic ankle instability. CAI is a debilitating condition that can stem from external joint injury or neurological disorder, and plagues millions of people each year. In fact, over 2 million people in the U.S. alone suffer from lateral ankle sprains each year and approximately 40% of these sprains lead to the development of CAI. Despite this widespread need, there is not yet a sufficient bracing solution for CAI on the market. In partnership with Icarus Medical Innovations, a local medical device company, my group and I worked to develop and test a custom 3D-printed ankle brace that addresses the shortfalls of current braces on the market. The

brace features a dynamic tensioning system for adjustable stability, as well as multi-axial control of the ankle joint. The efficacy of this brace was then validated using an iterative CAD design process, patient feedback, and mechanical testing.

My STS research paper delves into the realm of orthopedic care more broadly, identifying limitations in accessibility for low-income individuals. One of the main objectives of my research is to highlight historical events and policy changes that have contributed to the system of inequity currently seen in orthopedic care. This required an in-depth synthesis of healthcare and public policy data from relevant time frames – such as the Jim Crow era – in order to analyze trends on racial and socioeconomic discrimination. Using this data, I provide suggestions on how to counteract structural inequities in the orthopedic space. Another objective of my research is to address equitable market entry strategies with the goal of increasing the accessibility of our brace, particularly in low-income areas. This task incorporated research on different clinics, health insurance plans, and physician implicit biases to help model a comprehensive strategy on allocating resources to marginalized communities.

Working on both projects simultaneously has provided unique insights and encouraged me to bridge the gap between technical engineering work and broader societal issues. By focusing on the development of this ankle brace in my capstone project, I was able to gain a deep understanding of the specific challenges facing patients with CAI, as well as the limitations of current solutions on the market. This technical knowledge was then complemented by my STS research project, which allowed me to broaden my perspective and identify the broader societal issues surrounding orthopedic care, including issues of access, affordability, and structural inequalities.