Thesis Project Portfolio

Designing and Testing a Novel Custom 3D-Modeled Post-Operative Knee Brace
(Technical Report)

Supporting Knee Joint Health to Promote Longevity and Wellbeing
(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

Tyler Burtner
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Department of Biomedical Engineering

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Sociotechnical Synthesis

Introduction

Both my STS and technical research focused on addressing and supporting knee health. My technical research, which I completed as a capstone project, involved the design, development, and testing of a novel, 3D custom modeled post-operative knee brace to address shortcomings in the current standard of care for patients following their knee surgeries. My STS research was an investigation of the large-scale effects of chronic knee pain on the population of the United States, especially those effects manifested as comorbidities to knee osteoarthritis.

Project Summaries

My STS research paper examined the economic and health burden created by the incidence of chronic knee pain among the U.S. population. I began by summarizing the prevalence of knee osteoarthritis, the most common form of chronic knee pain, and then I described the significant economic burden caused by the management and treatment of knee osteoarthritis. I continued by establishing the link between knee osteoarthritis and exercise and longevity. I not only argued that knee pain causes a decrease in physical activity, but I also inferred that a decrease in physical activity leads to a shortening of a patient's life span, as evidenced by the high incidence of comorbidities among patients with knee osteoarthritis. In the remainder of the paper, I took a closer look at knee osteoarthritis comorbidities. After determining causality, I was able to develop a model equation which I used to estimate the larger burden of knee osteoarthritis on society.

For my technical project, my team and I designed and created a custom 3D modeled post-operative knee brace with an adjustable range of motion to be used over the entirety of a patient's recovery process and rehabilitation. Our design integrates multiple features into one device: full joint-immobilization, adjustable flexion and extension restrictions, and a system for

dynamic tensioning commonly used in unloader braces. We conducted extensive material testing, and following the execution of a patient testing protocol to assess the efficacy of the brace in promoting improved patient outcomes, our novel brace will ultimately be the first custom modeled post-operative brace on the market that accommodates each stage of rehabilitation.

Conclusion

During my work on both my STS research and my technical capstone project, I found that progress in one project enriched and supported progress and understanding in the other. For example, my examination of the health and economic burden of knee osteoarthritis helped to contextualize the design of the post-operative knee brace for my technical work. In fact, the brace design is aimed at mitigating knee pain to help prevent complications following surgery, especially the development of chronic knee pain. Additionally, my work designing the knee brace helped me to gain a better appreciation for the intricacies and challenges of treating knee pain. Taken together, these projects taught me how important knee health is to supporting longevity and a good quality of life, and I learned how even small advancements in supporting knee health will bring about significant societal and personal benefits.

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