

# **Thesis Portfolio**

**Development of a Novel Lumbar Spinal Phantom for Rivanna Medical**  
(Technical Report)

**Designing for the Sexes: Accounting for Differences Between Males and Females in Hip  
Replacement Technology Research and Development and Patient Outcomes**  
(STS Research Paper)

An Undergraduate Thesis  
Presented to

The Faculty of the  
School of Engineering and Applied Science  
University of Virginia

In Partial Fulfillment  
Of the Requirements for the Degree  
Bachelor of Science in Biomedical Engineering

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May 8, 2020

Technical Team Members:  
Jacob Matriccino

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### **SOCIOTECHNICAL SYNTHESIS**

**DEVELOPMENT OF A NOVEL LUMBAR SPINAL PHANTOM FOR RIVANNA MEDICAL**  
with Victoria Parodi, Jacob Matriccino

Technical Advisor: Adam Dixon, Department of Biomedical Engineering

**DESIGNING FOR THE SEXES: ACCOUNTING FOR DIFFERENCES BETWEEN MALES  
AND FEMALES IN HIP REPLACEMENT TECHNOLOGY RESEARCH AND  
DEVELOPMENT AND PATIENT OUTCOMES**

STS Advisor: S. Travis Elliott, Department of Engineering and Society

### **PROSPECTUS**

Technical Advisor: Adam Dixon, Department of Biomedical Engineering

STS advisor: S. Travis Elliott, Department of Engineering and Society

**Socio-Technical Synthesis: Development of a Novel Lumbar Spinal Phantom for Rivanna Medical & Accounting for Differences Between Males and Females in Hip Replacement Technology Research and Development and Patient Outcomes**

My technical work and my STS research are connected primarily through the idea of medical devices, specifically highlighting the research and development (R&D) stage of technological innovation. Medical devices are any instrument, machine, apparatus, implant, or any similar article, that is intended for use in the diagnosis of disease or other conditions, and they are central to both my technical project and my research paper. However, the two works differ in the way that they explore medical devices. My technical work focuses on the development of a novel training device for medical devices, whereas my research explores the influence of sex-based bias on medical device design and patient outcomes. So, while my technical work and my STS research approach medical devices from different angles, the theme of medical devices as medical solutions for treatment, prevention, and diagnosis is consistent across both projects.

My technical work explores the idea of developing training devices for doctors learn new technologies before using them on patients. Specifically, my capstone team developed a novel lumbar spinal phantom for Rivanna Medical, a local Charlottesville start-up company. A phantom is a device that mimics human tissue for the purposes of imaging and clinical training. The device was designed to address three areas of focus: longevity, acoustic properties, and material properties. The novel phantom provides Rivanna Medical with an in-house product, support their business model by increasing company visibility and decreasing cost, and improving the longevity of spinal phantoms utilized by clinicians, ultimately delivering superior training performance.

My STS research also explores medical devices, but from a different angle. My research

focused on the influence of sex-based bias on the medical device design and patient outcomes, and explored how the presence of bias in the R&D process of medical devices have led to different outcomes for males and females. I examined the case of the hip replacement through the lens of Social Construction of Technology (SCOT) to provide understanding of the existing sex-based bias in the R&D process and its influence in order to improve patient outcomes and advance medical treatment, prevention, and diagnosis.

Working on these two projects simultaneously greatly added value to both. My technical work gave me a better understanding of the details that go into creating a novel technology and how R&D operates in a business environment, which helped me provide accurate context and background for my research paper. Similarly, the research I conducted for my STS paper helped me see how biases in the development stages impact the device design and patient outcomes. This increased my motivation to create a training device that would help train physicians to use a novel medical device that would directly affect patients. In summary, working on both my STS research paper and my technical project together this past year has allowed me to explore medical device from multiple angles and each work contributed to improving the quality of the other.