

## **Thesis Portfolio**

**Assessment of Hydrogels to Aid in Point of Care Ultrasound Barrier Reduction at the  
University of Virginia**  
(Technical Report)

**How Specific Demographics Contribute to Disparate Outcomes in the Patient-Physician  
Relationship**  
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree  
Bachelor of Science, School of Engineering

Deborah Wood  
Spring 2022

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# Sociotechnical Synthesis

STS 4600-022

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Deborah Wood

Biomedical Engineering

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments



Signature \_\_\_\_\_ Date 05 May 2022  
Deborah Wood



Approved \_\_\_\_\_ Date 04 May 2022  
Richard D. Jacques, Ph.D. STS Advisor, Department of Engineering & Society

## **Sociotechnical Synthesis** (Executive Summary)

### A Multifaceted Approach to Improving Medical Care through Patient-Physician Interactions

Point of care ultrasound (POCUS) is a technique performed and interpreted by a physician at a patient's bedside to establish a medical diagnosis. With this diagnostic tool, patients spend less time waiting to receive critical information about their disease state, access medical care or treatment to alleviate their symptoms more quickly and increase the quality of their patient-physician relationships. POCUS, however, is inconvenient to perform with ultrasound gel since physicians must wipe off the gel each time it is used and cannot reuse the material on an additional body part. Thus, my technical project centered on assessing accessible hydrogels to replace ultrasound gel for POCUS use at the University of Virginia. My sociotechnical project sought to comprehend how social aspects beyond medical device implementation play a role in medical care by determining how specific demographics shape distinct outcomes in the patient-physician relationship.

The technical portion of my thesis explored how to improve POCUS use at the University of Virginia. I initially interviewed several internal medicine physicians to determine which barriers persist for primary care physicians using POCUS. From these informational interviews, I learned that many of these barriers are institutional, such as no structured curriculum, poor machine availability, and inadequate protocols to optimize time during an examination. Therefore, I aimed to improve point of care ultrasound (POCUS) performance by decreasing the time to conduct a diagnostic exam. With less time taken for examination, primary care physicians at UVA will be more likely to adopt POCUS. My project focused on assessing how

well accessible hydrogels captured ultrasound images to determine which can most appropriately replace messy and single-use ultrasound gel.

In the sociotechnical portion of my thesis, I investigated the factors that encourage variable patient-physician interactions. Using the sociotechnical framework of Actor-Network Theory, I studied demographics that define a patient or physician's identity: age, gender, race, and income. Through case studies consisting of primary scientific literature and secondary systematic reviews, I determined that each of these factors presents opportunities for patients to experience differences in satisfaction and for physicians to differ in their modes of communication used with their patients. I then established additional metrics to alleviate the gap in outcomes that persists with the aid of four commonly touted models for the patient-physician relationship.

While replacing ultrasound gel with a hydrogel improves the convenience of POCUS, the medical system comprises more than technologies like these. There are social dynamics that medical technologies interact with while physicians provide medical treatment. I performed my sociotechnical research to connect my technical project and the social and ethical considerations that persist alongside it. I considered how patient and physician demographics provide a baseline to understand the quality of the patient-physician relationship. In this vein, I learned how productively POCUS performs in each patient-physician interaction from a social standpoint.

It is easy to believe that your technical thesis best represents what it means to be an engineer since the word refers to someone who synthesizes or advances technologies. However, you should find great fulfillment in looking beyond your technology to clearly understand at least one way that your technical work fits in the broader society outside of its obvious function. Within my sociotechnical thesis, I bridged the implications of my technical work in the hopes of

thinking about the social dilemmas following my technical work. More importantly, I have heightened my capacity to be a conscientious engineer.

**Acknowledgements:** I acknowledge Dr. Masahiro Morikawa of UVA Family Medicine for his role in advising my technical project. Dr. John Hossack of the Biomedical Engineering Department provided consultations on the construction of gel phantoms for ultrasonography and methods to analyze ultrasound image quality. I bestow additional thanks to Dr. Timothy Allen, Dr. Shannon Barker, and our teaching assistants, who provided office hours for my technical project. In culminating my Prospectus and STS research paper, I acknowledge Dr. Benjamin Laugelli and Dr. Richard Jacques.

In creating these acknowledgments, I reflect on a couple of things to guide future students. You must consider what you have previously learned in your classes and what resources you have at your disposal, such as office hours and interlibrary loans through the library system. Another thing to examine is what expertise your current mentors have to inform whom you need to reach out to for additional information.