

Thesis Project Portfolio

FEA for a Focused-Ultrasound Transducer Prototype Intended for the Pulverization of Heart Calcification
(Technical Report)

Rethinking Informed Consent: How Can Lay Patients Discern High-Tech Interventions?
(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

As a biomedical engineering student at UVA, I have dedicated the past few years to trying to learn about the processes of the human body as well as interventions that can help to address disease. That being said, when presented with my technical project for the capstone, it took a great deal of explanation and background information for me to even understand the basic idea of what was going on. This sparked my motivation for writing my STS paper which investigates the principle of informed consent in modern practice; specifically, how nonexpert patients can make informed decisions regarding advanced treatments that they may not be able to technically comprehend. I think it will become evident in my description below that the technical level of expertise required to comprehend my technical project, which is using computer simulations to assist the prototyping process for a focused ultrasound transducer, is far above that of the average patient who may have need of such eventual treatment. I thought that if it was difficult for a full-time student to comprehend this topic, it would be much more difficult for working individuals with little to no technical or medical expertise to do so.

For my technical project, I am using software called OnScale which is specifically designed to simulate piezoelectric materials, which is what an ultrasound transducer is made from. I will be using OnScale to perform simulations that will help prove the viability of a focused ultrasound prototype and after that to help optimize the design. The proposed device would be mounted on an endoscope and guided down the esophagus, then pointed towards the heart and activated to pulverize heart calcification caused by a condition known as degenerative mitral stenosis (DMS), which is a basic breakdown in functioning of certain valves in the heart. DMS is a highly fatal condition, which currently has very limited treatment options; in fact, most people who suffer from this condition already have multiple risk factors such as advanced age,

obesity, etc. This makes the present treatment options, primarily surgical interventions, even more limited in their scope, which leaves these individuals in an almost helpless state.

My STS topic is an exploration of the medical ethics concept of informed consent: its origins, how it has evolved, and its flaws and limitations in current practice. Specifically, I am interested in how someone without legitimate medical training can come to a level of comprehension sufficient to make justifiable decisions regarding their healthcare when it comes to technically complicated interventions. My technical project has the possibility to assist in the development of a product which may save many lives if it reaches market at some point given the fatality of DMS. My STS research would then encourage changes in the medical industry (at least in mindset) which would assist these individuals in making the best decisions for their own health outcomes by coming to a deeper understanding of these technologies: this can either help assuage some irrational fears or else assist patients in avoiding treatments which they determine may not be best suited for them.

Considering technical, organizational, and cultural elements is crucial to the STS process: there are many diverse actors, human and otherwise, involved in the healthcare system and thinking deeply about then expressing the interactions between them is the only way to perceive the whole picture and therefore make prudent decisions guiding research. As it stands, the process of informed consent has become a cumbersome series of documents to sign – making the patient *more*, not less, confused – as opposed to a helpful principle governing patient-practitioner interactions. STS perspectives, such as the one provided by Martin and Schinzinger in “Engineering as Social Experimentation,” are extremely supportive of ethical responsibility in engineering because they provide frameworks for analysis and can even inform a personal ethos for engineers. Informed consent in practice will be one of the beneficiaries of this improved

ethos, and the next time you go to the doctor hopefully you will have one less form to sign and one more friend to consult.