Thesis Project Portfolio

Designing a Novel Ultrasound Probe-Body Interface

(Technical Report)

Ultrasound and the Family: to Create or not to Create

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The technical project is titled “Designing a Novel Ultrasound-Body Interface.” The primary objective of this project is to find a suitable alternative to ultrasound gel, which our advisor, Dr. Masahiro Morikawa, of the Family Medicine department of the UVA hospital, finds very time-consuming and messy. Design criteria for our alternatives to ultrasound gel included that the material must have an acoustic impedance similar to that of ultrasound gel, it must be non-toxic, chemically unreactive, and must be cleanable and reusable in order to be cost-effective. Our project began with a literature search for materials that had an acceptable acoustic impedance. Acoustic impedance is a property of a material that determines how a sound wave (in our case ultrasound) will reflect or be transmitted as it travels from one material into another material. Materials with similar acoustic impedances will transmit sound waves between them with very little reflection. Reflection of sound waves between materials is something we need to avoid, as this is what creates what are called “artifacts” in the ultrasound image, which detract from image clarity. Silicone materials Sylgard-184 and Sylgard-170, manufactured by Dow Corning, were identified to have acceptable acoustic impedances to serve as a material interface between the ultrasound probe/transducer and soft tissue. They both are generally recognized as safe and unreactive, and they have the potential to tune their physical properties such as material stiffness through changing the ratio of their components. Both Sylgard-184 and Sylgard-170 are available as a mixture of a silicone elastomer base and chemical crosslinker. Increasing the ratio of crosslinker to base increases the material stiffness, and decreasing the ratio of crosslinker to base decreases the material stiffness. Samples of these materials were requested and obtained from Dow. A handheld ultrasound transducer and simulated soft tissue in the form of an orange were used in conjunction with the prepared materials to evaluate image clarity. The interfaces between the probe and the material and the material and the simulated soft tissue proved to be

major difficulties. Air was determined to be present between the materials, meaning that a clear seal between the probe and material and between the material and simulated soft tissue was not present. This was elucidated by the fact that when ultrasound gel was placed at the interfaces, a clearer image was obtained. Future efforts in this project may involve tuning the physical properties of the tissue by making it softer so that the interface between the elements has no air between it.

The STS project is titled “Ultrasound and the Family: to Create or not to Create.” This paper seeks to understand the role that ultrasound technology plays in the social creation of family, in both positive and negative ways. The use of obstetric ultrasound in pregnancies that lead to abortion is discussed, as is the role of ultrasound in the determining of sex of fetuses, which can lead to sex-selective abortion. Sex-selective abortion in countries with a “son preference” such as China is discussed, as are the demographic and social results of ultrasound-aided sex-selective abortion. These include negative social effects such as human trafficking and imbalances in the marriage market. The opinion is stated that in countries with high risk of sex-selective abortion, ultrasound should not be used for sex-determining purposes. The paper then shifts to consider the positive roles that ultrasound technology plays in the social creation of family, such as in cementing the parents’s beliefs as to the reality of the pregnancy and regarding their future responsibilities. The orientation of the law toward ultrasound technology in the United States is also considered, with mandatory viewing of the fetus before abortion being analyzed from a utilitarian and care ethics perspective. The paper concludes with perspectives on how ultrasound technology can be used to create family and also to hinder and stop its creation.