

Thesis Project Portfolio

Design of a Robotic Rat Hindlimb Knee and Hip Focus

(Technical Report)

Using Social Construction of Technology to Examine Stakeholder Influence in Limb Salvage Surgery for Patients with Bone Sarcomas

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

My technical and STS projects are related because both address how medical technology can serve patients through the development and social integration of novel medical devices that aim to restore previously lost physical function in the patient. The technical project involves the creation of a robotic rat hindlimb with a polycentric knee with the ultimate goal of improved modeling for volumetric muscle loss (VML) injuries. The STS research paper examines through the use of the Social Construction of Technology (SCOT) why limb salvage surgery has become the dominant treatment over amputation for patients with bone sarcomas. While the technical project is mainly focused on the design accuracy and biomechanical modeling of the robot, the STS paper explores how social groups, including patients, physicians, and industry stakeholders, can shape the adoption of surgical designs. The SCOT framework allows for a bridge between the two that emphasizes how technological adoption is not purely performance based.

The technical project responds to an important current need in musculoskeletal research: a cost-effective, reproducible physical model for studying VML injuries in rats. Traditional rat studies are expensive and ethically complex with the requirement of costly invasive surgeries with no recovery. To solve this, we are designing a robotic rat hindlimb with a polycentric knee joint using a four-bar linkage, which more closely replicates the natural movement and gait of a rat than the more commonly used hinge joints. Our model allows for variable muscle activation and deactivation using actuators as muscle replacements. The use of this model allows for more trials, less cost, and increased ethical compliance for research.

The STS paper explores why limb salvage surgery is now widely preferred over amputation for the treatment of bone sarcomas. SCOT emphasizes that the success of technology is not solely driven by pure function but also affected by interpretations of relevant social groups. The paper shows how patients, physicians, and the medical device industry came to a mutual

consensus from their primary needs (quality of life, prestige and innovation, and profits, respectively) being met. This analysis highlights how clinical decisions are shaped by social values and incentives in addition to clinical data.

Working on the technical project while writing the STS paper gave me a key perspective of being grounded in engineering problem solving while still identifying how the device would be viewed through social analysis. The STS research taught me to ask questions about how different stakeholders, that may not be commonly considered, will view certain aspects of the design. Ultimately, combining both projects made me a better engineer by emphasizing the social dynamics that may often be an afterthought so that they are understood as integral to design success.