Voxelated 3D Bioprinting Highly Organized Yet Heterogeneous Tissue Constructs
(Technical Report)

Disparities in Kidney Transplant Allocation in the United States: A Technological Politics Analysis
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Socio-Technical Synthesis

For my senior thesis, I explored both a technical and an STS project to better understand the socio-technical relationship that connects them. The need for reliable, efficient, and biocompatible kidney transplants is evident in society, and both the technical and STS projects address aspects of this problem from a different perspective. By addressing both the technical and social aspects of the problem, society can work towards designing a system that gives every patient equal access to a kidney transplant, whether tissue-engineered or donated. In what follows, I will summarize my technical and STS projects, and offer a reflection on what I have gained as a result of doing both projects simultaneously, as opposed to in isolation.

To aid in the public health issue of organ shortage, the technical nature of this project focused on the implementation of a novel 3D bioprinting technology to manufacture highly organized and complex pancreatic tissue constructs, in hopes of creating entire organs in the future. 3D bioprinting is a tissue engineering technique that uses 3D printing technology to combine cells, growth factors, and biomaterials to fabricate tissue constructs that mimic natural tissues. Implementing a novel bioprinting process developed by University of Virginia Professor, Dr. Cai, my team studied the rheological characteristics of the polymer-based hydrogel used for 3D printing spherical voxels. Pancreatic islet cells are encapsulated within these hydrogel voxels to create a highly organized yet heterogeneous tissue construct. Specifically, my group focused on data analysis of gel crosslinking kinetics, the influence of mesh size on biomolecule diffusion, and the effects of polymer entanglement on hydrogel properties. We derived mathematical models to characterize these relationships which can be used in the future for hydrogels of different compositions for various tissue types. Building upon our research, it is possible to

create highly organized tissue constructs that can be easily customized by changing the composition and distribution of hydrogel particles.

The STS project implemented Langdon Winner's Theory of Technological Politics to analyze inequalities in kidney organ transplant allocation throughout the United States. The multifaceted social aspects that contribute to disparities in organ allocation, specifically kidneys, was analyzed using information surrounding the number of kidney transplants per year and donor/patient profiles. Using Technological Politics, I argued that the kidney organ transplant system shapes power relations among patient populations by privileging some groups and marginalizing others based upon demographic, socioeconomic, and geographic factors.

Completing the STS project alongside my technical project has helped me to better understand the broader social implications of my technical work, and has provided an appreciation for the importance of the work outside of a lab setting. In addition, working on the STS project simultaneously has prompted me to reflect on the importance of diversity and inclusion in engineering design. I have realized that innovation without inclusivity often leads to the marginalization of certain groups, whether intentional or not. I have attempted to apply these insights to my technical work, and hope to continue to apply them throughout my career as an engineer.