Thesis Project Portfolio

Device for Automated Selection and Placement of Cell Clusters Within Biofabricated Tissue Constructs

(Technical Report)

Race and Income:

The Inequality of Organ Transplantation

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Table of Contents

Sociotechnical Synthesis

(Executive Summary)

Addressing Barriers in Organ Transplantation

Each year, over 6,000 Americans die while waiting for an organ transplant. The largest single cause of these deaths is a lack of available organs; however, inequalities in our healthcare system are also a contributing factor. Both my technical and STS projects focus on making organ transplants more accessible and effective. For my technical project, my team and I built a cell selection and placement device, designed to be adapted into existing 3D bioprinting technology. For my STS project, I investigated the technical, organizational, and cultural factors that lead to less organ transplants and worse health outcomes for minority groups.

The technical portion of my thesis produced an inexpensive micromanipulator device to aid current 3D bioprinting technologies. The greatest challenge today in conducting research on artificial tissue constructs is that bioprinters only have the capability to print homogenous, in vivo compatible, scaffolds. The process of seeding living cell clusters into this scaffold requires that the cell clusters either be placed individually by hand or be placed by a commercial cell selection device, which can cost tens of thousands of dollars. The device that my team built can be assembled from readily available parts for less than $500. It consists of a mount, a 3-axis stepper motor system, and a micro syringe apparatus. The stepper motor system and micro syringe are controlled by an Arduino Uno, which can be connected to and controlled by any computer. The 3-axis stepper motor system allows our device to position its syringe at any location with a precision of 100 microns. The micro syringe apparatus gives our device the ability to aspirate and place cell clusters with a diameter greater than 500 microns. Our device

will make it possible for vastly more research to be conducted on artificial organs by removing the need for a prohibitive amount of work to be done to seed cell clusters into bioscaffolds.

In my STS research, I investigated the barriers that exist to organ transplantation for different minority groups using Tomasso Venturini's research method of Actor Network Theory and the cartography of controversies. Press et al. (2005) describes how minority racial groups receive proportionally less organ transplants and worse health outcomes than their white counterparts. My analysis of these inequalities revealed that the barriers to transplantation can be broken down into three distinct categories: technical, organizational, and cultural barriers. This breakdown allows the huge sociotechnical system of organ transplantation to be better understood by lawmakers and researchers so that improvements can be made to address the inequality within the system.

When put together, my technical and STS projects represent two different approaches to improving the same field: organ transplantation. While my technical project aims to accelerate the production of a future technology, artificial organs, my STS project provides recommendations on how we can improve our current organ transplantation system to make it more equitable. Additionally, one of the main conclusions of the technical category of my STS research was that future technological advances, such as the implementation of artificial organs, will make organ transplantation more equal. My STS research exemplifies the themes of STS 4500 through its analysis of a real life sociotechnical system. My technical project exemplifies the themes of STS 4600 through my team's compliance with the professional standards of our advisor and medical device regulation

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