Thesis Project Portfolio

Microdevice Enabling Long-Term in Vitro Studies of Biofabricated Constructs

(Technical Report)

The Role of Psychological Wellness in Type 1 Diabetes Management

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Executive Summary

While the topics of my capstone project and my STS research project are not explicitly related, my interest in both is a result of my passion for medicine and its intersection with engineering. The primary motivation for my capstone project is to build a tool that allows for accurate modeling of complex tissue and disease state and progression. Advancement of the biomedical engineering fields of tissue engineering and disease modeling is integral to improving our medical capabilities and the quality of life of a large portion of the population. One disease that could potentially be cured through tissue engineering is Type 1 Diabetes, which is the focus of my STS research paper. The motivation for this project was to analyze how T1D treatment can be improved in order to improve patient quality of life by increasing mental health care and resources. This topic was of particular interest to me as a recently diagnosed type 1 diabetic, and so my personal experience as a patient and my passion for medicine and engineering were merged in working on both projects.

The technical project achieved the goal of designing, fabricating, and iterating upon a microfluidic device designed to contain and stabilize granular hydrogels for long term *in vitro* cell culture. Granular hydrogels are an important area of research in tissue engineering and disease modeling because they allow for increased cell mobility and reagent exchange, and features such as biological fibers can be easily printed into these granular particles. My partner, Joshua Goedert, and I designed and fabricated various devices with different key features, such as perfusion channels, and performed differing tests to validate their usability. Additionally, we designed and fabricated a photomask to fit on top of one of our device designs, so that we can selectively crosslink hydrogel to form varying features. Our work on this project has been

important to advancing the study of granular hydrogels and the use of microdevices to culture cells and model complex tissue structures.

The research paper examines the connection between mental well-being and Type 1 Diabetes management, particularly at the interface of health care and standards of treatment and the physical and emotional burden of disease management. The term “diabetes distress” refers to the kind of burnout that T1D patients experience as a result of the demanding nature of disease management, and this distress often causes negative disease outcomes. The question to be answered in this paper is: How does the psychological condition of Type 1 Diabetes patients impact their ability to manage the disease, and how can standard treatment plans change to take this connection into account and improve disease management. The answer to this question is formulated through discourse analysis of the topics of diabetes distress, the current diabetes care, and other relevant subjects. Analysis is performed using the Wicked Problem framework common in the field of STS. By answering this research question, improvements can be made to the standard of medical care for those with diabetes, improving quality of life and decreasing the chances of serious disease complications by promoting the importance of mental health.

Working on both projects simultaneously has allowed me to expand my understanding of what it means to be an engineer, especially in the medical field. Although all engineers must take the social implications of their work into account, it is specifically important in biomedical engineering to keep all aspects of health, disease, and patient experience in mind. Although this technical project was relatively far removed from any sort of clinical application, as it is intended to be a tool to promote further research in the tissue engineering field, performing the research and analysis for my STS paper served as a constant reminder of the true motivation behind both projects: making people’s lives better. As an engineer, there is a drive to create some technology

that is efficient, effective, and solves some sort of problem. The field of STS is integral in providing context to the problem at hand, as well as shedding light onto what kinds of solutions are viable in our complex society. Conducting research on the intersection of mental health and T1D has allowed me to develop a unique perspective on the importance of biomedical innovation, such as that demonstrated in my technical project.