Thesis Project Portfolio

Elucidating Plectin Specific Pathways to Develop Novel Pancreatic Cancer Therapies
(Technical Report)

Systemic Failures in Medical Devices: An Actor-Network Theory Analysis of the DePuy ASR Hip Implant Recall

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

Zachary Jung – April 25, 2025 – STS4600

Sociotechnical Synthesis: Hip Implants and Pancreatic Cancer

In my technical project, I am investigating the role of cell surface plectin (CSP) in pancreatic ductal adenocarcinoma (PDAC) using a tetracycline-inducible CRISPR/Cas9 gene-editing system. This system allows for the precise modulation of gene expression in cancer cells to better understand how CSP contributes to tumor progression and potential resistance mechanisms. To carry out this work, I have constructed a network of human and non-human actors—including lentiviral vectors, gene-editing components, PDAC cell lines, and regulatory transcriptional elements—all coordinated toward the goal of studying cancer-specific vulnerabilities. To gain insight into how such biomedical networks form, stabilize, and sometimes fail, my STS research analyzes the 2010 recall of the DePuy ASR hip implant through Actor-Network Theory. In this case, DePuy functioned as the network builder, assembling a system of surgeons, regulatory bodies, patients, and medical technologies around a device that ultimately caused harm. By studying the collapse of that network, I hope to better understand the dynamics and ethical stakes involved in constructing reliable and responsible networks in biomedical innovation—insights that directly inform the challenges encountered in my own technical work.

The technical component of my work focuses on designing a tetracycline-inducible CRISPR/Cas9 system that allows for conditional knockdown of the PLEC gene in PDAC cells. By delivering this system using lentiviral particles and inducing gene editing with tetracycline, I can temporally control Cas9 activity and investigate how loss of surface-localized plectin affects cancer cell proliferation, migration, and resistance to therapy. This design enables both functional investigation of a novel cancer biomarker and the potential development of targeted treatments that exploit its mislocalization to the cell surface.

My STS research paper, by contrast, investigates how medical technologies can fail when their surrounding networks become misaligned. Using Actor-Network Theory as a conceptual framework, I argue that the DePuy ASR hip implant recall reveals systemic failures in the medical device industry by showing how profit-driven decision-making undermined a network built around patient care. I examine how DePuy acted as a network builder, enrolling surgeons, patients, and regulators into a socio-technical system supported by marketing, surgeon incentives, and regulatory approval pathways. I show how both human and non-human actors—including the implant itself—contributed to the network's collapse, and how inadequate post-market surveillance, biased training, and suppression of risk data destabilized what initially appeared to be a functional medical technology.

Working on these two projects simultaneously allowed me to explore biomedical innovation from both technical and sociological perspectives. My technical work gave me firsthand experience in assembling and managing a complex network of tools and biological systems to answer a research question. At the same time, my STS research reminded me of the ethical responsibilities that come with creating medical technologies. It prompted reflection on how easily trust can be eroded when safety is deprioritized, and how essential transparency, accountability, and critical feedback are in the design and deployment of new tools. Going forward, the insights I gained from studying network failure in my STS research will influence how I approach the design and implementation of future biomedical technologies—by ensuring that scientific rigor is matched by ethical and systemic responsibility.