Thesis Project Portfolio

Strain Gauge-Based Torque Sensor for Orthopedic Surgery Applications

(Technical Report)

The Cost of Complacency: Moral Responsibility in the Space Shuttle Columbia Disaster

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis: Informed Decision-Making in Engineering Systems

My technical project and STS research paper are connected through the concept of informed decision-making within complex sociotechnical systems. While these projects may not seem directly related at first, a deeper inspection reveals the correspondence between them. In my technical project, my team and I designed a device that increases orthopedic surgeons' decision-making ability by providing them with real-time feedback about bone characteristics. In contrast, my STS research paper examines the Space Shuttle *Columbia* disaster and the critical warning signs that were overlooked. When viewed together, these projects illustrate how the communication and interpretation of vital information impact responsible decision-making.

My technical project focuses on equipping orthopedic surgeons with the information necessary to enhance decision-making during operations. Currently, no technology exists that provides surgeons with immediate feedback regarding bone strength while drilling pilot holes for screws, plates, and other fixation hardware. As a result, doctors rely primarily on their intuition and experience, which can lead to complications when working with poor bone quality such as improper healing. To address this problem, my capstone team designed a device that attaches to a standard orthopedic drill, transmits real-time bone characteristics via an RGB LED, and stores the data to a CSV file for post-operative analysis. Future iterations of the device will consider the axial force component on torque measurements as well as wirelessly transfer data to a computer, providing surgeons with more information during procedures. By producing quantitative, real-time insights about local bone attributes, this device seeks to enhance decision-making and reduce surgical complications.

My STS paper also explores the theme of informed decision-making, but from an ethical and sociotechnical perspective. Specifically, it examines the key actors involved in the Space

Shuttle *Columbia* disaster to determine who bears moral responsibility. Although the *Columbia* accident occurred in a complex system, there were several warning signs that could have prevented the disaster had they been acted upon. Through the use of the STS framework Actor-Network Theory, I identify each major contributor to the tragedy and how they interacted to form the system. Then, I apply the ethical Responsibility framework to assess the extent to which each key human actor meets the conditions for blameworthiness. My analysis concludes by placing accountability on the chairwoman of the Mission Management Team, Linda Ham, due to her neglect of potential problems raised during the mission.

Working on these projects concurrently has given me a more holistic perspective of engineering as both a technical and ethical discipline. My technical project illustrated the role engineers play in supporting informed decision-making through the use of tools and data, while my STS research made me more aware of how lapses in communication and accountability can lead to catastrophic consequences. This past year has inspired me to think more critically about how engineering solutions contribute to, or hinder, educated decisions within broader sociotechnical systems. In the future, I hope to approach projects with a greater awareness of both technical obstacles and the human contexts in which they operate.