

Thesis Project Portfolio

Development and Evaluation of a 3D-Printed Adapter for Docking Hohmann Retractors to Weitlaner Retractors

(Technical Report)

Constructing Failure: A SCOT Analysis of Modular Titanium Alloy Neck Adapter (MTANA) Breakdowns in Hip Replacement Systems

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Spring, 2025

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Sociotechnical Synthesis

Medical Device Design & the Social Construction of Success & Failure

The development of medical devices sits at a complex intersection where engineering design meets human factors, institutional constraints, and diverse stakeholder priorities. My technical project and STS research paper explore complementary perspectives on this relationship. While my technical work focused on creating a novel 3D-printed adapter to improve surgical workflow in Orthopaedic procedures, my STS research examined how competing interpretations of "success" among different stakeholders contributed to the failure of Modular Titanium Alloy Neck Adapters (MTANAs) in hip replacement systems. The connection between these projects lies in their shared exploration of how technical design choices and sociotechnical factors influence the ultimate success or failure of medical devices.

My technical project involves the development and evaluation of a 3D-printed adapter designed to dock the Hohmann retractor onto the Weitlaner retractor during Orthopaedic procedures. The posterolateral approach for open reduction and internal fixation (ORIF) of fractures typically requires multiple surgical assistants to maintain proper tissue retraction. Our adapter addresses this challenge by enabling hands-free retraction, potentially improving surgical efficiency and reducing dependency on additional staff. Through an iterative design process, we developed prototypes using Autodesk Fusion and tested them in both simulated environments and cadaveric specimens. Material selection proved critical, with Nylon PA12 emerging as the optimal choice due to its balance of tensile strength, sterilization compatibility, and cost-effectiveness. Feedback from Orthopaedic professionals indicated that the adapter was easy to use, provided stable retraction, and could potentially save significant time during procedures.

My STS research paper employed Wiebe Bijker and Trevor Pinch's Social Construction of Technology (SCOT) framework to analyze the failure of MTANAs in hip replacement systems between 2004 and 2013. I argued that the MTANA crisis emerged not from isolated engineering miscalculations, but from the co-construction of risk by three relevant social groups: surgeons who prioritized intraoperative flexibility over long-term biomechanics, manufacturers who leveraged modularity for market differentiation, and regulators who applied inappropriate equivalence standards to novel material configurations. The paper examined how the interpretative flexibility of "success" among these stakeholders permitted the widespread adoption of a fundamentally unstable implant. The SCOT analysis revealed how competing priorities and power dynamics shaped the trajectory of this medical technology, demonstrating that technologies stabilize not because they are objectively safe but because powerful institutional players define problems and solutions in ways that suppress disconfirming evidence.

My STS research on MTANAs heightened my awareness of how different stakeholders' priorities can influence device adoption, sometimes at the expense of safety. This understanding directly informed my technical work, where I carefully balanced the needs of surgeons (ease of use, workflow efficiency) with material considerations and patient safety concerns. Conversely, the practical challenges of my technical project—navigating material constraints, user preferences, and regulatory requirements—gave me concrete experience with the sociotechnical negotiations I was analyzing theoretically in my STS research. Both projects reinforced that successful medical device design requires not just technical excellence but also an understanding of how devices function within complex sociotechnical systems where success is socially constructed through the interaction of diverse stakeholders with different values and priorities.