Design and Construction of a Half Humanoid Half Rotunda Robot: Rotundaur
(Technical Report)

A Care Ethics Analysis of the Boeing 737 MAX Crashes
(STS Research Paper)

An Undergraduate Thesis Portfolio

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Socio-Technical Synthesis: Tour-Guide Robot and Ethics in Aircraft Development

While my technical project and my STS research are not directly correlated, they are linked by the need to balance the technical goals of a mechatronic product and the needs of the user or consumer intended to use the product. Mechatronics, which is the synergistic implementation of mechanical engineering, electrical engineering, and computer science is the foundation of the technologies studied in my technical and STS projects, a robot and an airplane, respectively. My technical project focuses on designing a mechatronic system to best engage an intended user, while my STS research demonstrates the difficulty professional engineers can have balancing the needs of the user, the technical goals, and the financial needs of his/her company when developing a complex mechatronic system. While my technical and STS projects fall under different fields (robotics and aviation), the lessons learned from both projects related to prioritizing the user during the development of a mechatronic system is common.

My technical project investigates designing and building Rotundaur, a user-focused "tour-guide" robot for the Mechanical and Aerospace Engineering (MEC) building to interest prospective and current University of Virginia (UVA) students in Mechanical Engineering (ME). The project focused on designing Rotundaur to be capable of maneuvering throughout the second floor of the MEC building in conjunction with an interactive user-interface. My capstone team and I custom designed and fabricated the structural and aesthetic components of Rotundaur; utilizing 3D printing technology and mechanical components to create the appearance of a half humanoid and half Rotunda robot. Additionally, our team interfaced the mechanical parts, electrical circuits, and code making up Rotundaur to create engaging user-interactive features such as; "puppet mode," where the user can move Rotundaur's arms and then have Rotundaur repeat back the movements; and, a mecanum wheel drive train that the user can control using a

wireless controller to move Rotundaur in any direction, including side to side or diagonally, without changing Rotundaur's orientation. Rotundaur in the future will be used to complement tours given of the Mechanical Engineering Department to prospective students. The main objective of Rotundaur is to inspire interest in Mechanical Engineering by demonstrating the amazing things that can be accomplished using mechatronics and the knowledge gained during the pursuit of an ME degree at UVA.

My STS project, while in a different sub-field of Mechanical Engineering than my technical project, also explores creating a mechatronic system with mobility as the chief technical goal. However, my STS research displays what can go wrong when engineers do not enough prioritize the user's needs, such as safety, during the system's development. My research examines the ethics of Boeing's unsuccessful development of its 737-MAX aircraft which resulted in two catastrophic crashes. The 737-MAX aircraft, in which Boeing sought to integrate larger engines for greater fuel efficiency and a new automatic angle-of-attack correction software system, reveals the potential dangers of a poorly implemented mechatronic system. Instead of synergistically working together, the computer software forced the mechanical components to behave disastrously unexpectedly. Using Tronto's theory of care ethics, my paper demonstrates how Boeing failed in the development of the 737-MAX to uphold its duty of care owed to society and argues that Boeing should be held morally responsible for the plane crashes. My paper examines the duty of care engineering companies owe to society and points out the collective responsibility of all individuals in a company share to uphold this duty of care. The main objective of my research is to emphasize the paramount importance of consumers and their safety when designing and certifying products as a professional engineer.

Working on these two projects simultaneously, rather than independently, proved valuable to both. My technical project gave me a better understanding of how the best design to achieve a project's technical goal may not always be the best design to attract the intended user, but engineers must strike a balance and design to satisfy both appropriately. My STS research demonstrated the similar dilemma professional engineers face in harmonizing their technical interests, business interests, and the responsibility of care owed to stakeholders. By working on my technical and STS projects this year, I am motivated to continue to create useful and successful mechatronic systems that prioritize the desires and needs of the user.