Thesis Project Portfolio

HEDGE
Hypersonic ReEntry Deployable Glider Experiment
Critical Design

(Technical Report)

Actor Network Theory Analysis of the Failure of Boeing 737 MAX MCAS and Subsequent Crashes

(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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Sociotechnical Synthesis

Avionics govern all the electrical systems onboard a spacecraft or aircraft, and as such, they are critical to the operation of both. My technical report covers the implementation of an avionics system for a small unmanned satellite mission, whereas my research paper illustrates the importance of creating a well-engineered and safe avionics system for commercial aircraft. Aircraft and spacecraft design dictates multiple redundancies, especially in the most critical systems pertaining to avionics. While the consequences of failure are much higher for manned aircraft and spacecraft, it is still critical to design an effective avionics platform with the necessary redundancies for small unmanned spacecraft missions. A successful mission remains a critical objective due to the significant amounts of time and money that are invested in these missions.

My technical work covers the preliminary design and prototyping of an avionics system for a small satellite known as a CubeSat, that will be used to collect hypersonic flight (speeds in excess of Mach 5) data during re-entry into the atmosphere. My capstone group prototyped the avionics system with a Raspberry Pi microcontroller in lieu of the ISIS onboard computer (OBC) that will be used in the final design. The Raspberry Pi was connected to thermocouples and pressure transducers and programmed to record the respective temperature and pressure data which is then relayed to the Iridium satellite constellation and back down to the ground station where the data can be observed. The goal of our design is to create a reliable prototype for next year's capstone team that will finalize the design and ultimately launch the satellite for a successful hypersonic flight data collection and telemetry. This project will be a groundbreaking leap by serving as a proof of concept for creating far more affordable hypersonic flight experiments.

My STS research project delves into a case study on the failure of a critical avionics system (the MCAS) on the 737 MAX which did not have adequate redundancies. The functionality of the avionics on the 737 MAX is much more important due to its role in the airlines so my research focuses on exploring the non-technical aspects which contributed to a faulty design and the subsequent crashes. Actor-Network Theory (ANT) identifies a network builder and the role they played in constructing their network to achieve a goal. My claim is that Boeing's avaricious management practices as the network builder resulted in an under-engineered MCAS system. Boeing's activity regarding the 737 MAX project combined with the airlines being rogue actors culminated in the two fatal crashes and the ultimate failure of its 737 MAX network. My research emphasizes the importance of considering non-technical factors in engineering projects especially where the safety and well-being of the public are potentially at stake.

Working on these two projects in conjunction with each other helped me consider the non-technical pressures placed on a team designing an avionics system. My technical project created a tangible experience of time and budget constraints which can be attributed to virtually any engineering project. Being more aware of these non-technical constraints through my STS research, I was more focused on ensuring that these constraints would not interfere with the design of a reliable and redundant avionics system. Overall, each project had its own merits in teaching me the significance of either the technical aspects of avionics design or the non-technical pressures which can hamper the success of an avionics system or any other engineering project.