**Thesis Project Portfolio**

**Solar-Powered Fixed-Wing Aircraft Design**

(Technical Report)

**Analysis of the NASA Helios HP03 Prototype Crash Using Actor-Network Theory**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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## Sociotechnical Synthesis

My technical work and STS research intersect through sustainable unmanned aerial vehicle (UAV) development, examining how technical capabilities and institutional forces affect project success. Our capstone group project, Solar-Powered Autonomous Reconnaissance Craft (SPARC), challenges engineering limitations through the creation of a modular design with the ability to achieve long-distance flight for several stakeholder purposes. Throughout the process, the team completed multiple iterations and rigorous testing to refine the aircraft design. Simultaneously, my STS research examines NASA's Helios project through actor-network theory (ANT) to better inform our approach. Through my research, I analyze the interaction between technical decisions, institutional pressures, and environmental conditions that led to the crash of the HP03 prototype.

SPARC's design aims to advance high-altitude platform systems (HAPS) beyond current limitations by balancing flight endurance with payload flexibility. It offers a unique system architecture capable of supporting payload requirements for stable, adaptable, mission-specific flight operations. The system uses solar panels, multiple batteries, integration of advanced control systems, and autonomous navigation to fly along a set path. These attributes enable multi-day or weekly continuous operation using GPS and autopilot software for complex maneuvers with minimal human intervention. Beyond the team's primary objectives, SPARC hopes to promote experiential learning for UVA aerospace engineers and demonstrate the capabilities of current solar panel and energy storage technologies for aviation applications.

My STS research explores UAV development using ANT, specifically regarding the 2003 crash of NASA's HP03 prototype. My research first defines the institutional factors, including the Joint Sponsored Research Agreement (JSRA) between NASA and AeroVironment, as network builders who prioritized an accelerated development schedule and cost reduction over safety considerations. During flight, environmental factors, such as proper account for atmospheric turbulence, acted as powerful non-human actors. Using their existing plane in a dual objective program introduced competing technical requirements that NASA engineers overlooked to complete their objectives. The technical modifications needed to adapt the high altitude-focused HP01 prototype to fit the long-duration goal for the HP03 prototype, combined with institutional and environmental factors, ultimately compromised network stability. My ANT analysis aims to demonstrate how engineering failures are not due to a single technical factor alone. Moreover, the research illuminates how institutional pressures, among other non-human and human actors, can significantly shape decision-making.

Working on both projects in tandem provided valuable insights for future sustainable aviation technology. SPARC offered hands-on experience to help better understand the process undergone to develop UAV technology. The STS research showed how engineers should equally consider human and non-human actors during the design and testing of UAV development. Understanding the Helios failure through ANT better informed the team's approach and helped implement redundancies within the design and other safety measures against institutional pressures. While the design process required deadlines and completion goals to stay on track, we addressed and documented each roadblock. Through these projects, I better understand the sociotechnical challenges within UAV development and was committed to holding SPARC to a high standard to avoid the downfalls that ultimately led to the failure of the HP03 prototype.