**Thesis Project Portfolio**

# Hypersonic Atmospheric Reentry Deceleration Experiment (HARD-E)

(Technical Report)

# Social Construction of Spaceflight Technology

(STS Research Paper)

An Undergraduate Thesis

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**Sociotechnical Synthesis**

Space has always been a fascination of mankind. Wondering about what lies beyond our terrestrial atmosphere, and feeling insignificant against the scope of the universe is almost a universal experience of human beings. In efforts to satiate this hunger for the unknown, space exploration technology — whether it be as simple as a telescope or as robust as the International Space Station — has been a central part of human history for many years. Nowadays, spacefaring is possible, opening up a host of possibilities for how space tech can benefit humanity. The STS paper aims to address and analyze the adaptation of spaceflight technology to the needs of society over time, and even predict some future adaptations. The technical portion of the paper describes the design of an orbital reentry experiment experiencing hypersonic flight conditions. While the STS portion covers a variety of use cases for spaceflight technology, the technical paper covers just one of those cases in great detail.

Since the launch of Sputnik in 1957, humans have been using spacefaring technology to satisfy a host of needs. The type of needs and the way in which the technology was used to satisfy said need, is always changing. The sociotechnical paper uses the STS framework known as Social Construction of Technology (SCOT) to analyze and explain how society morphed and adapted spaceflight technology to satisfy its contemporary needs. Examining this topic through the lens of SCOT shows that spaceflight technology has transitioned through a few major use cases: diplomatic, scientific, and commercial purposes. What was interesting, however, was that the transition was not chronological. The interpretation of the technology would bounce around between the aforementioned use cases (sometimes occupying multiple at once) depending on the needs and state of society at the time. Beyond examining existing and past use cases, the paper

aims to predict some future interpretations of the purpose of spaceflight technology and a handful of externalities that could arise.

Hypersonics (flight speeds of Mach 5 and above) has been a rapidly growing area of interest within defense and general engineering for the past couple decades. The technical report describes the design of the experiment titled Hypersonic Atmospheric Reentry Deceleration Experiment (HARD-E). HARD-E consists of a 10 cm x 30 cm CubeSat designed to reenter Earth's atmosphere at hypersonic speeds while collecting and relaying flight data. HARD-E is equipped with pressure sensors, thermocouples, and accelerometers to measure hypersonic flight conditions in an effort to help researchers and engineers better understand a hypersonic flight environment. Research, including literature reviews of similar experiments, as well as expert consultation was conducted to help with component selection and logistical planning of the experiment. 3D modeling software was used to design the CubeSat and arrange the components. Thermal, stress, and flow simulations were all conducted to verify the integrity of the design and ensure that it would survive the atmospheric and flight environment. The technical paper also serves as an official proposal for NASA and other governmental space agencies to fund the experiment.

The STS paper uses SCOT to identify a variety of interpretations of spaceflight technology that society have adapted over time. The technical paper describes the design of spaceflight experiment within the context of the use case of scientific advancement. Space-tech can

certainly lend itself well to the advancement of society, and understanding its interpretative flexibility is key in doing so.