Thesis Project Portfolio

Project ATLAS Hybrid Rocket Engine

(Technical Report)

An Analysis of Technology Transfer in Aerospace Research and Development

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

My technical work and STS research are both centered on the field of aerospace research and development (R&D) within the U.S. My technical work is a direct participation in the field as a hybrid rocket motor project funded through an academic research center, while my STS research focuses on understanding the project-level impacts from changes in high-level technology transfer practices. Along with this, the field of hybrid rocket motor research proved to be an effective representative for my STS analysis.

There has been a significant research effort in hybrid rocket motors over the past few decades to improve the technical maturity of the technology; however, it remains troubled by actual performance characteristics. Our technical project was to design, build, and test a conventional hybrid rocket motor to evaluate novel injectors and fuel grain material and designs. A conventional hybrid motor uses one liquid oxidizer and one solid fuel. Our propellant combination was liquid nitrous oxide as the oxidizer, and Acrylonitrile Butadiene Styrene (ABS) plastic as the fuel. ABS was chosen over other options as it is easily 3D printable, allowing the team to explore several design options of various cross-section fuel grains. This was useful since the shape of cross-section determines the distribution of thrust over time, a valuable choice for designers. The motor structure was made up of an aluminum combustion chamber with a phenolic laminate insulator, graphite nozzle, ceramic-resin 3D printed oxidizer injector, aluminum valves, and a commercially sold high-pressure tank. The team's injector design and manufacturing is novel to published research and has allowed us to explore more complicated injector geometries. The advantages of this being the improved oxidizer distribution and combustion efficiency. The motor was evaluated through several hydrostatic tests, cold flow tests, and hot fire tests to prove the design's functionality and measure actual performance. These tests were performed on a remote test stand with integrated sensors also designed by the team.

My STS research explores the practice of technology transfer between civilian and military stakeholders in the field of aerospace and its influence on modern-day R&D within the United States. Using the conceptual framework of Hughesian technological systems, the investigation of technology transfer was directed towards a comparison of different levels of adaptation as well as overarching economic and legislative artifacts. A review of existing literature revealed that due to the end of the cold war, federal R&D budgets had been reduced, directly impacting the rate of aerospace innovation. With the consequence of a shrinking Defense Industrial Base (DIB) looming, the Department of Defense (DoD) looked to stem its losses by influencing the commercial sector to better support national security needs. In response to this, research mandates for dual use technology became written policy in the 1990s with varying success, making technology transfer mandatory and systematized. The eventual goal of these policies being the integration of the U.S. commercial and defense industrial bases, despite significant barriers due to a difference in priorities and procurement practices. An analysis of the effects of these transfer practices was done by breaking down the research between the lines of low level/high level R&D and between the effects of spin-off/spin-on implementation. Data was gathered from sources including internal U.S. government reports, papers by members of the U.S. Armed Forces, and technical history review articles by researchers in that field. It was found that due to monetary pressures being the highest priority, the specific process of spinning-off technology has been consistently encouraged and practiced by government and industry stakeholders, regardless of the presence or lack of written policy. Using hybrid rocket engine development as a representative low level research field, it was found that these research directives were unaffected by the implementation of technology transfer policies. The reason for this being the categories lack of any form of adaptation or technological style. In contrast, the direction of high level R&D has been negatively affected by technology transfer trends; in particular, the practices of dual-use development and spin-on conversion resulting in national security and geopolitical concerns. The implications of these findings being that policy makers must take all potential consequences into account when drafting dual-use development programs, beyond just those regarding the financial and practical feasibility.

I believe that by working on both of these projects simultaneously, I was able to direct and verify a central point of my STS argument first-hand. In retrospection of my technical work, it became apparent that no considerations or decisions were made to the benefit of the eventual application of the work. Along with this, the source of our funding did not influence technical decisions in any way. This allowed me to conclude that no adaptation or technological style was present in this low-level research work. This personal conclusion contributed to my understanding that technology transfer practices would not influence low-level research as their complications primarily arise through the process of adaptation. This understanding directly informing my STS thesis statement. Along with this, my STS research put the position of my technical project into perspective in terms of how it interacts with the wider environment of research efforts in academia and the U.S. as a whole.