Thesis Project Portfolio

The Design and Testing of the Hoo-Rizon 1

A Sub-Scale Sounding Rocket

(Technical Report)

An Investigation in Whether or Not the Artemis Space Program to Reach the Moon Is Worth the Costs

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis Paper

Introduction

In 1962, President John F. Kennedy's call to reach the Moon marked a turning point in space exploration, leading to monumental achievements like the Apollo missions, the Space Shuttle, and the International Space Station. However, over fifty years later, NASA has remained mostly within Low Earth Orbit (LEO). The Artemis program aims to revive deep space exploration and stimulate economic growth, but repeated delays and escalating costs raise doubts about its long-term viability.

As government agencies reconsider their strategies, it is essential to assess both the technical and societal impacts of large-scale space initiatives. Hands-on experience, such as UVA's 2025 Rocket Capstone Project, plays a crucial role in preparing engineers for this evolving landscape. By designing and launching a subscale sounding rocket, the team not only builds aerospace skills but also contributes to broader discussions on innovation, risk, and sustainability.

Design and Testing of the Hoo-Rizon 1

The capstone project aimed to design, build, and launch a single-stage, subscale sounding rocket to 3,000 ft, recover it, and collect atmospheric data. Launch occurred on April 5th. Though the recovery system failed, the team gained critical experience in problem-solving, structural design, and avionics integration—building a foundation for future projects and careers.

The team followed system-level and subsystem-level methods to meet mission goals. Key frameworks included (1) NASA's life-cycle management, (2) iterative systems design, and (3)

basic project management for risk, cost, and schedule. Deliverables included a project pitch, conceptual design review, and preliminary design review.

Design tools such as Gantt charts, CFD software, and OpenRocket supported simulation and refinement. The final rocket stood 5’ 4” and was projected to reach about 2,500 ft. It featured three 3D-printed fins, a nose cone, centering rings, and an avionics bay with sensors for temperature, humidity, altitude, GPS, and camera footage. Due to regulations, the motor was installed on-site.

Evaluating the Artemis Program’s Worth

NASA’s Artemis program represents the U.S. return to lunar exploration and a step toward Mars. Despite its ambitions, the program has faced multiple delays and mounting costs. Each Space Launch System (SLS) launch is projected at $4.1 billion, compared to roughly $100 million for a SpaceX Starship launch—despite Starship offering similar or better performance.

Artemis leverages legacy parts, like the RS-25 engines, to preserve contracts and stimulate jobs, which helps political support but raises concerns about cost-efficiency. The program also includes infrastructure like Gateway and the Near Rectilinear Halo Orbit (NRHO), intended to support lunar missions and commercial expansion.

Gateway acts as a staging hub but introduces complexity and potential points of failure. NRHO provides stable Earth visibility but orbits close to the Moon only weekly, limiting surface access. These features add value but also risk. Given the program’s high cost and potential for mission failure, stakeholders must consider whether this current path is sustainable or in need of adjustment.

Conclusion

The Hoo-Rizon 1 Capstone Project exemplifies how student-led initiatives can integrate technical rigor, systems thinking, and hands-on experience to address challenges similar to those in professional aerospace programs. Despite recovery setbacks, the team met its design goals using a structured, iterative process.

In the context of NASA's Artemis program—marked by bold goals and significant challenges—the project highlights the importance of evaluating cost, risk, and societal impact. Both efforts show that sustainable space exploration requires more than technical capability; it demands critical reflection, responsible planning, and adaptability to shifting economic and technological conditions.