Thesis Project Portfolio

Design of an In-Situ Fuel, Oxygen, and Potable Water Supply System on Manned Mars Missions

(Technical Report)

Analyzing the Significance of Humanity's Social Mindset in Shaping History and the Future

(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

Defining Factors in the Approach to Sustainability

The lunar landing was a defining moment of the twentieth century, yet it is a tribute to the progress of humanity that a few decades later there is a push to make our mark on Mars. My capstone team addresses the issue of fueling the return trip from Mars by in situ resource utilization. My team's research brought to light the amount of technology available to implement sustainable practices; however, the practical application of this in the physical world is lacking. This led me to delve into the topic of how the collective human mentality is responsible for the acceptance of new ideals to spur a paradigm shift. Therefore, my STS research paper addresses the significance this mindset has in history as well as how contributing factors can be manipulated to shape the future.

The design of the technical portion of my thesis is unique compared to other Mars colony projects in that the fuel being used for the return trip will be hydrogen as opposed to alkanes. Hydrogen has low mass and high thrust but it is typically avoided due to storage issues, but we believe we resolved this by use of a graphene mesh. Taking in carbon dioxide from the atmosphere, the reducer in our process will then produce carbon monoxide and oxygen. Carbon monoxide is then combined with water mined from the Martian regolith and went to the water gas shift reactor to produce carbon dioxide and hydrogen. The remaining equipment in our process is used for separation of materials, storage of products, and heat transfer.

In my STS research, I explored how a shift in humanity's collective mindset occurs, using historical examples with economic, technological, and social relevance. Through investigation, I found a handful of factors that have varying weight in the influence it has over

people's perceptions, such as economic value, marketing to consumers, and the intentionality behind the product or idea. Given the varying contributors, I found it useful to examine this by use of trading zones since there was a combination of these factors in the case studies. I used this discovery to propose how to sway the public's opinion about the Mars mission as well as it can be applied to larger issues such as sustainability.

While my STS topic connects common trends of historical events, my research emphasized the unpredictability of human nature and there will never be a formula to perfectly map out a trendline for the future. My intention was to take these common trends and apply them to issues that deserve attention so that progress can be made. As mentioned previously, significant progress was made in the field of space exploration in just a few decades, imagine if that driven mindset was put towards other areas of prestige. Additionally, throughout the design of the technical project I was able to pinpoint decisions we were making for the success of the project that did not pertain mainly to the reactions of the process. Major contributors included economic feasibility, as well as the safety of the mission to ensure positive public feedback and encourage consecutive missions to Mars.