VDR 3: Prototype

Team 501

FAMU-FSU College of Engineering

EML 4551: Senior Design 1

Dr. McConomy

December 3, 2024

The Psyche team has refined their concept down to have a simpler, and more attainable goal. This goal is to provide a concept of intellectual merit to enable the use of selective laser melting (SLM) additive manufacturing on asteroid Psyche. Originally, the concept scope was too large due to a focus on the whole additive manufacturing process rather than on a specific portion of the design. A project of the original scale was not going to be possible to complete given the time and budget provided. Now the project focuses on a niche aspect of 3D printing that would pose a problem given Psyche's gravitational effects. The first portion of the merit is an electromagnetic printing bed that prevents the metal powder from staying suspended in the printing volume due to microgravity. The next portion is using electromagnets to remove/clean the bulk of the excess metal powder that was not used after the prints are completed. With these new changes to the scope, the team is more confident that it can be completed by Engineering Design Day. Currently, the team has finished their cardboard prototype that will display this newly refined intellectual merit of having an electromagnetic bed and powder removal system.

The upcoming stages of the design process have started to shift from the concepts phase to implementing physical designs. One of the early stages of the second semester will be beginning to place orders for parts. This can be a time-consuming process, and it is important to start early. The Bill of Materials needs to be constantly revised as the prototype design evolves. To stay within the budget, the team must minimize ordering parts that may be later discarded. Further research to maximize electromagnet efficiency will provide important optimization for the system. The team will also begin to start creating a digital twin for the prototype, as well as for the NASA rendition. This will allow for ensuring that pieces fit together well and are sized correctly. Some of these parts could also be directly 3D printed for use within the prototype. Further down the line the prototype construction will begin. The prototype will serve to validate

our intellectual merit and demonstrate the functionalities of the system. Once the prototype is complete, tests must be conducted to prove that it accomplishes its critical functions. One possible method of testing if the design prevents powder suspension is doing a computational study. The method to test the excess powder remover will be to use a set amount of iron filings and measure the percentage of material weight gathered by our system.

One of the problems identified is dividing the amount of work between the physical prototype being showcased at senior design day and the theoretical digital design of the prototype being submitted to NASA. The team will need to decide how to dedicate their time to each design as the spring semester schedule becomes more concrete. The benefit of dividing into sub-teams based on availability is that sub-teams can meet at dedicated times more frequently. A technical problem area is determining how to provide a uniform electromagnetic field on the print bed. One possible solution the team has found is to use large Helmholtz coils that contain the entire printing volume. These coils can provide a uniform field within their cylindrical cross section. Further research must be conducted to determine if this idea will be feasible for the NASA prototype, but the cost of producing one restricts its use in the physical prototype. Instead, a collection of smaller electromagnets situated under the print bed will be used to demonstrate the idea. Another technical problem is the flow of gas within the chambers of the printer and within the powder removal system. A pressure difference needs to be present, maintained, and actuated for the gas to flow. Extensive research must be done to design the system that will solve this problem, considering its use in the environment of Psyche. This inert gas consideration will be researched and included in our future work; not implemented into our final prototype.