**Department of Mechanical Engineering**
NASA Psyche Sampling Team
ME 486C - Section 006

To: Dr. David Trevas

From: Andrew Acosta, Sultan Almarzouqi, Sam Armstrong, Karissa Barroso, Scott Sprauer

Date: February 7, 2020

Re: Hardware Review I Memo

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The NASA Psyche Sampling team is currently up-to-date according to the Semester II Gantt Chart that they created at the end of Fall 2019. The team has assigned each individual with a role and task so that the team can start to build the different components of the sampling system. Continuing from last semester, the team will be using most of the same parts from last semester. The prototype sub-assemblies can be seen in Figures 1, 2, 3, 4. These include the two side motors, the drill, the coring bit, and storage system. The shape of the tower will most likely stay the same, but the team has decided to change the material from wood to a metal, either aluminum or steel.

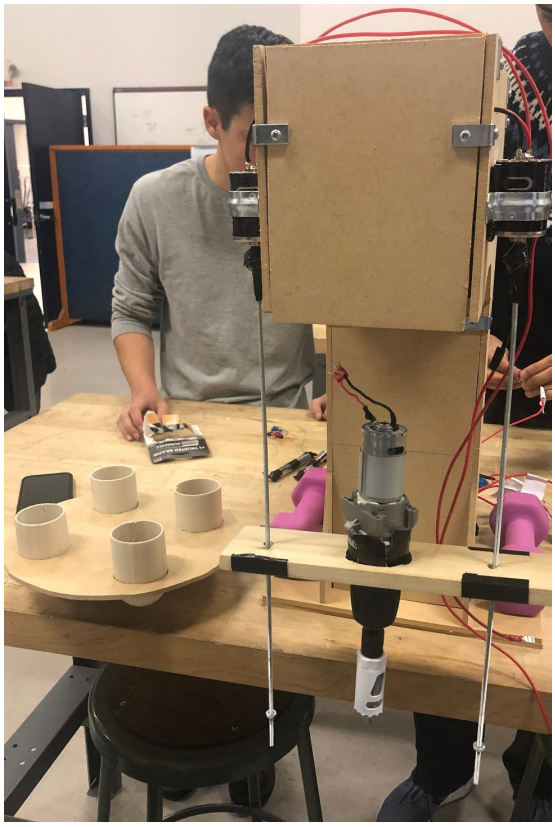

Figure 1: Semester One Final Prototype

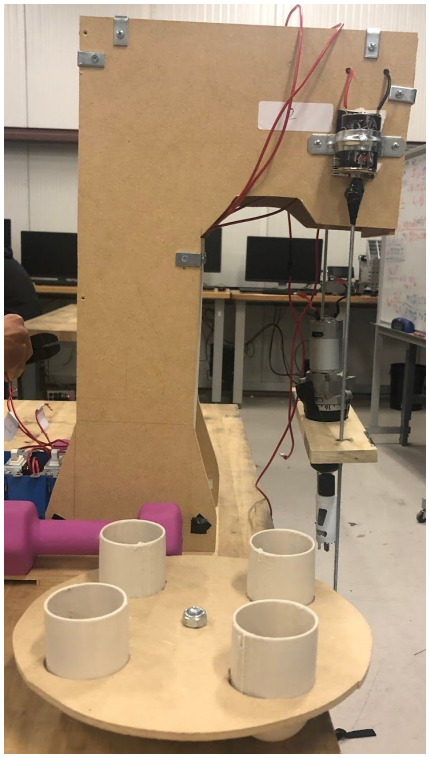

Figure 2: Rotary Carousel Containment Device

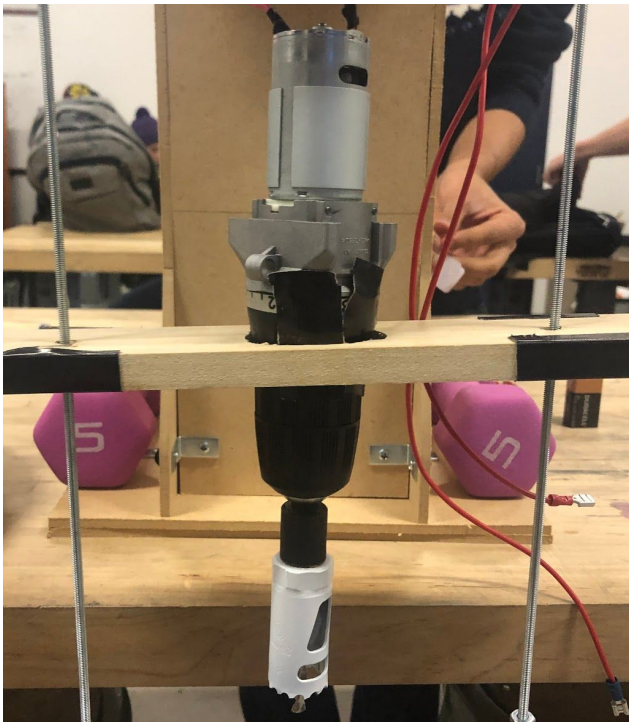

Figure 3: Core Sample Drilling Assembly

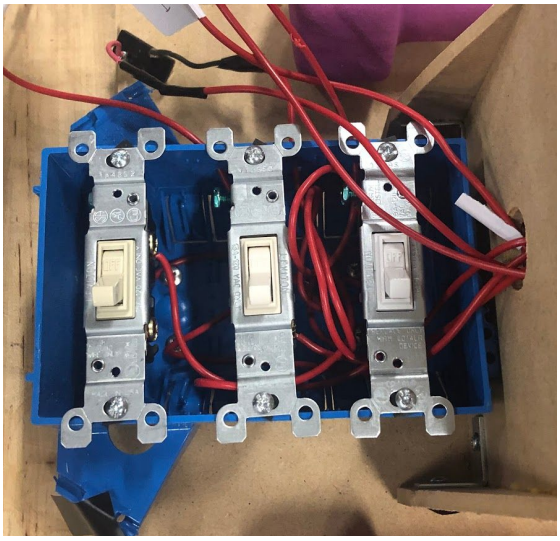

Figure 4: Electrictronics Housing

To begin preparing for the semester ahead, the team began with reviewing the prototype created last semester. While meeting with their faculty advisor, Dr. David Trevas, the team developed a plan and stricter “to do” list to ensure that parts and components arive and are put together before the March deadline. In the following paragraphs, each team member will discuss what they will be in charge of for the hardware review and their plans to get parts ready for full assembly.

First, Karissa will be in charge of obtaining the materials needed for the test space. This test space is important for both NASA sponsored projects at Northern Arizona University (NAU) because testing must be done on their prototypes before that final product is due. This testing space consists of a wooden base set up that is capable of housing the different types of common, everyday materials that the sampling system will be tested on. She will work with the project manager on the Psyche Rover team to get this base built and ready for use by both teams in 98C once the materials are received from their client, Dr. Cassie Bowman. Aside from preparing this surface, she and Andrew will take over communication with K&M Machine Tool Metallurgy to get the base of the sampling system created. The base, attached to the electromagnetic ring that Andrew is creating, will be fully machined out of a steel or aluminum. This material will be chosen based on cost, so the team will most likely have this part machined out of aluminum, but is still undetermined until a set price quote is given. This means that this will also include reviewing and submitting drawings of the base to the company to get quotes, or even a possible sponsorship depending on the cost of the material and machining. These drawings will be submitted by the end of this week so that the team can move forward with construction of the other subsystems.

Samuel Armstrong will be re-evaluating the vertical linear actuation system for the drill. The current design uses two pieces of all thread driven by two high speed motors. The receiving drill base has two nuts that match the respected thread of the two lengths of all-thread. Future plans for the actuator system will include a gear reduction. This will allow the motors to transmit power at a lower speed and a higher torque, meaning the pitch of the thread will not need to be course. This has led to the idea of using a ball-screw as it generates minimal friction. Sam will be looking into the use of ball-screw advancements for the vertical actuation. As this is a topic previously researched by a past capstone team in their CNC

router design, it will be useful to look into their project. This will hopefully prove useful as it will allow the team to build on what problems and successes they found in their research.

Andrew Acosta has been developing the electromagnetic base. He will design drawings of the magnetic base that will have three-to-four vertical columns that will attach to the steel base so that electrical wires can be wrapped around to create an electromagnetic force. These drawings will be submitted to K&M Machine Tool Metallurgy so that they will be created. This magnetic base will also be large enough to house the rest of the systems, such as the tower that holds the drill. Andrew will also look into gearboxes so that the motors lowering the drill can rotate the threads at a lower, yet reasonable speed. Lastly, he will look into more depth about obtaining the diamond coring bits from the geology department here on NAU campus. These bits will be able to attach and unattach to the drilling system so that it is not fixed to the sampling system.

Sultan Almarzouqi reviewed the main drill motor on the NASA sampling system device. The prototype created in the Fall 2019 semester had a Ryobi hand drill motor used in it. For the final prototype the team have decided to try using the same drill that was used for the Fall 2019 semester prototype to see if it can handle drilling through the testing surfaces, including a thin surface of steel, which will be the hardest material that the drill will need to operate on. The team does, however, speculate that the Ryobi hand drill motor has a high chance of not working since it has low torque and low horsepower on it. If the Ryobi hand drill motor does fail, the team has determined a back up one pase drilling motor that has 0.25 horsepower, about 0.75 lb-ft torque. The new drill motor has the best specs to drill through the ⅛ inch thick steel surface that the testing surface will obtain.

Lastly, For this project the team has decided to use a few moving parts using motors. The team plans to control these motors using Arduinos. Scott Sprauer will be taking lead on understanding how to program and use the Arduino to do what is wanted from the motors. The plan is to create code to turn on and off motors at a certain time as well as automatically slowing the motors down or speeding them up when the torque reaches a certain level. Scott began attending the Arduino club to get help from Dr. Trevas to get the program codes written and hands-on Arduino testing that is needed created for the drilling system. Scott also will also investigate how to control the motors, via controller or Bluetooth. While attending this club, Scott has already begun writing a sufficient code that is able to control the motors with a joystick that is capable of activating the motors to move in a clockwise and counterclockwise direction. He will work towards creating programming sufficient speeds for the motors and making the control system bluetooth so that it can be controlled farther away from the full system.

Overall, the NASA Psyche Sampling Team has created a productive plan and has begun completing their assigned tasks so final product building can start within the next week. The team plans on using the helpful advice given by Dr. Trevas and will be implementing as much feedback as possible to create a device that reaches the expectations of the teams client.

## DISCLAIMER

This work was created in partial fulfillment of Northern Arizona University's Capstone Course "ME 486C". The work is a result of the Psyche Student Collaborations component of NASA's Psyche Mission (https://psyche.asu.edu). "Psyche: A Journey to a Metal World" [Contract number NNM16AA09C] is part of the NASA Discovery Program mission to solar system targets. Trade names and trademarks of ASU and NASA are used in this work for identification only. Their usage does not constitute an official endorsement, either expressed or implied, by Arizona State University or National Aeronautics and Space Administration. The content is solely the responsibility of the authors and does not necessarily represent the official views of ASU or NASA.