

# **NAU Psyche Rover**

## **Post Mortem Analysis**

**Team 20F11  
ME 486C Section2**

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This report will evaluate the first semester of the NAU Psyche Capstone team's performance. This analysis is to help the team members find what was efficient and what aspects needed improvement. Our team started last semester by stating a purpose and setting goals and incorporating them in a team charter. This charter laid out guidelines that each member was to follow and rules for addressing any grievances that arise. Our team worked well together and did not need to implement any corrective actions. The team's cohesiveness formed over the four months jointly worked together and allowed us to achieve the first steps of our stated purpose.

The team started designing a rover that will be sent to the Psyche asteroid to further the information known about Psyche and what it can tell us about planet formation. The hypothetical rover needs to be able to traverse flat metallic surfaces with metal and/or rocky debris. The model, designed in solid works, will be able to traverse these surfaces as well as be able to withstand the harsh conditions of an asteroid in space.

During the Fall 2020 semester the team put the Psyche mission above all else. The team received a grade of A for our overall deliverables. The Psyche team created a rover in SolidWorks and is set to begin building a prototype next week (1-20-2021). This rover built in SolidWorks comes with CAD drawings and each part of the rover was compiled into an assembly. After the assembly was complete the team then conducted a Finite Element Analysis (FEA) on the frame. The FEA allowed the team to believe that the model built in SolidWorks will be able to perform the desired tasks required by the customer.

The Psyche team was efficient at making sure everyone had input into the overall design of the project. Each idea presented to the team was talked about in a constructive and professional manner. Any team member who could not make a meeting clearly communicated that they were unable to attend. When a team member did not make a meeting due to scheduling issues the team filled in the person who missed the meeting.

All the members showed up and contributed to all the client meetings which were conducted Mondays at 10:30 am every other week. A major reason the Psyche team was successful in the first semester was since all team members abided by the ground rules set out in the beginning of the fall 2020 semester. During these hard Covid times the Psyche team adapted to the new methods of learning and communicating styles required to make this project a success.

One of the team's greatest accomplishments last semester was our approach to team meetings. During meetings, each team member was confident freely sharing their opinions, and were able to navigate differing opinions efficiently without making anyone feel unheard, or that their opinion was not appreciated. Maintaining cordiality throughout all communications, even when team members had conflicting views about how to move forward with the project. Although the team sometimes struggled with communication for a variety of reasons, most of which relating to the remote nature of last semester, the team was always able to keep on track with our goals.

Another area in which the team's performance excelled was concept generation. All team members contributed heavily to this step of the project, contributing meaningful ideas and drawings along the way. This meant that when the team finally landed on a design for the rover, it was something all were immensely proud of, and could fully get behind. This pride in the design continues to motivate to push harder and go further with the project, since all are deeply invested in the outcome. Without taking the time to generate dozens of concepts, and without the contribution of every single member, motivation could have been lacking.

Some of the problematic areas in project performance include unspecific project goals and our lack of technical design details. Since the client was not looking for anything specific when it came to prototyping (they were fine with both a physical prototype or a fleshed-out simulation for the final product) the team did not go into the semester with much clarity about where the project would end up.

This was further complicated by unclear messaging from the capstone instructor on whether the team was expected to prototype the rover. This was due, in part, to the Covid – 19 pandemic; the instructor was not allowed to require us to prototype at the beginning of the semester since it would require teams to meet in person. However, halfway through the semester, the messaging received from the instructor shifted and it seems they were intent on everyone prototyping at least some aspect of their design. For this reason, it was not until the very end of last semester and over winter break that it was concluded where the project was going. If we had set out last semester with a clear idea of what we wanted to prototype, the scale, the level of functionality, etc., then we may have arrived at this semester with more of the steps laid out for prototyping, rather than having to scramble to get something started right away.

The other negative aspect of our performance is our lack of technical detail on our final CAD model. For instance, there are no motors or motor mounts modeled in the final CAD. This sets us back because before we start prototyping, we need to modify our CAD to include motor mounts and determine where motors will be placed. Moving forward, we will have to work to make up for this deficiency in our design, which will take time away from prototyping.

The team found that scheduling tasks via Gantt Chart was ineffective. The group decided that weekly task reminders were a more effective means of scheduling. The main issue that the group had with scheduling via Gantt Chart was due dates. Unless the chart was checked daily, a task could go unfinished without anyone realizing. Implementing weekly task reminders ensured everyone was aware of their tasks and due dates.

In conjunction with weekly task reminders, the team held weekly meetings. These meetings allowed for constant updates on individual research and progress. The transition to a more virtual oriented capstone allowed the group to schedule meetings more effectively, via video chat. These weekly team meetings also allowed group members to voice their ideas more often, avoiding potential issues with clashing ideas.

The transition to a more virtual oriented capstone also made connecting with the client much more convenient. The group had bi-weekly client meetings in which progress regarding the design process was discussed. This client interaction helped keep team members on track and allowed the client to remain present in the design process. Another benefit of the bi-weekly client meetings was constant direction from the client, which prevented the group from deviating in the desired design.

Team meetings were held via Microsoft (MS) teams, which proved to be an effective collaboration tool. Group files were also created and shared via MS Teams. One benefit of using the software, allowed members to create Word documents, Excel spreadsheets, PowerPoints, etc. and edit them within the desktop app. This prevented most formatting errors commonly seen when working within google collaboration software, i.e., google sheets.

Most of the interactions between the client and our group occurred through a program called Basecamp. The program allowed our group to keep contact with the client directly, any time. Basecamp also allowed our group to talk to members of other Psyche capstone teams from other colleges. Basecamp also made file storage and sorting simple, allowing the client to track the group's progress.

The small size of our capstone group meant that communication among members should be easy. However, a few communication issues arose throughout the semester. These included confusion on the design of the hypothesized rover as well as what materials the team would use to build it. These issues were resolved by having more team meetings to discuss what everyone was working on throughout each week.

Along with the few communication issues the team encountered came some issues with time. Due to these issues the team felt that we did not have enough time to complete everything that we intended to last semester.

One thing that contributed to the communication issues the team encountered was a lack of instruction and guidance from the team's instructor.

- Not given due dates.
- Meetings announced the morning of.
- Assignments hidden from view in bblearn not made student visible until past start date.

Another problem that the team encountered was the limited budget that we were provided. With a more limited budget the team does not have a lot of room to prototype and/or buy excess materials for the design.

The main organizational action that can be made this semester to better the team's performance is to communicate more with the professor. During the first capstone semester, many assignments deadlines were given to the team days before it was due. This caused the team to rush through certain components of the design process. This could have been easily avoided if a proper schedule is provided. This will be solved by asking the instructor about upcoming deliverables and forming a planner to allow the team to have as much time as needed to complete the task. The extra time will allow the team to provide more precise work.

Prototyping will need to be done throughout the semester. This will require scheduling for when the team should meet to work on the physical prototype. With this schedule, team members will know when to set time aside to work on the project. If more time is needed within the week to prototype, then the team can agree to meet another day as well. This will ensure that the prototypes will be completed on time.

The team learned many technical lessons during the first semester capstone. One of our first ideas for how the rover would attach to the metallic surface was by using magnets. We then met with Dr. Rona Oran from MIT who provided information on magnetism on the asteroid. With this information, the team was able to narrow down the choices for the attachment to the surface. Another attachment idea was to use a gecko grip that was in development. This grip was being designed to help robots and people attach to the side of the space station to perform repairs. This material was thought to be a good fit for the how the rover will attach to the asteroid surface. We then spoke to another specialist, Dr. Donald Ruffatto from JPL. The team then got an understanding on how the material works and if it would work for the rover. Since the rover requires some complex Arduino programming to operate. The team learned about the basics and later upgraded to more advanced Arduino skills. This knowledge will help the team in the coming semester to program the prototype of this six-legged rover and how it will traverse the surfaces. Many more technical lessons will be learned throughout the prototyping stages of this project.

The Psyche team has had a good first semester and is looking positively at finishing the capstone project. We have discussed strategies for moving forward and discussed what we need to improve on. The team is expecting new challenges to crop up throughout the semester but with using the coping strategies conceived and used in the first semester success is within the team's reach.