Design Status Memorandum:

**Objectives:** The main objective of this project is enhancing the previously built rover, which is battery powered, by integrating solar power, autonomous power switching between solar and battery power, and an independent cleaning system for the solar panel.

**Major Deliverables Promised:** Upon completion of our project, we will be delivering a functional solar power system which will be added onto the existing planetary exploration rover LOUIS. This solar power system will have autonomous power switching between battery and solar power, depending on available sunlight and user preference. We will also have an autonomous cleaning system incorporated into our design to clean the solar panel of dust or debris which will be set on a timer. Our team will ensure that the additions we make will only be improvements to the rover, without losing any of the general functionality existing prior to our additions. Other deliverables include comprehensive reports and presentations, as well as complete engineering analyses detailing the technical aspects of the project.

**General Timeline:** Since the start of our project, our team has surpassed the planning stages of the project, and we are now in the analysis stage of our project. Here, we plan to verify the feasibility of our project. To do so, our group has devised certain analyses that aim to test the feasibility of our functions. These analyses involve simulations and calculations that will produce specific results and scenarios that we can analyze to drive our project to the next stage. Moving forward to the Spring 2025 Semester, our team is aiming to reach the manufacturing and testing stages of our project. During the manufacturing stage, our team is expecting to receive all ordered items to begin the assemblies of our functions, which will then be implemented onto our existing rover. Once our manufacturing is complete, we hope to test these functions and full system during the testing stage of the project. For testing, our group aims to put our functions and systems through a multitude of real-world scenarios that we can observe and collect data from based on the performances that our systems yield. Using this data and testing, we will be able to fine-tune and finalize our rover for peak performance.

**Summary Statement**: Based on the current progress of our project, it appears that our group is on-target with our schedule. We also have a Gantt chart to visualize the pre-determined milestones that have been set forth by our group, and it appears that we are still on pace with our schedule as well. We have efficiently utilized time during the Planning stage to provide adequate time for our current Analysis phase and future Manufacturing and Testing stages. Even though our group is on-target, we aspire to work even more diligently and efficiently to potentially be ahead of our schedule.

**Accomplished Work:**

A diagram of a conveyor belt

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Figure 1: Fusion Drawing of Ideation

* **Solar Panel:** The team selected the monocrystalline solar panel to provide power to the rover. This panel provides the highest efficiency, and its lower heat coefficient allows for better output in the Louisiana climate. Although these panels are the most expensive, its higher efficiency will allow the team to reach the desired power output with a smaller panel. We are still researching specific panels to find a good balance of open circuit voltage to short-circuit current.
* **Autonomous Power Switching:** The team selected the solar charge controller to perform the autonomous power switching. This method provides the best quality in its ability to easily and accurately monitor the power generation of the solar panels and decide whether to use battery power. Although this was the most expensive of the options, the functionality it provides highly outweighs the price. We have met with the solar electronic company, Morningstar, to get some advice on the types of charge controllers they have and which ones would work best for us.
* **Cleaning System:** As seen in the above drawing, the team decided to move forward with a rolling, soft-bristle brush for the main method of cleaning. It will move across the panel via a linear actuator. After looking into the electrostatic removal technique and the air compressor method, the brush method was overall cheaper, lighter, and will clean relatively effectively, despite concerns over potential scratching. Due to the durability of the solar panel we selected, scratching should not be an issue. Furthermore, we have begun to create speed profiles of the linear actuator motors (see Figure 2), have reached out to vendors for brush quotes, and selected OpenBuilds as our linear actuator vendor.

A graph with numbers and lines

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**Remaining Work:**

**Solar Panel:** The team has narrowed down our solar panel selection to a few companies including but not limited to Sunpower and LG. The team will reach out to both of these companies for further clarification on both price and applicability to the project. The team would also like to meet with our advisor for clarification on selection of solar panels as if focusing on only the max power would be advisable or if both the voltage and current also matter. Hopefully, the panel will be selected by November 11th.

* **Autonomous Power Switching:** The team has reached out to Morningstar again to get some quotes on some charge controllers and are still waiting on a response for that. The two main concerns are voltage range, weight, and size. The two best options we have right now are the Genstar and the Tristar. Once we have made this decision, we will be able to simulate the wiring and powering of the system. Morningstar also told us they will work closely with us to help us program the controller to best fit the needs of our project. Hopefully, the components will be selected by November 15th.
* **Cleaning System:** Currently, the team is waiting to hear back from a brush vendor to then be able to determine the speed profile of the rotational motor. To make the profile, we need the radius of the brush. After this, we will be able to make the motor selection. We are still determining which motor to use for the linear actuator as well. Hopefully, the motor selection can be completed by November 22nd.

**Time and Resources Planned:**

* **Solar Panel & Autonomous Power Switching:** Once the team has chosen a solar panel and charge controller to accomplish the power switching for the rover, we estimate 15 hours for conducting simulations of these components working together based on the chosen parts. The majority of these simulations will be conducted in MATLAB Simulink. This will give us important information about how the added solar power will increase available power for the rover to use before needing to recharge, as well as load flow analysis to help with sizing wiring or other components. Our team also estimates that we will spend approximately 5 hours communicating with the company we purchase the charge controller from about setting up the controller and how to program it.
* **Cleaning System:** The team estimates that we will need to spend the most time developing the cleaning system, as we will have to set up the actuating motors and program a microcontroller for the cleaning cycle while also doing mechanical work to attach the linear actuators and spinning brush to the solar panel. We plan for about 25 hours of work on programming and troubleshooting the cleaning cycle and rotation of the brush. We also expect to spend an additional 15 hours deciding/designing how to mount all of our components onto the rover and for integration of parts, such as how to attach the brush to the linear actuator.

**Summary Table for This Semester:**

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| **OBJECTIVES** | **DELIVERABLES\*** | **WORK ITEMS** | **TIMELINE PROGRESS** |
| Addition of solar power to the rover | Functional solar power system capable of switching between solar and battery power as needed | **1.** Choose a specific solar panel and charge controller.  **2.** Determine method of power switching. | 45% |
| Self-cleaning of the solar panel | Cleaning system to automatically remove dust or debris that could be detrimental to power generation | **1.** Purchase custom parts, such as the brush and long rails for the linear actuators.  **2.** Determine how to mount components to the rover.  **3.** Size motors & run Simulink simulations. | 30% |

\*Deliverables shown are only those specific to the respective objectives, not including reports/analyses for the project as a whole.

**Major Changes/Challenges:** We changed the style of the linear actuator from a lead screw to a belt and pinion style. This was because the lead screw did not have long enough rails for our solar panel. Additionally, we might need a relay driver paired with the charge controller if we go with the TriStar model. This is because the TriStar doesn’t have a load output to connect with, however the TriStar and relay driver communicate well together.