Showcase Judging Criteria

1. **Project Definition:** The team/individual defines the overall problem, and the need for the problem to be solved.The presenter was able to explain the engineering, science or technical approach used for the project. (10 Points) 12.5%
2. **Requirements**: The team/ Individual has a proper set of requirements that are quantitative, measurable, and rational (10 Points) 12.5 %
3. **Overall Presentation:** Students can give a cohesive oral presentation of their project. The poster tells a story, is clean, and easily readable. Additional props on display have a reason and are used to better explain details of the project. Students can field questions and give adequate response and reason. (15 Points) 18.75%
4. **Classroom Knowledge:** The team effectively presented the use of knowledge from the classroom to solve their given problem. Students can describe specific classes from their curriculum that they used to solve the problem (15 Points) 18.75%
5. **Engineering/ Scientific Design Principle:** The team/ individual was able to identify alternatives and use engineering design/ scientific methods and principles to solve their problem. Students were able to use proper analysis techniques to solve their problem. (20 Points) 25%
6. **Team/ Project Management:** The design was successfully completed in a given time frame and met milestones. Multi-year projects have documented and prepared the project for future research. The team responsibly used resources provided and money (5 Points) 6.25%
7. **Project Impact:** The students can demonstrate an understanding of the impact their project has on their field and/or in society (5 Points) 6.25%

Judging Points Breakdown

25% - **Engineering/ Scientific Design Principle**
18.75% - **Overall Presentation**
18.75% - **Classroom Knowledge**
12.5% - **Requirements**
12.5% - **Project Definition**
6.25% - **Team/Project Management**
6.25% - **Project Impact**

Showcase Virtual Showroom Outline

Virtual Showroom submissions: Student Design Showcase > Student Design Showcase | Florida Tech (fit.edu)

1. **Project Title**: Robotic Mining Capstone (RMC)

2. **Team Members**:
    a. Sidney Causey
    b. Shayla Peak
    c. Mohammed Aljameeli
    d. Junot Damen
    e. Izaya Farrar
    f. Eric Moseley
    g. Michael Muller
    h. Liam Sapper
    i. Chelsea Sweeney
    j. Shelsy Toppenberg
    k. Noah Walters

3. **Team Leaders**:
    a. Project Manager: Sidney Causey
    b. Systems Engineer: Shayla Peak

4. **Faculty Advisor**: Dr. Chiradeep Sen

5. **Category**: Mechanical Engineering

6. **Project Summary**:
   Robotic Mining Capstone (RMC) is a university project in which students must engineer a lunar robot capable of driving, excavating, and constructing a berm designed to shield from radiation, blasts, ejecta, and the harsh space environment. Development of autonomous regolith-handling robots is fundamental for a long-term sustainable human presence on the lunar surface in conjunction with NASA’s Artemis Program. Additionally, the robot’s ability to build berms will protect structures such as astronaut habitats, cryogenic propellant tank farms, and in-situ supplemental food crop centers like NASA’s Veggie Project. RMC’s robot is designed to maximize berm volume relative to its size while employing an efficient regolith storage mechanism. Fly ash was used in analog excavation testing to represent the mechanical behavior of lunar maria regolith. To ensure the completion of the robot, engineering design was divided into three subsystems, excavation, structures, and controls.

7. **Project Objective:**

The principal objective of RMC is to design and manufacture a lunar robot capable of excavating, storing, transporting, and depositing surface-level regolith to build a berm which shall shield critical structures from the harsh space environment. Protecting astronaut infrastructure is essential in developing a sustained off-planet human presence.

8. Manufacturing / Design Methods:

After conducting a thorough literature review of robotic excavation mechanisms, the team opted for a bucket drum design due to its proven success and relative simplicity. The fidelity of this design was validated through Becker 3D® simulations, a software demonstrating regolith particle loading which yielded the prototype's fill capacity. The selected bucket drum design was coined "double-double" for its double-scoop double-storage geometry.

For mobility, hollow rigid wheels with grousers were selected to improve traction while minimizing dust buildup. The robot's wheels were 3D-printed in-house from PLA. Through Ansys® simulations, it was proven that PLA can handle expected torques during digging and driving with a factor of safety of 1.23. The chassis is built from Al 6063, selected for its light weight and machinability. Passive dust control measures were taken to protect sensitive components during driving and excavating. These include implementing 3D-printed dust covers and plugging exposed holes with puddy.

For the controls suite, a Rasbery Pi is utilized for the on-board computer with Python scripting responsible for executing manual and autonomous waypoint navigation sequences. Brushless motors were implemented for their efficiency and longer lifespan. Additional electrical hardware includes a 12V 9Ah lead acid battery, motor controllers, through bore encoders with hall sensors, an IMU, and a COTS kill switch. All electronics are housed within a sealed box to mitigate dust erosion of wiring and sensitive components.

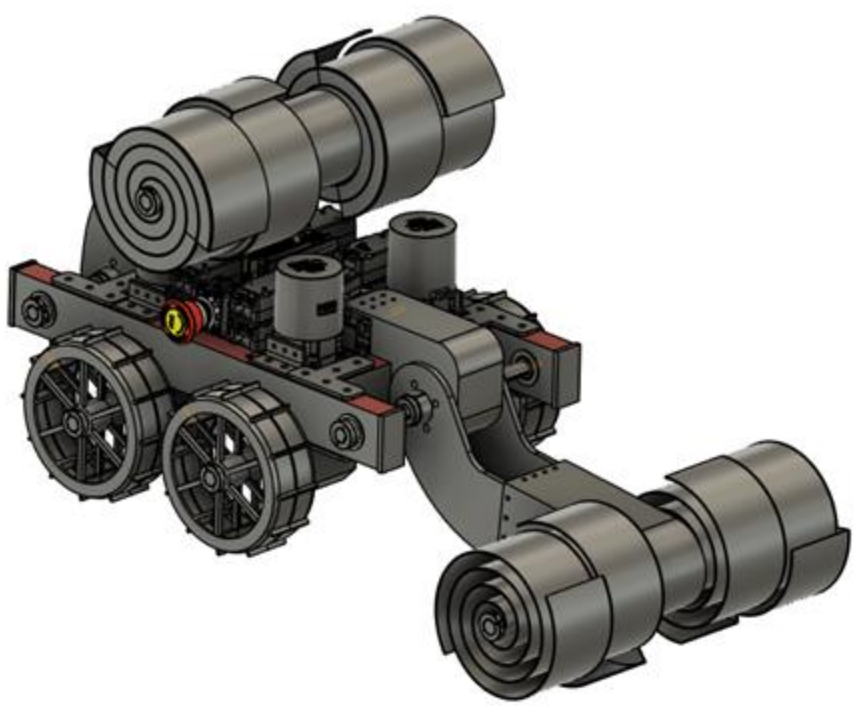
9. Analysis:

A suite of programs was used to perform a comprehensive analysis of the robot. Torque profiling and stress analysis were conducted using Ansys® for the wheels. Anticipated bending stress on the chassis was determined using a MATLAB® shear-moment script. Webots® was used to create a simulated mission arena with rocks, craters, and mining zones. A mock robot was piloted through this virtual arena to refine the capabilities of the physical prototype. In order to refine the excavation design, Becker 3D® simulated the regolith particle loading into and out of each bucket drum. This yielded a percent fill capacity (~80% per drum). In addition to the aforementioned programs, first order calculations were performed by hand and in Python to confirm expected magnitudes.

10. Future Works:

Future work includes refining the robot's autonomous navigation code and implementing an image path planning algorithm. While the robot is capable of manual control, full autonomy will require additional testing for turn precision, waypoint accuracy, and calibration of the IMU to mitigate sensor drift and system noise. For lunar-based applications, the team envisions the installation of on-board image processing by which the robot may navigate through a local region without the necessity of dropping waypoints beforehand.

11. **Attach Project Image:**



12. **Attach Files:** showcase poster link here once completed