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San Diego, California
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1. Team Structure

Leadership and Membership | Our team consists of 9 different divisions each led by division leads, who organize project activities and directly manage members' progress. Undergraduate student Giovanni Diaz-Lopez serves as the team's project manager, overseeing 5 of the divisions in addition to administrative management. Undergraduate student Jefferson Young serves as project lead and oversees 4 divisions, in addition to handling technical management for all divisions. Division leads serve as liaisons to the project manager and lead as well as to other divisions. The team consists of roughly 50 members ranging from all years of university pursuing STEM-related majors. The club's main goal is to provide anyone with any level of experience the opportunity to learn something new whilst working on a substantial project.

Communications and Information Management | All communication and collaboration between divisions, leads, and advisors are done through in-person and virtual meetings, with information management and online communication done via Discord, Google Drive, and GitHub. Discord is the team's main method of general communication between members. GitHub enables file sharing of CAD models and code files between members. Google Drive is the main storage of technical documentation, notes, administrative records and planning documents. Training manuals and guides dedicated to programming embedded systems and modeling through CAD were organized by the project leads to give those with no experience the necessary knowledge to contribute. These touched upon topics in programming with C++ and Python, working with embedded systems using microcontrollers, and CAD in SolidWorks. The team's primary method of recruitment and outreach were through tabling events sponsored by the university and social media.

2. Team Resources

Finances |Funding for the Aztec Rover Team is provided by the SDSU Student Success Fee and the ASME SD chapter. Division leads input items, relevant purchasing information and store links into the team ordering form. The leads then inform the project manager to review and submit the necessary components to be purchased to the SSF coordinator. After the request is processed, items are purchased and the divisions are notified when the components arrive. Prior to the competition, a rough budget was created by the project leads considering first and second phase divisions, potential travel expenses expected, and general division budgets. Expenditure is tracked by the budget throughout the project development timeline. A finer budget reevaluation is planned after all Bill Of Materials are submitted to the project leads to further redistribute funding where necessary.

Facilities | The team will be utilizing the workshop located in the Engineering basement.. The workshop facilitates milling, laser cutting, waterjet cutting, a large scale horizontal bandsaw, welding, and 3D printing. All members must undergo SDSU's Environmental Health and Safety training prior to operating any school facilities.

3. Project Management Plan

Development Lifecycle Approach | Our design process utilizes a top-down design approach adapted from NASA's System Engineering Engine to guide the progression of the project. All members first go through training to gain crucial skills necessary to contribute to the rover. Divisions first collected design criteria specified by the URC rules and guidelines to define mission objectives and important considerations during designing and decision making. General systems are researched during brainstorming to assess their effectiveness at meeting objectives through trade studies. After decisions are made, systems are sectioned into their components, with further trade studies made to identify solutions that best fulfill our criteria. Calculations and preliminary feasibility checks are performed on selected solutions. Designs are sketched, modelled, and simulated iteratively to improve optimization before fabrication and assembly. Divisions freely collaborate and coordinate in parallel, responding to rapidly changing information and modifying integration accordingly. Division leads handle management of goals, task breakdown for members, ensuring deliverables are made by specific deadlines, and providing resources and assistance to members.

Systems Integration and Test Plan | Division leads and project leadership meet once weekly in person to provide an opportunity for leadership to communicate design changes, as well as receive feedback and support on planning and delegation. Divisions meet weekly over virtual platforms for members to provide progress updates and receive feedback on design changes by leads. Weekly meetings additionally facilitate system-level understanding among members and promote collaboration on assignments. Divisions requiring structural testing perform finite element analysis during the design phase and physical tests during the prototyping phase to inform on changes needed. Autonomous tasks are tested on a local level in a variety of environments to verify that models work as intended and perform reliably. After the rover is fabricated, more comprehensive evaluations can be performed. The drone will be simulated before fabrication, then tested in an outdoor environment for tuning and design changes. Once the rover is fabricated, the arm and manipulator will be tested using a mock lander for the equipment servicing mission. The arm and manipulator will be further tested with full delivery mission trials outside in real-time. The science mission will be simulated by performing experiments in a laboratory setting, then outside with practice samples.

4. Preliminary Technical Design

Chassis, Drivetrain and Suspension, Arm, Manipulator | The current chassis design consists of a rectangular box formed with rail extrusion elements for versatile mounting and ease of assembly. For drivetrain and suspension, a rocker-bogie mechanism and TPU printed wheels are utilized. The arm is a two joint articulated arm with a rotating base for 6 degrees of freedom. The end effector is a parallel jaw gripper to perform many tasks, and will have three degrees of rotation to allow alignment without moving the rover. Brushless stepper motors and built-in gearing reductions are used for accuracy and robustness.

Laboratory, Procurement | The science mission will be completed using a rotating test tube holder and onboard laboratory equipment. The procurement system will use an auger to collect soil samples, discarding topsoil using a motorized gate. Soil of the correct depth will enter one of six isolated test tubes. The procurement system also utilizes moisture and temperature probes that lower into the soil. Raman spectroscopy is utilized on each sample to identify specific compounds that indicate the existence of life.

Vision, GNSS | The autonomous navigation mission is completed using the rover's camera system for active terrain recognition and hazard avoidance. The cameras are also used to identify visual markers of key locations to navigate autonomously to them. With the provided coordinates, real-time kinematic GNSS is used to track the rover and provide a means to reach locations only given coordinate information. After reaching areas of interest, the rover will signal a completed marker before moving to the next area. The vision system is also used to provide operators a way of observing the rover's environment during operation.

Power, Controls, Remote | The electronics system consists of off-the-shelf batteries and a power distribution board to provide power to the rover components. A battery management system is also included to track voltage and current of the batteries, displaying this information on the rover and operator's interface. An emergency stop button will instantly cut off power to all rover electronics. A Nvidia Jetson Nano Orin NX is used as the rover's on-board computer. The computer is connected to a unified breakout PCB to a Raspberry Pi Pico microcontroller to interface with all electronics of each payload system. Communication is facilitated through the I2C communication protocol between the microcontroller and components, with USB connection being used between the Pico and NX. Communication between the base station and rover is facilitated through two 900 Mhz point-to-point radios through an omnidirectional antenna on the rover and directional on the base station.

Table 1 - Budgeting Table

	Budget
GNSS	$1,500.00
Vision	$500.00
Remote	$1,000.00
Drivetrain & Suspension	$4,000.00
Laboratory	$750.00
Procurement	$750.00
Arm	$1,000.00
Quickswap	$750.00
Drone	$750.00
Chassis	$500.00
Armor	$250.00
Power	$1,500.00
Controls	$250.00
Travel	$1700.00
Project Surplus	$1800.00
TOTAL PROJECTED EXPENSES	$17000.00

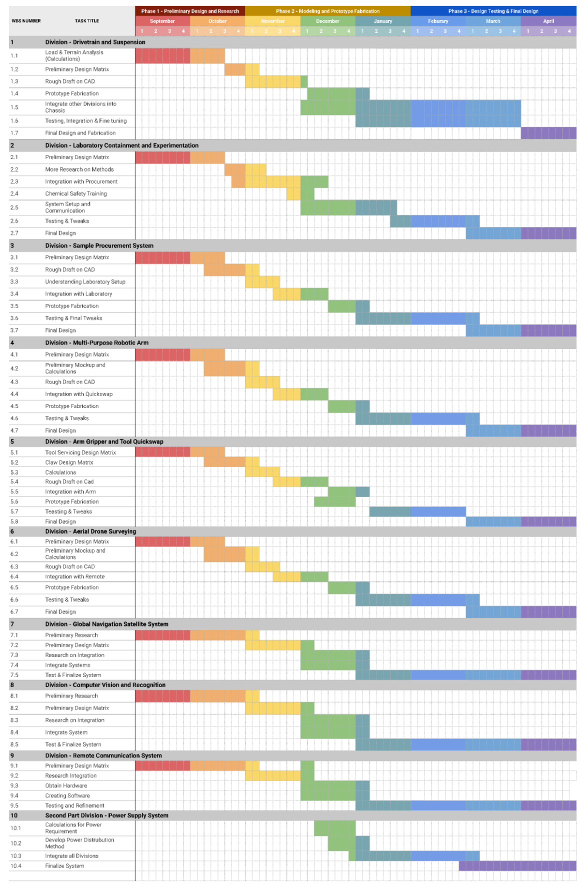

Figure 1 - Gantt Chart

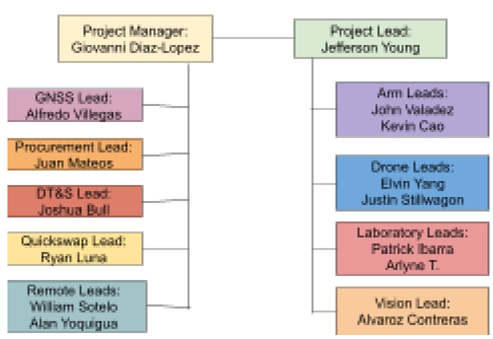

Figure 2 - Team Structure Diagram

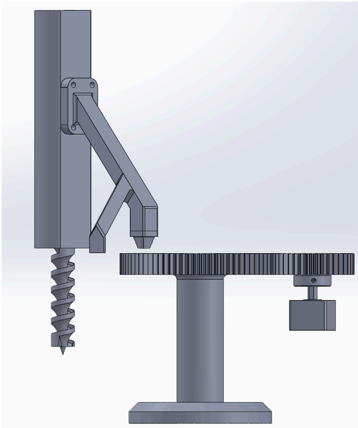

Figure 3 - Auger & Carousel

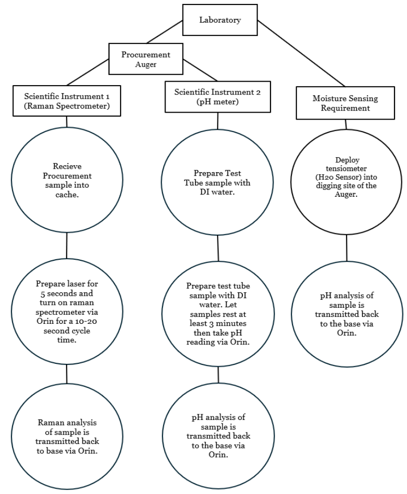

Figure 4 - Laboratory Process Chart

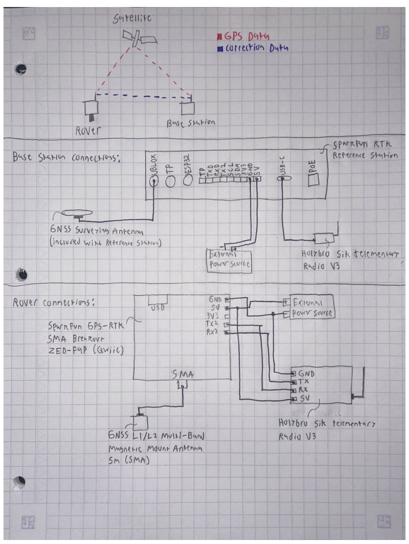

Figure 5 - GNSS System Setup

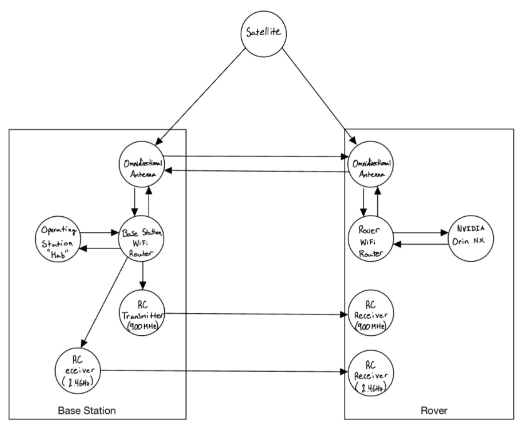

Figure 6 - Remote System Level Diagram

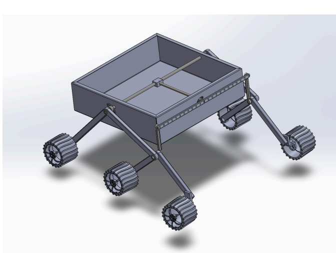

Figure 7 - Drivetrain & Suspension

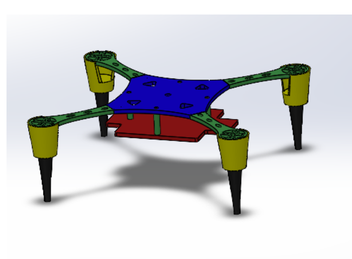

Figure 8 - Drone Stack

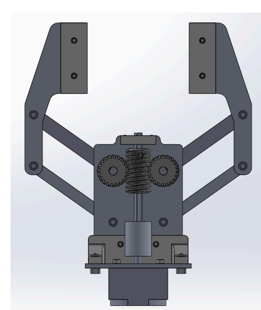

Figure 9 - Cross-Section of Quickswap