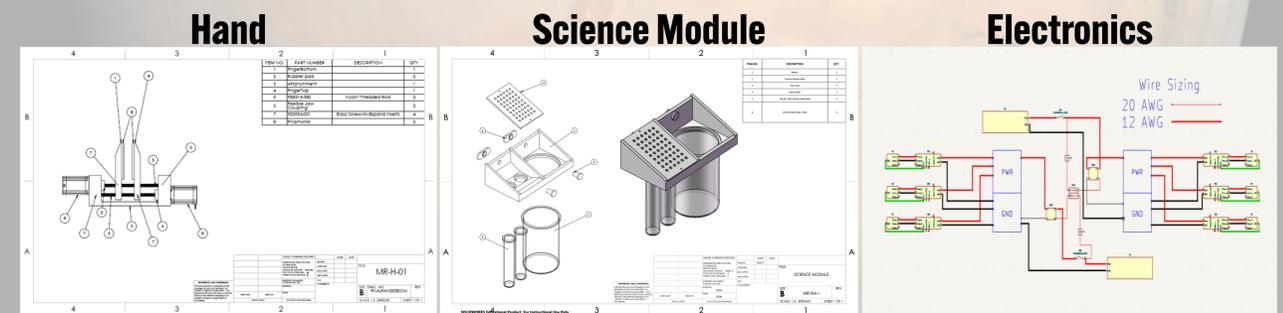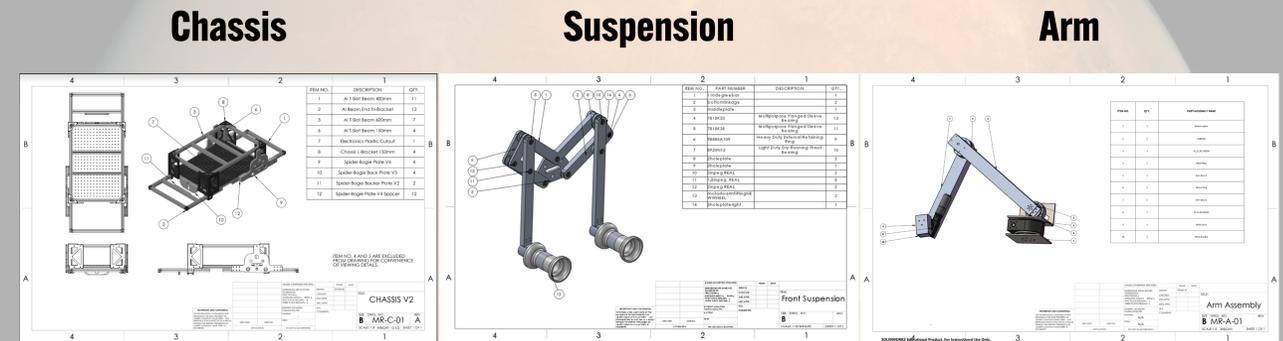# USU Mars Rover Team

The Mars Society's University Rover Challenge challenges students to build remotely operated rovers that can accomplish a variety of tasks that might one day assist astronauts working on the surface of Mars. Rovers compete in four missions:

- Science Mission to investigate a site for the presence of life.
- Delivery Mission to deliver a variety of objects to astronauts in the field across rugged terrain.
- Equipment Servicing Mission to perform dexterous operations on a mock lander using a robotic arm.
- Autonomous Navigation Mission to autonomously travel to a series of locations.

Some key performance variables we chose to focus on are:

1) Rover Speed: points in the rover competition are weighted heavily on completion time. The faster our rover goes, the faster it can complete the missions.
2) Tolerance of Wheel Rotation: accurate positioning of the rover is critical for the delivery mission and for placing the rover in the most effective position for the arm to work.
3) Radio Distance: effective communication with the rover at long distances is necessary to complete all the missions.
4) Arm Lift Weight: the rover arm must be capable of carrying loads up to 5 kg for the delivery mission
5) Suspension Height: all the missions require the rover to travel over rough terrain, so the abltiiy of the rover to drive over rocks and other obstructions is necessary

Chassis
Suspension
Arm
Hand
Science Module
Electronics

PURPOSE

1) For the delivery mission of the University Rover Challenge, the rover will need to go 1 km away and back with a limited time of 60 minutes. the faster the rover can get there, the more time there will be for harder obstacles.

2) For the servicing mission, the rover must position itself accurately to access sections of the challenge. Excess movement of more than 34 degrees results in about 10 cm lateral uncertainty. Which will result in complications in precision for the competition missions. the tolerance should be as low as possible to increase the mission effectiveness.

3) The University Rover Challenge requires the radio communication signal to reach at least 1 km from the command station.

4) The rover challenge requires that the rover lift at least 5 kg. A strong arm allows for easy movement while transporting loads during the relevant missions.

5) The terrain around the mars desert research station is said to include soft sandy areas, gravel, rough stony areas, rock and boulder fields, vertical drops, and steep loosely consolidated slopes. Verifying the height of the suspension should help us figure out how well the rover can handle this terrain.

METHOD

The rover speed was initially tested using the max RPM of the wheels and converting it into forward velocity; however, once the rover was fully running, the rover speed was physically measured

The wheel rotation tolerance was initially measured using the hall sensor tolerance provided on the motor data sheet. Once the rover was driving, the lateral distance after the signal was measured to determining the tolerance

To estimate the radio distance the general equation relating the antenna height to the radius of the earth was used. Once the rover was controlled remotely, the distance was tested by driving the rover until signal loss

To test the load capability of the arm, the sum of the moments was calculated to generate the force generated by the arm. When the arm was fully running, the hand was loaded, and arm motion was tested.

The maximum height of the suspension was measured using the largest distance between the wheels without collision in SolidWorks.

Performance Variable	Target	Threshold	Predicted performance	Actual performance
Deflection of arm	1.97E-03 cm	3.94E-03 cm	3.3E-2 cm	N/A
Rover Speed	4 km/hr	2 km/hr	25.68 km/hr	26 km/hr
Arm Lift Weight	7 kg	5 kg	6.8 kg	10 kg
Tolerance of wheel rotation	1 deg	10 deg	8.57 deg	9 deg
Suspension Travel Height	15 cm	9 cm	11.61 cm	23.5 cm
Horizontal Rover visibility	360 deg	135 deg	87 deg	360 deg
Camera Resolution	1280x720	848x480	1920x1080	1280x720
Radio distance	2 km	1 km	2.787 km	330 m
Climbing incline	60 deg	30 deg	40 deg	33 deg
Volume of sample	150 g	5 g	200 g	180 g
Pincher Torque	12 oz-in	5 oz-in	11.8328 oz-in	8.3 oz-in

The results of the key performance variables and future improvements are as follows

1) Rover Speed: Run at 2.6 km/hr, surpassing target of 4 km/hr. Theoretical max velocity is 26 km/h.
2) Tolerance of Wheel Rotation: Approximately 9 degrees. A braking system would improve accuracy.
3) Radio Distance: Radio distance reached approximately 330 meters with a small antenna. Upgrading to a high-end antenna could improve communication.
4) Arm Lift Weight: The rover arm lifted a weight of 10 kg, surpassing the threshold. Mass reduction by drilling hole patterns and furthering the control code would be beneficial.
5) Suspension Clearance: Suspension clearance is 23.5 cm, surpassing the threshold. Improvements include mass reduction from the legs and adding stability upgrades like machined spacers.

What We Learned:

- Extensive experience with motor controllers and operating motors from a computer
- Creating a radio controller that can both receive and transmit data
- Effectively designing and 3D printing parts for strength and critical connections
- Machining parts efficiently and knowing when to delegate to more experienced machinists
- The cost of ordering custom/technical parts and the associated shipping times
- The use of chemicals in life detection and the general field of astrobiology
- Coding conventions for vehicle and arm control

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