**Goal**

The mission of Team Wall-E was to create a robot capable of autonomously navigating terrain similar to what is found on Mars with the following criteria:

- A budget of $500.
- The size of a cat.
- Research on each of the sensors, motors, and mechanical equipment.
- The lower weight class by creating a robot under 1.5 kg.
- Multiple types of sensors to minimize failures due to sensors.
- Avoid obstacles while heading towards the beacon.
- The team planned to exceed each deadline and to have something new added and integrated to the robot in progress for each weekly meeting with the team advisor.
- Traverse Mars-Like terrain, including but not limited to: rocks, ditches, steep inclines, sand, and cold temperatures.
- Robot assembled two weeks before date of challenge.
- Adequate testing to avoid critical errors at the dunes.
- Adaptive and unique design.

**Design**

Team Wall-E first decided on a four-wheeled bot with skid steering. A prototype was built, consisting of a cardboard box and foam football wheels. When this design proved to be unsatisfactory, inspiration was drawn from existing designs. The final design was based off of NASA's Curiosity Rover.

- The six wheels would provide support while also ensuring effective navigation of the terrain.
- A differential bar would stabilize the chassis and prevent over rotation.
- The chassis was manufactured from an aluminum sheet, with internal support to prevent buckling of the sides.
- The customized robot was made of 3D printed joints, connecting pieces, sensor mounts, and a differential bar that were initially designed in Creo Parametric.
- Four of the six rubber wheels were powered by geared DC motors (500 RPM).
- The sensor array included three time-of-flight distance sensors, utilizing IR laser light.
- The mount for these was designed so the sensors were arranged in an arc and could be rotated by a standard RC servo.
- This enabled detection of obstacles in front and to the sides of the robot.
- An additional ultrasonic sensor was mounted to the front as a backup to the time-of-flight sensors.
- One whisker sensor on each of the front corners provided additional detection capabilities.
- Rocker-bogie designed system in the build of the support.
- Lightweight materials.

**Lessons Learned**

Wall-E did not succeed in the challenge.

- The first major issue that was noticed immediately in testing was its inability to turn on concrete and carpet.
- Had Wall-E been tested earlier, a solution could have been found.
- On hard packed sand the robot performed fine but once in the softer sand of the course the problems started.
- The robot ran slowly before coming to a stop and digging itself in.
- Once the wheels dug in, sand flooded the motors causing two of them to seize.
- The first lesson learned was the importance of testing with enough time in advance to fix mechanical issues.
- The catastrophic failure of the motors showed the team the importance of preparing for the worst.
- Sand in its very nature gets everywhere and the worst thing it could have done was to cause the motors to fail.
- The time-of-flight distance sensors did not work well with the reflected rays of sunlight off the sand.