

# Mars Rover Design Team

## Winter 2019 Newsletter

### From the Desk of the CEO

It's good to occasionally reflect on the impact of our team. It often helps clarify our greater purpose and can even result in a great story.

On Halloween, we took our 2018 competition rover, Atlas, to Rolla's trick-or-treating event where it used its robotic arm to hand out candy to children. The arm was the star of the show! For many kids, this event seemed to be their first close encounter with robotics. One child in a Minion costume saw Atlas from across the street and ran over to us, his parents trailing. His eyes never left the arm while he stood in line. He was so enthralled when the arm gave him candy that he shouted, "THE FUTURE IS TODAY!".

When team member Mark Hampton later told the rest of our team about the child's reaction, the look on his face was one of complete awe; it was clear the experience impacted him as much as it did the child.

That's why we do these outreach events, and why inspiring the next generation is a key part of our mission. These activities change people's lives and our team is proud to have such an impact.

All the best,  
Andrew Rausch  
CEO - Mars Rover Design Team



# Technical Update

Our six technical subteams spent the past semester designing Missouri S&T's 2019 competition rover. In October, we hosted a series of preliminary design reviews with faculty and team alumni to discuss our proposed subsystems. Their feedback helped us revise our design decisions over the next two months.

The most important design revision concerned the rover's suspension subsystem, as our students determined the initial design was not feasible within our competition-mandated weight constraint and projected manufacturing schedule. We decided to reuse the "Mantis" suspension design that proved successful on our two previous rovers. All other onboard mechanical subsystem designs were finalized during a weekend-long internal critical design review.

Over Thanksgiving break, our students began manufacturing the rover's four mechanical subsystems and have completed about 20% of the final rover. By December, our electrical/PCB subteam completed all board designs and will begin assembling and testing them at the start of the spring semester.



Connor Jones mills the robotic arm's main wrist structure.

The following sections highlight some of our current technical milestones.

## Autonomous Point-to-Point (P2P)

```
// Normalize accelerometer measurement
norm = sqrt(ax * ax + ay * ay + az * az);
if (norm == 0.0f) return; // handle NaN
norm = 1.0f/norm;
ax *= norm;
ay *= norm;
az *= norm;

// Normalize magnetometer measurement
norm = sqrt(mx * mx + my * my + mz * mz);
if (norm == 0.0f) return; // handle NaN
norm = 1.0f/norm;
mx *= norm;
my *= norm;
mz *= norm;

// Reference direction of Earth's magnetic field
_2q1mx = 2.0f * q1 * mx;
_2q1my = 2.0f * q1 * my;
_2q1mz = 2.0f * q1 * mz;
_2q2mx = 2.0f * q2 * mx;
hx = mx * q1q1 - _2q1my * q4 + _2q1mz * q3 + mx * q2q2;
hy = _2q1mx * q4 + my * q1q1 - _2q1mz * q2 + _2q2mx * q3;
_2bx = sqrt(hx * hx + hy * hy);
_2bz = -_2q1mx * q3 + _2q1my * q2 + mz * q1q1 + _2q2mz * q3;
_4bx = 2.0f * _2bx;
_4bz = 2.0f * _2bz;
```

### Primary functions:

- Enables rover to navigate using GPS coordinates
- Relays navigation information to rover's stereoscopic vision, LiDAR, neural network

### Mission criticality:

- Essential to complete the URC Autonomous Traversal task

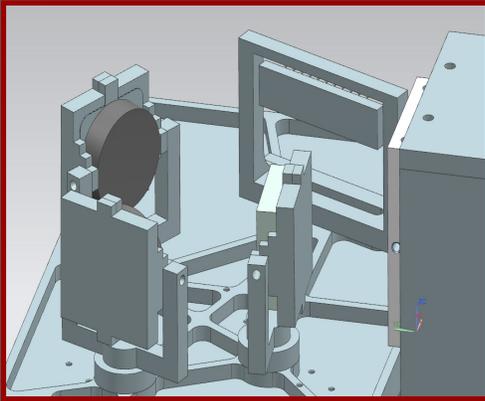
### Current status:

- P2P system runs using a drifting compass heading

### Next stage:

- Improve system reliability and precision

## Charged Coupled Device (CCD)



### Primary functions:

- Measures light grading across a linear pixel array
- Evaluates soil sample composition for signs of life

### Mission criticality:

- Essential to conduct experiments in situ and complete URC Science task

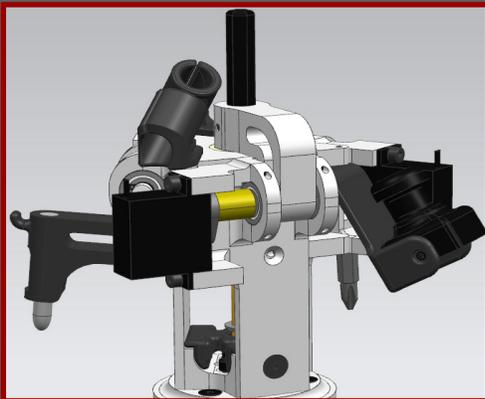
### Current status:

- Reads spectrographic data asynchronously at  $\frac{1}{4}$  its maximum resolution

### Next stage:

- Develop synchronization of CCD data and increase overall resolution

## Robotic Arm End Effectors



### Primary functions:

- Collect, assess, and release objects in the field
- Service equipment with an onboard 3-in-1 tool array

### Mission criticality:

- Essential to complete URC Equipment Servicing and Extreme Retrieval and Delivery tasks

### Current status:

- Finalized CAD models of each end effector

### Next stage:

- Manufacture and test each end effector

## Save the Date!

The 2019 University Rover Challenge (URC) is scheduled for May 30 - June 1, 2019 at the Mars Desert Research Station outside Hanksville, Utah.

## Team Update

This fall, our business subteam focused their efforts on two areas: planning fundraisers and assisting with our Preliminary Design Review (PDR), the first of three pre-competition documents required by URC. The PDR explains our team's technical designs, team structure, business plans, and preparations for the 2019 URC. We are happy to announce we successfully passed our first competition milestone!

Our public relations subteam promoted our vision "Today. Tomorrow. Forever." at several major outreach events this semester. In October, we partnered with the Missouri S&T American Chemical Society chapter to celebrate National Chemistry Week with their program "Chemistry is Out of this World". This event taught the public about chemistry's role in exploring outer space.

The following month, we exhibited our 2018 rover, Atlas, at a preschool space week event hosted by Greentree Learning and Childcare Center in Rolla. We also hosted our fifth annual Space Week and "Tour of the Planets" on the Missouri S&T campus - our biggest events of the fall semester.



Keyton Rovka teaches the future generation about Mars during the Greentree Child Care Space Week.

## Space Week



Dr. John Story lectures about the evolution of the solar system during Space Week.

The heart of our mission is to inspire future generations of students to explore science, technology, engineering, and mathematics.

Space Week, held every November, educates the public about space, science, and technology through interactive activities and guest speakers.

Our 2018 event featured a stargazing night at the Missouri S&T observatory and a screening of *Mercury 13*, a documentary about the women associated with NASA's Project Mercury. Guest speakers included Missouri S&T professors Dr. Rainer Glaser and Dr. John Story, Dark Energy Survey physicist Michael Baumer, and our team's founder, Michael Bouchard. Each event was free of cost and open to the general public.

## Tour of the Planets



Katie Pitz talks to elementary school students and their families about constellations during Tour of the Planets.

At the end of every Space Week, we host “Tour of the Planets”, an event for local elementary school students and their families. Team members spend the afternoon teaching children about the solar system through space-related crafts, games, and science experiments.

This year we were also joined by representatives of the Missouri S&T Physics department who performed liquid nitrogen demonstrations. Over seventy children attended our event! “Tour of the Planets” is just one of the many ways we continue team traditions and inspire the next generation of space explorers.

## Join Us!

Enjoy learning about us? Follow us on social media for more stories, pictures, and videos of our team and our rovers in action!



Be part of our story. Donate at <https://marsrover.mst.edu/sponsors/#instructions> or contact us at [marsrover@mst.edu](mailto:marsrover@mst.edu) to find out how you can make a difference.

