Three years ago Kevin Sloan, a cofounder of the Penn State Chapter of the Mars Society, thought of a way to involve more university students in the organization. At the 2005 International Mars Society Convention, he and a group of fellow students had a hallway conversation about the project with Robert Zubrin, president of the Mars Society, who has always been keenly interested in student involvement. They developed the idea of a robotics project with students to encourage more groups to become involved and to expose more students to and build on the success of the Mars Desert Research Station in the middle of Utah. The University Rover Challenge (URC) was born.

The first competition, URC 2007, brought representatives from four universities to the southeastern Utah desert to compete in two separate tasks. URC 2008 brought competitors from seven universities, including: Brigham Young University; Iowa State University; University of California, Los Angeles; York University, Toronto, Canada; Georgia Institute of Technology; University of Nevada, Reno; and my current school, Oregon State University. The four tasks in URC 2008 were much more difficult than the two tasks in 2007.

Tasks were in two categories: engineering and scientific. Each engineering task had a clearly defined goal: to deliver a package to an immobilized, distressed astronaut in under 30 minutes and to tighten...
Evidence and to present their conclusions to a panel of scientists. The first scientific task included studying the surrounding geology for signs of water, and the second analyzed soil at GPS-specified locations for temperature, moisture and acidity (pH).

Building this robot with a team of engineering students would be tough in any time scale; building this rover in just four short months was incredibly challenging. But we did it. And here’s how.

MARCH—TEAM BUILDING & SPONSORSHIP

Building a team of experienced robotics enthusiasts was critical to our success; in fact, even before we had the goal of competing in URC, our robotics club dreamed up and hosted competitive mini-events such as robotic sumo and line followers for its members. These smaller competitions allowed the development of the skills and experiences that prepared members to face future struggles such as the URC.

After building the fundamentals of a team, our second step was to secure sponsorships for our Mars rover. We drove many hundreds of miles to visit other robotics clubs and companies in the area. Parallax, our major technical sponsor, is 500 miles away. Oregon Space Grant Consortium, our financial sponsor, is nicely located on the OSU campus. Help comes from near and far, so look hard for it.

Our compacted timeline inhibited us from building a custom chassis, which we needed for the competition in Utah. Just so happened that Parallax had a prototype chassis that needed testing. It was a perfect partnership. The QuadRover’s 2.5 horsepower 4-stroke gasoline engine ran a hydraulic compressor that pushed fluid through hydraulic motors connected to each wheel on each side of the rover. The direction of the hydraulic flow was controlled by solenoids. QuadRover’s front and back wheels are connected with a belt to allow turning by shifting the steering. A dry weight of 89 pounds pushed the limit at the competition’s weightin.

The final weight was just one pound under the URC 2008’s 110-pound limit. The gasoline engine took our rover up to 12mph. This, plus a high ground clearance, great strength, sufficient balance and a fuel tank that allowed the rover to run for longer than an hour, was a perfect chassis for roving the Utah desert. Using the Quad Rover, however, limited space for our electronics. Our solution was to use an embedded microcontroller to do all of the necessary electronic tasks.

Parallax also supplied us with their Propeller microcontroller—a compact powerhouse with eight independent cores that made multitasking manageable. Overall, Parallax equipped us with two effective tools that worked together.

Our design month ended with our feeling very comfortable about our progress. We had a talented and diverse team of four and two generous sponsors; we knew something special was forming.

APRIL—TIME TO BUILD

In April, 2008, our team developed a professional-grade robotic arm and control scheme for the hydraulic motors. All of our group became ham-radio settled to hear Amateur Television (ATV) equipment. Team member Jordan often called his father, who is also an electrical engineer, to discuss video-transmission techniques. We used the VM-70X ATV transmitter to broadcast our NTSC video signal on channel 58. Essentially, we turned our rover into a mobile TV station. We also wanted a way to record a split video signal using composite and coaxial cables, so we bought a VCR. Jordan also bought a digital camera, the Olympus 850SW, immediately tore it apart and added an interface for the microcontroller to make it work. We tested this system in just four short months.

Rory designed the robotic-arm segments in Solidworks, punched out the brackets using an AMADA punch, and then bent the brackets into place with a brake press. His segments came in six, six and eight-inch lengths, so our robotic arm is customizable to any task. Ben programmed his Ubuntu-based laptop with a C+ GUI. The GUI had multiple regions to dynamically change the screen’s display. It also read a PlayStation II controller and output serial commands through the data modem. My task was to assist everyone else with their projects and to also develop a way to control the robotic arm. A teleoperator scheme whereby we manipulated a robotic-arm model at the base station and the remote robotic arm duplicated its motion allowed us to gain a sense of intuition through this remote controller. Our individual projects went quite smoothly in this phase, but testing proved to be a challenge. All four team members tested their own components, but we did not connect or test them until the first rehearsal in May. We were asking for trouble.

MAY—ONLY 4 WEEKS LEFT!

During prior robotic sumo contests, we had learned that our team is a group of procrastinators, and each of us had seen a personal project fail because of this flaw. We wanted to avoid a repeat of this in training to Utah, we rented a rehearsal building at the local fairgrounds. Local high school robotics teams, friends, OSU Robotics Club members and even our parents supported us and welcomed us to our awesome Mars Rover. In true form, our small squad procrastinated until three days before the rehearsal to assemble our parts to make the rover. We pulled an all-nighter the day before rehearsed and, consequently, the rover did not function as we had intended. Vibrations from the engine caused the wires that powered the serial data modem to become disconnected and reset our rover. This problem would have been avoided if testing had encompassed an assembled rover.

Procrastination had struck again. This embarrassing afternoon was an inflection point for our project. Disappointment would cause our entire project to fail, but using the failure as a lesson would make something good happen. We called in some favors and found advice from OSU faculty and invited OSU Robotics club members to join our project. Three weeks later at a local park, a successful rehearsal showed that two lessons had been learned: first, be skeptical of modular interconnections and test them when they are integrated into the entire system; second, be humble enough to ask for help.

JUNE—ROVING UTAH

Competing at URC 2008 in Utah gave us hands-on robotics experience that just can’t be replicated in a university lecture hall and memories that will last a lifetime. Team Gossa will remember the most stressful “Mars rover video game” using a PlayStation II controller to drive our rover during the four events. Jordan Levy ran his most frantic

DIVERSE ROBOT DESIGNS AT 2008 URC

Owing to windy weather at the outset of the 2008 URC and the difficult challenges faced by the robots, the competition became something of an unforgettable adventure. Kevin Snavely and Alex Kirk provide a nice overview of the event in The Space Review, www.thespacereview.com/article/1551.

“Battling high winds on the first day of competition that destroyed several logistics tents and hindered teams’ ability to erect antenna masts, rovers were put to work in the Construction and Geology tasks. In the former, the awkwardly inclined bolt panels proved to be exceptionally difficult for most teams, most of whom were unable to properly secure the panels. York University (Toronto, Canada) took a narrow victory in this event by being the only team to fully secure a single bolt.”

“Day two and its calmer weather put teams to work in the Emergency Navigation and Soil Characterization tasks. In the former, Oregon State University built a large lead by being the only team to find the distressed astronaut in the allotted 35 minutes. Georgia Tech and Iowa State University finished second and third with performances that took them within a few meters of the astronaut as the clock ticked down to zero.”

For more, visit The Space Review.

OSU Robotics Club

http://oregonstate.edu/groups/osurc

OSU URC Forums


Parallax, www.parallax.com, (888) 512-1024

Mars Society,

http://www.marsociety.org/

Mars Society, URC 2008 teams, www.marsociety.org/portal/teams

OSU Robotics Club

http://oregonstate.edu/groups/osurc

OSU URC Journal


OSU URC Forums


Parallax, www.parallax.com, (888) 512-1024

SolidWorks, www.solidworks.com, (800) 693-9006

Space Review (URC Recap), www.thespacereview.com/article/1551

For more information, please see our source guide on page___