THE MARS QUARTERLY

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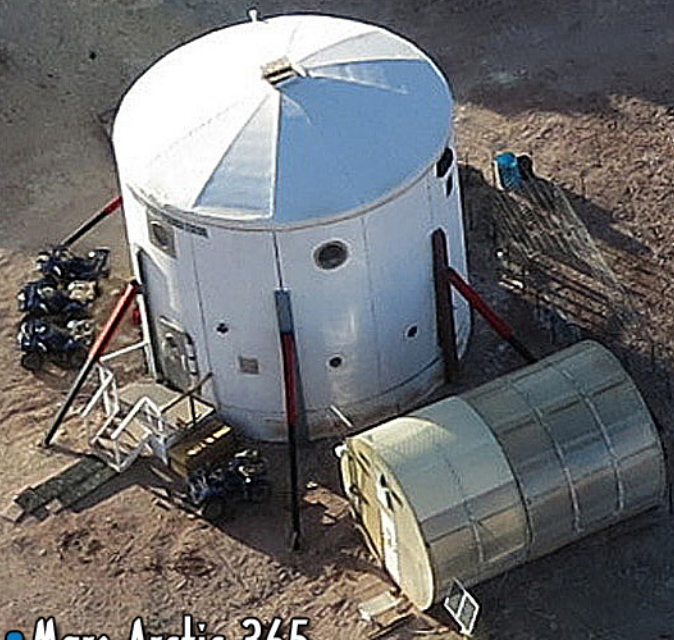
An Urgent Appeal for Help

Robert Zubrin



In This Issue:

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IN THIS ISSUE

On the Cover –
An aerial view of MDRS taken from a quad-copter (credit: Jim Urquhart), and a MDRS crew member directing a rover across the Mars-like Utah desert.

FROM THE FLIGHT DECK

It is becoming more and more apparent that Science, Technology, Engineering and Mathematics (or STEM) are playing a larger role in our global society and greatly impacting the direction it takes. The Mars Society understands that encouraging today's youth to study and pursue STEM education is a key element in ensuring humanity's future in space and long-term survival.

Three programs organized by the Mars Society - the University Rover Challenge (URC), the Youth Rover Challenge (YRC) and the European Rover Challenge (ERC) - are galvanizing students to get further involved in STEM-related learning and research. Established in 2006 and managed by Kevin Sloan, the URC is an annual competition held in the Utah desert that brings together college student teams from the U.S. and around the world to design and build rovers that will test robotic, engineering and field science methods for future planetary exploration. The URC draws from an international pool of talented and promising students, with 31 student teams scheduled to participate this June.

Another version of the URC, but intended for younger students, is the YRC. Organized in 2013 by Chuck McMurray, the YRC is an annual educational project designed to challenge students in grades 5-12 to build LEGO Mindstorm rovers and compete in a nationwide (eventually worldwide) contest. With 22 student teams registered for the inaugural competition to be held in the coming months, the YRC provides students with an opportunity to delve into basic elements of engineering and robotics.

Finally, the Mars Society's Poland chapter launched a new annual initiative in late 2013 called the ERC. Similar in many aspects to the URC, the ERC will involve student teams from mainly European-based universities and research institutes testing various aspects of rover technology for possible use in future Mars exploration. The three-day competition will take place in Poland later this year.

Please visit the Mars Society web site (www.MarsSociety.org) to learn more about these important programs.

Michael Stoltz, Editor

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Mars Arctic 365 Crew Selection Underway

Semi-finalists for crew selection for the Mars Society's Mars Arctic 365 (MA365) mission were announced in February 2014. Chosen from a pool of over 200 applicants, the 62 semi-finalists consist of 49 men and 13 women drawn from 17 countries (the United States, Canada, Brazil, the United Kingdom, France, Germany, Italy, Sweden, Finland, Russia, Ukraine, Bulgaria, Turkey, India, Japan, Australia and New Zealand).

The individuals selected represent a broad range of expertise and skills including geology, biology, medicine, aerospace, mechanical and electrical engineering, Arctic and wilderness survival training and journalism.

A complete list of the semi-finalists can be found on the Mars Society web site (www.MarsSociety.org).

The next step in the MA365 crew recruitment is down-selecting to 18 finalists. Once chosen, the finalists will be divided into three crews of six people each and then sent to the Mars Society's Flashline Mars Arctic Research Station (FMARS) on Devon Island in northern Canada for two weeks of challenging field testing in the late summer of 2014. On the basis of demonstrated performance, the best crew will be selected for further training, leading to the initiation of the Mars Arctic one-year mission at FMARS the following year.

Situated at 75 degrees north and less than 1,000 miles from the North Pole, the FMARS facility is perched on the rim of a 14-mile wide impact crater in the midst of a polar desert considered one of the most Mars-like environments on Earth.

"The Earth's polar regions are the closest analog to the surface of Mars that we will find until we actually land on Mars. The Mars Society has long been the leader in exploiting these regions and is continuing that tradition with this new initiative. This effort will bring real understanding to the space exploration community about what it will take to settle human beings on the surface of Mars," said former NASA Administrator Dr. Mike Griffin.

By conducting this full-scale dress rehearsal of a human expedition to Mars in a realistic habitat and environment for practically the same duration as an actual mission to the Red Planet, the Mars Society will take a great step forward in learning how people can work together to effectively explore the new frontier of the Red Planet.

The individuals selected represent a broad range of expertise and skills including geology, biology, medicine, aerospace, mechanical and electrical engineering, Arctic and wilderness survival training and journalism.

Nadav Neuhaus

THE MARS SOCIETY

An Urgent Appeal from Dr. Robert Zubrin

Dear Friends,

Last month, the Mars Society selected 62 crew semi-finalists for the Mars Arctic 365 (MA365) mission, which will be the highest fidelity human Mars simulation in history. As part of this, our organization is currently planning a second refit mission to our FMARS facility in northern Canada this July to complete preparations for long-term continuous operations at the station. Following this, three crews of six candidates will be tested and trained on Devon Island, allowing us to choose a final crew for actual participation in our 12-month long Mars-on-Earth analog, a historic project that will show our global community the promise of human Mars exploration and settlement.

The MA365 mission is truly an unprecedented undertaking. While past simulations by the Mars Society and others have achieved much good scientific data and attracted worldwide attention, MA365 will go much further. The expedition will deal with isolation issues as other studies have done in the past, but instead of sitting safe and sound in a warm room in a major city or tropical space center, the crew at FMARS will be conducting a sustained program of geological, microbiological, engineering and climatological field exploration in a cold, dangerous and remote environment, while operating under many of the same constraints that a human crew would face on the Red Planet. Only under these conditions, where the crew is trying to accomplish real scientific work, while dealing with bulky equipment, cold weather, discomfort and isolation, will the real stresses of a human Mars mission be encountered, and the methods for dealing with them mastered. Only under these conditions will all sorts of problems that Mars explorers are likely to face be driven into the open so they can be dealt with. Only by doing these types of full-scale missions can we make ourselves ready to go to Mars.

Nothing like this has ever been done before!

The Mars Society has made the commitment, but we need your help to make it happen! History is clearly not a spectator sport. If we want human explorers on Mars, we need everyone to pitch in and donate! Our group recently launched a special Indiegogo crowdsourcing campaign to help raise money for this important project. The campaign deadline is April 21st at 11:59 p.m. PDT. There's still time! Please help us by 1) donating generously to MA365 (www.MarsSociety.org) and 2) spreading the word about our mission and online campaign! Thank you, and On to Mars!

Dr. Robert Zubrin
President & Founder
The Mars Society

MDRS: Becoming an Astronaut-Mind

Elizabeth Howell

What does it mean to explore? Does it mean to set foot on unoccupied lands, such as tramping in a forest? Setting boot prints on another world for the first time, as Neil Armstrong did? Or is it more a condition of the spirit where you are embarking on something new, perhaps putting two things together in an unexpected way or solving a problem using a different approach?

I would argue that the Mars Society's Mars Desert Research Station (MDRS) in Utah is an example of the latter. It's a spot where small crews come together in an isolated environment and are tested. Pushed. Given strict regulations to work with, this forces them to come up with creative ways to complete their duties properly.

While I've been writing and thinking about space for nearly 20 years, actually experiencing a mission on site – simulated as it was – taught me a lot about the unknown unknowns. If I was part of a real crew, I'd better learn some dehydrated recipes quickly; after a few days of my cooking, I got comments (framed as kind jokes) as such, so I'm sure it could be grating after a few weeks.

I'd need to be able to fix a plugged toilet (that happened to me three times), hike up a steep hill safely and accurately (lost track of how many times I asked for help) and be cheerful and productive in a confined space with restrictions on water, Internet and other comforts many take for granted.

I'm framing my experience at MDRS in terms of negatives, but that's not the right way at looking at being a pioneer. It's about knowing there will be challenges and doing your best in the face of them. You confront the challenges – in a come-at-me sense – and work with your crewmates to make these challenges fade into the background. When you can get to that point, that's when the real work of MDRS begins. For serving on such a mission is not about wrestling with your environment. It's about letting the environment change you into a better person. That's the sort of exploration that MDRS provides.

I spent two weeks at MDRS in January 2014. I was part of a University of North Dakota-led crew that had never met face-to-face before. Different ages, different countries, vastly different backgrounds, all tied together at the surface by only one thing: a love of space. Luckily, the selection process seemed to bring out individuals who were suited to extreme environments. Everyone on Crew 133 was adaptable, many worked through sickness and injury, and although conflicts flared up, I can't recall a hasty word ever being said.

This was the attitude I came in with: these five other people have to be my family. There is no choice in the matter in thinking that way, because for safety reasons it's best to trust each other. As family members, we will work together to accomplish our goals, and when problems come up (always think when, never think if) we will solve them in a way that helps all. Within hours of meeting my crewmates, I knew they thought the same way. This helped us time and time again at MDRS.

Our crew best demonstrated this when unforeseen circumstances threw us into a five-day water shortage midway through our mission. Yes, we had some anxious moments thinking about how we would get through it, but nobody brought up staying at a motel as an option. We brainstormed, we came up with procedures, and then every last person followed through on them.

We got better at cleaning spacesuits without water. We found ways of washing up after meals using just a dab of liquid on each dish. Showers were obviously out, so I bound my long hair into a bun and used baking powder instead of shampoo. Sure, we probably didn't smell that great, but after a day or so of thinking through things, we had other priorities on our mind. Science, engineering, general Hab activities. Even then, though, we still had a lot to learn about exploring.

My first few days in particular had no spare time in them. Well, in truth there were brief minutes between bedtime and sleep, when I had to do something different to wind down after a busy day. I thumbed the pages of Chris Hadfield's *An Astronaut's Guide to Life on Earth*, which always, always brought up how the mission and the crew have to come before yourself.

An astronaut, by Hadfield's definition, isn't a spaceflight participant. It's somebody who is constantly optimizing things for the best mission outcome possible, and in that process of optimization, becoming a better person. A parallel would be the protagonist of *Zen and the Art of Motorcycle Maintenance*, who draws comparisons between motorcycles that are taken care of and the studious, methodical mechanic who lets the challenge of that work change him into an even more studious, methodical mechanic after every single job.

You can't come at the work by being a pessimist, by being ruled with fear. At the same time, however, you can't come at the work by being naïve. The

best approach is informed optimism. Plan for the problems, come up with procedures to fix the problems, and then focus on the mission. Put the worst out of your mind until the time comes to deal with it.

To me, Hadfield's words will always be entwined with that feeling of tired novelty, of new-kid-on-the-block, that MDRS put me into every single day. I wasn't an astronaut-mind when I came into the experience and likely not one when I left, but I tried to twist my thoughts in that direction. Especially when things got hard. The mission had to be first.

So when the water shortage came, and we made changes and then directed a planned 16 gallons to plants instead of people, that was a good thing. The astronaut does not complain about the mission plan being fulfilled, even at the expense of his or her own desires. The astronaut smiles and is happy that another thing on the checklist can be crossed off, then moves seamlessly to the next goal.

People ask me what I did during my time at MDRS, and that's easy enough to rattle off. We wore spacesuits, we rode ATVs, we did science experiments, and we took careful care of our Habitat. We ate, slept, worked a lot, joked about missing bacon cheeseburgers and ice cream (and then were delighted when crew members actually made bacon cheeseburgers and pudding out of dehydrated food).

There was something different, however, about these tasks. Each day stood out like Sirius in the Hab window, which I could see every night before stepping sideways into my stateroom. There was something very different about this place.

It was because each moment counted. You couldn't let your mind wander because there was so much to finish, so much to experience and only two weeks to get it all done. I'd stir the potatoes, flip to my computer to resize the crew photos, turn to help a crew member with an experiment and then go back to cooking. Activity proceeded like this for 17 hours a day, sometimes, and then the moment the clattering water heater woke me up in the morning, I'd be on my feet again rather than trying to catch some more sleep. Time was short, and the results from these days had to last a long time.

About a week after leaving MDRS, I was taking a short walk from my house in Canada to a shopping mall and had to climb a steep, snowy hill to make the journey. After those hills in Utah, I wasn't scared any more of the slope. I positioned my feet as a crew member showed me how to do and made it up the hill accurately. Maybe not gracefully, but certainly with less risk of slipping than before I took the mission.

We did big things on site so that coming back, a lot of little things would make more sense. Whether in science or in daily tasks, there are parts of MDRS that will always remain with Crew 133. I can't wait to see how our crew incorporates the experience of "Mars" into their respective lives.

Ms. Howell is a space journalist who wrote about MDRS crew 133 in a series of articles for SPACE.com.

News Brief

URC Sets Registration Record This Year

The Mars Society is pleased to announce that 31 student teams from six countries and four continents have officially registered for the 2014 University Rover Challenge (URC), setting a new participation record for the annual international rover competition. Countries represented this year include the United States, India, Egypt, Poland, Canada and Bangladesh.

A sampling of some of the participating universities includes Cornell University, Warsaw University of Technology, Yale University, Cairo University, Czestochowa University of Technology, University of Michigan, Military Institute of Science & Technology and York University. To view the full list of schools involved in the URC, please visit urc.MarsSociety.org.

Scheduled for May 29-31, 2014, the URC is the world's leading robotics competition for college students. Held annually in the desert of southern Utah, URC challenges student teams to design and build the next generation of Mars rovers that will one day work side-by-side with astronauts exploring the Red Planet. Founded in 2006, the URC consistently draws an international field of the most talented and promising science, engineering and computer science students.

"In 2013, we shattered every previous URC milestone and had our winning team from Bialystok University of Technology score an almost unthinkable 493 points out of 500. For 2014 our registered field has more than doubled over last year, and we are eager to welcome many new teams to the competition. Everybody involved in the competition is getting excited. We know 2014 is going to be an incredible year!" said URC Director Kevin Sloan.

GreenHab: Planting the Seeds of Our Martian Future

Nick Orenstein

Martian expeditions take on a multitude of roles, and Noah's Ark is certainly one of the more formidable ones. Missions to Mars – and to Mars analog stations such as the Mars Desert Research Station (MDRS) – take life from Earth, uproot just enough of it, and give it safe passage across the vastness of space. Just as Noah did, crew members escape societal and environmental dangers on Earth to start fresh. To breathe life anew. To seed visions of lush, green, sustaining life in an otherwise hostile world.

I spent the duration of the MDRS Crew 132 mission collaborating with GreenHab Officer Charles Parrish to ready the GreenHab for the 2013-2014 season. "As humanity ventures farther from home, plants are being recognized as an integral component of deep space habitation for a myriad of reasons such as gas exchange, waste treatment and food production," says Parrish. "Horticulture is the hope for humanity to practice stewardship for life throughout the solar system and beyond."

The MDRS GreenHab has long had the potential to fulfill such a mission. Now, after a number of recent improvements, it is poised to successfully provide crews with fresh vegetables, tasty herbs, a beautiful relaxing room and experimental space for science.

Charles and I designed and constructed a top-drip hydroponics system which utilizes a 20-gallon nutrient reservoir to feed two tracks of felt grow bags filled with a soil medium enriched in mycorrhizae and bat guano. We installed a new high-flow exhaust fan for forced-air ventilation in the greenhouse. Additional planters and planting areas were arranged in designated areas for herbs, flowers, food crops and temporary experiments. To mark the first day of the Earth year, we planted the first seeds of new life at MDRS. The rest of Crew 132 joined GreenHab Officer Parrish and me in the greenhouse for a ceremonial planting. The renovated Zen Garden is now incubating our fledgling settlement's promises and hopes, along with a cactus planted in "Martian" soil samples gathered during an EVA.

Maintaining a greenhouse is an ongoing operation that requires patience. Horticulture does not start and stop in two week increments. We have also formulated procedures and a schedule for the entire field season so that all MDRS crews meaningfully contribute to the GreenHab mission. At MDRS, crew members are stewards of life on Mars. The growing season requires that each crew has unique duties of seed germination, transplanting and harvesting. We all stand on the shoulders of giants; those who harvest should thank those who germinated for their commitment to the season-long effort.

Charles and I also spent several days repairing the GreenHab structure. The building foundation has settled over time and one half of the structure has fractured away from the central wall, forming a long gap. This was debilitating to a greenhouse as it ruined all thermal insulation. An external air breach of this sort on Mars compromises human survivability as well.

A remote habitat must cope with maintenance on its own. Things will break down on Mars. Sometimes, this is an inconvenience like missing an ATV ride. Sometimes it is life-threatening like a structural hole to space. I surmise that most scientists travel to MDRS expecting only a research station. What they find is what NASA astronauts find at the ISS: a habitat in constant need of repair using limited supplies. This should motivate engineers to expedite development of manufacturing innovations for space and planetary surface applications. Technologies like 3-D printing, ISRU, robotic repairs and smarter designs are a must.

The GreenHab's primary purpose is food growth for crew consumption. The hydroponics system already hosts Ithaca and Crisp Mint lettuces as well as Cayenne and California Wonder peppers. As last frost approaches, crews will plant little finger carrots, radish, snap peas and Old Homestead beans into potted planters. The Zen Garden's herbs – green onion, cilantro, Emily basil and cress – are joined by a

cactus and hanging baskets of viola and petunia flowers to add some lively color.

This season will serve as a plant growth control study for future seasons. Hydroponics nutrients were purchased from a consumer supplier; next year we hope to mix our own from raw chemicals. Temperature, relative humidity and water consumption monitoring will direct us on how best to implement additional environmental control improvements. Growth tests comparing enriched soil medium, standard organic compost and MDRS-area soil could possibly lead to future studies using certified Martian regolith simulant.

Upcoming crews are also welcome to use the experimental area for horticultural tests, pending approval by the MDRS Remote Science Team. For example, Lucie Poulet of Crew 135 has developed an experiment to study lighting conditions (quantity and quality of light) in the GreenHab with and without supplemental LEDs. Her results on greenhouse automation and illumination efficiency will lead to reductions in crew time and labor for greenhouse operations and maintenance as well as improve plant growth in the GreenHab.

Several people deserve thanks for providing all sorts of help from horticultural advice to sourcing high quality seeds to working in the GreenHab. The 2013-2014 GreenHab Team members currently consist of Charles Parrish, Spencer Orenstein, Stephanie Fong, Haritina Mogosanu, Adam Sachs, Andrew Carter, Dan Antonaccio, Mollie Parsons and Sarabeth Brockley.

I very much look forward to continuing my duties as GreenHab Coordinator. My push to install the new hydroponics system is just a start along the important road towards an automated, digitally controlled greenhouse. With experience and regular improvements, I hope the GreenHab can implement crop-cycling that provides year round harvest for all crews. Furthermore, I see hydroponics as a stepping-stone towards aquaponics in which vegetables are paired with a fish tank to approach a closed-loop ecosystem.

MDRS is a site and experience for crew members to "practice for Mars." As future astronauts venture off to hostile environments, they must create self-sustainable, net-zero habitats. As with frontier settlers from Earth's history, future space explorers will not want to – nor should they – be dependent on the uncertain ability of their home world to continuously supply them with life support such as food. The GreenHab is essential to this vision.

The circle of life spins on, evolving and expanding as we humble human explorers push the boundary ever outwards.

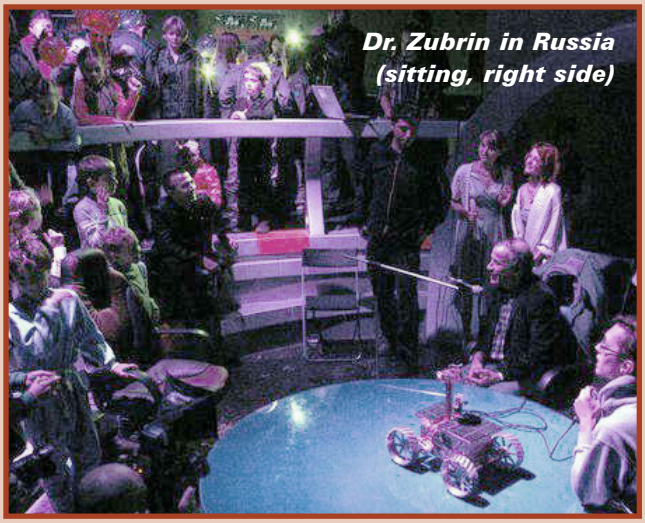
Mr. Orenstein was MDRS crew 132 commander and also serves as MDRS GreenHab Coordinator.

News Brief

Two Chapters Added to Mars Society Family

Considerable progress has been made in recent months in boosting the presence of the Mars Society globally. In October 2013, following a visit by Mars Society President Dr. Robert Zubrin to Moscow, a core group of Mars Society supporters was formed in Russia to help establish an organized chapter in the world's largest country. In December, the new chapter launched a new Facebook group page, now with well over 300 members/supporters. The organizers are building towards having a founding convention in Moscow in April 2014.

A new Mars Society chapter was also established in Mexico, again following a visit by Dr. Zubrin to Xalapa, Veracruz in the southeastern part of the country. Dr. Zubrin addressed a gathering of several hundred Mars advocates about current Red Planet exploration and planning for a humans-to-Mars mission. An organizing committee consisting of 20 people has been set up to lead the effort, as has a chapter Facebook group page. A formal founding conference is planned for later this year. This marks the third Spanish-speaking chapter founded in recent years, with the other two being in Spain and Peru.



Dr. Zubrin in Russia (sitting, right side)

Testing Google Glass "on Mars"

Tereza Pultarova and Ondrej Doule

"OK, glass, open the fridge." Crew 135 cameraman Filip Koubek is standing in the kitchen area of the 25 square meter living/working space of the Mars Desert Research Station (MDRS) with a pair of plastic shades on his nose, messing around. Crew 135 was testing Google's hottest innovation – the wearable Google Glass gadget – and the "OK, glass" phrase used for command confirmation really stuck with them.

The crew's commander, Florida Institute of Technology-based extreme environments architect Ondrej Doule, brought a Google Glass set for an ergonomics study that would try to assess its usability when integrated into a space suit helmet. Although augmented reality devices, developed for military purposes, are already entering the mainstream commercial market, no one has tested them in space yet.

"I believe that in the not so distant future some sort of head-up or head-down displays, or even a projection of information on some suitable surface inside the helmet will become indispensable for astronauts," Ondrej says. "However, due to extremely high safety, technical and material requirements, space flight is usually about five years behind in adopting commercial innovations."

According to available information, no one has tested the Google Glass in a space-analog environment either, making the Crew 135 possibly the first team to do so.

"The purpose of this experiment was to test a head-mounted display or a head-up display (HUD) for the purpose of gaining more information inside a space suit, basically to improve the efficiency of an astronaut, to improve safety, to improve communication and so on," said Ondrej.

The team encountered several problems early on. The first test subject chosen was the crew's journalist Tereza. Although her head is rather small compared with, for example, some of the men in the crew, she struggled to put the space suit helmet on without shifting the Google Glass on her nose.

The space suit helmet is like a big glass bubble covering the person's whole head: once you are inside you can't touch your face to adjust anything, whether it's your hair falling over your eyes or glasses slipping down your nose. Once you are geared up and in the air lock, you simply have to push through any discomfort and continue with the mission to accomplish your goal.

The first EVA focused on activating the glass while suited up, which requires tilting your head 30 degrees upwards. Tereza thought she couldn't activate the glass because the helmet restricted her movement. Eventually, she tried closing one eye – and there it was. Since the glass had shifted slightly when she was putting her helmet on, the focus had changed, and she wasn't able to see the display with both eyes open. When she closed the left eye, however, she suddenly saw the information clearly in the right upper corner of her field of view.

For the second EVA, Ondrej adjusted the glass by adding a rubber strap to fix the glass more securely to the head. The next tested subject, the crew's Executive Officer Lucie Poulet, saw the display well with both eyes. The compass, a thin white vertical line pointing to one spot on a carousel denoting north, south, east and west, showed the direction where the person was heading. The semi-transparent display was comfortably positioned out of the main field of view. The hardware of the glass, however, still sometimes interfered with the front of the visor since the projection crystal is placed centimeters in front of the glass itself.

During the experiment, a wide angle camera was mounted on the outside of the helmet to monitor the face of the test subject and capture every movement of his or her head to see how difficult it was to use the Google Glass. Another camera was attached to the person's chest to determine the position of the body.

"I think the experiment went really well," said Ondrej. "Google Glass worked well, and we collected a lot of data. We learned that the hands-free method of activating and otherwise controlling a head-up display such as the Google Glass is really important inside the helmet where you cannot touch your head or activate anything with your hand." It is clear that the head motion commands may be one of the possibilities to control information gathering and some non-critical functions of the EVA spacesuit in the helmet visor. "We intend to perform six EVAs with the Glass and keep improving the navigation experiment."

The HUD for navigation is one of the most common functions that can be very effectively used in extreme environments where protective glasses or helmet may constrain work with exterior displays, tools and devices. The Google Glass, with its augmented reality features, is certainly a step toward a next generation of augmented reality full face displays that are prevalent in modern sci-fi, such as *Star Trek: Into Darkness*. Such devices will help to make navigation more intuitive and to streamline EVAs in which the astronaut may already be laden with numerous pieces of equipment.

Dr. Doule was MDRS crew 135 commander and Ms. Pultarova served as the same crew's journalist.

MDRS Photo Gallery

Crew Photos from the 2013-14 Mars Desert Research Station Field Season

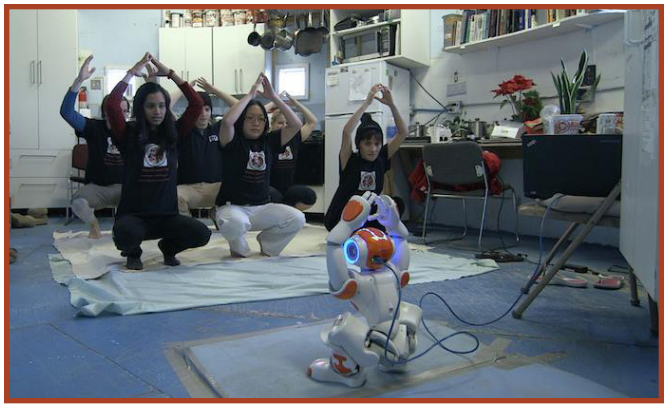
Looking out over Mars landscape

Celebrating the holidays "on Mars"

Testing camera prior to EVA

Leaving Mars hab on EVA

Preparing for tele-surgery test

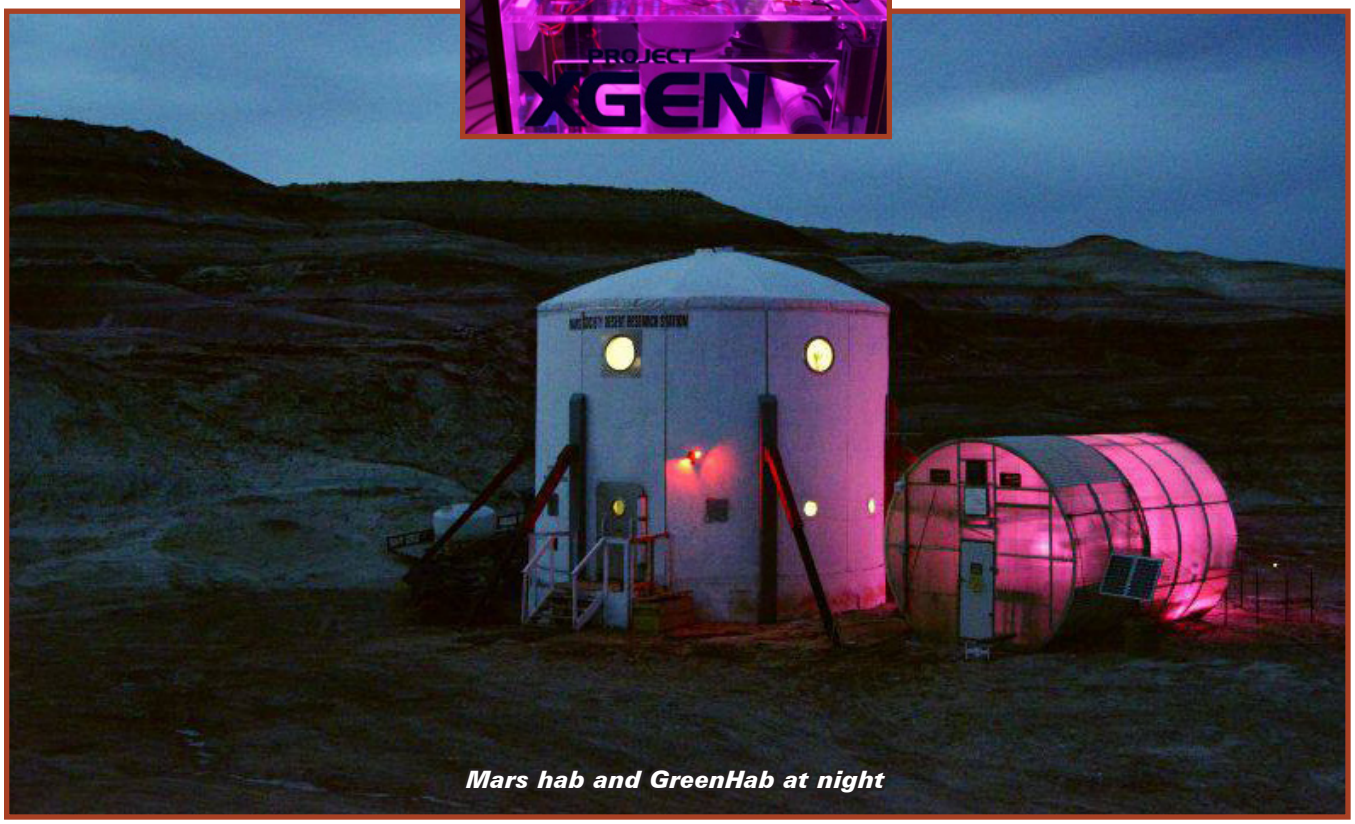


Doing yoga led by NAO robot

Crew members on mobile EVA

Collecting soil samples

Plants inside aeroponics device



Mars hab and GreenHab at night

Past, Present, Future on Mars - Q&A with MER Scientist Dr. Jim Rice

Jason Rhian

NASA

As NASA's Mars Exploration Rover (MER) Opportunity passes the one-decade mark on the Red Planet, Dr. James Rice, an astro-geologist and science/geology team member working on NASA's MER program, looked back on ten years of achievements and a future filled with possibilities. Rice detailed how the robot has survived adversity and astonished all observers.

What Rice thought would be an assignment lasting some ninety days has become an effort which has lasted half as long as some careers. While he might not have expected to have been working with Spirit (which went offline in 2010) and Opportunity as long as he has, he also has no regrets about how the past ten years on Mars have turned out.

Sitting down for a chat with Dr. Rice revealed the heart and soul behind the MER project and provided an insight as to perhaps why a program given a lifespan of just three months has lasted more than a decade.

The Mars Quarterly: First, Dr. Rice, we'd like to thank you for sitting down and taking the time to chat with us about Opportunity.

Rice: No problem, it's my pleasure.

The Past

TMQ: Let's get right to it, the Mars Exploration Rover Opportunity just had a birthday!

Rice: Yeah, you're right, we just celebrated our tenth year on the surface of Mars just a couple months ago with Opportunity. Unfortunately Spirit didn't survive that long, but it had a lot longer life than we originally planned. Not too bad for a 90 day mission!

TMQ: Can you provide us with some of the highlights?

Rice: A lot of folks want us to tell them what the high points of this mission have been. That's really difficult to do because you have to think back over the course of ten years and that gets really hard to do. A couple things bubble up very quickly, but I think the most amazing highlight has been the journey as a whole. Nobody knew when the rovers landed in January of 2004 that they'd still be going after all that time. We thought we might be going around 120 days and if we got lucky maybe 180 days – but no one thought that this far down the road that we'd still be operating, making discoveries and doing great science up there. I think it's a testament to the engineers who built these vehicles.

I think what is important for folks to know is that not only were these spacecraft designed to last only 90 days, 90 sols, but that they were also only supposed to drive about a kilometer. We're closing in on some 39 kilometers with Opportunity right now. Words really can't describe what we're feeling right now. We're overjoyed. We take each day as a blessing, as a gift, because we don't know if we're going to have tomorrow. So each day we try to do the best that we can in terms of operation planning and collecting the data.

The Present

TMQ: Tell us a bit about the rock that Opportunity discovered recently which has created so much interest.

Rice: Yes, this was a mysterious little rock. We called it Pinnacle Island, a dinky little rock only some four centimeters wide. But it's very unusual: it's like nothing that we've seen in the last ten years on the Martian surface. It's got us all on the science team scratching our heads and wondering what this thing is telling us, and that's the fun thing about this mission of discovery is that we come across things that are totally unexpected. We're currently trying to put together what this rock is trying to tell us. We'll get that, but we're still in the phase of collecting all the data that we can in terms of imaging and APXS (Alpha Proton X-Ray Spectrometer) data, and it's like a brand new mission right now.

When we first saw it, someone said it looked like a jelly donut, but I don't think that's accurate. It's more like a danish. At its center, it's kind of red-colored. We've examined it with the APXS and discovered that it's super-high in sulfur, magnesium and manganese. I mean measurements that are higher than anything we've ever seen before. What we think happened is when Opportunity turned around, one of the rover's wheels popped the rock to where it currently is at. We're not entirely certain, but we think it got to its present location when Opportunity conducted a turn in place.

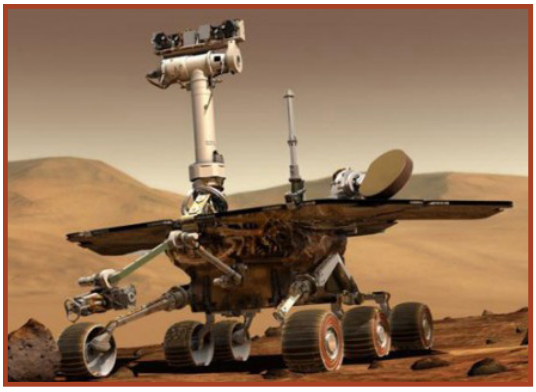
Our preliminary interpretation is still a work in progress, but we think this is a rock which has been highly altered in interactions with water. We're still trying to figure out the exact location from where it got popped loose. We think we've seen the area it came from, and we're probably going to have to go investigate up there with the rover. It was really strange because we took pictures and then four sols later we look back and there's a rock there that wasn't there four sols earlier.

TMQ: Isn't Opportunity currently traversing the surface of Mars backward?

Rice: Actually, we were driving both of them backwards. A weird thing happened – both rovers ended up having problems with their right

front wheel and the actuators. That's one of the beautiful things about the engineering of this vehicle: you can drive it forwards and backwards. We've done things with these rovers which were never planned. We have driven them up hills, sent them down into craters, even before we lost Spirit back in 2010, which still lasted six-and-a-half years.

With Opportunity right now we have that right front wheel problem and the heater has been stuck on since the day we landed, but we have work-arounds for that. The other thing is the instrument deployment device, the arm: we've had some problems, kind of like arthritis. It doesn't work like it did we when landed 10 years ago, but the team developed work-arounds. We've got a really clever team, and the fact that we were only supposed to be rolling three months and here we are at ten years is proof of that.



The Future

TMQ: Are the dust-clearing events doing enough to keep Opportunity going, or are you starting to see the rover's power levels drop slowly toward a point of no return?

Rice: Not really. The night we landed we started with sparkling clean solar panels that were generating 900 watt-hours. I need to do some homework to figure out the exact numbers, but I think now we're down around 400 to 500 watt-hours and sometimes we go up to 550, but that's enough to still drive around and get some good science done. I think the "red line," the closest we ever got to it, well Spirit hit it because it died, but the closest that Opportunity ever got was in 2007 during the Martian summer when a regional dust storm came through there. Dust storms aren't very good for solar-powered vehicles, and we were getting down around those numbers, but we survived it. So, we're okay, and we're never really near a margin like that.

Any day now, the vehicle could go. A critical link in that system could break and we'd be dead. But given that Opportunity is close to the Martian equator, it never really had any close calls other than that dust storm back in 2007.

TMQ: What do you think the future holds for Opportunity? What is it telling us and what should we take away from the fact that it has been such a long-lived mission?

Rice: This rover has done great things: it's lasted over a decade and it's still going strong, still doing work. It doesn't get a lot of the attention like Curiosity is getting, which is the new kid on the block. But we're still holding our own. I work every day on Mars. However, one thing this mission drives home to me is that we need astronauts up there. If we had just two astronauts up there trained in geology, they could've done everything in three weeks that Opportunity has done in ten years; they probably could have done it in less than that. I feel comfortable in saying that because we've driven almost 39 kilometers in 10 years. Apollo 17 was in Taurus-Littrow for three days and they drove I think it was 37 kilometers.

These rovers are great emissaries for us, but they're no replacement for people. At times it's frustrating and slow to work with these things. I think that we need to get astronauts up there to examine the whole question about life on Mars; I think it's going to take boots-on-the-ground to obtain the definitive answer to that question.

I live in Arizona, so when I see pictures of Mars, it doesn't look so bizarre or alien; instead, it drives home the fact that Mars is the most Earth-like planet near our world. We've found dry lakebeds on Mars. I did my dissertation on that, and at the time it was controversial. Ten years later when I worked on the mission that discovered lake beds on Mars, that was very fulfilling.

If I had to pick the biggest scientific discovery we made during the past decade on Mars, I think I'd have to say it was the silicates in the clay minerals. The reason that this is important is because it tells us that water was interacting with rock for long periods of time, geologically significant periods of time. Water was covering these rocks up, flowing through them, and this was "drinkable" water: it had a neutral pH or else clay minerals wouldn't have formed like the rocks that formed at Eagle Crater.

What this makes you start to think about is, "Did life get started on Mars?" Our mission was to land at two places on Mars and search out habitable environments where life could have gained a foothold. On the geology mission, we couldn't say whether life had ever arisen there, but we did identify several environments where life could have gained a foothold. That has really changed the game.

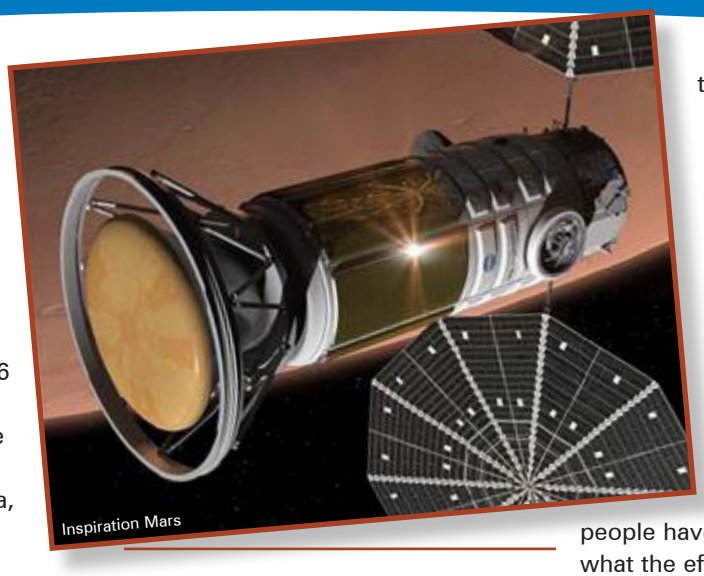
TMQ: It certainly has been an amazing time, and we'd like to thank you for speaking with us about this incredibly successful mission.

Rice: It really has been. Thanks so much!

Dr. James Rice currently serves as Senior Scientist at the Planetary Science Institute and co-investigator for the Mars Exploration Rover project. He has worked for more than 25 years on uncovering the history of Mars' geology and the influence that water has played on the surface of the Red Planet. He has worked with NASA's Astrogeology Headquarters of the United States Geological Survey, the Mars Spaceflight Facility with Arizona State University and the Lunar and Planetary Laboratory located at the University of Arizona. Dr. Rice has also served on both NASA's Mars Odyssey and Lunar Reconnaissance Orbiter (LRO) missions. He has been involved with selecting the landing site for every NASA mission to the Red Planet since Mars Pathfinder, which landed in 1995.

Jason Rhian is Senior Editor of SpaceFlight Insider (spaceflightinsider.com) and is a regular contributor to The Mars Quarterly.

Massive Worldwide Response to Inspiration Mars Student Design Contest


Inspiration Mars

The Mars Society's Inspiration Mars International Student Design Competition has drawn a massive international response. As of the January 31, 2014 deadline, letters of intent to compete in the contest have been received from 38 teams representing 56 universities in 15 countries.

Nations represented include the United States, Russia, the Netherlands, Germany, Austria, Italy, the United Kingdom, Portugal, Poland, Mauritius, India, Bangladesh, Japan, Colombia and Canada.

A sampling of some of the institutions signed up to participate include John Hopkins University, St. Petersburg State Polytechnical University, Ohio State University, Warsaw University of Technology, University of Notre Dame, Indira Gandhi National Open University, York University, Karl-Franzens-Universität Graz, International Space University, Purdue University, Islamic University of Technology, University of Stuttgart, Keio University, Ioffe Physical Technical Institute of the Russian Academy of Sciences, and University of Glasgow. To view a complete list of participating schools, please visit the Mars Society web site (www.marssociety.org).

The Inspiration Mars International Student Design Competition was officially launched during the 16th Annual International Mars Society Convention in August 2013. The contest is open to university engineering student teams from around the world and intended to design a two-person Mars flyby mission for 2018 as cheaply, safely and simply as possible.

Inspiration Mars Executive Director Dennis Tito was present for the announcement. "Inspiration Mars is looking for the most creative ideas from engineers all over the world," said Dr. Tito at the convention. "Furthermore, we want to engage the explorers of tomorrow with a real and exciting mission and demonstrate what a powerful force space exploration can be in inspiring young people to develop their talent. This contest will accomplish both of those objectives."

Inspiration Mars said they wanted to show that space exploration can inspire youth to develop their talent. Well, they have delivered. The call has been sounded, and from all over the world young people have answered.

Commenting on the global response to the competition, Mars Society President Dr. Robert Zubrin said, "This contest is providing a tremendous opportunity for legions of young engineers to directly contribute their talent to this breakthrough project to open the space frontier. From what we are seeing right now, there are many prepared to take up that challenge. Inspiration Mars said they wanted to show that space exploration can inspire youth to develop their talent. Well, they have delivered. The call has been sounded, and from all over the world young people have answered. Just imagine what the effect would be on STEM education if a full-scale program to explore and settle the Red Planet were set in motion. Consider what the vast number of new young scientists, engineers, inventors, medical researchers and technology entrepreneurs resulting from such an inspiring challenge could do to advance humanity."

Alumni, faculty and other university staff may participate in the contest as well, but the teams must be predominantly composed of and led by university students. Teams were required to submit their design reports of no more than 50 pages in writing by March 15th. From there, a down-select will occur with the top ten finalist teams invited to present and defend their designs before a panel of six judges chosen by the Mars Society, Inspiration Mars and NASA. The presentations will take place during a public event at NASA Ames Research Center in April 2014.

Chapter Close-Up: Poland

Joanna Jodłowska and Mateusz Józefowicz

Polish rover team with Secretary of State John Kerry.

Mars Society Polska (MSP) is considered one of the most active non-governmental organizations dealing with the space sector in Poland and plays an active role in shaping the country's space policy. This is due in part because until 2012 Poland was not a member of the European Space Agency (ESA) and had no space program or agency of its own.

MSP did not spring from a complete void. First of all, there is the long, if not always well-known, history of Polish involvement in space exploration. During the post-WWII Communist era, the country had an ambitious program of meteorological rockets. Known as Meteor, the rockets were supposed to measure winds at altitudes of 18 to 50 kilometers and, during the program's most productive years, actually flew much higher and reached the edge of space. While the Meteor program was eventually cancelled due to Soviet objections, Polish involvement in space exploration continued with Polish cosmonaut Mirosław Hermaszewski being sent into space on aboard a Soviet Soyuz spacecraft.

More recently, the Polish Academy of Sciences has taken part in developing instruments for various space missions, including Mars Express, Phobos-Grunt (which unfortunately failed) and Rosetta. It is also worth mentioning that the designer of the Lunar Roving Vehicle used by NASA's Apollo missions, Mieczysław Grzegorz Bekker, also known as as Gregory Bekker, was born and educated in Poland, so his work can be considered the first Polish contribution to planetary exploration vehicles. There must be something in the soil here, since even Wernher Von Braun (far from being Polish) was born in Wyrzysk, territory of the Prussian partition of the Polish state. Let's also not forget to mention Nicolaus Copernicus, who was born in Torun.

In recent years, several Polish institutes and companies have participated in international space projects, and some smaller businesses have manufactured individual components used during prominent space missions, including NASA's Mars rovers. Despite these activities, Poland lacked a unified space policy and was not taking any serious action to prepare such a policy or to educate its public.

The first really significant step in that direction was the conclusion of ESA membership negotiations in 2012. Since then Warsaw has shown more interest in space exploration, and Mars Society Polska has participated in community consultations and in compiling a new Polish space strategy document, with MSP's contribution to it being a focus on education, Mars exploration technologies, robotics and a call for sending another Polish astronaut into space. All this, together with the Polish Academy of Sciences' recent achievements, has led to placing Mars and planetary robotic exploration on

the short list of Polish space specializations. MSP is also working for a Polish crew member on the future manned mission to the Red Planet. This is done in the form of lobbying, but also in support of more recent efforts, such as Polish student teams entering the Inspiration Mars design competition.

Equally important to MSP's work with the government and industry is its effort to reach out to the general public with space-related projects and events. Established in 1999, MSP entered the Mars Society's Mars Pressurized Vehicle competition. The Polish design gained international recognition, with some of the hardware being built. In addition, MSP initiated a public outreach campaign, organizing a number of successful conferences and events, with the inaugural one being the 2007 Mars Festival.

In 2009, the first Polish team participated in the Mars Society's University Rover Challenge (URC). This generated significant public and media interest and laid the groundwork for an endeavor currently known as the Polish Analog Exploration Rover Development Program. A number of other Polish teams have participated in the URC since then, with some of them securing high scores, including Magma 2 (2011) and Hyperion (2013), both of which won first place.

The technical knowledge gained through participating in those competitions resulted in the founding of a spin-off company, ABM Space Education. The company's office was opened in Torun in 2011, with the official ribbon-cutting being carried out by Simon P. Worden of NASA's Ames Research Center. Currently, ABM SE designs rovers, tests them in various conditions, including in the Sahara desert, and provides Internet and satellite access service to a Mars rover analog for testing and education purposes.

The wide public interest, including significant coverage in the Polish media, was not just a boon for MSP itself, but also helped a larger cause, that being the successful URC rover teams which became ambassadors for the idea of a new Polish space policy. The Magma 2 team met with the Polish Prime Minister Donald Tusk and Minister of Economics Waldemar Pawlak right before the signing of ESA accession documents. Both Magma 2 and the ABM SE-developed Magma White were present at the Polish Parliament during the vote on ESA membership, which concluded with no opposing votes (an amazing thing for the Polish Parliament). The rovers and their designers were so popular that for a while it seemed that they were given access to all kinds of visiting VIPs, including U.S. Secretary of State John Kerry and German Chancellor Angela Merkel. They also gave presentations about their successful rovers in Geneva, Berlin, Paris and across Poland.

MSP is also working for a Polish crew member on the future manned mission to the Red Planet. This is done in the form of lobbying, but also in support of more recent efforts, such as Polish student teams entering the Inspiration Mars design competition.

All of this led us to take the obvious next step: organizing the European Rover Challenge (ERC), which will take place this September. It will be hosted in Pozdzamcze Checinskie near Kielce in southern Poland. The ERC differs from the URC in some significant aspects. The terrain will be artificially shaped to resemble the Martian surface, since, unlike the URC site at the Mars Desert Research Station, the ERC site is not located in the desert. Furthermore, the ERC will involve a sizeable live audience, using its proximity to a major Polish city to benefit public awareness and education. There are also differences between the tasks conducted at both competitions.

The ERC was initially thought of as a contest mainly for European student teams that couldn't afford a trip to the U.S. and had to withdraw from the URC competition for financial reasons. Surprisingly, the ERC has generated considerable interest beyond the European continent, with applications being received from teams in Colombia, India and Egypt.

Initial feedback about the ERC and its planning have been good. Signed agreements with the Marshall of the Swietokrzyskie Voivodeship and the Regional Science and Technology Center in Poland, which will host the event, have already secured basic funding, with more expected to come from government institutions and private sponsors. In addition, we have also received support from other European Mars Society chapters and the Austrian Space Forum.

MSP is working to ensure a truly international experience, with prominent judges from NASA, ESA and the Russian Space Agency. There are also hopes that a Russian team will also enter the competition.

To top all that off, there will be other relevant events happening alongside the ERC to help ensure wider public attendance. The 14th European Mars Society Conference will take place in Poland this year. As part of that, plans are in the works to organize a science popularization event in a form of a "Science Picnic" with various experiments and presentations.

The MSP leadership feels that the ERC will be of great interest to the general public in Poland, with an appeal (we hope) similar in some respects to fans visiting a sports event or exhibition, without sacrificing any of the complexity of the contest. The goal of MSP, now and in the future, is to use the ERC and other Mars and space related events to expand public interest in exploring the Red Planet.

Ms. Jodłowska and Mr. Józefowicz are Mars Society Poland members.

Youth Rover Challenge to Encourage STEM Education

The 2014 Youth Rover Challenge (YRC), a STEM-focused educational program for students in grades 5-12, began its inaugural year with 22 teams registering as part of the Mars Society-operated competition. 16 teams have signed up for the junior varsity level (ages 9-11), while the remaining six teams are participating at the varsity level (ages 12-17).

YRC is intended to provide young students with an inexpensive opportunity to build and compete at a national level using specially-designed LEGO educational kits, consisting of LEGO Mindstorm NXT 2.0 based robotic rovers with LEGO digital designer software.

To eliminate the need for travel costs, participants are allowed to conduct testing and qualification in their home communities. All student teams, including one adult supervisor, videotape the necessary field tasks carried out by the rover, which include drilling holes in sandy surfaces to retrieving a specific colored ball.

Teams are required to carry out their operations on a Mars-like surface typically found in sandboxes at local schools or parks. Many contestants have chosen to build their own 'Mars' sandboxes at home, with the minimum size for a home-made arena being 8' x 8'.

"Our primary goal is to have younger students excited, engaged and focused on a robotic program with a strong Mars flavor prior to beginning university level learning," said YRC Director Chuck McMurray during the official announcement of the new contest at the 16th Annual International Mars Society Convention last year.

To learn more about the YRC competition and keep track of ongoing results from this year's contest, please visit the program web site at: YouthRover.com.

Sandbox for YRC testing

LEGO rover under construction

Join Us in Houston at the 2014 International Mars Society Convention!

August 7-10, 2014 at the South Shore Harbour Resort in League City, Texas

The Mars Society will be holding its 17th Annual International Mars Society Convention on August 7-10, 2014 at the South Shore Harbour Resort in League City, Texas, just outside Houston and minutes from NASA's Johnson Space Center.

The 2014 Mars Society Convention will bring together key experts, scientists, policymakers, journalists and aerospace executives to discuss the latest news about Mars exploration and planning for a human mission to the Red Planet in the coming decade.

Online registration for the Mars Society Convention is now open. Rooms at the South Shore Harbour Resort are available to convention attendees at a special discounted rate. Please visit our web site (www.MarsSociety.org) for more details.

THE MARS SOCIETY

Learn more: www.MarsSociety.org

THE MARS SOCIETY

THE MARS SOCIETY is a 501(c)3 tax-exempt non-profit organization with headquarters in Colorado, USA, committed to furthering the goal of the exploration and settlement of the Red Planet, via broad public outreach to instill the vision of pioneering Mars, support of ever more aggressive government funded Mars exploration programs around the world, and conducting Mars exploration on a private basis.

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