EXECUTIVE SUMMARY

The Mars Society's Mars Desert Research Station (MDRS) provides a unique environment for simulating planetary surface exploration activities. It enables the field testing and development of systems and procedures in an integrated environment that includes a human crew. It also allows participants to get invaluable first-hand experience with this type of operation, thus making it particularly suitable for participation by students of aerospace engineering and related fields.

After concluding eight highly successful two-week rotations at MDRS from spring 2005 to spring 2012 (MDRS Crews 37, 47, 60, 69, 79, 93, 101, 115), the Mars Society @ Georgia Tech student chapter (MSGT) assembled another crew of its members interested in pursuing Human Space Flight-related research and outreach at MDRS this May.

The mission will include multiple science and engineering activities:

- Navigation, communication, and data transmission research
- Wind Turbine demonstration and evaluation
- Astronomical and atmospheric observations
- Human factors and crew dynamics research
- Waste water processes and management investigations
- Particulate matter (i.e. dust) mitigation research
- NASA INSPIRE outreach opportunities

The crew will be led by Christine Redmond, a 3rd year mechanical engineering undergraduate whose role will be the crew's commander. Crew members for the five station crew slots and mission support will be selected in early 2013. The crew is currently undergoing thorough training and familiarization in preparation for their mission at MDRS. The mission support crew will be based out of a Mission Support Center on the Georgia Tech campus and will work closely with the Mars Society mission support personnel in conjunction with the crew at the Mars simulation.

Following the mission, a post-mission report and conference papers will summarize the results and document mission planning, organization, and lessons learned.
The Mars Desert Research Station Crew 130 is composed of a diverse group of space enthusiast individuals. The 16 person group includes a variety of engineering majors and years in school ranging from first year undergraduates to graduate students. The crew will be split in two groups, the mission support team that will support the crew at Georgia Tech, and the group that will travel to Utah to spend two weeks in Mars simulation. During the simulation the crew will perform a wide range of experiments and extra vehicular activities.

**Crew 130 Biographies**

**Jackie Alexander**

With hopes of one day being an astronaut, Jacqueline Alexander applied to Georgia Tech and successfully entered the class of 2014 to major in mechanical engineering. She is a member of Astronomy Club, Wreck Racing, and African American Student Union (AASU). She is very interested in human space flight and astronomy. An interesting fact about her: As part of training with the US Navy, she flew a T-34C (the first plane students at flight school learn to fly), lived on a US Submarine for a week, navigated a US Navy ship, and spent a week with the Marines over the summer. Jackie grew up as a military brat. She was born in Savannah, Georgia and has lived in Hawai'i; Columbus, Georgia; Fayetteville, North Carolina; Seoul, South Korea; and Vienna, Virginia. In her free time, Jackie likes to play the piano, work-out, and socialize on facebook.
Jordan Bell

Jordan is a third year mechanical engineering student from Herndon, Virginia and a member of the Honors Program. She is interested in rocketry and is attending Georgia Tech Lorraine this summer. Currently she is a Resident Advisor, the Principal Bassist for the Georgia Tech Symphonic Orchestra, and the Launch Vehicle lead for the Georgia Tech Ramblin’ Rocketeers USLI Team. She has interned at the National Air and Space Museum, Udvar Hazy Center and NASA Headquarters in Washington, DC.

Shelby Bottoms

Shelby Bottoms is a third year Aerospace Engineering student at the Georgia Institute of Technology. She is from Overland Park, Kansas and plans to work in the space industry upon graduating in 2015. On campus, Shelby is on the Georgia Tech Goldrush Dance Team and is involved with Emerging Leaders, Engineers Without Borders, Christian Campus Fellowship, M&M Mentoring, and Astronomy Club. She has a passion for space, and as a teenager she attended astronomy camp, many years of space camp, and held a summer internship at NASA Johnson Space Center. She is very excited to be a part of MDRS Crew 130!

Graham Kosiba

Graham Kosiba is a 4th year Mechanical Engineering student at Georgia Tech. Graham was born in Gainesville, GA. Graham has always had an unquenchable thirst for science and learning. Space has always been a source of passion and true wonder for Graham. Like so many, Graham grew up claiming to become an astronaut, he is still steadfast in his claim. On campus Graham is the President of the Planetary Society at Georgia Tech and a member of the Glee Club. Graham is currently involved in research at the Ben T. Zinn Combustion Lab. His research focus is spark ignition of premixed and nonpremixed flows for aerospace applications. Outside of academia Graham enjoys longboarding, listening to and playing music, and climbing trees. Graham is looking forward to this research opportunity immensely and can’t wait to ship out to Mars.

Shannon O’Shea

Shannon O’Shea is from Marietta Georgia. She is a 4th year Mechanical Engineering student at Georgia Tech. She is also a member of the Georgia Tech Honors Program. She has always been very interested in math, science, and space exploration and graduated from a math and science magnet high school. Her extracurricular activities include participating in and mentoring robotics teams, Formula One in Schools, Science Olympiad, NASA Science Bowl, and she attended space camp. Her interests also include drafting, mechanical design, and traveling. She worked as a television production assistant intern at a local educational TV station. Currently she is a co-op student with the NASA Johnson Space Center and has worked in the Thermal Systems & Engineering Support Branch, the Robotic Systems Technology Branch in the Robonaut 2 lab, and the International Space Station Mechanisms, Maintenance & Crew Systems Mission Operations group which she will also be returning to for my final tour next summer. She hopes to get a full time job with the NASA Johnson Space Center after I graduate.
Jessica Pfeffer

Jessica Pfeffer is a first year Aerospace Engineering student at Georgia Tech. She is from Lancaster, California and has interned at NASA Dryden Flight Research Center through the NASA INSPIRE program. Jessica has been interested in aerospace for as long as she can remember. Reading weekly newspaper articles about the Mars rovers, Spirit and Opportunity, throughout the fourth grade furthered this interest. Jessica is also involved in Georgia Tech’s Grand Challenges living/learning community, SWE, and is a member of the Georgia Tech marching band. Jessica is really excited to participate in MDRS this year!

Christine Redmond

Christine Redmond is a third year studying Mechanical Engineering at Georgia Tech. Christine served as Health and Safety Officer and Outreach Officer on crew 101 in spring 2011. Last year she served on the Georgia Tech mission support team for crew 115. Her interest in engineering was first sparked after watching the movie October Sky in the fourth grade. Competing in the Sally Ride Toy Challenge throughout middle school and spending a few weeks at Space Camp in Huntsville Alabama locked her heart on NASA. She has spent the past three summers at NASA’s Goddard Space and Flight Center working in the Mechanical and Advanced Manufacturing branches. She hopes to work for NASA after finishing her formal education.

Matthew Schumann

Matthew Schumann is a senior in Mechanical Engineering with a minor in Nuclear & Radiological Engineering at the Georgia Institute of Technology. He will be graduating this December and beginning his masters in Nuclear Engineering this spring. He is very interested in space exploration as well as the applications of nuclear power to space. He has interned at the Test Resource Management division in Arlington, VA as well as at the Survivability & Vulnerability Test directorate in White Sands Missile Range, NM.

Jacky Silva – Mission Support Senior Advisor

Jackelynne Silva-Martinez earned two bachelor degrees from Rutgers University, Mechanical and Aerospace Engineering, and Spanish Translation and Interpretation. Upon graduation, she worked for Lockheed Martin, Space Systems Company as an Antennas Mechanical Design Engineer and as a Systems Integration and Test Engineer for commercial and government satellite programs. She earned a Certificate in Lean Six Sigma from the Lockheed Martin Greenbelt Program, and a Certificate in Engineering Management from Drexel University. She is now pursuing two Master degrees, one in Aerospace Engineering with concentration in Space Systems at Georgia Tech, and another one in Aeronautical Science with concentration in Human Factors at Embry Riddle University. Jackelynne is currently a Mechanical Engineer at NASA Jet Propulsion Laboratory on the Robotic Manipulators and Deployable Booms group performing sample acquisition and handling verification and validation tests for the Mars Science Laboratory mission. Jackelynne was born and raised in Cusco, Peru, is married to Electrical Project Engineer Victor Martinez, enjoys reading, traveling, dancing, and learning from different cultures. Her interests include human spaceflight, human factors, life cycle systems engineering, design and construction in extreme environments, and STEM initiatives.
Steffan Slater

Steffan Slater is a 4th year aerospace engineering student at Georgia Tech with a minor in computer science. He was always interested in space, and his move to Huntsville, Alabama, the Rocket City, in 2004 only strengthened that interest. He co-oped with GE Aviation three times, working on various aspects of jet engines. He also participates in space systems research at Georgia Tech and is the president of the school’s AIAA student chapter. He also enjoys making items on the 3D printers in the Invention Studio, playing video games, and martial arts. His primary career objective is to be a part of the team that first puts a human on Mars, and he can think of no better place to practice than MDRS.

Austin Tango

Austin tango is a senior in the aerospace engineering program at Georgia Tech. He was born in Houston Texas, and was a frequent visitor to the Johnson Space Center. After moving to Georgia in 1999, he joined the Boy Scouts and achieved the rank of Eagle in 2006. Aside from his undergraduate college classes, he has had the opportunity to acquire his Pilot's license and gain research experience at the Aerospace Systems Design Lab. His interest in research, flying and aerospace led me to join the MDRS team this fall.

Courtney Thompson

Courtney Thompson is a third year Aerospace Engineering student at the Georgia Institute of Technology. She is from Covington, GA and will be graduating Fall 2014. She has had a passion for space exploration since she was a child, a fact strengthened after visiting Kennedy Space Center multiple times and watching the last shuttle launch. She has been involved with astronomy for two years and helped lead the youth group at Crossroads Baptist Church for five years. She dreams of working in the human exploration field and even going to space herself one day.

Douglas Trent

Douglas Trent is a second year Aerospace Engineering graduate student at Georgia Tech. He works as a graduate research assistant in the Aerospace Systems Design Lab and is a graduate Co-op (Pathways) student with the NASA Marshall Space Flight Center. He graduated Magna Cum Laude with a bachelor's degree in Mechanical Engineering from California State University, Sacramento. Before being accepted to Georgia Tech, Douglas Interned at the NASA Marshall Space Flight Center for two terms as a design and test engineer with the environmental control and life support systems development group. His interests include human space flight with research experience in regenerative water recovery systems, propellant slosh suppression, and crowd sourced rapid design methods. He is a student member of AIAA and Tau Beta Pi. Douglas’ interest in science and technology, combined with his passion for the outdoors and exploration, drives his aspiration of someday becoming an astronaut. By earning his Eagle Scout, and later working as an outdoor guide for his undergraduate university, Douglas has gained valuable leadership skills and experience which are applied daily to his academic and professional careers. His other hobbies include backpacking, caving, snowboarding, and motorcycles.
Kyle Yawn

Kyle Yawn is a fifth year Aerospace Engineering student at the Georgia Institute of Technology. Born and raised in Bonaire, GA, Kyle was given a passion for human spaceflight in middle school thanks to a wonderful science teacher. Through the International Science and Engineering Fair as well as the Team America Rocketry Challenge and the Student Launch Initiative in middle school and high school, Kyle was able to gain valuable experience early in scientific and engineering processes which made him that much more passionate about spaceflight. He has spent the better part of the past two years working at NASA Goddard Space Flight Center and NASA Johnson Space Center covering a variety of roles from exploring methods to remove lunar dust from space suits, designing and certifying hardware for use on the International Space Station, developing an atmospheric processing module to produce methane from the Martian atmosphere, as well as supporting real time maintenance operations on board the International Space Station. Kyle believes that humanity must remain focused on human space exploration and that the Earth has incredible benefits waiting when we begin traveling outside of low Earth orbit once again. He plans on working for NASA upon graduation.

Lubna Zubair

Lubna Zubair is a first year Aerospace Engineering undergraduate from Voorhees, New Jersey. She has always been interested in space, and her passion escalated after spending summers attending Space Camp in Huntsville, Alabama and an Aerospace Engineering Camp at Embry Riddle University. After graduating from Georgia Tech she hopes to one day work at NASA and become an astronaut. She is looking forward to working on the MDRS team.

Jeremiah Robertson

Jeremiah Robertson is a first year Aerospace Engineering student at the Georgia Institute of Technology. He is from Springfield, MO and plans to work in the Aerospace industry upon graduating. He is a member of the Residence Hall Association, the American Helicopter Society, and Grand Challenges Program at Georgia Tech. Jeremiah has been interested in space and technology ever since he entered the Missouri Academy for Science, Mathematics, and Technology during the latter half of his high school career. He has conducted 2 years of research in chemistry analyzing the combinations of ligands with Germanium 9 atoms and exotic metals. Currently, he is a co-op student with Sikorsky Aircraft under United Technologies Corporation. He conducts Flight Test Engineering in West Palm Beach FL. Outside of academia, Jeremiah loves playing basketball, jamming out to music, and flying RC helicopters.
Experiments

Comet Observation

The Mars Desert Research Station has a newly refurbished observatory with a 14-inch telescope. This observatory will be utilized to observe comets C/2012 S1 (ISON) and C/2011 L4 (PANSTARRS), two non-periodic comets with the potential to be very bright and visible to the naked eye. At the time of the mission, C/2011 L4 will be just past perihelion, having reached it on March 10, and C/2012 S1 will still be approaching the sun, reaching it on November 28. This provides the opportunity to observe two comets at the same time, both before and after perihelion. Astronomical observations would be important activities for a Mars outpost, as the thin atmosphere and lack of light pollution enhances visibility significantly, and the larger radius of Mars' orbit potentially allows for earlier detection of space objects. The size of the MDRS observatory’s telescope is comparable to one that might be present at a Mars outpost.

Communications Delay

When communicating with someone on Mars from earth there is a minimum communications delay of 3 minutes to a maximum delay of 20 minutes each way. This delay makes it impossible to have real time conversations. Having a delay will cause logistics and operational problems not currently experienced in human space travel. Different methods of communications with our mission control team will be tested to determine the time difference and effectiveness of communication using written communication vs. videos to help troubleshoot tasks. We would also compare running a task without a time delay to running it with a time delay in order to determine what unforeseen difficulties arise.

Constructing and Testing the Reliability of a Balloon Launched Repeater

Communication using only geological elevation around the Hab for repeater placement proved to be insufficient in allowing constant communication with base and the EVA team. Past Georgia Tech crews 37 and 47 have attempted deploying a payload-carrying tethered balloon as an effort to provide constant communication to EVA crews. Implementation of balloon communication systems on Mars provides the benefit of cutting down launch mass of a radio tower, minimizes risks which crews may face conducting a mountain climbing EVA required to set up repeater, and it is more cost effective than a low-orbiting communications satellite.

High winds in past crew rotations has prevented successful experiment results. Crew 130 will build on the knowledge and resources acquired from past crews as well as implement wind stabilizing fins on the balloon design to further develop this experiment. The plan is based on equipping each EVA team member with a GPS receiver coupled to a handheld amateur radio for automatic position transmission to the Hab, where the positions can be displayed and forwarded for publishing on the Internet in near-real-time. A ground-based repeater will be placed in a strategic location in the area of operations to enhance coverage. An additional repeater will be attached to a tethered helium-filled balloon, further increasing communications range. The crew will use the positioning data recorded during EVAs to improve and update the MDRS database of waypoints, exploration sites and trails.

Dust Mitigation Study

Dust mitigation and management is a field that requires further study and will be one of the main challenges to overcome while living on Mars. Dust would be a problem if it gets into the habitat, it could be harmful to the health of astronauts and difficult to remove, clogging up the air filters within the habitat. Dust also poses a problem for energy production as it settles onto the surfaces of solar panels. Experiments with dust mitigation techniques will be conducted within the air lock of the habitat and on the solar panels outside of the habitat. This study will attempt to mitigate the amount of dust from space suits carried into the airlock. The experiment will be conducted with both Earth regolith and lunar simulant.
**Food Study**

Crew 130 will be participating in the food study as it has during the past three rotations. This experiment is organized by investigator Jean Hunter, of the Cornell University. This will entail consuming only shelf stable foods for the duration of simulation in order to increase mission realism as well as to monitor psychological impact of such a diet. A major goal of this food study is to determine the acceptability of available instant foods and food prepared by the crew from shelf stable ingredients. This study will also assess the time commitment for preparation of instant and crew-cooked foods and determine if they are correlated with the cook’s self-reported cooking skill and experience along with assessing the effect of the type of food consumed on crewmembers’ intake of food, and aspects of crewmembers’ mood.

**Ham Radio Experiments**

HAM radio is a great form of emergency communication on Earth, and will prove very useful to the exploration of the Martian surface. One way that we can demonstrate this use is through using APRS systems. These systems will be located on each crew member when conducting an excursion away from the base and will record GPS coordinates. Using HAM radio we can transmit these coordinates back to the base in order to monitor where each crew member is. This information is extremely useful in an emergency situation, and can also give the public an idea of what our surface exploration paths consist of.

**Rapid Prototype Machine Demonstration and Educational Outreach**

Crew 130 will be bringing a 3D printer to MDRS to demonstrate the feasibility of printing spare parts on site for basic hab maintenance and repairs. This project will also serve as an educational outreach project which will allow students from various locations around the country to serve as our repair crew while we are at the station.

**Human Factors Investigation**

A major aspect pertaining to long duration human space flight is the maintenance and evaluation of crew psychological health. The success or failure of a mission hinges on the proper function of crew dynamics. Experiments will be conducted during simulation to examine the mechanisms that can promote or degrade effective interactions within the crew. The effects of the slightly longer Martian day upon the psychology of the crew will also be examined through maintaining a day/night cycle of approximately 24.5 hours. This examination will be linked to the characterization of physical stress endured by crew members during simulation. Personality profiles will also be utilized to better explain the morphology of crew dynamics during simulation.

**Remote Terrain Scouting**

Much of the surface exploration can be assisted via topographic data from spacecraft orbiting Mars. However, the detail level of this data can be expanded further by aerial vehicles controlled by the crew members at the base. Since Mars has an atmosphere, vehicles similar to our present day UAVs can be deployed to map the terrain and make more efficient use of the crew’s time by directing them to areas of the most biological and geological interest. By deploying and operating UAVs with mounting video cameras in the areas surrounding our base, we can have a better idea of what areas we would like to study before venturing too far away from the safety of our habitat. We will then have images to study before leaving the base to more effectively utilize our time and therefore minimize risks of venturing into the unknown.

**Sleep Cycle Monitoring**

A major aspect pertaining to long duration human space flight is the maintenance and evaluation of crew psychological health. The success or failure of a mission hinges on the proper function of crew dynamics. A sleep study will be performed with the use of a cell phone app to track the sleep cycles of the astronauts to develop a link between physical stress endured during simulation, sleep cycles, and the psychological effects.
**Wind Power Verification**

Wind power has been identified as a top choice for energy generation for some systems on Mars. Wind power could still generate electricity during month-long Martian global dust storms which would inhibit solar power generation. Crew 130 will continue researching the feasibility of using wind power as a supplement to the gas generator power system of the hab. Power output of the turbine will be monitored over an extended period of time and wind speed at various points around the hab will be recorded to determine ideal placement of wind turbine.

**Outreach**

Crew 130’s goal is to create a program which will enable high school students across the nation to participate in our research experience. One planned activity will involve bringing a 3D printer to the research station and having the students create CAD models of spare parts for the research station which we can print as we need them. The students will have the exciting opportunity to act as Crew 130’s repair crew! Additional outreach activities planned include Classroom Video Chats and the creation of an online blog. This will allow our out of state crew members to connect with their home communities.

Crew 130 has exciting plans to continue an outreach initiative with the NASA INSPIRE program. NASA INSPIRE is a national program sponsored by NASA with the goal to encourage 9th through 12th grade students to explore STEM careers. The central point of the INSPIRE program is an Online Learning Community (OLC) through which NASA reaches students from all regions of the country. INSPIRE students will submit research proposals through the OLC to Crew 130 for review. Crew 130 will then select the top experiment proposals and work with the high school students to develop their experiment for the upcoming mission to MDRS. During the two week simulation Crew 130 will conduct a chat with the OLC from the MDRS. Students will receive an update on the mission and have the opportunity to ask questions to the crew.

Finally, Crew 130 has planned hands-on science and engineering activities as well as a presentation of experiments the Georgia Tech Crew did last year to do in person at local schools in Atlanta. This form of outreach would be primarily for elementary and middle schools. We have already reached out to students ages 9-14 who are part of the First Lego League (FLL) Robotics program at a local middle school. Crew 130 also has plans to work with the Astronomy Club at Georgia Tech to host a free public night at the observatory. Students who participate will be able to visit the observatory at Georgia Tech and learn more about the stars, moon, planets, and night sky. This particular activity will be a small group of students, so we can connect with them on more of a one-on-one level and hopefully build a strong enough relationship to stay in contact with those who, like us, are really motivated to learn more about space.
The opportunity to participate in the Mars Desert Research Station experience is described by the Mars Society as “hard work, no pay, eternal glory.” Out of the 16 crew members, ten will be supporting as Mission Specialists from the GT campus, and six will be supporting from the Mars simulation station. This six student crew must provide its own funding to be able to participate in this incredible opportunity to learn, to conduct experiments, and to explore the challenges that must be overcome to one day colonize Mars. We are asking for your partnership as we gather the financial support that is necessary for us to participate.

Expenses

The expenses of our mission total $8,760. This cost covers our travel to the Mars Desert Research Station, our living expenses while at the station and the cost of research equipment. An itemized budget is listed below.

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<th>Expense</th>
<th>Cost per person</th>
<th>Quantity</th>
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** If interested in specifically sponsoring a particular project, please let us know.

Sponsorship Levels

**Silver Level ($100)**

Name of company or organization listed on all crew documentation (including submission of research to conferences, website, presentations, and any printed literature)

**Gold Level ($250)**

Name and logo of company or organization listed on all crew documentation (including submission of research to conferences, presentations, website, and any printed literature)

**Platinum Level ($500)**

All gold level benefits, plus
Acknowledgement of donation in the Georgia Tech newspaper, The Technique (distribution of over 13,000 copies)

How to Contribute

Any personal or corporate sponsors should made payable to the Georgia Tech Foundation and mailed to this address:

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Please include a short note with your check stating the purpose or designation of your gift or note the purpose on the memo line of your check. Your gift will be recorded and receipted promptly on behalf of the specific program, school, or other designation you indicate. The Georgia Tech Foundation, Inc. Tax ID is 58-6043294.
**The cover page image was taken during GT Crew 101 simulation of two crew members exploring the martian landscape**