THE MARS QUARTERLY

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VOLUME 3, ISSUE 1 - SUMMER 2011

Mars Science Laboratory
John Grotzinger, Project Scientist

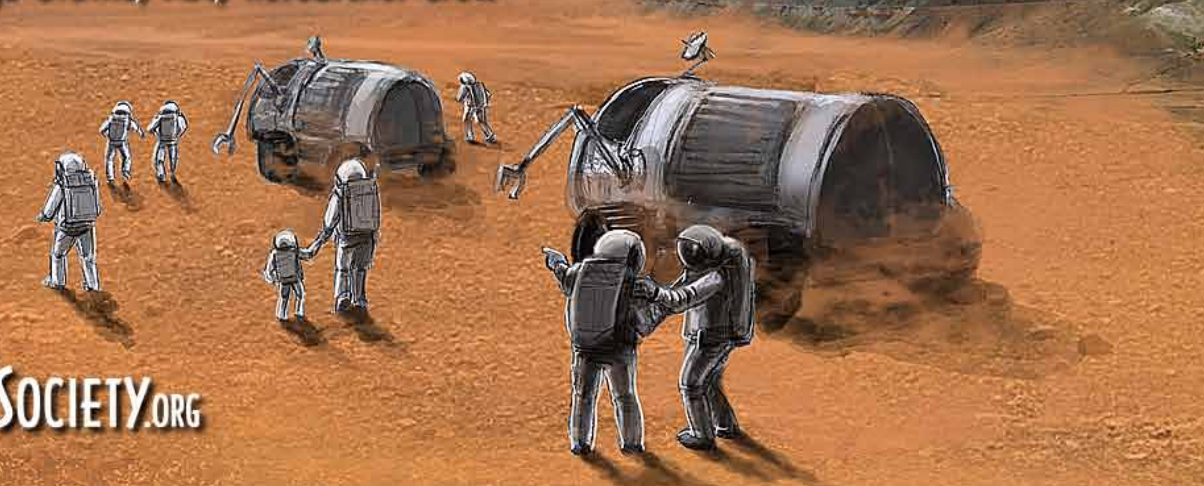
NASA Planetary Decadal Survey-
Mars Missions: A Discussion with
- Jim Green, Director of Planetary Science-NASA
- Michael Meyer, Lead Scientist NASA - Mars Exploration Program
- Robert Zubrin, The Mars Society

Don't Miss It - 14th Annual International Mars Society Convention, August 4-7, Dallas, Texas

Spaceward Bound-Australia
Chris McKay, NASA

Hubble and James Webb Space Telescope
Mario Livio, STScI

European Space Agency - Mars500 Mission
A Discussion with Diego Urbina, MSc, Researcher-Crew



IN THIS ISSUE

About the cover image:
Winning Convention Poster by Markus Iske, of Germany

FROM THE FLIGHT DECK

After a year-long hiatus, we welcome you back to the pages of *The Mars Quarterly*. This issue remains true to all you have come to expect from the flagship publication of The Mars Society – articles and interviews with the top scientists and experts involved in Mars research and exploration.

This summer issue has impressive content: an exclusive interview with John Grotzinger, Project Scientist of the Mars Science Laboratory that launches this November; a round table discussion with Jim Green, NASA's Director of Planetary Science, Michael Meyer, lead scientist for NASA's Mars Exploration Program, and Robert Zubrin, President of The Mars Society, regarding NASA's Planetary Decadal and plans for future Mars missions; an interview with Christopher McKay, Principal Investigator of NASA's Spaceward Bound program, an interview with Mario Livio regarding Hubble and the James Webb Space Telescope, and an exclusive interview with Diego Urbina, who is currently serving as a member of the crew of ESA's Mars500 mission, and much, much more. We thank everyone who contributed their time so generously toward the season premiere of *The Mars Quarterly.*

I look forward to seeing you at our 14th Annual International Convention in Dallas, Texas, August 4-7.

On to Mars!

Susan Holden Martin,
Editor-in-Chief

THE MARS QUARTERLY

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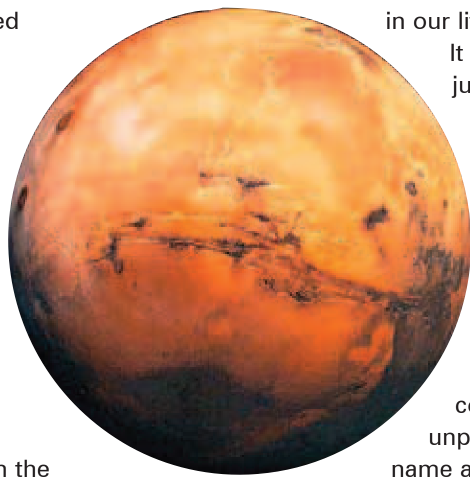
Welcome to the Summer 2011 issue of *The Mars Quarterly*

Robert Zubrin

A great deal is happening on the Mars front. As this issue of The Mars Quarterly goes to press, NASA is preparing the mobile Mars Science Lab, Curiosity, for launch. Powered by a radioisotope generator, this craft is equipped with advanced instrumentation that will enable it to explore the Red Planet with an effectiveness far exceeding anything attempted before. The previously cancelled Orion crew capsule program has been restored, and NASA is moving ahead, however slowly, on the design of a heavy lift launch vehicle. Meanwhile, by no means to be outdone, the entrepreneurial SpaceX company has announced that it is proceeding with development of a semi-heavy launch vehicle (53 tonnes to orbit – more than twice the capacity of any booster now flying) on its own, with first flight scheduled for as soon as 2013. If successful, the advent of this vehicle could radically change the prospects for both robotic and near-term human Mars exploration, and possibly ignite a highly competitive commercial space race as well.



On other fronts, the Mars Society has continued its studies of human Mars missions at the Mars Desert Research Station (MDRS) in the Utah desert, and, as reported in this issue, one of the veterans of that program is currently part of a 500-day mission simulation being conducted in Russia. Meanwhile, as the US presidential race gears up, the shuttle program is shutting down, presenting us with a wide-open political situation that could offer us a once-in-a-generation chance to make human Mars exploration a reality, but which could also end in disaster. The question is now posed: Will we replace the shuttle with a space program that is truly committed to breaking the bonds of Earth, or will America walk away from the future? The great debate is now on which will determine if humans reach Mars in our lifetime.

It is at this critical juncture that the Mars Society will once again gather its forces at its annual convention. Scheduled for August 4-7 in Dallas, the lineup for the coming conference is unprecedented. To name a few, our plenary speakers will include:

- Dr. Paul Davies, internationally famed physicist and author of the plan for a one-way mission to Mars.
- Homer Hickam, Apollo veteran, and author of the bestselling memoir October Sky.
- William Borucki, PI of the Kepler mission, which is seeking Earth-like worlds circling other stars.
- Dr. Bruno Marino, a leading investigator of terraforming: creating new biospheres around other planets.
- Dr. Everett Gibson, a leading NASA investigator of the famous Alan Hills Meteorite.
- Paul Wooster, one of the leading engineers of SpaceX – which is developing heavy lift boosters that could soon make access to orbit affordable enough to enable human exploration beyond LEO.
- Hum Mandell, Apollo veteran and a leader of the 1993 NASA Design Reference mission effort that produced a low-cost plan for human Mars exploration.
- Dr. Robert Zubrin, President, The Mars Society (i.e., me), with an updated edition of The Case for Mars, and a new daring plan to get humans to the Red Planet in this decade.

Some highlights of the conference will include special sessions and talks on:

- Space Debate: Is President Obama's new course for NASA a breakthrough or a dead end? Proponents and opponents will have it out. You decide who is right.
- The Mars Sample Return: How can this flagship mission of the robotic Mars exploration program serve to open the way for humans?
- Private Enterprise and Mars: Can entrepreneurs blaze the path to the Red Planet?
- The One Way Mission to Mars: Is going one-way the best way?
- VASIMR Propulsion: Silver bullet or Hoax?
- Heavy Lift Boosters vs. Orbital Propellant Depots: What do we really need to get to Mars?

We will also have leading scientists with the latest revolutionary discoveries from the Mars rovers and other robotic missions, and top engineers engaged in designing the craft that could take humans back to the Moon and on to Mars. Hundreds of technical papers will be presented to advance the discussion on the best way to reach the Red Planet. Please come and add your ideas to the great debate!

So enjoy this issue of TMQ, which touches on many of these issues, share it with others, and make it to Dallas if you can. But whatever your circumstances, find a way to join the fight. A new world awaits, but it will only be reached if those who understand its importance do what is necessary to open the way.

Ad Martem per ardua. Ad astra per spem.

Golden, Colorado
June 20, 2011

Mars Science Laboratory

John Grotzinger, Project Scientst

Editors Note: This interview was conducted in early July, prior to the announcement that NASA had narrowed the landing site preferences to Eberswalde and Gale Crater.

TMQ: A decision is coming up on the final MSL landing site. Which of the four landing sites looks the most promising right now?

Grotzinger: We are really down to the final two and it is between Eberswalde and Gale, and beyond that at this moment we don't really have a strong preference. We will be reviewing all the data before we make the final decision.

TMQ: Any idea when the final decision will be made?

Grotzinger: Assistant Administrator Ed Weiler said that he expects it will be sometime in the next few weeks but there is nothing definite right now.

TMQ: Could the choice of landing site be modified during cruise, if necessary?

Grotzinger: We do anticipate in the next few weeks having a final choice, but technically it is still possible to change things before trajectory correction maneuver #1, so if something completely unforeseen came up in terms of engineering it would be possible to do that.

TMQ: What are the long term objectives for MSL, and how will that help you decide where to send Curiosity once it lands on Mars?

Grotzinger: The overarching science objective for MSL is to undertake a detailed study of habitable environments on Mars with an emphasis on ancient Mars. Within that context a habitable environment means a source of water, a source of energy that microbes use for metabolism, and a source of carbon to build structures for life as we know it. So that would be the primary goal, and then we have some strategies in mind to go additionally a step beyond that if we do find a habitable environment - we would sample it using our payload to undertake the search for organic compounds to see if they might be preserved in the rock record. That might be an indication that there had been former life there, it degraded and left only large organic molecules. We can speculate about such an investigation because this is how we do it for very old rocks on Earth, and large organic molecules are the kind of calling cards that we see most often that represent signs of earlier life on Earth.

TMQ: How will MSL build on what we have already learned from Spirit and Opportunity?

Grotzinger: Spirit and Opportunity have discovered specific paleoenvironments and arguably either the sulfates at Meridiani or the silica deposits at Gusev could have been habitable, and with the orbiters we now know as well that some of these environments like the sulfates are distributed over broad regions of Mars. So the rovers give us the ability to really confirm and elaborate on what the orbiters are mapping, and that directs us to new landing sites. We then get confidence ahead of our mission that we are going to be able to do at least as well as Spirit and Opportunity have done. But a brand new place will give us not just one option, but several different types of habitable environments to test, or completely different concepts to test altogether – like ancient river deltas.

TMQ: What is the significance of sulfates?

Grotzinger: The way most people are likely to understand sulfates is a bit of an anachronism– my grandparents used to buy Epsom salts that they would dissolve in a little bowl and put their feet in it – and that is a magnesium sulfate mineral, but the important thing is that the formula is MgSO4-7H2O. So this is a sulfate mineral that is very strongly hydrated. On Mars we see sulfate minerals and they have goofy names like Keiserite and Hexahydrite, but they have anywhere between one and six waters in them, so these are minerals that we know had to have formed in the presence of water. When we see them from orbit we get the strong sense that we really will discover a habitable environment if we land there. Or, on the other hand, if we see clay minerals as well, and we know that the clays contain water in their structures, we have a second mineralogical indication that there has been water there in the past. If we also observe geomorphic indicators like river channels and deltas and things like that that tells us that there was very likely water there in the past.

TMQ: We know that the mission of MSL is to determine the planet's habitability and that it will do this by using a suite of sophisticated instruments. What can you tell us about the various instruments, and is any one mission critical?

Grotzinger: I think it is fair to say that MSL really is a mobile roving laboratory. Our remote sensing capability features a strong suite of cameras in addition to a laser, which has real outreach appeal because it has the power to make a rock spark up to 7 meters away from the rover and we look at the light emitted from the spark. So we go around zapping our way across the planet looking at the surface and getting a sense of the composition and then if a given exposure of rocks looks really different we might choose to drive Curiosity up to it and explore it in more detail. But once we get to the rock that we are interested in we can then drill it – we have a small drill that is about 1.5cm in diameter and penetrates to depths up to about 5cm – and the powder that is produced when that drilling occurs moves through the rover - it goes through a series of sieves, comes out at the end in a grain size that is less than 150 microns and then that sample is dumped into the belly of rover where it gets split and shared between two instruments. One instrument does a process called X-ray diffraction and that is the definitive way on Earth that we determine crystal structures, so with that we can once and for all really determine what the mineralogy is on the surface of Mars at the landing site.

The other instrument is really regarded as potentially the most important instrument when it comes to the detection of organic compounds. It is called the SAM instrument – Sample Analysis of Mars – and it is able to take the rock powder and process it, including things like heating it up to maybe 1,000 degrees centigrade and as that heat occurs it drives off the volatiles that are in the rock. So if there was water in the rock that would be liberated as gas, if there was carbon in the rock it would be liberated as carbon dioxide and if there was sulfate in the rock it would be liberated as sulfur dioxide. So as you heat these rocks up, they decompose and produce these gases and then we are able to analyze. In addition to that, we are also able to drive off any organic compounds that were in there and then we can measure them as well with the instrument and determine if there are large molecular weight organic compounds there. So that instrument is very important for determining whether or not it was a habitable environment and was it also the kind of environment that would favor the preservation of organic carbon.

TMQ: What might we discover about Earth's evolution by looking at Mars, and why is that important?

Grotzinger: That's a really good question. The fascinating thing about studying Mars, and I think this is really the most overarching point, is that as terrestrial planets and nearest neighbors they had many of the same initial and boundary conditions, and there is a lot of reason to think that early on Mars may have had the same amount of water that Earth did. But there are important differences – it is not obvious to us that Mars ever had plate tectonics the way that Earth does – so there are some differences, however on the balance it seems to have been a very Earth-like planet. It has always been intriguing to ask "could life have evolved on Mars?" However the real opportunity for exploration is that part of the rock record in Mars' history that preserves evidence for how Mars diverged from Earth's evolution. Earth went in one direction and Mars went down a different path. This is always the interesting thing about any problem in evolution whether it be inanimate evolution of planetary bodies or organic evolution – why does one entity follow one path and why does another one take another path?

MSL ChemCam Spark. Image Credit: NASA

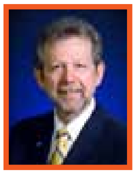
What we hope to do with MSL is to really study that environmental divergence between the early history of Mars as we are beginning to understand it more and more, but we have lots of questions and we have lots of hypotheses that the MER rovers, Spirit and Opportunity really can't close out on. But with MSL we think we are really going to be able to test some of these hypotheses and then come up with a scenario for helping us understand why Mars did go down the path that it did very much unlike Earth's. So to get back to your original question, what's really important is that we do think that they were similar early on, and that allows us to ask the fascinating question "why did they evolve differently?" and what does that have to do, for example, with the potential development or evolution of life on Mars if it ever did get started?

TMQ: What do you think might be the next step after MSL? Will we have a new generation of rovers? And if so, what would you want them to be capable of that we haven't done so far?

Grotzinger: That is a really good question as well. One of the important things about MSL is that it carries an instrument called RAD which is a radiation detector that works in a passive mode so on a day-to-day basis. This instrument was contributed by NASA's human space flight division and it is designed as an initial precursor step to assess the modern environment of Mars in terms of the effects of radiation as a precursor toward potential human missions to Mars. So the next step then in the Mars program is to do a Mars sample return, and what that allows is really the kick-off of technology development that means you have to take stuff from the surface of the planet, then take it to orbit, and then figure out some way to get it back to Earth. So as a precursor to human exploration you need to develop technologies that allow you to get astronauts back to Earth. So this will be tremendously exciting I think for a couple of reasons – scientifically it will be awesome to get some chunks of Mars back to Earth, other than the meteorites that get delivered for free, and the technology development is something that really takes a firm step in the direction towards eventual human exploration of Mars.

NASA Planetary Decadal Survey 2013-2022

A Discussion with Jim Green, Michael Meyer, and Robert Zubrin



TMQ: What are the priorities and goals of the robotic Mars missions for the coming decade?

Green: That is really well-specified. It is in the new Planetary Decadal[1] that was issued in March and that gives an overview of the planetary program, but it integrates Mars into the planetary program just like it is currently in our budget. The Mars Program used to be a separate organization, but that changed quite a few years ago. Unlike in the past where the academy had separate documents on Mars, in this Planetary Decadal we are integrating Mars science with the rest of the solar system. You can grab that document at any time and get the overview of the whole solar system science for the next decade, including Mars.

Let me review the highlights of the Planetary Decadal. There are a set of missions that are laid out in the Planetary Decadal, that are principal investigator-led missions and strategic missions. The principal investigator-led (PI) missions come in two types. One is the Discovery Program and the other one is the New Frontiers Program. The recommendation in the Decadal is that the Discovery cost cap be around a half a billion dollars excluding the launch vehicle, and the New Frontiers program be around a billion dollars excluding the launch vehicle. The Discovery program is one that has been tremendously successful over the years and in fact we just recently selected three new Discovery missions for study. This would be called a Phase A study. One goes to Titan – it actually is a boat that lands on the surface of Titan in one of the large methane lakes. Another study we are doing is a mission that lands on a comet and takes a ride with the comet as it moves toward perihelion – its closest approach – and actually hops around on the comet examining vents or cometary jets of material. The third is a Mars lander and this mission is called GEMS[2] to be launched in 2016. It makes a series of geophysical measurements, seismic and heat flow, after it lands on the surface of Mars. Those three will be studied over this next year and then about this time next year we will be announcing which one of the three that we will pick to move forward.

The next set of missions is in the New Frontiers area. These are principal investigator missions that are well-focused. There is a set of five targets that are planned. Mars is not in the New Frontiers set of missions, however the next set of strategic missions - what we call our flagship or large mission –is Mars Sample Return. Mars Sample Return is accomplished over a series of missions and the Planetary Decadal describes that series of missions in a high level overview pretty well. What is laid out in the Decadal is the basic architecture we are following. We are working very hard with ESA (European Space Agency) to complete a partnership that will include a 2016 orbiter that will orbit Mars and make trace gas measurements. In addition, it will provide the communication necessary to support the 2018 lander, which will be used to collect samples and be ready for the next decade of missions to Mars that would be able to return those samples to complete the Mars Sample Return mission.

Zubrin: Can you clarify – is the 2018 mission separate from the ExoMars mission, or is that the ExoMars mission?

Green: Working with ESA we have now combined both Agency objects into one rover. The requirements for Sample Return in terms of caching that we want to do are combined with the ESA ExoMars set of analytical instruments.

Meyer: Although we don't know it yet, we hope to be able to cache some of the drill samples that ExoMars will bring back. They hope to be able to drill down two meters.

Green: We are also anticipating a horizontal drilling system that will drill rocks. So there should be quite a set of samples that can be taken and the preliminary analysis of some of those to determine that those are the right samples, and then NASA is responsible for developing a cache for those samples.

Zubrin: Can you describe how you are going to get those samples back to Earth?

Green: Sure - that is also described in the Decadal report. It is high level architecture that requires two additional Mars launch opportunities be used. One opportunity would put down on the surface a system called the Mars Ascent Vehicle or MAV, together with a fetch rover that would be able to collect the cache and bring it to the MAV. Then another opportunity, and these may not occur in this order, that would have an orbiter that would be ready to collect those samples from orbit after the MAV puts those samples in orbit. It would capture those samples and return them to Earth. So at a high level there are two other Mars launch opportunities to be used for getting samples off the surface and then capturing them in orbit and bringing them back.

Meyer: One of the important aspects of taking the samples into orbit and having a separate vehicle - the orbiter - pick up that sample while it is in orbit and bringing it back to Earth is that you are doing an

1 NASA Planetary Scence Decadal Survey 2013-2022. http://solarsystem.nasa.gov/2013decadal/

2 Gravity and Extreme Magnetism SMEX. http://gems.gsfc.nasa.gov/

important set of planetary protection requirements in separating the samples that are in the vessel, whose exterior has been in contact with Mars, and encapsulating the container by moving it to the orbiter. What that does is break the contact with Mars and lets you then bring the samples back to Earth. It is a way to ensure that you are not bringing some of Mars on the exterior; any part of Mars is totally contained.

Green: To review then, the robotic missions to Mars as they are now set up are this: we are going to launch MSL, the Curiosity rover, in November of this year and it will land in August of next year. That is the 2011 Mars launch opportunity. The 2013 opportunity is MAVEN (Mars Atmosphere and Volatile Evolution). That was the last Mars scout mission selected in a competitive environment, since we moved the scout opportunities to the Discovery Program of small missions as supported in the Planetary Decadal. Then in 2016, the next opportunity is a joint orbiter with ESA – the ExoMars Trace Gas Orbiter. That also provides a long-term communication link for the next event which is the 2018 rover mission. The 2018 rover mission is the beginning of Mars Sample Return through a collection of samples, surface analysis and caching.

Zubrin: How many rovers are involved in that?

Green: The 2018 mission will only have one rover.

Zubrin: Do you have plans for additional rovers after that

Green: Well that will be through this decadal, and the 2018 mission is a commitment by ESA and NASA for a Mars Sample Return. So as I have mentioned, in the next decade we would anticipate a fetch rover to be able to go to where the samples are cached and then bring them to the MAV. So just in that architecture - yes there is one additional rover, the fetch rover.

Zubrin: So that also means that if we don't achieve precision surface rendezvous, at least the Mars Sample Return can gather its own samples.

Green: That is part of an architecture that is currently being discussed and of course one we have time to decide on. But indeed, that is one of those decision branches that give us flexibility – –we need flexibility in Mars environment. But that hasn't been decided.

Zubrin: The 2018 rover is also the one that will have the drill?

Green: Yes.

Zubrin: Is it going to be a requirement for the fetch rover that it be able to gather field samples?

Green: Well as I mentioned, the fetch rover will be in the next decade. So we are somewhat distant from being able to determine all of its requirements. Right now the fetch rover has a requirement to collect the samples, and that's from the cache that will be created in 2018. I think as we get closer to 2018, we will able to map out the rest of the architecture better. But what you are saying is a great concept - that the fetch rover also have the ability to collect the samples. That is something at this point we are not committing to.

Meyer: One of the things that is more than likely is that on the MAV there will be some way to collect at least grab samples, using the fetch rover or something of that nature. So there will be an opportunity to collect samples even if we do not achieve rendezvous with the cache.

Zubrin: One thing that I notice here is that after Curiosity, the next thing you are landing is the 2018 rover. So there basically is nothing in this program that allows one to pretest precision surface rendezvous.

Green: What will be done with MSL, which utilizes a Sky Crane capability, is the same architecture that will be done with 2018. So we will learn how to do more precise landings with time. MSL is hugely different from Spirit and Opportunity whose landing ellipses were 120 km long; the landing ellipse for Curiosity is 20 km. So we are making major steps in the direction of being able to do more precise landing than having these large landing ellipses with each and every opportunity. We will learn a lot with the Sky Crane and that architecture will be used again for the 2018 mission.

Zubrin: All the development for Spirit and Opportunity has obviously already been done and they were tremendously successful in every respect. What would be the recurring cost if one wanted to conduct a program where we simply sent multiples of those kinds of rovers to Mars to different locations with different instruments?

Green: Spirit and Opportunity were developed in a very rapid time scale, approximately two years, and used parts in many ways that are no longer available. Some of the designs are not written down to the point where we can give them to somebody and say 'go make this exact copy'. So as you know, in this business each and every time we build something there are many unique aspects to it.

Zubrin: Is that wise?

Green: What we are doing with MSL is very different. With MSL we have been very careful to make sure we have the appropriate designs available to allow us to build-to-print many aspects of it – this is why the Sky Crane, the whole clamshell of the MSL architecture, can be reduced and therefore it will allow the 2018 mission to have the lowest cost possible based on the type of manufacturing capability at that point. Now of course there are always problems with components which are available today but not necessarily made tomorrow when you need them. So that is always one of those things you have to work around. But we changed our approaches between Spirit and Opportunity, which was a very fast turnaround build, to a more methodical way of developing and keeping designs for future rovers, and that of course starts with the MSL mission.

I think the heart of your question is really this – can we do good science with other MER-like rovers and the answer to that is yes. But what the Planetary Decadal is all about is where is the next leap? The next leap for Mars is Sample Return. If you ask our scientists 'do we know where to go to get the right samples?' The answer is yes. We have studied Mars, we've been down on the surface, and we have ground-truth data necessary to be compared with MRO and our other orbiters. So the scientists say we know where to go to bring back the right samples. And that is indeed the next leap. Can we do good science with MER-like rovers? Yes. And it may be possible for Discovery-level proposals to do something similar to that. MERS were more expensive than even the Discovery, but the first rover in the Discovery program was Pathfinder – so something can be done at that level. But that is a competitive program and is not part of the strategic program for Mars laid out in the Planetary Decadal which has the guiding principles that we are following.

TMQ: Will there be any more Mars Scout missions (competitively chosen)?

Green: The Mars Scouts in the next decade are really folded into the Discovery program and so indeed that's where they have ended up.

TMQ: Is there a potential collaboration between the robotic exploration effort and those in NASA planning for human exploration?

Green: That's also a very good topic. Indeed, what we as scientists do is to look at being able to understand much more about the current and past environment of Mars and everything we do does inform human exploration as you can imagine. But in addition to that we've worked very carefully with defining things that human exploration needs that then can be implemented on our missions in terms of instruments and providing the human exploration group the kind of information they need – like what's the radiation environment like? And so there is a RAD (Radiation Assessment Detector) instrument on MSL and also a little bit more about entry and descent – that's going to be extremely important. So we have worked very extensively with the human exploration group in these areas and we will continue to do so.

Meyer: We have had experience collaborating with our sister directorates, for instance on Odyssey we had the instrument called MARIE (Mars Radiation Environment Experiment) that measured the radiation environment existing on Mars in the upper atmosphere, and that was similar to instruments that have been flown on the Space Station. So we have a good comparison in that way. Then on MSL itself we have an instrument called RAD (Radiation Assessment Detector) which is a radiation detector that measures the full spectrum of radiation on the surface. That is paid for by ESMD (Exploration Science Mission Directorate), and as Jim mentioned in terms of understanding entry, the aeroshell is instrumented to measure what's going on - the heating of the heat shield, how much is ablated, what temperatures are reading, how much pressure there is – that sort of thing, to gain a much better understanding of the dynamics involved in entering the atmosphere. We have in place on the order of $10 million for SMD (Science Mission Directorate) and $20 million from ESMD for future collaboration on activities to improve how we are going to send people to visit other planetary bodies.

Zubrin: MARIE was quite important in establishing the radiation levels on the way to and in the proximity to Mars. Is there any payload space being allocated for experiments to be determined by the human exploration directorate – for example perhaps an experiment in extracting water from the Martian soil or making propellant out of the Martian atmosphere?

Meyer: Certainly that is the idea of what is to be determined. Right now we are doing the 2018 mission – I don't think there is going to be any extra room for putting other instruments on, other than trying to get the instruments that we need for what the Europeans want to do for exobiology and what we want to do for characterizing samples and for caching. But there is a possibility for future missions such as on the MAV to have other instruments and certainly there may be collaborations that come into Discovery where part of the instrumentation put on the platform may be provided by ESMD or SOMD (Space Operations Mission Directorate), or whatever the new combined organization is now called. So that is basically to be determined.

Zubrin: Ok, so let me turn that around then. You have your science missions and you are not in a hurry to have a requirement put on you to put 10 kg of payload that are extraneous to your current objectives. On the other hand, the human exploration program is basically stuck in the water. One of its primary technology development objectives is in situ propellant production. It has been sometimes discussed over there that the human exploration directorate should have its own Mars probes dedicated to engineering research. Of course on such probes the science directorate could piggyback some instruments as well, and obviously they would be making use of the heritage of Mars entry and landing systems that you guys have developed. Is there any thought of encouraging them to spend some of their money on planetary test missions and you could piggyback some instruments?

Meyer: Certainly the answer is yes. We have on occasions gotten together and talked about what we could do together. Some years ago we had quite a plan for exploring Mars when we thought human exploration to the planet was in the more near-term. So basically that needs to be worked out for sure, and I see a lot of opportunities for other nations to participate besides other directorates in Mars exploration. Right now we have a short-term timeline of getting the 2016 and 2018 collaborations working and getting those missions to Mars. Then what comes after is very much more open-ended.

Zubrin: I would love to have you or Mike come to the Mars Society conference and say "here is the Decadal plan and this is how we are going to pull it off, here are some other options, and here are some opportunities for innovative ideas that could come into the competitive route", etc. Because I don't think this is well-understood outside of the planning circles that you guys live in and interact with.

Green: I agree. The decadal document that just got rolled out is a great roadmap in planetary science for the next decade. We would be delighted to tell everyone what is in the Planetary Decadal and what our plans are for exploring Mars in the next 10 years to try to execute on it faithfully.

Dr. James Lauer Green has been the Director of Planetary Science at NASA since August 2006.

Dr. Michael A. Meyer is the lead scientist for NASA's Mars Exploration Program at NASA Headquarters in Washington.

Dr. Robert Zubrin is an aerospace engineer and author, and President of The Mars Society.

Call for Volunteers for MDRS 2011-12 Field Season

The Mars Society is pleased to announce that plans for the 11th field season at the Mars Desert Research Station (MDRS) are moving ahead rapidly. The upcoming field season is now planned to run from December 3, 2011 through May 6, 2012.

Volunteer slots are open for participation as a crew member at the MDRS in Utah. Crew members will be required to pay for their own transportation to and from Grand Junction, Colorado, and also pay a $1,000 participation fee (reduced to $500 for students) to cover station expenses.

Those interested in participating in the upcoming MDRS field season should send their applications to: mdrsvolunteers@aol.com by September 30, 2011 in order to be considered. Applications received well in advance of the September 30, 2011 deadline are greatly appreciated, and will receive special consideration for the earlier crew slots.

Both individual applications and group applications of up to an entire crew (6 people) will be considered.

For more details about applying as an MDRS volunteer, please click here http://mdrs.marssociety.org/home/participate/volunteer.

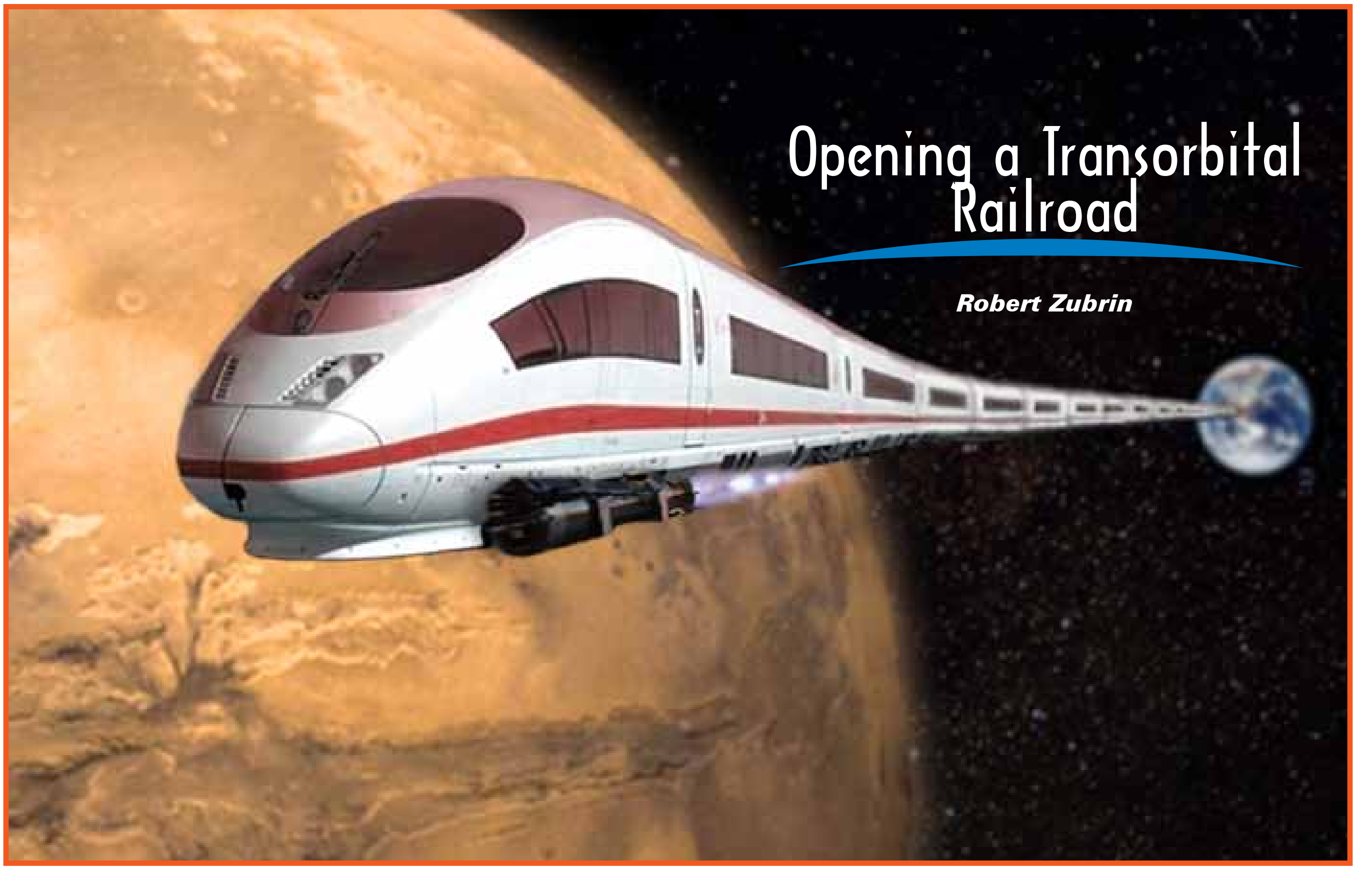


Image credit: Dmitriy Ivashchenko

Opening a Transorbital Railroad

Robert Zubrin

In the history of the American frontier, the opening of the transcontinental railroad was an epochal event. Almost instantly, the transit to the West Coast, which had previously required an arduous multi-month trek and a massive investment for an average family, became a quick and affordable excursion. As a result, the growth of the nation accelerated exponentially.

Can we today deliver a similar masterstroke, and open the way to the full and rapid development of the new frontier space? Can we open a "transorbital railroad"? I believe so.

The core idea is simple. The Shuttle program is ending. So let's just take a quarter of the Shuttle's budget and use it to set up a regular scheduled launch service to orbit using the most cost effective boosters on the commercial market.

One quarter of the Shuttle program would provide a budget of $1.2 billion per year. Right now the choice of most cost effective launcher is a horse race between the Boeing Delta IV, the Lockheed Atlas V, and the Spacex Falcon 9. However, starting in 2013, Spacex will field the Falcon Heavy, which, with a lift capacity of 53 metric tons and a price tag of $80 million, will offer three times the amount of goods delivered for the price as any of its competitors. So let's assume this is the initial baseline choice for the railroad. In that case, with a budget of $1.2 billion, the transorbital railroad could buy 15 launches per year, or one every 24 days, with a total lift capacity of 795 metric tons. This is nearly ten times the annual delivery capability of the shuttle program - which over the cost of its thirty-year history, averaged about 80 tons per year – performed at one quarter the cost.

Having bought these launches for $80 million each, the NASA transorbital railroad office would then turn around and sell payload space on board them at a severe discount price of $50 per kilogram. Thus a 53-ton-capacity launch could be offered for sale at $2.5 million, or divided into 5-ton compartments for sale at $250,000 each, with half-ton compartments made available for $25,000. While recovering only a tiny fraction of the transorbital railroad's costs, such low fees (levied primarily to discourage spurious use) would make spaceflight readily affordable.

As with a railroad, the transorbital railroad's launches would occur in accord with its schedule, regardless of whether or not all of its cargo capacity was subscribed by customers. Unsubscribed space would be filled with containers of water, food or space-storable propellants. These standardized, pressurizable containers, equipped with tracking beacons, plumbing attachments, hatches and electrical pass-throughs, would be released for orbital recovery by anyone with the initiative to collect them and put their contents and volumes to use. A payload dispenser, provided and loaded by the launch companies as part of their service, would be used to release partial payloads to go their separate ways once orbit is achieved.

As noted above, the budget required to run the transorbital railroad would be 25 percent that of the space shuttle program, but it would accomplish far more. The U.S. government would be able to use it to save a great deal of money, since its own departments in NASA, the military and other agencies could avail themselves of the transorbital railroad's low rates to launch their payloads at trivial cost. Much further savings would occur, however, since with launch costs so profoundly reduced, it no longer would be necessary to spend billions to ensure the ultimate degree of spacecraft reliability. Instead, commercial-grade parts could be used, thereby cutting the cost of spacecraft construction by orders of magnitude. While some failures would result, they would be eminently affordable, and moreover, enable a greatly accelerated rate of technological advance in spacecraft design, since unproven, non-space-rated components could be much more rapidly put to the test.

With such a huge amount of lift capability available to everyone at low cost, both public and private initiatives of every kind could take wing. If NASA's Exploration Mission Directorate were to desire to send expeditions to other worlds, all they would have to do is buy space on the transorbital railroad for their payloads. But private enterprises or foundations could use the transorbital railroad to launch their own lunar or Mars probes — or settlements — as well. Indeed, three launches of the Falcon Heavy would probably be sufficient to launch a minimal scale human Mars expedition, and with a price tag of $7.5 million for the three, the total cost of such a private sector effort would likely be no more than that sometimes expended by wealthy backers of teams striving to win the America's cup yachting event.

Those who believe in space solar power satellites would have the opportunity to put their business plans into action. Those wishing to launch and operate orbital space hotels or orbital industrial research labs would have the low-cost lift capacity necessary to make their concepts feasible. Those hoping to offer commercial orbital ferry service to transfer payloads from low Earth orbit to geostationary orbit or beyond would be able to get their crafts aloft, and have plenty of customers.

As such enterprises multiplied, a tax base would be created both on Earth and in space that would ultimately repay the government many times over for its transorbital railroad program costs. Indeed, since each $6 of economic activity produces $1 of tax revenue, it would only require the fostering of $7.2 billion per year of space-oriented economic activity to generate tax revenues greater than the cost of the railroad. Given the multiplicity of commercial opportunities the railroad would make possible, it is likely that this figure would be greatly exceeded, leaving Uncle Sam not only with a paid-for ride to space for all of his payloads, but a substantial source of income to help balance the nation's budget.

While the implementation of a cargo-only transorbital railroad would be a great advance over our current situation, we should not limit it to that. As John F. Kennedy said at the dawn of the space age, "We go into space because whatever mankind must undertake, free men must fully share." Thus the transorbital railroad's compartments should be open to receive passenger capsules provided by private vendors, thereby making affordable trips to orbit possible for anyone. Some might say that such open access to human spaceflight would put people at risk, and this is true. But bold endeavors have always involved risk, whether personal or financial, and free men and women should be allowed to decide for themselves what risks they are willing to accept in order to achieve their dreams.

We don't even have to wait for the Falcon Heavy to implement the transorbital railroad. We can begin it straight away, with 12 existing medium-lift launches per year. Once the Falcon Heavy becomes available, it could be integrated into the program to enable the full transorbital railroad capability discussed above. With a large guaranteed market, launch vehicle companies would compete hard to create ever more capable systems. They also would be able to put mass-production techniques into action, thereby causing the costs of their rockets to fall over time. This, in turn, would allow the transorbital railroad to further increase the frequency and capacity of its service, and would result in a dramatic drop in the cost of launch vehicles bought outside of the transorbital railroad program as well.

Some might say that the implementation of the transorbital railroad would represent an anticompetitive subsidization of the U.S. launch industry. But the federal government has always subsidized transportation, supporting the development of trails, canals, railroads, seaports, bridges, tunnels, subways, highways, aircraft and airports since the founding of the republic. Rather than complain, the Europeans or others distressed by low American launch prices could create transorbital railroads of their own, thus multiplying humanity's capacity to reach into space still further.

Within a few years, we could be sending not a mere handful of people per year to orbit, but hundreds. Instead of a narrow space program with timid objectives moving forward at the snail's pace of politically constrained bureaucracy, we could have dozens of bold endeavors of every kind, attempting to realize every vision and every dream — reaching out, taking risks and proving the impossible to be possible. With the aid of the transorbital railroad, the vast realm of the solar system could be truly opened to human hands, human minds, human hearts and human enterprise, a new ocean for free men and women to sail, their creativity unbounded, with prospects and possibilities as unlimited as space itself.

Robert Zubrin, an aerospace engineer, is President of the Mars Society (www.marssociety.org) and author of the recently revised and updated book "The Case for Mars: The Plan to Settle the Red Planet and Why We Must."

2011 University Rover Challenge

Kevin Sloan, Director

The 2011 University Rover Challenge (URC) welcomed eight teams from three countries to Hanksville, Utah in early June. The three day event, sponsored by TASC, Inc., asked teams to design and build the next generation of Mars rovers, and for the fifth year teams responded by delivering handcrafted technological masterpieces.

After Oregon State University ran away with the title at URC 2010, everyone was eager to see how the rest of the field would respond. Teams went home one year ago having learned many lessons the hard way, but they were all eager to rebound and give the defending champions a tough battle in 2011.

We asked a few of the teams about their URC 2011 experiences. Read about the event from the viewpoint of Jesse Grimes (JG), Operations Manager for the 2011 Oregon State University Rover Team, Saurabh Bhardwaj (SB), Co-Captain, and Carina Hoang (CH) from the York University Rover Team, Wojciech Głazewski (WG), the Magma2 Team Lead from the University of Bialystok, and Grzegorz Hapel (GH), Team Lead from the Wroclaw University of Technology. Other comments are from Kevin Sloan (KS), Director of the University Rover Challenge.

JG: We were very impressed at the quality and completeness of this year's rovers. Each year teams push the limits set from the year before. But this year all teams really did step it up. OSU is really proud to have been one of these teams to set the bar seemingly out of reach, and we're really impressed to see how all teams, especially the Magma 2 team, reacted to this. Magma 2 really seemed to have set out on a mission to solve the competition, not to just compete.

WG: [The] Magma2 Team [built around] simplicity, lightness and the use of plastics as well as additional equipment in the form of a hexacopter. This is a small flying object, has six blades and the flight is fully supervised and stabilized by a computer. On-deck is a video camera and a photo camera. Its main purpose is to observe from the air and perform photographic documentation of selected areas. It is worth mentioning that this is the first case of this type of equipment [aerial robots] used in the competition and a significant innovation in the approach to the topic of mobile robots. By working with flying objects taking-off from the deck of the rover, the possibilities of an exploratory and reconnaissance mobile robot are significantly extended.

JG: At OSU (Oregon State University) this year we really focused on making a better robot than our champion 2010 rover. The best approach we could think of following a decisive victory was to improve upon the design. We wanted to see the little unwanted quirks and bugs worked out, to really have a great machine. We dumped the old rover's Linux-based operating system for ATMEL microcontrollers and spent a lot of time and energy making custom PCB's that minimized the weight and maximized the functionality, more so than anything we could have bought off the shelf. The robotic arm was completely redesigned by a joint mechanical and electrical engineering senior project team and really ended up with something really great.

KS: It really seemed that OSU's 2010 rover introduced a lot of design elements that were picked up by other teams for 2011.

WG: This year the stakes were very close. Many teams were inspired by the winning design from Oregon State University last year. [The other rovers were] dominated by balloon wheels and cameras mounted on tripods, allowing you to easily change their position. It is clear however that the teams considered the favorites did not rely on solutions from last year, and each brought a lot of innovation. Copying other does not lead to victory - the best are always one step ahead.

KS: Innovative designs certainly were prevalent throughout all of the teams, although even the best rovers must be operated with precision amid the chaos of URC events. This is also where teamwork plays a major role.

CH: Of all the tasks at URC, my favourite has to be Astronaut

Assistance. Our base station team consisted of our driver, a navigator, system analyzer, and many watchers. It was the most exciting task. The navigator shouted headings and distances to the driver. The system analyzer kept track of wireless signal strength and watched all the subsystems. Everyone keenly looked for any sign of the astronaut. All of this ended with the anticipation of the package deployment. It had all the thrill of a real search and rescue mission!

WG: [Our first competition event] was the engineering panel. We started with [the rover] and read the manual. We made a sketch of the panel immediately to know where the switches were and the appropriate numbers. Switching the first switch has gone smoothly, our Cartesian manipulator worked perfectly. I admired our operator, Bartek, who virtually mastered the previous evening during manual control of each of the six degrees of freedom in the manipulator.

KS: In addition to the Presentation, Astronaut Assistance and the Equipment Servicing Tasks, the Sample Return and Site Survey Tasks were filled with excitement. This year's Site Survey Task featured an added complexity compared to previous years. Teams were required to not just find the markers in the field, but also had to identify marking on each post. Amazingly, teams were able to handle this challenge with considerable ease. In fact, it was impressive to see how seamlessly teams were able to transition between task events throughout the day.

GH: On the first day of the competition our team had to perform the scientific [Sample Return] and the equipment servicing task. We had a very good result in the first task mainly because of good biological knowledge by two members of our team. The issue was not trivial since in our team we had only engineers specializing in electronics and mechanics. Our rover finished this task a little strained. Also the manipulator and the drive unit suffered minor damages. Moreover, during the whole task we also had some problems with communication system. Our vehicle operated in the 900 MHz band which is the frequency reserved in Poland for wireless telephony, therefore we did not have a chance to check earlier whether it operated correctly.

SB: A typical day during the competition consists of two tasks separated by a 2.5-3 hour break. Our team spent the break times preparing our rover, E.V.E, for the next task. This meant having lunch in the desert with a couple of people in charge of making food runs into Hanksville for pizza or sandwiches. Before the science task, the mechanical team spent an hour getting sand out of the horizontal positioner for the arm. It took a lot of time, elbow grease and half a can of WD-40.

GH: The last task we performed after a break of 2.5 hours. During that time we managed to adapt the vehicle to the specific requirements of the navigation [Astronaut Assistance] task. It is difficult to say why this location of the competition (previously in the same place the rover had problems with the drive unit) appeared to be unfortunate for our team - even despite the fact this place was less challenging for the rovers. After localizing the first astronaut we went to search for another one. Everything was going well until the antenna mast on the vehicle got broken on one of the hills and the [judge] excluded us from further participation in the task.

KS: But despite the long hours working under the hot desert sun, teams always seemed to be in good spirits, enjoying the overall experience.

JG: One of the greatest aspects of the URC is the chance to talk to our robot building peers. It is so much fun as an engineer to see the differences and similarities in how teams approach the same problem. We really wish we had more time, within the competition framework, to talk to other teams.

We love seeing teams like Michigan who were really happy and enthusiastic to be at competition. After working so hard and for so long it's nice to get a friendly reminder that what we're doing is, in essence, a really great engineering project, and we have a lot of fun doing it.

KS: The entire spectrum of this competition, including the year spent working on the project before the field event, demands a lot of the teams.

SB: The URC experience is a unique opportunity for any university student. It is rare in today's academic climate for undergrad students to be involved in a year-long project such as this. The experience is almost surreal. The long days leading up to the competition are like the last leg of marathon. During the competition, the days almost melt together. Emotions always run high with no one willing to forgo the slightest chance to get an edge.

GH: To sum up, the participation in the University Rover Challenge was a great adventure, lesson and very good experience for our team. Our team included mainly the 2nd and 3rd year students who had just gained their knowledge on the basics of the engineering studies. They had to face very difficult tasks and they carried them out earnestly and diligently. The scope and the level of works prepared by them in most cases could be qualified as masters or engineer theses/ projects. After the competition most of them admitted that if they had known how much work it would take, they would not have decided to participate in the project. However none of them regretted it and they declared they would participate in the next year's project.

CH: Kevin and the rest of the URC staff have done a great job at continually raising the bar for the competition and motivating our rovers to evolve in lock-step with the tasks and requirements. As URC evolves, it feels more and more like a real Mars Mission with associated restrictions for weight, design and finance. This

makes every member of our team crucial to making our rover, E.V.E, a reality. Our team consists of people responsible for physical engineering and design, electrical systems, programming, science, finance and logistics. I have never before had the opportunity to meet so many different people with such distinct expertise. Overall, URC has taught us all many lessons in effective team work.

KS: And thanks to the outstanding work the teams are doing, incredible

attention has been drawn to the event, the students, and their rovers. I am always amazed at the publicity, and support, the teams receive at the local level.

JG: The OSU Rover is the probably the biggest and most popular public relations device they've ever had. We're constantly asked to drive the rover out to OSU's engineering awareness and promotion events. We've talked to high school robotics students, countless industry and company representatives, rubbed elbows with state representatives and senators, we even drove the rover over John Kitzhaber, the Governor of Oregon! The community around OSU really loves seeing and learning about the rover. Every time we take it out for a drive around campus and/or town we talk to dozens of interested people. And we're happy to answer any questions and explain what this robot is built for.

KS: Given everything that goes into a URC team, it is no surprise that URC veterans are going on to amazing careers and opportunities after they graduate and leave school.

JG: The URC has provided an amazing opportunity for student engineers to get experience that employers really look for when hiring. This is probably the biggest benefit from participating and doing well in the competition. From this year's team we have two people now working at NASA, two at Space Exploration Technologies, one at Intel, and various on campus lab/research positions for the summer and me - a Graduate Research position. All of these amazing and highly sought after jobs as a result from our participation in the URC. We can't thank the Mars Society enough. Thanks!

WG: After returning to Poland, immediately after landing at Okecie airport, we went to the Prime Minister's Office, where we met Prime Minister Donald Tusk with the young [Polish] inventors and winners of international competitions. We proudly handed the Prime Minister our team t-shirt, encouraging further support of the participation by Polish students in international competitions.

The Mars Society thanks TASC for sponsoring this annual event. If you would like to participate in next year's URC, contact Kevin Sloan for more information: Kevin@MarsSociety.org.

THE MUSK OBSERVATORY

Peter Detterline, Chief Astronomer

"Exploration is really the essence of the human spirit."

Martian explorers will certainly share this sentiment expressed by Apollo astronaut Frank Borman as they learn to live off the land of a distant planet. Their search for new knowledge will be gathered and displayed through various scientific stations, and one of these stations will undoubtedly be a Martian observatory. The domed structure will house several telescopes monitoring near Mars asteroids – an outpost for Mars and Earth's Planetary Defense Program – and performing various research tasks such as extending the parallax baseline from Earth to get better distance measurements to stars.

At the Mars Society, that vision of the future is happening today, as people from around the world can live in a simulated Martian habitat and learn the necessary skills for living on the Red Planet. And just like on a real Mars base, a Martian observatory is a part of that environment. The Musk Observatory, first constructed in 2003 at the Mars Desert Research Station in Utah, houses a 14" Celestron telescope capable of imaging a wide variety of objects in the night sky. Crew members have successfully used the instrument for a number of years until issues with increasing ground instability have caused the telescope mount and dome to become non-operational.

To align with the Mars Society's goal of educating people to the possibilities of human habitation on Mars, the mission and the goals of the Musk Observatory must expand into a greater public outreach program. To accomplish this, in a curriculum currently being developed, students from around the world will take part in the scientific process by being able to communicate with crew members, and to request images taken from the Musk Observatory. Students will also have the opportunity to search for asteroids online using real data provided by the observatory. In addition, scientists who visit the Mars Desert Research Station will have the opportunity to perform their own astronomical research projects and share their findings with the larger scientific community.

Renovations to the Musk Observatory will be necessary to accomplish these goals. The main telescope, the Celestron 14", is in great shape and will remain as the primary instrument. A second telescope (already donated) will be incorporated into the system, adding more versatility for imaging. Expenditures would include a new dome, telescope mount and imaging camera.

The current dome underwent great damage with the shutter being sheared off by high winds and the drive tracks pulled out of shape. A dome with a clamshell design would be optimal because it doesn't use a conventional shutter system with complicated alignment tracks, and would be able to handle the high winds that frequent the site.

A high precision mount will easily handle the load of both telescopes and take precision long exposures. These are essential conditions for a research telescope.

Finally, a new 8.3 megapixel color CCD camera is fundamental to obtain high resolution astronomical images as it replaces the old and outdated 2 megapixel camera currently used.

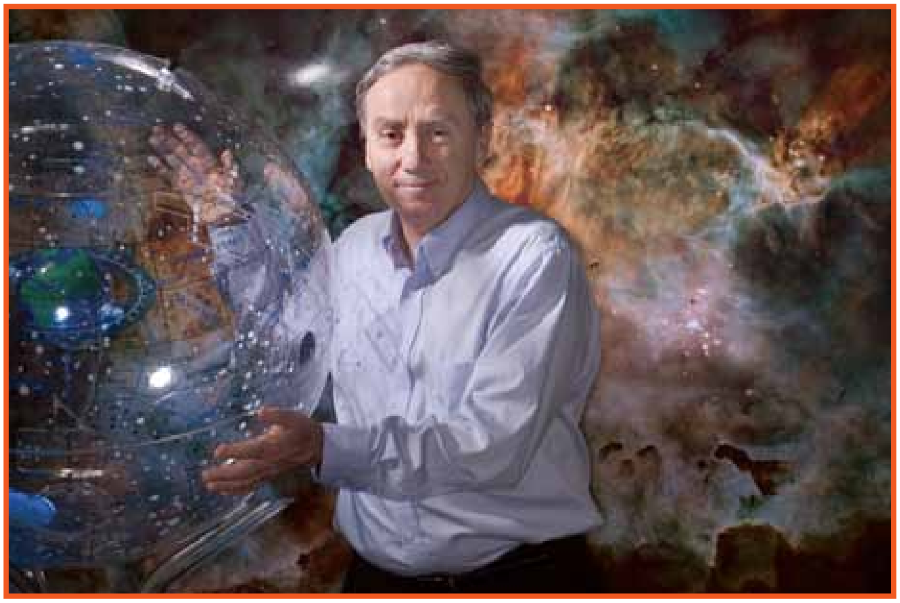
One of the key renovations to the observatory will be moving it to a more permanent setting. The instability of the ridge the observatory currently rests on wreaks havoc with polar alignment and all dome operations, so relocating it to a solid, secure and stable setting is crucial. We are performing geological surveys that will reveal the best replacement for the refurbished observatory.

Once these issues are addressed, the Musk Observatory will be a premier facility for public outreach and scientific research which will reflect brightly upon the Mars Society.

The cost of the renovations to The Musk Observatory is estimated to be $20,000. If you would like to make a restricted donation to fund these renovations, please send your check so marked to: The Mars Society, 11111 West 8th Avenue, Unit A, Lakewood, CO 80215, USA.

Peter Detterline is a founding member of The Mars Society. For more information regarding renovations at the Musk Observatory, please contact: info@marssociety.org.

Dr. Mario Livio – Hubble Space Telescope



TMQ: How long will the Hubble Space Telescope continue to function, and what will happen to the public's favorite telescope when it's no longer usable?

Dr. Livio: Hubble was last serviced in 2009 and this was meant to be the last servicing mission to Hubble. Formally from that servicing mission it was supposed to last for 5 years, but we have every reason to believe that Hubble will continue to function very well for 7, 8, or maybe as long as 10 years from the last servicing. When it finishes its mission, the idea would be to attach some propulsion module to it eventually that will direct it to fall into the sea rather than on land.

TMQ: What specific science question would you like Hubble to answer before it's no longer usable?

Dr. Livio: One of the biggest current mysteries that we have is the nature of the dark energy that is propelling the cosmic expansion to accelerate. We still don't know what this dark energy is. I certainly hope that still within the life of Hubble we will find more distant supernovae which will help us put better constraints on properties of this dark energy, particularly its strength and permanence – how strong is it and does it change with time. To be honest, I am a little bit skeptical that we will get a definitive answer to what dark energy is, but I certainly hope Hubble with help us to put better constraints on its nature and thereby help us come closer to an answer.

Another question has to do with the nature of dark matter. This is the matter that is holding together galaxies and clusters of galaxies and we hope to learn more about this dark matter – its distribution on large scales in the universe and so on.

To go from the very large to the much smaller, I hope that we will be able to detect more extrasolar planets and to study the composition of their atmospheres, mainly to find out which elements and which organic molecules exist in the atmospheres of these planets.

There are many other questions we hope to have answers for, but these are three important ones.

TMQ: What would you say is the greatest discovery that the Hubble Space Telescope has ever made?

Dr. Livio: The greatest discovery to date I would say would have to be dark energy. One has to be a little bit careful in saying this, as today there are many observatories and they all work in synergy with one another, so it is not a discovery that is exclusive to Hubble. Still, Hubble has certainly contributed much of the crucial data that showed that there exists this dark energy that pushes the cosmic expansion to accelerate. We know that at present this dark energy constitutes more than 70% of the energy of the universe, so it is the dominant energy form in the present universe. The fact that we have very few clues as to what this dark energy may be is really the most serious challenge perhaps that physics is facing today. So I would have to say that this is probably the most important discovery for Hubble.

TMQ: What specific science question are you looking forward to having answered with the James Webb Space Telescope?

Dr. Livio: There are very many questions to be answered by the James Webb Space Telescope. But let me mention two really big ones. One is that with the James Webb we will see the very first galaxies that formed in the universe. So we have already seen very distant galaxies from when the universe was very young, but the James Webb will literally show us the very first galaxies that formed in the universe, and perhaps even clusters of the very first stars that formed in the universe. It would not show us individual first stars, but it may be able to show us the very first clusters of first stars, and it certainly will show us the very first galaxies in the universe. That I would say is the number one question that it will answer.

The second question it will answer is on which extrasolar planets there is liquid water on the surface. We think that liquid water is essential for the origin of life, any form of life, and so by finding extrasolar planets on which there is liquid water on the surface, we will take a huge step towards identifying those extrasolar planets that may have developed life.

TMQ: The James Webb Space Telescope will view the universe in infrared only. Hubble monitored the sky in ultraviolet, visible and near infrared. Do you believe the James Webb Space Telescope should also have had the ability to monitor the sky in UV and visible wavelengths?

Dr. Livio: That was not possible. That telescope was designed from the beginning to actually look almost exclusively at infrared light, although it comes fairly close to visible light, but of course only the red side of visible light. So no, the James Webb was specifically designed with that goal in mind because if you want to look at the very distant universe and really the very first galaxies, you have to optimize it for infrared. It will be a next-generation telescope that will continue Hubble's legacy in the visible and ultraviolet, I mean one beyond James Webb, and there are already suggestions for such a telescope. There is a telescope that is provisionally called ATLAST (for Advanced Technology Large-Aperture Space Telescope), which will be an optical and ultraviolet telescope with a very large mirror, maybe as large as a 16 meter mirror and that could be, if you like, the actual large successor to Hubble in terms of seeing again in optical and ultraviolet, but JWST was specifically designed to be a different kind of telescope.

TMQ: In an interview you were quoted as saying. "[With the James Webb Space Telescope], we will construct an executive summary of the history of the Universe." What did you mean by this?

Dr. Livio: What I meant was that it will give us a very complete description of the history of global star formation in the universe. I mean not the rate at which a particular galaxy or galaxies are forming stars, but the rate at which the universe as a whole is forming new stars. The rate at which new stars are being born in the universe from its start to today – and it is that which I called an "executive summary" of the history of the universe in the sense that it gives us in a very concise way the story of the universe's evolution from the very beginning until today.

THE MARS SOCIETY

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SpaceX - Falcon 9

Jason Rhian, Staff Writer

CAPE CANAVERAL Fla. – Falcon 9 is the newest addition to the launch vehicles that have roared off the launch pads at Cape Canaveral Air Force Station (CCAFS). It is the third in a series of sleek rockets set to roar off of Space Launch Complex 40 (SLC-40) some time this fall. The rocket for that test flight is currently being prepared for launch.

Lying on its side and weighing in at 30 tons, the Falcon 9 is an awe-inspiring sight. In its current state the Falcon 9 is essentially a long white tube with the nine Merlin engines emerging from the "business end" of the rocket. The engine's plumbing is fully exposed and workers pore over the rocket's innards, working to ensure that the rocket will be ready in time for launch.

The set-up within the hangar is completely different from the usual vertical assembly methods; the Falcon 9 is assembled horizontally. This in many ways appears to be one of the determining factors that have allowed the Falcon 9 to be both economical and successful.

During the lead-up to the final launch of Space Shuttle Discovery a gauge fell from a worker's belt and struck the orbiter. Fortunately, the tool did not do any damage to the shuttle and it launched and returned without incident. The way that the Falcon 9 is readied for launch prevents similar incidents from taking place. Whenever a section of the Falcon 9 needs to be worked on or repaired it is only 15 feet off the ground at any point in time. That distance can be even further lessened by another innovation utilized at SLC-40.

Falcon 9s that are prepared for flight are fitted with rings - the entire assembly then rests on wheels that allow the rockets to be rotated. If engineers need to access one of the rockets that are located at the top, the rocket can be moved to provide access at a much lower level. At the farthest point any part or tool that falls does so at a maximum of approximately 15 feet.

"Assembling the rocket in this fashion helps to prevent severe damage to the launch vehicle," said SpaceX's Vice President of Communications Bobby Block during a recent interview. "If we need to reach one of the engines located at the top, rather than dangle someone over them, we rotate that section of the rocket closer to the ground. This is an enormous assistance to us in terms of risk-mitigation."

Jason Rhian holds dual bachelor degrees in journalism and in public relations, and has completed two NASA internships. He is a NASA/JPL volunteer and also assists numerous space-related groups and companies as either a writer or in media affairs. He can be reached at: jason@spacevidcast.com

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NASA Spaceward Bound: Australia 2011

Pilbara, North West Australia, July 9 – 20, 2011

A Discussion with Dr. Christopher P. McKay, Principal Investigator

TMQ: Not all of our readers are familiar with the Spaceward Bound program. What was the genesis of the program at NASA?

McKay: We had been doing field work in Mars-like environments for many years, and typically we go to places where we find evidence of life – deserts, polar regions or ancient mats. Then about four years ago we responded to an education call out of NASA headquarters and we proposed Spaceward Bound. There were two elements, one element was to bring teachers with us on these expeditions, and the other element was to send students to the Mars Desert Research Station (MDRS). We were trying to reach students from K through college. The K-12 students we can't take out with us so instead we bring the teachers out; college students we send to MDRS. So that was the idea of Spaceward Bound.

The expedition coming up in Australia is a science expedition. We want to study evidence of the earliest life on Earth and compare it to evidence of life in extreme environments like the Antarctic lake – Lake Untersee. We are going to take teachers with us in the spirit of this Spaceward Bound activity.

TMQ: Are you taking only teachers this trip?

McKay: We will have students with us, and of course there are scientists with us as it is a science expedition, but it will be focused on teachers. What we want them to do is to come with us and turn it into curriculum for their students.

TMQ: How many people will be in the group this trip, and what is the typical size of an expedition?

McKay: The number is changing by the minute, but it is on the order of 20 or so. It is one of the larger groups, but it is not the largest. We have had Spaceward Bound trips that have been as small as six and as many as a hundred. I like to have about equal numbers of scientists and teachers. Expeditions to remote locations, like the Arctic, have fewer people and expeditions to local sites, like the Mojave Desert, have more.

TMQ: How long is the expedition?

McKay: It varies from site to site, but this particular trip (to Australia) will be two weeks.

TMQ: What do students gain from these experiences?

McKay: It depends on the students. Some of them are actually working on projects for which this is their field work – this is their research. For some of them, this is their first time ever doing field work, so they learn what field work is and how it is different from lab work, and how it is more like exploration. It varies from student to student.

TMQ: Are the students self-directed or do the teachers promote a particular area of study?

McKay: We are focused on a particular area of research on our expedition. We talk with the teachers about broader questions as well and then how the teachers turn that into areas of study back home is up to them – how they turn it into materials for their classes – we leave that up to them.

TMQ: What is it that you are hoping to discover on the ground in Australia?

McKay: Scientifically, what I am hoping to discover is the link between the structures that we see in Antarctica and the structures that are observed in the early record of life on Earth. We think these Antarctic lakes, because of their physical isolation, represent simple microbial systems that are models for the earliest life on Earth. So we are hoping to explore that connection directly by comparing the structures we see in the early fossil record in Australia with what we had discovered previously in these lakes.

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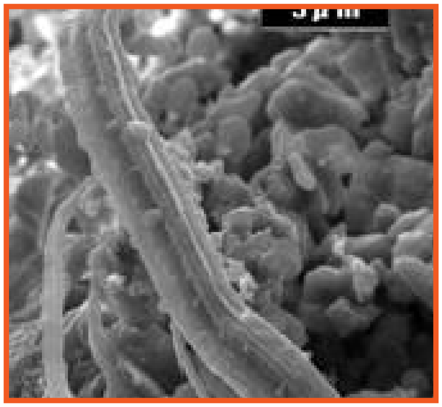
The CI Carbonaceous Chondrites as the Missing Old Meteorites of Mars -

A Discussion with Dr. John Brandenburg

Jason Rhian, Staff Writer



"Checkmate" says Dr. John Brandenburg, a scientist with ties to both NASA and the University of Central Florida. This is in reference to whether or not Mars once was a home for life. After a study of meteorites that have come from the Red Planet. Brandenburg feels that there can be little doubt that at some time in its past Mars was a home for life.

The scientist reached this conclusion after recent isotopic analysis of meteorites that have been in storage for an extended period. This study, according to Brandenburg, shows that Mars once had warm and wet sea beds that were abundant in the organic chemicals which are the building blocks of life.

"For all intents and purposes what we have found is Martian oil shale," Brandenburg said during a recent interview. "What this tells us is that Mars had a planetary seabed that formed under atmospheric conditions favorable for supporting life."

The meteorites studied are approximately 4.5 billion years old. They are the same age as the controversial ALH84001 meteorite that was discovered in Antarctica and was announced to the world back in 1996 as having evidence of harboring life. Supposed micro-fossils were the source of what became a hotly debated issue within the scientific community.

The meteorites Brandenburg studied have an identical make-up of oxygen and chromium like other rocks that have a confirmed Martian origin. Brandenburg has published a paper in the Journal of Cosmology entitled "The CI Carbonaceous Chondrites as the Missing Old Meteorites of Mars." CI stands for Carbonaceous Ivuna, which refers essentially to carbon-bearing meteorites from the Ivuna region of Mars.

"If verified, CI being from Mars would confirm that early Mars was warm, wet and rich in organic matter, the conditions for life," said Dr. David McKay, Chief of Astrobiology at the NASA Johnson Space Center in Houston.

Dr. Brandenburg's paper on CI Carbonaceous Chondrites can be found at:
http://JournalofCosmology.com/BrandenburgMeteor.pdf.

NASA Spaceward Bound: Australia 2011
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TMQ: How does that help us in terms of the history of Mars?

McKay: It may be a way to define what we look for on Mars. Stromatolites are fossilized microbial mats. They represent the earliest evidence for life on Earth. Although they are constructed by microscopic life they are large structures – they can be meters in size. If Mars had life early in its history there may be stromatolites on Mars. These would be evidence of life even if that live had long since vanished – the stromatolites would remain. Our goal on this expediton is to better understand the environments in which different types of stromatolites form. Thus, if we find stromatolites on Mars we can deduce the past environments that might have been present on that planet and supported life there.

TMQ: What is your overarching goal for this mission, in terms of science and in terms of education?

McKay: In terms of science I am hoping we will be able to develop a specific and useful comparison between the early fossils of life and the modern microbial mats in Antarctica, and that this comparison will give us new ideas for experiments and measurements the next time we travel to the Antarctic lake.   In terms of education, I hope we show the strong link between studies of the earliest life on Earth and the possibilities for life on early Mars. I hope this is something the teachers can use in their science classes.

Lucinda Land, Executive Director of The Mars Society is a participant in the Spaceward Bound Australia expedition. For more information about the expedition, please visit:
http://spacewardbound.nasa.gov/australia2011/index.html

European Space Agency - Mars500 Mission

A Discussion with Diego Urbina, MSc, Researcher-Crew

TMQ: How did you get involved in the Mars500 program?

Urbina: I had been involved with analog simulations for some time, having worked at ESA's Astronaut Training Division, and later with a stay at the Mars Society's MDRS. I felt attracted to Mars500 because it was such a huge challenge and a chance to do something few or no people had done before. I applied, got shortlisted with a phone interview, and right after the 15 days at MDRS, I flew from Hanksville to do a psych interview in Germany. There I got further shortlisted and went to Moscow to do the medicals and start the training.

TMQ: What was mission training for Mars500 like?

Urbina: It took several months, and was particular in the sense that it was both training and selection at the same time, so we knew only about half of us would get in. Most of the time was used in visits with the Principal Investigators of each of the 100 experiments, who taught us how to operate their payloads. We had safety training and various team building activities, among those a Soyuz landing winter survival training course outside of Moscow. These activities were monitored by psychologists to decide who would be chosen at the end.

TMQ: What are some of the challenges you've faced on the trip to date, both from a mission standpoint and personally?

Urbina: It takes some flexibility to adapt to the way things are done in a new country/culture. Not to say one way is better than the other, just that there is a different way, and it takes some time to adapt. It is not made easier by the fact that you are supposedly several million kilometers away from them and it takes extra effort to discuss over delayed text and video messages, as opposed to live voice or face-to-face communications, that for example you can actually do with your crewmates. However, that makes it, too, a good cultural experience.

TMQ: How have you and your fellow astronauts/cosmonauts been getting along?

Urbina: Very well. We have rather different backgrounds, but we work quite fluently and give each other their space, so there haven't been conflicts beyond normal differences in opinion. I have heard a lot of stories about conflicts in (even much shorter!) long-duration missions, so I am happy that things have gone rather smooth in that sense so far.

TMQ: How often are you and your crewmates in contact with Earth (both mission control and family/friends)?

Urbina: We can contact a team on the ground 24/7. Most of the contact occurs during working hours, however now that we could (figuratively speaking) do any experiment while blindfolded, communications are not as frequent as at the beginning, or on Mars. We can send private messages daily in two windows, in the morning and the evening. The relay of communications to our recipients is done manually by our ESA Capcom/ psychological support/"one-woman band" Elena Feichtinger who does a terrific job in this and in dealing with Principal Investigators, etc.

TMQ: What do you miss most while on the mission - certain foods, movies, going for a walk?

Urbina: I think what I may miss the most is seeing more people, different life situations, and nature. Regarding the films, we fortunately have a lot of movies in our hard drives, and the food is varied enough. At this point I am aware it exists, but I almost barely remember what it's like to have "better food." I guess it will be a good surprise to eat it back on Earth.

TMQ: How close do you feel the Mars500 mission is to actually simulating a real Mars mission? What parts can't be simulated?

Urbina: I think it simulates very well the isolation, psychologically and physiologically under the typical workload of a space trip, which is, in fact, the main objective of the mission. It is also the first time when all the legs of the mission are simulated very closely to the real ones in length, so

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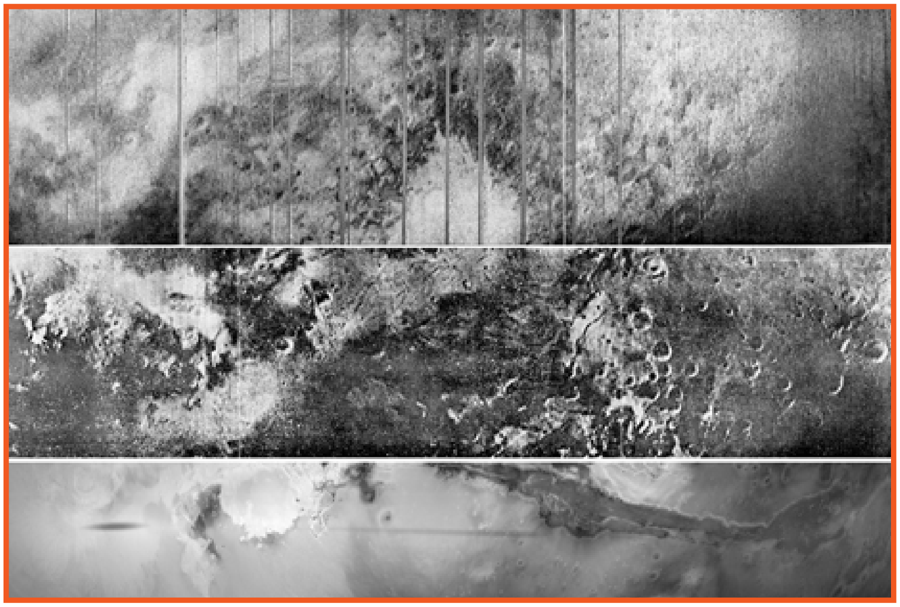
Sailing the Martian Breezes

Michael Carroll

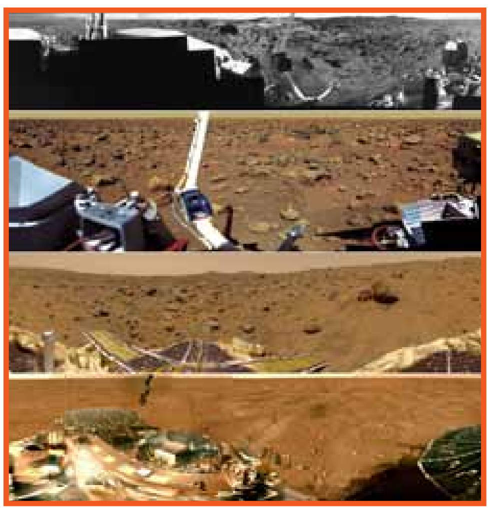
Human missions to Mars will be at the mercy of the Red Planet's strange and alien weather. Global dust storms, carbon dioxide snows, and blue sunsets all await the first Martian explorers. Mars has already taught humankind a lot about how air moves around a planet, how dust is distributed globally, and how weather works in a different environment. Its weather is a simplified version of our own. Locked within its rocks and polar caps lie records of changing weather patterns and climate over eons.

Understanding these things has not come easily. While telescopes hinted at constituents in the Martian air, ground-based instruments afforded only limited detail. The space age would change all of that, but how could engineers build a robot to investigate a hostile environment up close? Many hazards face a planetary spacecraft, from its harrowing launch to a months-long cruise through the hard vacuum of space. Once the spacecraft safely passes a meteoric entry into Mars' atmosphere, systems must deploy to carry it safely through the sky or to the surface.

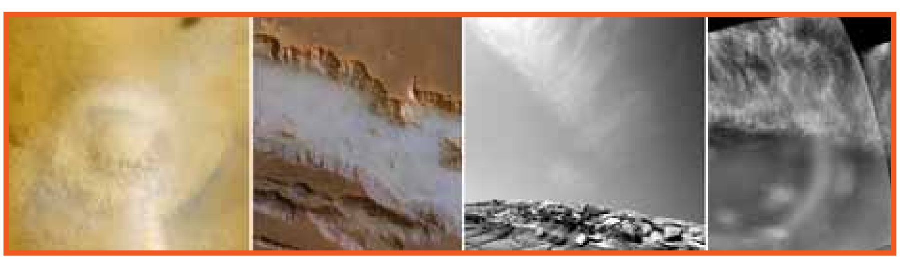
Early missions were challenged by a simple lack of scientific knowledge. Early Soviet designs assumed a much denser Martian atmosphere than the one we now know exists. Had their first Cosmos probes made it to Mars, they would have perished under parachutes far too small to do the job. Mars exploration veteran Ben Clark began to wonder if a Mars landing was even practical. "Mars is the hardest place to land on in the solar system. The atmosphere is thick enough that you can't do a propulsive landing like you can on the Moon, but it's not thick enough to just land on parachutes like you do on Earth. You have to have an entry capsule, then a parachute to slow you down. Then you've got to get out of that aeroshell to activate your airbags or fire up



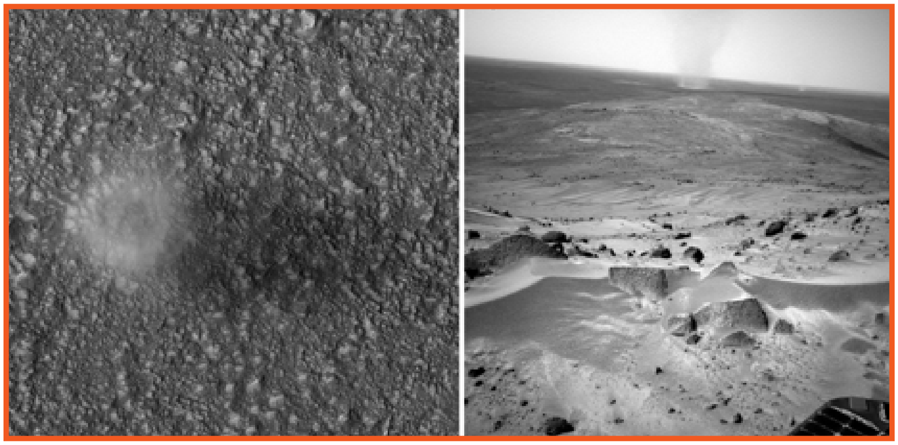
Soviet panoramas from the 1974 Mars 4 flyby (top), Mars 5 orbiter (center) and the 1989 Phobos 2 missions (bottom). Note the improvement in quality from 1974 to 1989. The shadow of the Martian moon Phobos is evident as dark streaks in the latter, because the Phobos orbiter followed in the same orbit as the moon. (Soviet photos reprocessed by Don Mitchell)



The surface can inform meteorologists of atmospheric conditions. Compare the patterned ground at the Phoenix landing site in the Martian arctic (bottom) to (top to bottom center) Viking 1, Viking 2 and Pathfinder/Sojourner sites. Because of a combination of temperature, pressure, and condensation of carbon dioxide and water, the northern arctic soil at the Phoenix site is saturated by water ice, forming domed polygons across the tundra-like landscape. (top to bottom: NASA/JPL, NASA/JPL, NASA/JPL, NASA/JPL-Caltech/University of Arizona/Texas A&M/James Canvin-www.nivnac.co.uk/mer)



An assortment of Martian clouds (l to r): clouds drape the flanks of the volcano Arsia Mons, with the shadow of the moon Phobos at upper center (MGS image MSSS/NASA); early morning fog fills a portion of the Valles Marineris (ESA/DLR/FU/Berlin, Neukum); wispy cirrus clouds drift above the edge of Endurance crater (Opportunity rover images NASA/JPL)



Dust devils seen from orbit (l) and from the Spirit rover in the Columbia Hills, Gusev Crater. (JPL)

One advanced concept for exploring the Martian environment: At the end of a two hour flight, its fuel spent, an ARES robotic Mars plane descends toward its final resting place in the ancient canyons of Terra Sabae. (art ©Michael Carroll)

descent engines. Mars is very tricky."

Clark and others envisioned crash-landing rovers that would come to rest on crushable Styrofoam wheels, airplanes, balloons, and "penetrators"—spike-like craft that would plow into the surface without any slowing systems at all.

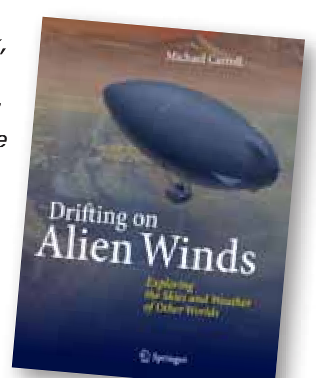
After a dozen failed attempts, Mars probes began to see success. Mariner and the Soviet Mars craft observed weather from orbit, while NASA's Vikings became the first successful landers. Since then, an armada of rovers, landers and orbiters has given us detailed views of the Martian environment.

Mars' polar caps are closely linked to its weather. The caps contain a mix of water ice and frozen CO_2. Polar CO_2 ices constitute a substantial portion of the thin Martian atmosphere, says California Institute of Technology scientist Andrew Ingersoll. "On Mars, there's an annual winter deposit of CO_2. When the sun hits it… atmospheric pressure goes up by about thirty percent."

Mars has a variety of cloud forms, including ground fog, convective, and cirrus clouds. The planet has another cloud system only recently discovered: an equatorial belt. In earlier missions, says Mars Reconnaissance Orbiter scientist Steve Lee, "you were looking at postage stamps spread across the surface. You didn't realize that this equatorial belt of clouds formed during aphelion (farthest point of the orbit around the sun). Once we got Hubble observations, these cloud belts just jumped right out."

The seasonal ebb and flow of atmosphere, global dust storms, and layered polar ices shed light on global warming and climate change not only on Mars, but also here at home.

For more on the subject, see Michael Carroll's newest book, Drifting on Alien Winds: Exploring the Skies and Weather of Other Worlds (Springer).



European Space Agency - Mars500 Mission

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that makes it remarkable. For example, I think the psychologists will have a field day with the data they get the weeks before our landing on Mars, and during the weeks right after departing from Mars. There are lots of emotions there, and it's hard to see that if you don't go through months of an experience like this.

Mars500 can't practically simulate weightlessness (even though we had an orthostatic intolerance test when landing on Mars) and radiation, which are also very important factors. But thanks to Mars500, discussions have already been triggered on doing these types of sims on the ISS - even if for a somewhat shorter time, based on what we will have learned here. A trip to Mars is a big puzzle with many variables or pieces, and we need to put them together one by one.

TMQ: After your experience with Mars500, do you feel that humans are ready to travel to Mars and possibly set up human colonies on the planet?

Urbina: I've always thought and still think we can - in fact that's why I got involved in the project, I know we can make it, even though I can say it is not easy. In the end the hardest part, though, is that we need to figure out a way to give this issue the importance that it deserves in order to get it done sooner.

The Mars Society would like to thank ESA, and particularly Elena Feichtinger, for cooperation in obtaining this interview. Diego will be appearing via video uplink at the 14th Annual International Mars Society Convention in Dallas, August 4-7.

For more information regarding the Mars500 mission and crew, please visit: http://www.esa.int/esaMI/Mars500/index.html

Astronauts for Hire, Inc. – A4H

A Discussion with Brian Shiro, CEO

TMQ: Brian, please tell our readers about yourself and your involvement with The Mars Society.

Brian: In addition to leading Astronauts4Hire (A4H), I work for NOAA as a geophysicist at the Pacific Tsunamis Warning Center. Although my job requires focus on some very Earth-bound problems, I have always been interested in space. I grew up watching Star Trek and reading science fiction books. In middle school I participated in Space Camp and a "Mission to Mars" summer camp, both of which inspired me to study astronomy and planetary science. Later as a university student, I worked or studied at three NASA centers and reveled in those experiences. I grew up hearing that humans would be on Mars by the late 1990s, so as far as I'm concerned we're behind schedule and have a lot of catching up to do.

When The Mars Society (TMS) first started the Mars Desert Research Station (MDRS) in 2001, I remember hearing about the project and was so intrigued by it. I always wanted to join a crew there but never thought I'd be able to find a way to make it happen. So for the next several years, I watched from the sidelines. I satisfied my Mars exploration cravings by reading the Red Mars series by Kim Stanley Robinson and helping some of my colleagues who were working on the Mars Exploration Rover Mission. I also did some research exploring the hypothesis that the giant Hellas impact could have triggered volcanism in the Tharsis region on Mars.

In late 2007 NASA announced it was looking for some new astronauts. I applied to the astronaut program and made it to the "Highly Qualified" stage. I had started a blog called "Astronaut for Hire" that chronicled my path through the astronaut selection process. The blog was (and still is) very popular among astronaut hopefuls because, for whatever reason, NASA was very tight-lipped during the 2008-2009 selection campaign. There was a lot of speculation because no one knew what was going on. So basically I dug up what information I could find and passed it on to my readers. As a result, I met a lot of great contacts within the space community and gained an understanding on what it takes to be an astronaut.

Shortly after hearing that NASA did not select me in early 2009, TMS announced that it needed a crew for FMARS, so I applied. Luckily for the past year I had been serving as a CapCom at MDRS. This gave me a foot in the door with TMS, and I was selected as a crewmember for the FMARS-12 expedition. Working closely with my fellow crewmembers and Dr. Zubrin, we planned a top-notch mission. As the crew's geophysicist, I led two research projects; one was to prospect for groundwater using electromagnetic equipment, and the other was to install a seismometer. Rather than go on and on about the wonderful experiences I had serving on the FMARS expedition, I'll refer you to the blog and video posts I produced during the mission at http://tinyurl.com/BrianFMARS.

Last year I returned to analog Mars as Commander of MDRS Crew 89. Although MDRS and FMARS are slightly different, I found that having already done a FMARS mission was a tremendous asset for me at MDRS. Plus, since I had already served as a MDRS CapCom, I had a good understanding of the mission support system in place at MDRS. We had a great crew that bonded instantly, and this contributed to the mission being a huge success. I like to think it was one of the best crews in recent history! In addition to managing the mission, I also led a research project at MDRS using seismic refraction to look for a buried paleochannel that a previous MDRS crew led by Carol Stoker had found using ground penetrating radar. The three field research projects I completed at both FMARS and MDRS served as the cornerstone of my master's thesis that I finished in 2010 in the Department of Space Studies at the University of North Dakota.

TMQ: Tell us about A4H and what led you to form that organization.

Brian: We established Astronauts for Hire, Inc., commonly referred to as Astronauts4Hire (A4H), in April 2010 to meet the challenge of developing a scientist-astronaut workforce capable of handling the stresses of repeated suborbital and orbital spaceflight. As the world's only commercial astronaut training cooperative and flight crew service, A4H provides opportunities for its members to develop and refine the skills necessary to become better astronaut candidates and then helps those individuals find flight opportunities as payload or mission specialists.

A4H is structured as a volunteer-based nonprofit organization. Our members currently represent 16 countries across North America, Europe, Asia, and Latin America. A large number of us have participated in MDRS or FMARS missions. Many members were finalists or highly qualified candidates in recent NASA, CSA, and ESA astronaut selection campaigns. A4H's commercial astronaut candidates are accomplished scientists and engineers representing a wide variety of fields in engineering, physical, and life sciences. As a result, A4H members are well-suited to support a broad range of human-tended experiments on parabolic, suborbital, and orbital missions. Hired by a company headed by a former FMARS Commander, A4H completed its first research contract testing the physiological effects of alcohol absorption in microgravity in February 2011.

In consultation with former astronauts and astronaut trainers, A4H has developed a comprehensive astronaut medical and training certification program to qualify its members for suborbital spaceflight missions. Major elements of the training program include high-G centrifuge, high-altitude indoctrination, distraction avoidance, parabolic microgravity flight, emergency egress, SCUBA, unusual attitude flight, survival, and classroom training on subjects ranging from human physiology and the space environment to basic spacecraft systems engineering. We anticipate certifying our first class of suborbital scientist astronauts in late 2011.

TMQ: What type of memberships do you offer?

Brian: There are two types of members in A4H. Flight Members are the "astronauts for hire" who receive support from the organization to undergo astronaut training and represent the organization by carrying out contract research jobs for principal investigators. There is a competitive selection process to apply for Flight Membership with opportunities arising about once per year. Applicants are asked to provide their educational and professional background in a CV and answer a series of essay questions. A selection committee comprised of internal A4H members and A4H's advisors (who are former astronauts and astronaut trainers), reviews the applications and interviews the best candidates prior to making a final decision. In our February 2011 selection, we had an admission rate of about 15%, which means we're getting some great candidates. We restrict Flight Membership this way because we have limited resources to go around and want to preserve the integrity of our astronaut corps as the best of the best.

We also offer an Associate membership. Associate members can participate and contribute to the organization just like Flight Members, but they are not eligible to receive training scholarships or work on A4H contracts. Unlike Flight Members, Associate Members can join at any time. In many cases, Associate Members are people waiting in the wings until a Flight Membership opportunity arises. We created the Associate Member option in response to the tremendous amount of interest from people wanting to help the organization. A4H currently has 36 Associate Members and 22 Flight Members.

TMQ: Who partners with A4H?

Brian: As a Research and Education Affiliate of the Commercial Spaceflight Federation and a sponsor of the 2011 Next-Generation Suborbital Researchers Conference, A4H has established itself as an integral player contributing to the growth of the commercial spaceflight industry. Going forward, A4H strives to serve as the industry's main facilitator of astronaut crew training and development. We have entered into strategic partnerships with a number of research and training organizations to help further these goals. Some of these are listed on our website, and we are always negotiating agreements with new partners as well. For example, we have just signed three MOU agreements with research labs to open opportunities for collaborations that would involve A4H.

TMQ: Do you plan to use the Mars Society's desert or arctic research stations for any of your programs?

Brian: I don't think there will be a need for that in the near term, because we are training for suborbital and orbital missions, not planetary missions. The only analog environment we are considering for training purposes right now is the ocean since SCUBA is such a good approximation to orbital EVAs. However, in the long term, I could see great benefit to training at a TMS facility once A4H astronauts start gearing up for walking on other worlds. In the meantime, we could consider sending crews for rotations at MDRS or FMARS for the purpose of enhancing team dynamics, or if A4H clients need us to test something under operational conditions similar to space missions.

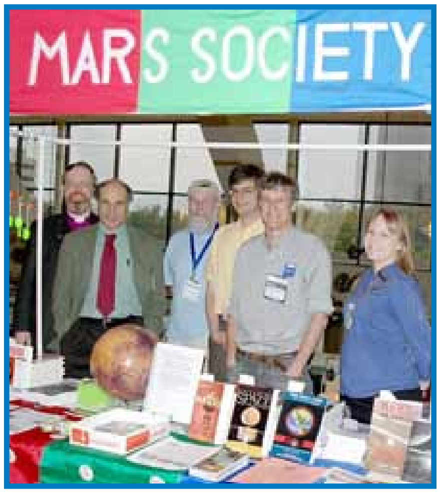
TMQ: What is next for A4H?

Brian: As Space Shuttle Atlantis completes its final orbits around the Earth this July, we will be undergoing our first group astronaut training activities. We'll be completing the NASTAR Suborbital Scientist Training Program, as well as emergency egress, sea survival, and spatial orientation training. After some zero-g and aerobatic flights later in the year, this will lead to A4H certifying its first class of suborbital scientist astronauts. I encourage everyone to follow A4H activities at www.astronauts4hire.org.

For information about the A4H inaugural training class, please visit: http://www.astronauts4hire.org/2011/06/press-release-astronauts4hire-announces.html

The 14th Annual International Mars Society Convention

A Greeting from our Hosts - The Dallas Chapter



The local Dallas Chapter of the Mars Society has been actively meeting as a group since the fall of 2003. Overall, we represent a very diverse group of individuals with backgrounds and careers that range from physicists to artists, geologists, engineers, financial experts, programmers, teachers and librarians.

Our group meets on the last Sunday of every month (varies around holidays), with an attendance of about 6 to 10 active members from all around the DFW Metroplex, to discuss and plan a variety of local events and activities to gain public support for the exploration and settlement of the planet Mars.

Our local membership also includes over 40 more members who subscribe to our e-mail distribution list—some of which are inactive because, for one reason or another, they cannot attend the meetings or because they have moved and are therefore too distant. Regardless, we consider them to be valued members of our organization—we even consider them our extended family—and we keep in touch via our newsletter.

Our membership base is not only local, but also nationwide, overseas, and on the Internet. Thanks to the global advocacy for the humans-to-Mars cause, and the support that we get from our national leadership team at the Mars Society headquarters, our online membership base has seen an increase in awareness and activity measured in terms of membership requests from social media websites and traffic to our website.

The Dallas Chapter has an active online presence through many of the popular social media websites like Facebook, LinkedIn, and Twitter. We also have our own public website, www.Dallasmars.org, maintained by a member who is all the way over in Japan and hopefully one day from Mars! ;-)

The founding of our local chapter began about eight years ago when a few Mars Society national members, who lived locally, were inspired by the topics discussed at one of the Mars Society national conventions. Shortly thereafter, they began to organize with other Mars enthusiasts who lived in the area, and decided to start a local chapter. Our first meeting had only three people, but we have been growing over time in both members and activities.

Many Mars Society members may know us from our T-shirt sales: we have designed, made and sold Mars Society convention T-shirts since 2004.

To focus more on local events, some of the local Dallas Chapter members volunteered their time to advocate Mars exploration and colonization by giving lectures and by teaching summer mini-courses about it to students in the Gifted Students Program at Southern Methodist University (SMU)—one of the large local colleges in this region.

In cooperation with a local disadvantaged junior high school, and in conjunction with the local National Space Society (NSS) chapter, we organized a school-sponsored 'Space Week' where we coordinated the development of a 'zero gravity spacewalk simulation'. Here, the objective was to work with students to build a device to simulate the effects of 'floating in space' by sliding around on a mechanics' dolly while trying to service a 'spacecraft' (perform simple tasks on a wooden prop), which all turned out to be a great success.

Every now and then we have visitors who visit our local Chapter meetings like NSS liaisons and some of their members or the surprising visit by the local Klingon Cub. And then there are these other times where we get to go on an adventure like the time we had the privilege of seeing the SpaceX facilities, as they are only a few hours away, while they test fired a Merlin engine—a magnificent experience for all who came along!

In 2007, we organized - in close cooperation with the local NSS chapter - an entire Mars Track Talk at the Dallas NSS/ISDC Convention, which helped set the stage for our main activity this year: the hosting of the 2011 Mars Society National Convention here in our very own Dallas, Texas!

As a relatively long-lived active chapter, we owe our success to the dedication of our members, the support of headquarters, and by continually keeping ourselves busy with new and exciting events, activities, and challenges.

If you are in the Dallas area on the last Sunday of every month (times may change during holidays) feel free to reach out to us or, better yet, come on by the Spaghetti Warehouse in Plano (right off Route 75 and 15th Street) at 6:30 PM and join us!

Most importantly: do not forget to come to the upcoming national convention in Dallas! For more information on the convention, please Click Here: http://www.marssociety.org/home/join_us/convention

Thanks,
The Dallas Chapter,
The Mars Society

The 14th Annual International Mars Society Convention

August 4-7, 2011 • Dallas, Texas

2011 Convention Registration and Donation Form

Primary Information:

Name: ________________________________

Address: ______________________________

City: _________________________________

State/Province: ___________ Zip: ___________

Country: ___________ __________________

Email: ________________________________

Convention Registration:

	Before 7/1/11	On/After 7/1/11	✓
Full - Active Member	$150	$210	
Full - Non-Member	$210	$270	
__ Student or __ Senior Member (check one)	$40	$75	
__ Student or __ Senior Non-Member (check one)	$70	$105	
Banquet Ticket*	$50	$50	

* included with full reg., not included with student/senior reg.

	1 year	3 year	Total
Regular Membership	$50	$100	
__ Student or __ Senior Membership (check one)	$25	$50	
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I'd like to sponsor a Mars Society project:

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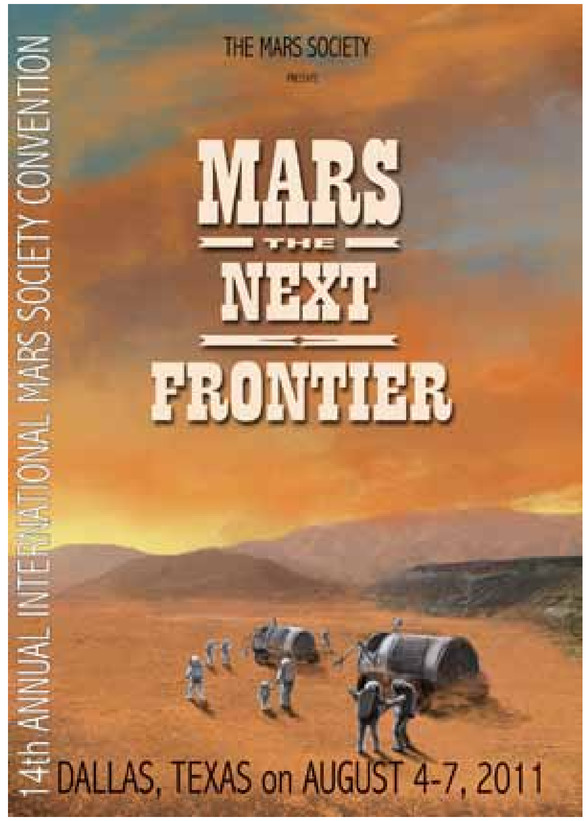
Return by mail to: The Mars Society,
Re: Convention Registration, 11111 W. 8th Avenue,
Unit A, Lakewood, CO, 80215, USA .
For more information and online registration,
please visit www.marssociety.org.

DALLAS 2011 CONVENTION



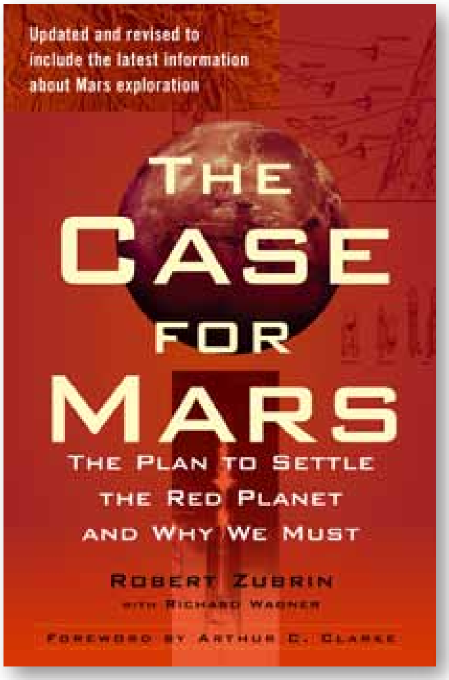
EMBASSY SUITES GRAPEVINE

www.marssociety.org

The Mars Society's International Convention offers a unique opportunity for those interested in Mars to come together and discuss the technology, science, social implications, philosophy and a multitude of other aspects of Mars exploration and settlement.

In addition, there will be extensive political discussions and planning meetings on how we can work together to turn NASA's space policy into a real exploration initiative, one capable of getting humans to the Red Planet in our lifetime. The convention agenda will also include a wide assortment of panels and debates concerning key issues bearing on Mars exploration and settlement, a banquet with lots of fun and entertainment, and plenary addresses from many prominent leaders and scientists involved in the humans-to-Mars effort.

TMQ BOOK CORNER



The Case for Mars

By Robert Zubrin with Richard Wagner
Published by Simon & Schuster, 2011

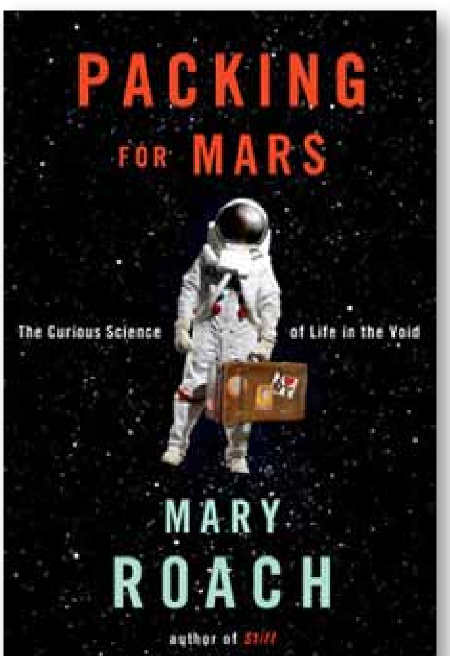
Since the beginning of human history, Mars has been an alluring dream—the stuff of legends, gods, and mystery. The planet most like ours, it has still been thought impossible to reach, let alone explore and inhabit. But all that changed when leading space exploration authority Robert Zubrin crafted a daring new blueprint, Mars Direct. When it was first published in 1996, The Case for Mars became an instant classic, lauded widely for its game-changing perspective by those who would see the American space program rise to the challenge of Mars; Carl Sagan called Zubrin the man who, “nearly alone, changed our thinking on this issue.” Now, fifteen years later, Zubrin brings readers up to date in this revised and updated anniversary edition filled with spectacular illustrations, extraordinary photographs, and one-of-a-kind anecdotes.

Unlike the dead world of the Moon, the Martian landscape is filled with possibility, but humans must be able to survive there. In the grand tradition of successful explorers, Zubrin calls for a travel-light and live-off-the-land approach to Martian settlement. He explains how scientists can use present-day technology to send humans to Mars; produce fuel and oxygen on the planet’s surface with its own natural resources; build bases and settlements; and one day terraform—or alter the atmosphere of the planet in order to pave the way for sustainable life. As the landmark mission of the Mars Science Laboratory begins, Zubrin lays out a comprehensive plan to build life on a new world.

Review courtesy of Simon and Schuster.
http://books.simonandschuster.com/Case-for-Mars/Richard-Wagner/9781451608113

Packing for Mars: The Curious Science of Life in the Void

By Mary Roach — Published by W. W. Norton & Company; 2010



In Packing for Mars, Roach tackles the strange science of space travel, and the psychology, technology, and politics that go into sending a crew into orbit. Roach is unfailingly inquisitive (Why is it impolite for astronauts to float upside down during conversations? Just how smelly does a spacecraft get after a two week mission?), and she eagerly seeks out the stories that don’t make it onto NASA’s website--from SPCA-certified space suits for chimps, to the trial-and-error approach to crafting menus during the space program’s early years (when the chefs are former livestock veterinarians, taste isn’t high on the priority list). Packing for Mars is a book for grownups who still secretly dream of being astronauts, and Roach lives it up on their behalf--weightless in a C-9 aircraft, she just can’t resist the opportunity to go “Supermanning” around the cabin. Her zeal for discovery, combined with her love of the absurd, amazing, and stranger-than-fiction, make Packing for Mars an uproarious trip into the world of space travel.

Excerpt from Amazon.com Review
--Lynette Mong
http://www.amazon.com/Packing-Mars-Curious-Science-Life/dp/0393068471

Trailblazing Mars: NASA's Next Giant Leap

By Pat Duggins

Published by University Press of Florida, 2010.

In his first book, Final Countdown, Pat Duggins summarized the events that led to the decision to retire the shuttle program and what was to follow after the last shuttle mission ended – the Constellation Program. For his latest offering, Trailblazing Mars: NASA's Next Giant Leap, Duggins details efforts to reach the Red Planet efforts that stretch all the way back to the earliest days of the space program.

Trailblazing Mars is a masterful summation of the history that makes up all the diverse elements that have led NASA up to this point. Starting with the NASA's numerous failures to the incredible success that is the Mars Exploration Rovers; Duggins covers all the important milestones in the exploration of the Red Planet. He also provides us with a succinct understanding of manned spaceflight, where is has been – and where it could go.

Trailblazing Mars works to correct the thinking that a trip to Mars will be reminiscent of the golden era of Apollo. Duggins compares the efforts to go to the Red Planet to a high-tech homesteading trip to another world. In short where Apollo was a quick week-long vacation – going to Mars will be a far more permanent affair and NASA is going to have to change dramatically to accomplish this.

In a recent speech at Kennedy Space Center President, Obama stated that he wanted to see astronauts on Mars within his lifetime. If that is to take place, the American public is going to have to face some very real issues – issues Duggins touches on in Trailblazing Mars. How will we handle it when we lose either a single astronaut or an entire crew in space? Unlike Apollo 1, Challenger and Columbia if something goes wrong millions of miles from home it is highly likely that those lost will never be recovered.

Pat Duggins is news director at Alabama Public Radio. He's known nationally as the "voice" of NASA coverage on National Public Radio. Pat has spent over twenty years providing stories on the space program, including the development of NASA's next generation spacecraft at the Marshall Space Flight Center in Huntsville, Alabama. He has covered over one hundred space shuttle missions for National Public Radio, starting with the 1986 Challenger accident. Following the 2003 loss of Columbia, Pat provided three hours of "live" coverage on NPR's Weekend Edition with Scott Simon.

In a time when long duration manned space missions seem to be drifting further and further away from the American imagination when our ability to do the impossible seems to have been concluded in December of 1972, this book highlights the truth. The truth Trailblazing Mars covers in incredible detail is that we as a species are capable of settling another world – we just have to choose to do so.

Review courtesy of Pat Duggins.
http://www.amazon.com/Trailblazing-Mars-NASAs-Next-Giant/dp/081303518X

The Case for Mars

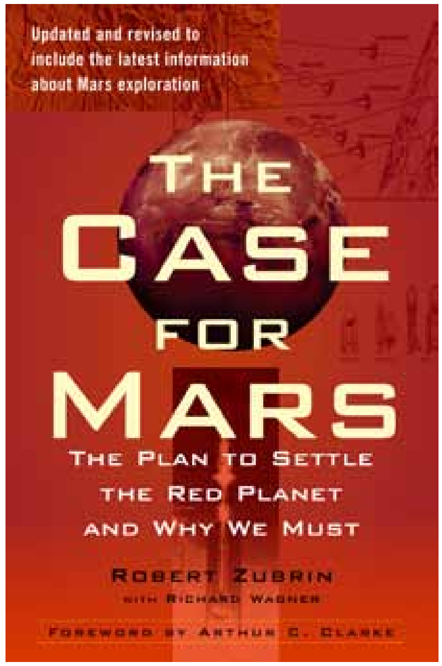
Preface to the Revised Edition

Our doubts are traitors
And make us lose the good we
oft might win
By fearing to attempt.
- *William Shakespeare, Measure for Measure*

A lot has happened in the 15 years since The Case for Mars was first published. A string of robotic missions were launched to the Red Planet, including Mars Pathfinder and Mars Global Surveyor in late 1996, Mars Polar Lander and Mars Climate Orbiter in 1999, Mars Odyssey in 2001, Spirit, Opportunity, and Mars Express in 2003, Mars Reconnaissance Orbiter in 2005, and Phoenix in 2007. With the exception of the 1999 flights, all of these missions have been brilliantly successful. As a result, our knowledge of the planet has greatly increased.

We now know for certain that Mars was once a warm and wet planet, possessing not only ponds and streams, but oceans of water on its surface, and continued to have an active hydrosphere for a period on the order of a billion years – a span five times as long as the time it took for life to appear on Earth after there was liquid water here. Thus, if the theory is correct that life is a natural phenomenon emerging from chemistry wherever there is liquid water, various minerals, and a sufficient period of time, then life must have appeared on Mars.

Furthermore, we know that much of that water remains on that planet today as ice or frozen mud, with the soil of continent-sized regions of the planet assessed as being more than 60 percent water by weight. Not only that, we have discovered that Mars has liquid water, not on the surface, but underground, where geothermal heating has warmed it to create environments capable of providing a home for life on Mars today. We have found places where water flowed out of the underground water table and down the slopes of craters within the



past ten years. Indeed, we have detected methane emissions characteristic of subterranean microbial life emerging from vents in the Martian surface. These are either the signatures of Martian life, or the proof of subsurface hydrothermal environments fully suitable for life. Either way, they identify exactly the places where astronauts could go, drill, and bring up water samples whose contents would reveal to us the truth about the nature, prevalence, and potential diversity of life in the universe.

Beyond that we have mapped the mineral content and topography of the planet from orbit, and photographed it in sufficient detail to be able to see and guide our small robotic rovers and to identify ideal landing sites and travel routes for future human explorers.

So now we know why we should go, and where we should go. But are we on our way? Not yet. In startling contrast to the brilliant and continuing success of the robotic Mars exploration program, over the fifteen years since the first publication of this book, NASA's human spaceflight program has made no progress whatsoever. The point requires emphasis. Aside from the information returned by the robots, NASA today is no better prepared to send humans to Mars than it was in 1996.

How can that be? The most frequent answer is lack of money. If only NASA had the kind of funding it did during the Apollo era, it is claimed, we would see great accomplishments in human spaceflight. This excuse, however, is completely false. The fact of the matter is that in today's dollars, the average NASA budget between 1961 (when President Kennedy gave his speech announcing the Apollo program) and 1973 (when the final Apollo-Skylab mission was flown) was $19 billion per year, nearly exactly the same as NASA's budget is today, and has been, in round numbers, since about 1990.

Nor is it the case that the Apollo-era NASA was able to accomplish more in the human spaceflight area because it did so at the expense of robotic exploration. In fact, during that period the unmanned exploration program was more active than it has been over the past 15 years, with some 40 lunar and planetary probes launched. In fact, if we extend our baseline to 15 years, matching the 1961 to 1975 period against 1996 to 2010, we find that the earlier NASA launched 10 Mars probes with 8 successes, nearly identical (but slightly superior) in flight rate and batting average to the modern NASA's track record of 9 Mars probes with 7 successes.

Yes, it is true that the NASA budget during the 1960s got a larger share of federal outlays, but that is not because NASA was richer, but because the nation was smaller and poorer. During the 1960s, America's population was 60 percent what it is today, and its GNP was 25 percent as great. These were hardly advantages for Apollo.

Furthermore, the technology available to America a half century ago was vastly inferior to that of today. The men who designed Apollo did their calculations on slide rules, capable of performing, at most, one calculation per second, not computers doing billions. Yet they solved all the problems necessary to take us from nearly zero human spaceflight capability to landing men on the moon and returning them to Earth in eight years.

As this book will show in detail, from a technological point of view, we are much better prepared to send humans to Mars today than they were to get men to the Moon in 1961. Yet they got there in eight years. We've gone nowhere in the past three and a half decades.

So, the question is, what did NASA have then that it doesn't have now?

The answer is Resolution

By resolution, I mean that quality associated with being able to determine what it is you truly want to accomplish, committing to that objective, creating a plan to achieve it, and then doing what is necessary to actually implement that plan.

During the Apollo period, that is how America's human spaceflight program operated. The objective was clear – get men to the moon and back by the end of the decade - the commitment to it was absolute. Accordingly, a plan was devised to achieve that goal in accord with that schedule, vehicle designs were created to implement that plan, technologies were developed to enable those vehicles, then the vehicles were built and the missions were flown.

The robotic space program also operated in that manner at that time, and continues to do so today. That is why it continues to deliver ever greater achievements.

It is not the fact that the unmanned exploration program employs robots that has made it a success. Rather it owes its success to the fact that the people running it are using their brains.

In contrast NASA's human spaceflight program has abandoned this rational approach entirely. Instead of designing things to implement plans, it develops things and then tries to find some use for them. It created the Space Shuttle without any clear idea of what it would be for, and thus it has proved to be of very limited value for supporting human space exploration.

The International Space Station (ISS) was conceived for the purpose of giving the Shuttle something to do, but requiring that the Station be built by the Shuttle has vastly increased the Station program costs and risks, over-complexified its design, and limited its size, while burdening it with a nightmare twenty-year assembly launch sequence. In contrast, the simpler yet bigger Skylab was designed and built in four years, and launched in one day. Moreover, the ISS itself has no rational purpose commensurate with its cost, risk, or multi-decadal preoccupation of the agency's time. The fact that this dismal assessment of the Station's value, while unacknowledged, as generally understood, was made amply clear by the sequel to the February 1, 2003 Columbia disaster. Coming down harshly on the space agency, the accident review committee chairman Admiral Harold Gehman pronounced that "if we are to accept the costs and risks of human spaceflight, we need to have goals worthy of those costs and risks." In response, the Bush administration did not even attempt to make the case that the ISS program met that standard. Instead it launched a new initiative to give NASA human spaceflight program something worthwhile to do, specifically a return to the Moon by 2020.

While it is true that flying to the Moon is certainly a more interesting activity than hanging out in a space station in low Earth orbit, creating urine and stool samples so that guinea pig scientists can catalog still more data on the progressive deterioration of human physiology in zero-gravity (which is completely unnecessary, since any competent Mars mission designer would employ artificial gravity aboard his interplanetary spacecraft in order to avoid such effects – unless, of course, he was mutilating his design in order to provide justification for Space Station research), it still fails the test of rationality. We have, after all, been to the Moon six times. Over 300 kilograms of lunar material has been returned to Earth, and few people show any active interest in them. The big picture regarding the nature of lunar geology is already understood, with further work largely a matter of filling in details. Moreover, the whole subject is of limited interest anyway, trivial in fact, in comparison with the questions of the origins and fundamental nature of life that would be addressed by the human exploration of Mars. And as to the matters of national pride and glory, self and world image, and reassertion of our will as a people to embrace and meet new challenges, one wonders what it says about America if the highest aspiration of our space program is to repeat a mission it accomplished a half-century before.

Notwithstanding the above, an even bigger problem with the Bush administration's goal of returning to the Moon was that it was not a real goal at all. Rather it was an attempt to create sizzle, without the steak, since as proclaimed in 2004 for achievement by the year 2020, it did not actually require NASA to do anything towards its fulfillment during the administration's time in office, even assuming a second term. Thus five more Bush years went by, without any Moon mission hardware being built, after which the putative program was handed off to the Obama administration, which had no stake in it.

Thus orphaned, without political protection, without any valid or compelling reason for existence, and without any material progress to show for itself, the program was predictably cancelled. In its place, the Obama administration put first a "flexible path" concept without even a pretense of purpose. Then, when that was found too absurd for even Congress to bear, a pseudo-goal of reaching a near-Earth asteroid by 2025 (i.e. beyond the time horizon requiring any action by the world of the present) was duly proclaimed, and ignored. However, since there are, after all, 27 swing electoral votes in Florida, the administration set forth a fanciful assortment of new projects, including spending several billion dollars to refurbish the Shuttle launch pads after the Shuttle stops flying, developing a high-power electric thruster without the very large space nuclear reactor required to drive it, building an orbiting refueling station to service interplanetary spaceships that do not exist, and creating a space capsule that can fly astronauts down from orbit but not up.

None of these strange projects serve any useful purpose, nor could any other alternative random set, not merely because they don't fit together into any functional combination, but because, in the absence of a goal, there is no useful purpose for them to serve. Without question, they'll all be cancelled when Obama leaves office, if not before, without producing anything useful, and after spending another 40 or 80 billion dollars and wasting another four to eight years, we'll be back to square-one once again.

Where there is no vision, the people perish.

The American people want and deserve a space program that really is going somewhere. But no goal can be sustained unless it can be backed up, and not by "rationales," but by reasons.

There are real and vital reasons why we should venture to Mars. It is the key to unlocking the secret of life in the universe. It is the challenge to adventure that will inspire millions of young people to enter science and engineering, and whose acceptance will reaffirm the nature of our society as a nation of pioneers. It is the door to an open future, a new frontier on a new world, a planet that can be settled, the beginning of humanity's career as a spacefaring species, with no limits to its resources or aspirations, as it continues to push outward into the infinite universe beyond.

For the science, for the challenge, for the future; that's why we should go to Mars.

The only meaningful counterargument against launching a humans to Mars initiative is the assertion that we cannot do it. This claim, however, is completely false.

We would need a heavy-lift launch vehicle (HLV), which we lack, say the opponents, and it would take vast sums and extended periods of time to create one - $36 billion and 12 years, according to the Obama administration's blue-ribbon human spaceflight review panel. This is nonsense. We flew our first heavy-lift vehicle, the Saturn V, in 1967, following a five-year development program during which we had to invent it as we went along. Today we know exactly what to do. As to cost, SpaceX company president Elon Musk testified directly to the panel that he would be willing to develop a 100 tonne to orbit class HLV for a fixed-price contract of $2.5 billion. This claim is very credible, since SpaceX recently developed and flew a 10 tonne to orbit medium lifter for a total program cost of $300 million. Indeed Lockheed Martin, the aerospace giant formerly led by panel chairman Norm Augustine, has designs for HLVs whose development it prices at $4 billion.

A human Mars lander would require a huge parachute, the opponents say, much bigger than anything we have used. A large parachute? Please, give me a break. If we could send men to the Moon, we can certainly make a large parachute. Or if we didn't care to do so, we could just use a more modest sized parachute system and complete the landing deceleration using rockets.

It takes too long to get to Mars, they say, so we have to delay launching the initiative until we can develop radically more advanced types of space propulsion capable of getting us there much faster. Wrong. Using existing chemical propulsion, we can go from Earth to Mars in six months, and in fact the Mars Odyssey spacecraft did exactly that in 2001. Trips of this duration are quite manageable by humans. In fact, it's the standard tour that scores of astronauts and cosmonauts have already performed aboard Russian space station Mir and the ISS.

We would need a nuclear reactor to power our base on the Martian surface, they say, and we don't have one. True. But we fielded our first practical nuclear reactor in this country, the one that powered the submarine Nautilus, in 1952, and the laws of physics haven't changed much since. We had nuclear power before we had color TV, passenger jets, or push button telephones. Nukes are 1940s technology. We can certainly build the little one needed to power a Mars base.

Cosmic rays, solar flares, zero-gravity health effects, psychological factors, dust storms, life support systems, excessive cost - the list of alleged show stoppers put forward by the naysayers goes on and on. They're wrong on every point.

In this book I will prove that to you. I will lay out in detail a plan for a near-term human Mars exploration mission that negates or solves every single one of these difficulties, accomplished using technology that we possess today.

The human exploration of Mars is not a task for some future generation. It is a task for ours.

We hold it in our power to begin the world anew.

Let's do it.

Golden Colorado,
March 9, 2011

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