"Expanding the Human Economy through Off-Planet Resources"

Moon Miners' Manifesto

& Moon Society Journal

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Submission address: "MMM", 1630 N. 32nd Street, Milwaukee, WI 53208-2040; **E-Mail**: kokhmmm@aol.com

In Focus Mars, and NASA's new "Nuclear Systems Initiative"

A central feature of NASA's new budget is its "Nuclear Systems Initiative." NASA explored several nuclear propulsion ideas back in the early seventies, but this effort, perhaps premature, fell victim to Nixon's cost cutting axe. So we have been hobbling around the solar system relying almost exclusively on chemical rockets. Even pushed to their theoretical performance limits, chemical engines are severely limited in what they can do. They permit us to crawl to Mars, the asteroids, and the outer planets with barely enough instrumentation to make these efforts worthwhile. While what we have learned from the Voyagers, Galileo and various Mars missions along with what we hope to learn from the Cassini-Huygens mission to Saturn and Titan is most amazing.

We have, however, only scratched the surface. Galileo's multiple orbits of Jupiter through the realm occupied by its four great moons has revealed four worlds each deserving of its own dedicated fully instrumented orbiter and a fleet of landers. Europa, especially, deserves as much attention as we have been giving to Mars. It is most likely, moreover, that Cassini will reveal Saturn's moons to be equally deserving of intensive, dedicated further study.

Our Annual Mars Theme Issue

Yet up to now, only two more outer system missions have been under consideration: the Pluto-Kuiper flyby, and a first Europa orbiter. Both have been so constrained by unrealistic budgets, that the amount of science either would be able to deliver, while very welcome and surely enlightening, succeed mainly in intensifying our curiosity even further. Both these targets are worth major missions, not lightweight token efforts. But given chemical rockets and the distances to be covered, we are limited in our achievements.

We have always been strongly supportive of near term missions to both Pluto and Europa. But perhaps it is time to take a longer, more patient view. Do we want to learn the little we can in the next 10-15 years, with slim chance of follow up missions to answer the many major questions both these limited teaser probes would raise? Or is it worth putting both these exciting chemical rocket missions on hold while we develop significantly superior nuclear electric propulsion engines that in the long run, promise to offer us much more science in a decade or two than we can hope to gather with another century of reliance on chemical rockets. [=> p. 2, col. 2]

Aviation on Mars - A Task Force & A Plan

At right, NASA's solar-powered unmanned Helios Prototype on its way to a record altitude of 96,863 feet on August 13th, 2001. Its 247 ft wingspan carried a payload of 100 lbs. to an altitude where Earth's atmosphere is as thin as Mars'. A new breed of planes will open the planet's vast roadless reaches to daring human pioneers. See pp. 5-6

Moon Miners' Manifesto

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÷ **EMAIL** to KokhMMM@aol.com (*preferred*)
÷ **Mac diskette** or **typed hard copy** to:

Moon Miners' Manifesto, c/o Peter Kokh,
1630 N. 32nd Street, Milwaukee WI 53208-2040

fi IN FOCUS Editorial continued from p. 1.

What is under consideration, is development of a uranium-fueled nuclear fission reactor with an advanced electric propulsion system that energizes a set of ion engines. Safety will be paramount:

- the nuclear reactor would stay intact in the event of a launch failure.
- the nuclear hardware is to be launched in a "cold", non-operating state.
- The reactor (of any future spacecraft mission) would be activated at nearly 1,555 miles (2,500 kilometers) distance from Earth. This high, non-decaying orbit altitude was chosen to be compliant with the NASA Orbital Debris Guidelines in case the system failed to start.

Sean O'Keefe, NASA's new administrator, is making a gamble that many are unhappy with. Two most scientifically important missions are being put on hold for the development of a propulsion system which may take longer than expected to perfect. Even many of those who applaud NASA's Nuclear Systems Initiative for its unquestioned promise, feel that this new emphasis does not justify scrapping two conventional missions already well into their planning stages. Indeed, given the way the Bush administration is spending billions futilely strengthening *only some of many weak links* in our defenses, it is disturbing to see worthwhile initiatives cut to pay the price.

We'd very much like to be around when the first Europa orbiter peeks below that moon's ice crust to confirm and map the ocean below. But we'd be even happier if we knew that we had developed the technology to open the outer solar system to routine science missions that would enable much more thorough exploration.

Nuclear electric propulsion for unmanned probes is just the beginning. If humans in the flesh are ever to go beyond Mars (or to go beyond exploration of Mars to opening it up as a new frontier) we will need a faster, and safer, means of propulsion. Safer? Yes, because shorter trip times mean less total exposure to the radiation hazards of space. Nuclear thermal rockets could cut trip time to the Moon to 24 hours (instead of three days), one way to Mars down form 6-9 months to perhaps three. At the same time, the faster propulsion would work to lengthen launch windows significantly. Humans to Mars by chemical rockets is possible, just! Longer missions to the asteroids and beyond would stretch this old revered technology to the point of suicidal absurdity. If we want an open ended future for humans in the solar system, we have no choice but to get beyond the infancy of our "Space Age."

Patience is a difficult virtue to practice. It does not mean siting around waiting. It means aggressively working for better options. We owe this to ourselves, to our dreams. Go NASA, go! - PK

To Mars by way of La Paz

No, not Mexico, Bolivia!

by Peter Kokh

TheSearch for Mars Analogs

We've all heard of other "Terrestrial Roads" to Mars:

- to Mars via the Dry Valleys of Antarctica
- to Mars via Canada's Devon Island
- to Mars via Hanksville, Utah

All these places have their analogies to Mars. The Antarctic dry valleys are very cold and ultra dry, as close a climatic match as is to be found on Earth. But the logistics between here and there leave much to be desired. Devon Island is remote, but in comparison to the Dry Valleys, practically in our back yard. here the analogy is not so much the climate but the terrain, and paucity of vegetation. South Central Utah is red rock country and also has vegetation-free areas. Plus it is in easy reach of Salt Lake City, Las Vegas, Albuquerque, and Denver.

Why add La Paz, Bolivia to this list?

Because on Mars, the air is thin -- as thin as it is between 100,000 and 125,000 feet up here on Earth. That's something it's fair to say that most of us will never directly experience. Sure there's Mount Everest and our own Mount McKinley, and closer to home to most readers, Pike's Peak in Utah at 14,002 ft. (I've been there myself.) But these are all uninhabited places.

La Paz, Bolivia, is the world's highest capital city at 12,000 ft. nestled in the Altiplano valley between parallel ranges of the mighty Andes. And now suddenly well over a million in population, it is also the world's highest major city, significantly higher than Cuzco, Quito, Nairobi, Bogota, and Mexico City, in descending order. [For nit-pickers, much smaller Lhasa in Tibet is a 100 meters higher.]

La Paz' J. F. Kennedy Airport, at 13,800 feet is even higher. But that's a lot lower than 100,000 ft. let alone 125,000 ft. But for the current bunch of major human settlement's, La Paz is as close as this planet has to offer. Curiously, one of the nearby scenic musts is Vale de Luna, Valley of the Moon. With its Mars-hued rocks, perhaps it is misnamed! For a glimpse of this scenic treasure, go to:

http://www.cogs.susx.ac.uk/users/fabricer/trips/bolipix/profond.gif

To Mars by way of La Paz? The point of course is that if you think that 12,000 feet up is high, then maybe you had better think twice about going to Mars. But if you are looking for a vacation trip out of the ordinary and that will put you in a Mars mood, why not here? One thing is for sure. You can have much more fun in La Paz than in Antarctica, Devon Island, or the middle of nowhere in Utah!

Just thought you'd want to know. :) <MMM>

Mars Aviation Task Force

A Mars Society project for exploring the design issues, the relevant framework, and the operational characteristics of an airborne transportation system on Mars.

by Paul Swift (pswift@shaw.ca) and Peter Kokh

Segue form the piece at left -- Peter Kokh

The highest major airport on Earth with regular scheduled jet service is La Paz, Bolivia's J. F. Kennedy International airport at 13,800 ft. It was a milestone of aviation history when the first Boeing 727 arrived. Now if that was such a feat, how can we be serious about flying on Mars where the air is as thin as it is at 100-125 thousand feet up on Earth?

Despite the tremendous challenge and many hurdles, there is quite a bit of excitement, *and confidence*, that we can learn to do just that! NASA has several unmanned Mars drone plane probe designs in the works, including the *KittyHawk*, which would be on its way next year for a maiden flight over the immense Valles Marineris canyon on December 3, 2003 as part of a celebration of the 100th anniversary of the Wright Brothers famous first flight -- *had it not been for the Mars Polar Lander fiasco.*

On August 13th, last year, NASA's solar-powered unmanned Helios prototype reached a record altitude of 96,863 feet, where the air is about as thin as it is on Mars. (See page 1, bottom, this issue.)

But aviation designers are looking beyond lightweight unpiloted exploration craft. For more than fifteen years they have been brainstorming just how we can achieve piloted flight on the Red Planet.

What's at stake

On Mars the role of special airplanes will not only be to assist truly global exploration of this intriguing world, but to be the workhorse of expansion of a human frontier on Mars to territory as vast as Earth's seven continents combined. The trackless surface is a veritable minefield of boulders, and creation of a global road network would be slow and expensive. Large aircraft that could take off and land vertically carring runway-building equipment would open the planet by building runways that could then be used by conventional aircraft of various types.

Unlike the situation facing Lunan pioneers, an "umbilical cord" to Earth is not feasible. The governing paradigm will be that of the "egg and yolk sac." Because of the long 25+ month wait between launch windows, plus additional wait for return windows, reliance on Earth-based rescue, repair, and relief would be a recipe for certain disaster and failure. The first expeditions will have to bring with them whatever resources they may need to fall back upon in order to recover from mishaps and disasters.

Once we commit to the establishment of an open-ended frontier community, it will make much more sense to develop a broad diversity of local resources. If you need copper, for instance, and there is none in the local soils, you will want to be able to access such a resource elsewhere on Mars. In other words, an interdependent plurality of settlements scattered over the Martian globe will be much more viable and self-reliant than any possible single site.

Roads can and will be built in and around the various settlements. But we will need to "leapfrog" hundreds and thousands of miles/kilometers of intervening trackless, rugged terrain to forge scattered settlements into one diversified Martian economy.

For this task, Mars aircraft will be essential. We will need planes for prospectors and geologists seeking to verify and pinpoint strategic resources: metals, alloy ingredients, water, thorium and uranium, etc. We'll need VTOL search & rescue craft. And cargo planes to ship specialty manufactures from one area to another. Passenger airliners too.

Without planes, to reach and explore a remote site, one would have to return to Earth and launch again to a new site - sheer folly!. Yes, flying on Mars will pose great risks. The fearful can stay behind. It is absurd to think of opening a frontier without risk.

If we want to open Mars, it is essential that we soon fly drone scout aircraft on Mars, and then quickly begin developing human-piloted craft. Our goal should be to have such a craft included in the first Mars Landing mission. Aim high, hit the mark!

Readings:

Dirigible Airships for Martian Surface Exploration by W. Mitchell Clapp. AAS 84-176. Case for Mars II, Ed. Christopher P. McKay, 1985, American Astronautical Society ISBN 0-877030220-3, pp 489-96.

Nuclear Thermal Ascent Vehicle Using Indigenous Fuels for Multiple Takeoffs and Landings (NIMF) by Robert M. Zubrin, pp. 17-28, Proceedings of ISDC '89, Ed. Jeffrey G. Liss, Univelt, ISBN 0-912183-09-8

Mars Airplane Design Studies, Kenneth R. Silver and Michael F. Lembeck, pp. 204-15, ISDC'89 op. cit.

A presentation by Paul Swift, Mars Convention 2000

The Mars Aviation Task Force - Paul Swift

This is a formal announcement that the Mars Society will be hosting a unique discussion group on the topic of traveling through the 'air' on Mars. Specifically, this discussion group will consider all aspects of crewed airborne transport on Mars.

The Martian environment will require a multi faceted approach to enable humans to move about the surface of the planet. It is acknowledged that aground transportation segment will be a vital and necessary subsystem of this Mars Transportation System, but is not a part of this discussion.

The time is now here to start to formulate the types of missions that will be undertaken by the first comers to Mars, as well as the groups to subsequently come doing their extended work..

Discussions are expected to focus on some of these following issues:

- The Martian aerial environment
- Base camp and 'fly' camp placement and servicing
- Crew and passenger selection and functions
- Mission definitions
- Range and capacity of aerial vehicles
- Speed and payload capability
- Landing, takeoff limitations and requirements
- Fuel system management
- Propulsion and structural requirements
- Crew safety procedures
- Search and rescue etc.

The reason for putting this list into action now is simple. We will soon be overtaken by events unless we are very proactive in this area. The time to define the Airborne segment of the Mars Transportation System is now. We have the capability of specifying what is needed, building and testing it here on Earth, while learning perhaps some new skills and putting our theoretical approach into practice.

- Hardware proposals include wing supported airplanes, rocket supported aerodynamic vehicles as well as non-aerodynamic vehicles.
- Propulsion varies from propeller driven to rocket or steam jet, or an engine that may use certain elements from the Martian soil or atmosphere.
- Fuel categories include chemical, solar, nuclear.

Listed here are some of the missions that will help determine how we think as designers of aircraft:

- Long range recon - eyeball & camera plus sensors
- Mapping • Cinema-photography
- Landform examination (outcrops / anomalies)
- Outpost servicing • Search & Rescue
- Point to point delivery/pickup of people/supplies
- Fuel depot management • Atmosphere research

And probably more. These require characteristics in the flight vehicle vastly different from one another, including speed. Some of these missions will require flying as fast as possible, while for others it will be hard toy fly slow enough. Some flights will carry only a tiny payload, while others must have massive cargo capacity. I foresee several aircraft types, one for each type of mission. The low level Mark I Eyeball terrain recon mission at low speed and highly maneuverable (my pet project.) Medium range search & rescue high speed vehicle for point to point operations. Heavy lifter for outpost construcion and resupply.

The area of field maintainence is extemely critical. But it all boils down to the design. Is it built to be manufactured cheaply, or built for easy field access to all components? You can squeeze by on Earth, but flying over Mars, mechanical problems must be field-solvable. A staffed and well-equipped hanger may be half the globe away.

[As a preliminary reference document, the content of a presentation by Paul Swift to the Mars Society membership at the 3rd Annual Mars Convention in Toronto in 2000 is on this site for consideration.]

Where to find us

We may or may not have the Mars Aviation Task Force website and email discussion group up and running by the time this issue of MMM arrives in your mailbox. Our target date is mid-late April. And here are the addresses we have reserved:

http://MarsHome.org/MarsAviation

MarsAviation-Subscribe@lists.MarsSociety.org

Non-technical assistance needed -- Peter Kokh

If you think that flying on Mars is a great idea but are not an aviation engineer, we can still use your help. Two early priorities for the Mars Aviation Task Force do not require technical proficiency:

1. Compile an exhaustive **bibliography** that will be accessible online covering
   a. Papers on Aviation on Mars
   b. Papers on Aviation on Earth at very high "Marslike" altitudes
2. Compile an **image library** accessible online of appropriate artwork to include serious sketches of Mars Aircraft design ideas but also historical and fictional art in the "inspirational" category (Bonestell's depiction of Von Braun's great winged Mars Landing Craft, for example.)

Outreach & Recruiting Opportunities Galore

The immediate spark behind this effort is an opportunity in Milwaukee. *Aviation Career Day* is an annual event held at Mitchell Field International Airport every year on the last Thursday evening / Friday morning each April. At last year's event, we reserved a table for the Wisconsin Mars Society chapter & LRS with the theme "You can fly on Mars!"

Aviation and Experimental Aviation enthusiasts are an enormous untapped resource. In every part of the country and abroad there are annual Air Show events at which, following our model, chapters of the Mars Society and National Space Society can get the message across: *"We Can Fly on Mars!"* **<MMM>**

Mining Mars' Atmosphere as *if our survival depended on it!*

by Peter Kokh

Mars' atmosphere is 97% carbon dioxide, the rest mostly nitrogen, with some argon and traces of water vapor. Thin as it is, this "air" is thick enough for aerobrake assistance in landing from orbit, or on direct trajectories from Earth -- saving fuel. We are also confident that it is just thick enough to support flight. And from this atmosphere we can derive both oxygen and nitrogen to provide breathable air in our pressurized outpost and settlement structures. These are three critical pluses for the exploration of Mars.

But the usefulness of this thin envelope does not end here. Its chemical feedstock potential will help pioneers make do without the fossil fuel bounty to which we have become addicted on Earth. Robert Zubrin's ISRU [in situ resource utilization] experiments, repeated successfully by others, show that we can use Mars' air to produce *useful fuel combinations:* carbon monoxide + oxygen; and the more potent methane (CH4) + oxygen. These bottled or liquefied fuels will run generators for electric power, operate machinery, and provide fuel for Earth return craft, surface transports, and even aircraft.

Power for generators and fuel for vehicles are extremely important. We will need both right away, and having to bring along from Earth only the capitol equipment needed to produce these fuels rather than fuels themselves, will not only make early missions that much more doable, but lay the groundwork for successor missions and outpost expansion.

Chemical industry feedstocks

On Earth, we rely on petrochemicals not only for fuels, but also for feedstocks for our diversified chemical industries, *even for pharmaceuticals*. If a frontier is to be established on Mars, we will need some way to kick start the local equivalent of a petrochemicals industry so as to minimize very expensive imports from Earth.

Assuming that Mars does not possess non-biogenic oil, coal, and gas resources, how far can we go towards building up a chemicals industry on feedstocks synthesized from the ingredients of the Mars air soup?

While there is a fringe group that maintains that the Earth's oil and gas reserves are not biogenic, i.e. not fossil-derived, this is a view that has a long way to go to earn respect. The mainstream view is that our petroleum, coal, shale, and much of our gas reserves are the bounty of abundant terrestrial vegetation in eons past. If we were to find such resources on Mars, it would be quite astounding and radically revolutionize much of our geological, and even cosmological assumptions. It is a romantic notion much more unlikely than finding alien artifacts on Mars.

What is at stake? If we can even start down this road, leaving to future Martian pioneers how to advance further, we will have helped kick open the door to Mars that much wider.

But there are challenges that we must recognize. On the one hand, we have a good supply of elemental ingredients. On the other, "starting from scratch" i.e. with elemental ingredients, is not the route of chemical synthesis we are familiar with. Like many a modern Kitchen Queen or King, we are used to using "starter" pre-prepared ingredients like gravy mixes, canned soups, canned spaghetti sauece, etc. Our petrochemicals industry supplies many advanced "building block" molecules isolated from petroleum and/or coal in the refining process.

Chemical Engineering Young Turks to the Rescue

Essentially, what we must undertake on Mars is one of those "paths not taken" in the course of industrial development on Earth. Not taken, because we did not have to go that route. While some research along these lines may exist, it is a safe bet that a lot of it has not been pursued.

To prepare the way, we need qualified people to find the chemical pathways and to "engineer" ways to follow them on an industrial scale (not as laboratory curiosities.) Indeed, we may want to set up a

Mars Atmospheric Feedstocks Task Force
"Sabatier Products Unlimited"

by that, or some other name, to pursue previously unexplored avenues.

Starting with the easy stuff first - Ammonia

In addition to fuels, one of our earliest and most essential needs will be nitrate fertilizers. It is a common misconception that on Earth, plants get all the nitrogen they need directly from the air. In fact, only certain microorganisms, and some legumes (been family) in whose roots some of these micro-organisms live in a symbiotic relationship, are able to "fix nitrogen" directly from the air.

In our greenhouses on Mars, we will have to inoculate our soils with these special microbes and also cultivate legumes. But we can also use Mars Air to produce ammonia (NH_3) via the Haber Process and from this we can make nitrate fertilizers. Ammonia can also serve as a refrigerant.

Other logical feedstock products are NH_4OH ammonium hydroxide, and reacted with sulfur and chlorine, ammonium sulfate and ammonium chloride.

More Nitrogen products

N_2O Laughing gas is used as a mild anesthetic but can also be combusted with carbon to revert back to pure Mars Air (CO_2 + N_2) providing another fuel combination option for specialized uses. NO Nitric Oxide can be used to make HNO_3 nitric acid.for the manufacture of explosives, celluloid, dyes, nitrates and fertilizers, and as an handy laboratory reagent. Nitrogen compounds are a logical place to start.

N_2O_5 **Dinitrogen Pentoxide**, according to Jeffrey Landis, a respected NASA researcher and writer, is sufficiently unstable as to be classified as an explosive. But *if* it could be stabilized somehow, (it may be naive on our part to suggest that it can) it would be very useful. You see it is stable as a white powder throughout the entire temperature range found on Mars. *If* it could be handled safely, it could be used as air-derived shielding for Mars habitats and outposts. The advantage? We wouldn't have to disturb the soil around the outpost to get shielding, Given all the boulders we see on Mars, and the possibility of permafrost hardening of the soil, that could be quite an advantage. A catch is that the traditional way of preparing dinitrogen pentoxide is to react phosphorous pentoxide with nitric acid. If we could not find a direct route, then we would have to synthesize P_2O_5 first.

Hydrocarbon chemistry

Now it gets harder. Hydrocarbons are the most important of all chemical feedstocks. We refine these from petroleum or coal. How far can we get synthesizing basic hydrocarbon feedstocks directly from the carbon, oxygen, and hydrogen in Mars' atmosphere?

Methane CH_4 is the first in a series followed by Ethane C_2H_6 and Propane C_3H_8. If we could synthesize ethane and propane, we'd have additional fuels as well as the building blocks of ethylene C_2H_4 (> polyethylene) & propylene C_3H_6 (> polypropylene -- trade names: Olefin, Herculon, etc.)

The Alcohol family begins with Methyl Alcohol CH_3OH derived from Methane and Ethyl Alcohol C_2H_5OH derived from Ethane.

These two avenues can give us a head start by allowing pioneers to manufacture many useful products. But from here on it may get harder. Starting on this foundation, future Martians will be able to go much farther as their population increases and as their industries continue to diversify.

Growing Chemical Feedstocks on the Farm

It will be practical common sense to use biological assistance in our efforts to build a chemical industry on Mars Air resources. We will be bringing both animals (ourselves, at least) and plants ton Mars and we would deserve to fail if we overlooked all the chemical byproducts these living creatures synthesize directly or indirectly. Some instances:

- Urea, NH_2CONH_2, from human urine
- Organic dyes and adhesives, oils and solvents
- Oliferous (oil-bearing) plants

The list of useful plant / animal byproducts that can be used as chemical feedstocks is already lengthy and continually growing. The partnership of farm and chemical industry is a two way one.

Mining Mars Air can jump start a diversified industrial underpinning for settlement. **<MMM>**

Drilling for Water on Mars

Water "on location" for drinking, bathing, growing food, and for industrial purposes.

by Peter Kokh

Up until Mars Odyssey arrived in Mars orbit, schemes for supplying water to an outpost/settlement have fallen into 3 general categories:

1. Squeeze water vapor out of the thin atmosphere. While Mars atmosphere is less than a hundredth the thickness of Earth's (at the surface) and its capacity to hold water is vastly less, there is still some water vapor in the air. In the Sabatier reactor ISRU process of air-mining for oxygen and fuels (carbon monoxide, methane) it should be feasible to produce a steady trickle of condensed water vapor as a by-product.
2. Fetch ice from one of the caps, if the outpost is near one of them. Water Ice, known for some time to be the major constituent of the North Polar Cap, could be transported equatorward by truck, pipe-line, or by enclosed, pressurized, heated neo-Lowellian canals. Not a minor undertaking, any such scheme might be part of an advanced phase.

   See MMM #62 February, 1993 page 6 " The Canals of Mars: From Self-Deception to Reality." P. Kokh
3. Taping permafrost and/or ground water

Still in the early part of its mission, the Mars Odyssey Orbiter has been detecting the tell tale signature of hydrogen, implying water or water ice, not only at both poles and throughout the circumpolar areas, but just about everywhere. The probe's gamma ray spectrometer is similar to that flown on Lunar Prospector. Its resolution is similarly coarse, about 100 km or 60 miles. This is good enough to give us a general idea, but if we want to validate a short list of premium Mars outpost locations, we will want to fly another mission with a much more powerful instrument, so that we "can land on the dime."

But the presence of frozen water or permafrost in the soils of a proposed site is still far from adequate information. What is the percentage of water content in the soil? How deep does these layers extend? How saline is it and what salts are involved?

We have become accustomed to thinking of ice and permafrost on Mars. But if this frozen resource is more than a surface phenomenon, if these deposits go down and down and ... then at some point we will encounter liquid water aquifers. Why? Because Mars has a hot iron core, smaller and less hot than Earth's but bigger and hotter than the Moon's. However cold the surface may be, at some point as one probes deeper and deeper, the temperature will start to rise, steadily. Eventually, a point will be reached where liquid water would replace ice. Can we drill to that depth? Or do such aquifers run too deep? The rate at which settlement operations, including farming and industry, can expand, hangs in the balance.

Location, Location, Location

We'll want to site our outpost, or certainly our first settlement, handy to an aquifer if possible, but not on soil so saturated that it could become unstable if we succeeded someday in warming Mars.

Water from Permafrost

There may be permafrost mining at various places on Earth, in Alaska, Canada, or Siberia. But given the abundance of streams of liquid water in most subarctic areas, it could be that no one has tried to engineer such a system. If so, that can be fixed. We can experiment with permafrost mining here on Earth. The idea would be to come up with two or more workable systems and send an unmanned probe to a verified permafrost area to conduct field tests on location. When we send people, it would be insane to equip them with systems that have not been tested on location.

If the ice is salty

Another reason for unmanned permafrost testing on location is to determine its quality and purity. If the water ice is saline then:

1. crews will need distilling equipment to produce drinkable water
2. crews will need storage facilities to store the salts isolated in the distilling process as these will become an important resource, a treasure for both industry and agriculture

Given that the era of flowing liquid water (an ocean, rivers, lakes) has been much shorter on Mars than on Earth, there may be salt, but much less of it, i.e. in lesser concentrations. Nonetheless, salt mining could be an important pillar for diversifying Martian industries, hastening the day of manufacturing self-reliance.

Below is a chart of the major sea salts found in Earth's global ocean. If we can mine them from salt on Mars, this will add greatly to the resources we can tap in the atmosphere:

Main Salts in Earth Seawater

Cations	g/kg	Anions	g/kg
Sodium	10.76	**Chloride**	19.35
Magnesium	1.30	**Sulfate**	2.71
Calcium	0.41	**Carbon**ate	0.14
Potassium	0.40	**Bromide**	0.07
Strontium	0.01	**Boric** acid	0.03

Those in bold face would be especially useful -- the others easily found in the soil itself.

The Upshot

It is not enough to get excited about Mars Odyssey findings. We have to follow them up with a series of segue probes before we can intelligently plan a manned commitment to Mars. <MMM>

Mapping Angus Bay at High Resolution

by Peter Kokh and Paul Blase

"Angus Bay" is a colloquial nickname for the Mare Anguis ("Sea of Serpents") area NE of Mare Crisium. This sea is an irregular area filled with lava overflows from the much larger, fairly circular Mare Crisium ("Sea of Crises") near the NE limb of the Moon. This is the general location of the proposed commercial Artemis Moonbase™ but pinning down an exact location waits upon much better photography.

TransOrbital's **Lunar TrailBlazer** unmanned commercial lunar imaging probe will use two HDTV quality cameras to photograph and map the Moon at medium resolution, and selected areas at high resolution (>1 meter!). A priority goal is to present high res data for Angus Bay to ASI and The Moon Society.

TransOrbital is a for-profit company and, without government coffers to turn to, must raise the money needed to fly this mission. If the mission is successful, TransOrbital will be able to market a medium-resolution surface atlas of the Moon, with high resolution maps of select areas, so as to recoup its expenses, retire its debts, and go on to pursue follow up missions. The road back to the Moon has to be terraced one profit-making step at a time. The deployment of Artemis Moonbase will be a proud major milestone along this road. More information on TransOrbital's website: http://www.transorbital.net.

Reader support is appreciated. **<TO/MMM>**

"Let's roll!"

"All that is needed for evil to prevail
is for good men to do nothing."

"Keep your dreams under wraps,
and watch them die."

"What purpose can life have,
if one does not take responsibility
for his or her own dreams?"

"We have a butt,
so that we can get off it."

"Build it and they will come."

"Let's roll!"

http://www.moonsociety.org

Please make NEWS submissions to
David Wetnight at newsmonger@asi.org
Other submissions: KokhMMM@aol.com

The Moon Society was formed in July, 2000 as a broad-based membership organization with local chapters, to spearhead a drive for further exploration and utilization of the Moon in cooper-ation with other like-focused organizations and groups.

Artemis Society International was formed in August 1994 as a forum for supporters and participants in the **Artemis Project™** quest to establish a commercial Moonbase as a first step to a permanent, self-supporting lunar community. **ASI** does not engage in any form of commercial business directly, but seeks to build a Project support business team. Registered trademarks of the Artemis Project™ belong to The Lunar Resources Company®

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Society Contemplates $10,000 Project-X

From Amy McGovern <amy@cs.umass.edu>
Secretary of the Moon Society

" Dream with us! "

Question: Assuming that the Moon Society had $10,000 to spend on a project (or on several smaller projects), what projects would you like to see us accomplish and why?

Specifically, we would like the projects to accomplish several goals:

1. Be a visible sign that we are getting closer to landing on the Moon. This means that the projects should be directly related to Moon activities.
2. Be useful for public consumption. In particular, we want the projects to generate excitement in the membership and to help us to raise more money for the larger projects that we need to accomplish.

Although we recognize the importance of some of the more esoteric projects necessary to bring us to the Moon, we are not necessarily interested in those right now as they may not help us in the above goals.

The Moon Society and Artemis have considerable plans for projects that will bring us closer to human habitats on the moon. However, these projects require a significant amount of money which we do not have right now. Instead, we would like to bootstrap our projects and our funds by starting on smaller projects that will provide the visibility necessary to fund raise for the larger projects.

The ideas brought up by the officers and the board so far are listed below. The names in parentheses indicate members who have projects in these areas that we know about.

- studying methods for extracting oxygen from lunar rocks
- hydroponic garden experiments (Vik O)
- building a robot regolith mover (Dave W)
- rockets (Michael M)
- building a moon habitat environmental simulator (similar to the Mars one)
- Traveling Project Leto mockup
- Jumpstarting Artemis Project businesses (i.e. business plan contest)

Robotic Regolith Mover

From: David Wetnight <davew@intrex.net>
[Newly elected Vice-President of the Moon Society]

I am starting on a project to build a prototype robot capable of moving regolith. I welcome anyone who is interested to visit my bot page at:
http://evildave.dyndns.org/bot.html

The page is rather bare but I will keep it up to date with my progress. I am open to suggestions so please feel free to speak up.

[OPINION PIECE: The MSJ pages are open to members who wish to express alternative or opposing options.]

Incorporating the "Hostel" Strategy into the Artemis Moonbase™ Mission Plans

by Peter Kokh

THE LUNAR "HOSTEL": An Alternate Concept for First Beachhead and Secondary Outposts. Peter Kokh, Douglas Armstrong, Mark R. Kaehny, and Joseph Suszynski. © 1991 The Lunar Reclamation Society, Inc. -- Publication record:

- Procedings of the Tenth Annual International Space Development Conference, San Antonio, TX, Univelt, ISBN 0-912183-05-5, paper SDC-021, pp. 75-92
- Serialized in MMM #s 48-50, SEP-DEC '91
- Online: http://www.lunar-reclamation.org/hostels_paper1.htm

Intentions vs. Realities

The intention of the Artemis Project is to establish a "first Commercial Moonbase" as the start of uninterrupted human presence on the Moon from that point on, by leading to self sustaining resource-using settlements. The reality, however, is that just the landing of the first Artemis Moonbase structure on the Moon will not be enough to support an uninterrupted succession of human crews.

The reference mission Moonbase architecture does not include, in the first landing mission, power systems that will allow "overnighting," staying through the end of the two week long lunar dayspan, past nightfall and through the ensuing two week long nightspan, before the sun rises and brings with it the energizing power of its warming rays.

Overnighting on the very first return mission would be a very mighty leap beyond the accomplishments of the Apollo era. Even the longest Apollo landing mission only stayed a few "morning hours" of one 29.5 (24 hr.) day long lunar day/night cycle.

see MMM # 88 SEP '95, p 3. Starting over on the Moon: I. Bursting Apollo's "Envelope", P.Kokh
http://www.asi.org/adb/06/09/03/02/088/bursting-envelope.html

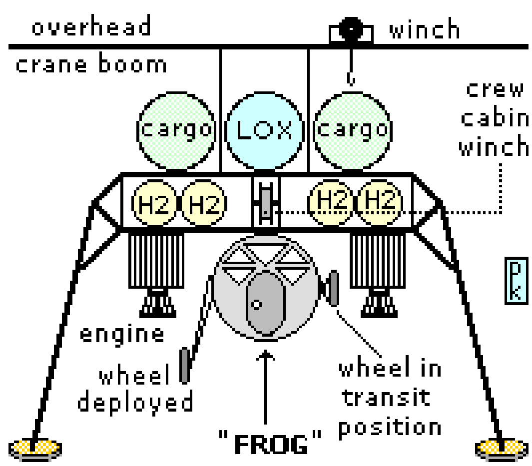
It will probably take several missions to build up this capacity to overnight. If we want to bring all the equipment we need to achieve this on the first mission, we will be creating an impossibly high threshold for the first mission. We want to get back to the Moon as soon as possible. That means being content to bring along the "base structure" only on the first mission. That means, in fact, that for perhaps the first few missions, the Artemis Moonbase will be a "tended" facility only. It will take some time to transition it to a permanently manned outpost. Getting through the first night, will, in comparison with the Apollo achievements, be a tremendous milestone. Getting through successive nightspans "routinely" will be another.

Many members are anxious to being lunar industry, and I count myself among them. But as the old saying goes, you must crawl before you walk. Indeed, we can do some on location (in situ) industtrial demonstrations during our first dayspan set up visits. But in the light of what is at stake, it will be far more important to concentrate on building up our capacity to successfully overnight.

Enter the "hostel" concept

In our 1991 paper, we explored the hostel concept. By "hostel" we meant a structure that can function as an outpost "only when a visiting vehicle crew cab is docked with it." Our whole idea was to lower the threshold to our return to the Moon. For this, we proposed two things:

1. an outpost which would essentially be "big, dumb volume" able to hold pressure, and outfitted with volume-hungry items
2. an "amphibious" lunar lander vehicle. Our "frog" would have an underslung crew cab, engines to either side, cargo and fuel tanks above. Upon landing, the crew cab would deploy wheels, winch itself down to the surface, and drive off to dock with the prelanded hostel outpost structure.

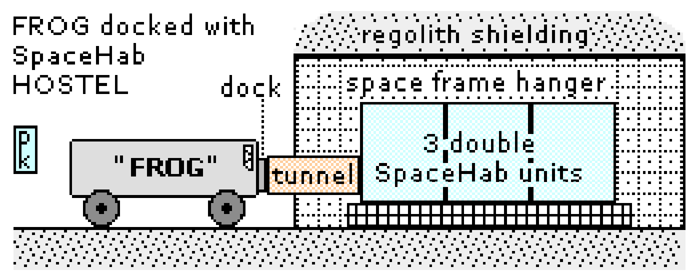


This crew cab would necessarily have to have everything needed to keep the crew alive in transit:

- life-support (air & water recycling, thermal controls, etc.)
- communications systems
- computing systems / work stations
- navigation systems
- galley kitchen, etc.
- airlock at one end
- docking port at the other end

Now, if this crew cab is designed in "amphibious" fashion, able to function in the ocean of space as well as on the land of the Moon, and thus able to dock with a prelanded pressurized structure, then there is no need to duplicate its systems in that structure. No, not even for redundancy. For if the systems in the lander crew cab were to fail, the crew would be stranded on the Moon, with little chance of rescue before nightfall. The lander crew cab systems have to be built to survive, and that is enough.

Until the outpost is fully outfitted and able to function on its own, dayspan and nightspan, it can accommodate visiting crews with the visiting vehicle docked. In tandem, frog and hostel will serve as a fully functional outpost. For EVA, personnel would reenter the frog, exiting the airlock at the other end.



Note the following in the above illustration:

- The docking tunnel is part of the Moonbase Hostel
- a space frame "hanger" has been built around the deployed Moonbase units, and then covered with regolith shielding by equipment deployed with SpaceHab structure and teleoperated from Earth

The reason for a shielded hanger rather than covering the outpost structure with regolith directly, is that a hanger allows for ease of expansion as well as for an unpressurized space to store fuel and air tanks and other supplies protected from cosmic rays, UV, and micro-meteorites. It would make sense to erect a generously sized hanger, with a footprint large enough to handle any and all outpost expansion foreseen as required to make it fully operational and fully nightspan worthy, without a visiting vehicle at the docking port. If shielding is applied directly, then it must be removed from those areas to which later expansion modules are to be attached. Thus the direct shielding approach sets up a hassle-loaded barrier to further expansion, thereby putting further expansion at risk of cancellation. So here is the deal:

1. tele-deploy the Moonbase main structure
2. tele-deploy hanger and shielding
3. send first crew in "frog" and *open up shop!*

FROG Division of Labor

Items the visiting crew cab must have anyway just for the journey from Earth to the Moon:

- Communications Center -------------
- Navigations Systems, Computer Bank-
- Air quality and ventilation---------
- Thermal management controls-------
- Water recycling / treatment---------
- Toilet & Shower---------------------
- Fresh Food locker-------------------
- Galley: meal prep, scrap disposal----
- First aid & trauma cabinet----------
- Cab windows, both ends-------------
- In place exercise center-------------
- in transit entertainment console-----
- Limited tape/disk collection---------

Capacities incorporated in early frogs, and gradually switched to the hostel structure:

- EVA airlock for Moonwalk sorties----
- Laundry facility---------------------
- Isolation berth(s)--------------------
- Wet/dry compact workstation---------
- Moon rock sample analysis-----------
- Moon sample experiment lab---------
- Electrolysis equipment for LH2, LO2--
- Fuel Cells for use when decoupled----

FROG

HOSTEL Division of Labor

HOSTEL

At first, the triple stack SpaceHab Moonbase would house space-intensive functions:

- “Bedrooms” with personal computer
- Lounge-Chapel-Dining “ward room”
- More ample exercise room
- Growing Library (multi-media)
- Office
- Dry space-needing workstations
- Dry storage for samples, sorting, etc.
- Panoramic visual access to the outside (if not in the original landing stack, then a priority for early added modules)

With each visiting frog, more equipment would be brought in to gradually develop operational autonomy for the outpost (i.e. without docked frog). As the hostel becomes better equipped, each frog mission can

- Main (solar power) generation equipment
- Electrolysis equipment for LH2, LO2 using waste water as a feed stock
- Fuel Cells to turn LH2 & LO2 into power and fresh water during nightspan
- Toilet, shower, laundry facilities
- Unpressurized rover
- Expanded medical facility

As successive frogs need to arrive ever less “loaded,” they can bring along more and more cargo. Finally, the last “frog” mission can leave the frog on the Moon to serve as the outpost’s pressurized lunar exploration / field trip rover / coach / campmobile. When its crew needs to be replaced, it can go home on the next visiting vehicle. The “frog” would become a “toad” in effect, giving up its amphibious spacefaring capacity for a wholly ground-based future.

Design Objectives of the 1991 Hostel Study

In writing our paper for ISDC ‘91, we had four principal objectives:

1. Define the logical division of functions between visiting vehicle and shelter,and how these differ with the particular purpose of the hostel and the prospects for its future
2. Define design constraints on the visiting vehicle. Co-designing this vehicle will be necessary if the potential of the hostel approach is to be realized
3. Outline logical paths of evolution towards stand alone status for the Hostel
4. Examine possible architectures, whether for pre-fabrication on Earth or for construction on the Moon using native materials.

Our ultimate purpose, however, was to define the easiest, lowest possible threshold for returning to the Moon with a shelter that could gradually be developed into a fully autonomous outpost, capable of supporting crews throughout the lunar dayspan-nightspan cycle (the “sunth”) as a beachhead on the Moon that could grow in time to become a resource-using industrial settlement for people choosing to make the Moon their homes.

While pursuing this “define and design” exercise, we realized that the hostel approach was ideal not only for an initial “return” to the Moon, but for a tended lunar farside radio astronomy facility, and for establishing additional footholds on the Moon in areas remote from the initial outpost site.

Artemis Moonbase Reference Mission vs. Hostel

It is not our purpose here to suggest an alternative to the current SpaceHab stack design for the initial Artemis Moonbase. Rather we want to suggest a better way to carry out that mission, a better way to insure that it is not another dead end stunt, only with a commercial twist. From the Apollo moonwalk “picnics” to setting up a permanent cabin or camp on the Moon is a big step. It requires more than setting down a pressurized structure. We hope this essay encourages reexamination of the Reference mission, integrating these proposed improvements.

Meandering Through The Universe

A Column on the Cooperative Movement
on the Space Frontier © 2002 by Richard Richardson

Continuing last month's exploration of Minimum Cost Design (MCD)

So what are the implications of Minimum Cost Design? How does it apply to settling space — using for our example (as noted in last month's column) an Earth-to-space launch rocket?

Let's begin with the material which makes up a great deal of the mass of the launch vehicle — the frame and skin. There may be some examples of high-tech composites or other materials used to construct the frame and/or skin of some rocket powered launch vehicles, but by far, the most common material used is aluminum. But steel is stronger. So why aluminum? The idea is that the less mass that the engine has to push, the better. And aluminum has considerably less mass per volume than steel (it's lighter). If it's lighter, then the payload can be heavier, *or* the rocket can get the payload moving faster, *or* a combination of both.

So, why not use paper? It's much lighter than aluminum. Obviously there are other considerations, like heat resistance and strength. There are a number of forces which act upon the frame and skin of the launch vehicle. The structural components are there to maintain connection between the various parts of the entire system, to maintain the necessary orientation of the engine to the rest of the system, and to maintain many other critical relationships (which are usually taken for granted) between the various components of the system ... and to do so under all normal operating conditions. The skin provides other critical functions, though most pertain to operation in an atmosphere (which applies to our specific example, here) but it is usually possible to use less or no skin for purely space based vehicles. Anyway, aluminum is used because it is strong enough to resist the many forces acting against the structural integrity of the launch vehicle, it's lighter than steel, and the technology for working with it is well established.

Yet, it seems probable that cost has been almost completely ignored with very simplistic assumptions taking the place of careful analysis. It is assumed that the less the mass of the material used to build the frame and skin of the vehicle, the more efficient the system, and therefore, the lower the cost to operate the system. But this is a specious argument. There is no law of physics to justify it. Nor is there support for such reasoning in economics. The same applies for advanced composite materials. Lighter (less mass), when not required by physics, does not always equal greater economic efficiency.

To start, we have to ask ourselves what our purpose is. What *is* our goal? To settle space. Why has the job not already been done? Cost. We have the bare essentials of the necessary technology but we haven't spent the money to make a fleet of space vehicles and the rest of the necessary space transportation infrastructure. We haven't spent the money for various reasons, but primarily because it would cost too much.

So what is the key factor in moving us closer to our goal of settling space? *Decreasing the cost of the job.*

Now, getting to our example of a launch vehicle, let's look at the aluminum vs. steel question. Common steel can take about 35,000 pounds per square inch of tension (if my source is correct). Aluminum has about a 20,000 psi capacity (same caveat). So steel has about 1.75 times the tensile strength of aluminum. But steel weighs about 2.8 times as much as aluminum. However, according to Mark Goll (Texas Spacelines, Inc. chief — if you will recall from last month), aluminum costs about 5.8 times more than steel. I'm guessing that this is on a pound per pound basis, but I suspect that a per volume or per strength basis would be more pertinent. However, since I believe the conclusions are still valid, let's proceed, continuing with Mark's numbers. But maybe the structural engineers among us could spare some brain time to hash this out a bit to determine whether per mass unit or some other comparison would be the most useful.

Anyway, we have comparisons of strength, of weight (really, mass), and of price. Both can meet the structural characteristics necessary for the job. Which is better (considering our goal)? Let's plug in the numbers for a hypothetical rocket constructed of aluminum with the following parameters:

Given:

- 100 lbs of fuel
- **I***sp* of 250
- Mass ratio: 4.5 (therefore, *ln***(MR)** = 1.5)

So, *delta***V** =
I*sp* * *ln***(MR)** * **g** = 250 * 1.5 * 32 = 12,033 ft/s^2.

Now let's see how steel compares:

Given:

- 100 lbs of fuel
- Mass ratio: 3.3 (therefore, *ln***(MR)** = 1.19)
- **I***sp* of 250

So, *delta***V** =
I*sp* * *ln***(MR)** * **g** = 250 * 1.19 * 32 = 9520 ft/s^2.

Clearly, aluminum wins the *delta***V** comparison on a per mass unit basis ... just as we would have expected. But let's consider economy now. How much *delta***V** do we get per dollar. Expressing *delta***V** in ft/s (following Mr. Goll's lead), our steel vehicle has:

- *delta***V** of 9520 ft/s^2

(Remember that *delta***V** is acceleration, ie, change of velocity.)

Given our mass ratio and amount of fuel, we come up with a total aluminum mass for the first rocket of about 28 lbs and about 43 lbs of steel for the second one. If a pound of steel costs 12¢ and a pound of aluminum costs 70¢, then the aluminum rocket's metal costs $19.60 and the steel rocket's metal, $5.16.

So, for the aluminum rocket *delta***V/$** =

12033ft/s2/$19.60, or **614**ft/s^2 /dollar.

And, for the steel rocket *delta***V/$** =

9520ft/s2/$5.16 = **1844** ft/s^2/dollar.

Notice that we get about 1230ft/s^2 more per dollar from the *steel* rocket than from the aluminum one. Also note that aluminum is more difficult and expensive to work with, more susceptible to damage, and, to meet strength requirements, often has to be worked into more complex shapes, often with more individual parts, which increases costs further.

Okay, let's say we want to change the velocity of our simplistic hypothetical rocket from 0ft/s to 20,000ft/s. It will (theoretically) cost us:

for aluminum:

20,000 ft/s^2 /(1 dollar/614ft/s^2) = **$32.57**

and for steel:

20,000 ft/s^2 /(1 dollar/1844ft/s^2) = **$10.84**.

Scale this up a few tens of thousands of times, and which one would you rather pay for?

The question then becomes: Are there engines powerful enough to accelerate a steel rocket with useful payloads at a high enough rate of acceleration to be able to move it out of Earth's atmosphere and into orbit before exhausting its fuel? If smaller payloads had to be the norm, then a corollary question might be along the lines of: Are there ways to make due with smaller payloads or smaller *delta***V** s? Answers might be found through any of a variety of strategies such as on orbit assembly, fabrication on the moon from lunar materials and then shipping from there, etc? **<RRR>**

Richard's homepage:
http://richardpatricia.homestead.com

A Friendly Reminder

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SENTRY - An Automatic Near-Earth Asteroid Collision Monitoring System

For World Release: 13 Mar 2002 Jet Propulsion Lab

NASA's Near-Earth Object Program Office (http://neo.jpl.nasa.gov) announces the arrival of the Sentry automatic impact monitoring system. In development for nearly two years, Sentry is a highly automated, accurate, and robust system for continually updating the orbits, future close Earth approaches, and Earth impact probabilities for all Near-Earth Asteroids (NEAs).

When interpreting the Sentry Impact Risks Page (http://neo.jpl.nasa.gov/risk/), where information on known potential NEA impacts is posted, one must bear in mind that an Earth collision by a sizable NEA is a very low probability event. Objects normally appear on the Risks Page because their orbits can bring them close to the Earth's orbit and the limited number of available observations do not yet allow their trajectories to be well-enough defined. In such cases, there may be a wide range of possible future paths that can be fit to the existing observations, sometimes including a few that can intersect the Earth.

Whenever a newly discovered NEA is posted on the Sentry Impact Risks Page, by far the most likely outcome is that the object will eventually be removed as new observations become available, the object's orbit is improved, and its future motion is more tightly constrained. As a result, several new NEAs each month may be listed on the Sentry Impact Risks page, only to be removed shortly afterwards. This is a normal process, completely expected. The removal of an object from the Impact Risks page does not indicate that the object's risk was evaluated mistakenly: the risk was real until additional observations showed that it was not.

While completely independent, the Sentry system is meant to be complementary to the NEODyS CLOMON impact monitoring system operated in Pisa, Italy. Personnel from both the Sentry and NEODyS systems are in constant communication, cross checking each other's results and providing constructive feedback to continuously improve the efficiency, accuracy, and robustness of both systems.

The Sentry system was developed largely by Drs. Steve Chesley and Alan Chamberlin with significant technical help from Dr. Paul Chodas. Ron Baalke provided web site updates. Donald K. Yeomans manages NASA's Near-Earth Object Program Office.

In the April Popular Science issue

"Seven ideas that will correct NASA's trajectory and get Americans to love the space program again" by Dawn Stover"

http://www.popsci.com/popsci/aviation/article/0,12543,216204,00.html

♂ Mars Society Updates ♂

Dispatch from Mars Base Utah

Robert Zubrin -- Feb 7, 2002

After months of delays, the Mars Desert Research Station finally went operational today. A lot of things are still balky, the satellite communication system is behaving erratically, much of the internal network doesn't work, and there is a problem with one of the water pumps. But we have a completed and fully provisioned station, afairly well equipped lab, a good power system, five functioning spacesuit simulators, three good ATV's, sufficient satellite and local UHF com capabilities to function, and a highly qualified crew that is willing to do what it takes to push through. So today we began.

MDRS is the 2nd Mars analog research station built & operated by the Mars Society in remote areas. The first was the Flashline Mars Arctic Research Station, which started work on Canada's Devon Island last summer. This one is located in the desert west of Hanksville, Utah, amid several hundred square miles of unvegetated, uninhabited land. The landscape is composed largely of red Jurassic sedi-mentary rocks, that look as much like Mars as one could desire, and whose varied geology provides an excellent target for Mars exploration operations research.

For the next 3 months our station will operate here with varied crews in a series of 2-week rotations. We will attempt to conduct a sustained program of field research into the geology, paleontology, micro-biology, etc, of the area while working in the same style and under many of the same constraints as we will have to do when we explore Mars. For example, crew members will wear elaborate spacesuit simula-tors whenever they go outside. These suits limit their mobility, dexterity, agility, endur-ance, and ability to see and hear in much the same way that an actual spacesuit would. Our communication with the outside world is through a (currently rather balky) satellite link to Mars Society Mission Support in Denver. Together with the virtual backroom of science experts that Mission Support can muster, the crew must do theanalysis of the samples collected in the station's lab, repair and maintain their equipment, and handle the reportage and chores of daily life.

This is not the optimal way to do field science, so we don't expect to make many original discoveries about the Utah desert. But, while we are trying to do quality natural science, natural science per-se is not our objective. Instead, we are using the search for knowledge about the surrounding desert in much the same way as a marksman uses a paper practice target; his goal is not to put holes in the target - that could be easily accomplished by stabbing the target paper with a screwdriver. Rather, he is using the target as an aid in learning how to shoot. It is the same with us. By attempting to produce themaximum science return we can while operating under Mars mission type constraints, we hope to start learning how to effectively explore on Mars.

This first season will last 3 months. Before it is over we planto conduct underground searches for water with electromagnetic sounding equipment, ground penetrating radar, and possibly seismic devices. These are essential tasks that humans will need to do on Mars. We will operate a closed-loop ecological life support system to recycle the water of the station, and we will see not only whether or not such a system works, but whether it is a morale booster or a fatal drain on crew time. We will do both intensive pedestrian exploration near the hab and motorized exploration at long distances from the base. We may, as we did last summer in the Arctic, be able to implement combined human-robot exploration operations to test which tactics work and which do not. What kind of robots or other tools do we really want to have on Mars to assist human explorers? This is a key question. The most impor-tant step in any engineering design process is to define the require-ments. It does no good to design and build a superbly engineered system if it is the wrong system to do the job that needs to be done. That's why operations research of the type we will do here is so important.

We made a start doing this kind of work with our Flashline MarsArctic Research Station. But Mars simulation operations on Devon Island are extremely expensive, and realistically, are only possible during the summer months. With the opening the Mars Desert Research Station, however, research operations will now be possible nearly year-round. This will allow a much larger quantity and variety of investigations to go forward.

The first crew coming from various locations, met each other for the first time in Hanksville this morning. We then drove out to the hab together. Our team includes Steve McDaniel and Troy Wegman, both biologists. Steve is a PhD turned attorney, who works with the Texas Technology Litigators firm. Troy does microscopy for the Mayo Clinic. There are also two women: Jennifer Heldmann a planetary geology PhD student from the University of Colorado, and Heather Chluda, and aerospace engineer who works on the Space Shuttle program at Boeing-Rocketdyne. Finally the crew is rounded out by Frank Schubert, the Project Manager, who works as an architect, and me, an astronautical engineer. I'm in command, but only for a week. After that I will be rotated out and replaced by Tony Muscatello, a chemist who leads Mars Society Mission Support. Frank will also leave after a week to be replaced by Professor de Wet, a geologist from Franklin and Marshall University. Everyone else will stay for the full two weeks, after which another 2-week long volunteer crew will take their places.

We got to the station around mid morning and worked together as ateam hauling in the lab equipment and the provisions for the season, and following that, cleaning the place up. Then, while Steve and Troy set up the biology lab, Frank fixed various things, Heather and Jennifer programmed our mobile weather station, and I labored, with only partial success, to get the Starband satellite dish to work. I can see why these things aren't very popular. Believe me, if you have a DSL line, a cable modem, or a copper telephone line for thatmatter, don't get a satellite dish. These gadgets are finicky. Sometimes they work fast, sometimes very slow, sometimes they lose link in the middle of a transmission and you have to start all over again.

But then again, the communication links from Mars won't always be so great. We'll fix it if we can, live with it if we have to. We start field operations tomorrow. **<RZ>**

More at: http://www.marssociety.org/MDRS/2002Dispatches/0208/index.asp

Gary Fisher of Philadelphia Area Space Alliance (PASA) and President of the Independence Chapter of the Mars Society, points at a topographic globe of Mars on which low basins are blue, suggesting that they were once an ocean basin.

1st MDRS Simulation Season ends May 4th

This inaugural season there will be a total of six 2-week 6-person crew rotations at MDRS, ending May 4. The crews have had equal numbers of men and women, and of foreign and U.S. nationals.

After May 4, the MDRS will cease simulation operations for the summer, during which time Mars Society simulation research will continue at the Flashline Mars Arctic Research Station on Devon Island and the MDRS will be used for public outreach and educational activities.

The MDRS will then resume operations in October for its 2nd field season ending May 2003.

MDRS Biology Report

from Steve McDaniel Feb 8, 2002

The biology lab was completely brought online by this evening. All components including equiment and supplies arrived from NASA-JSC and Texas A&M University and were deployed. The equipment in place includes a UV-fluorescent scope and supporting supplies, a gross specimen examination scope, microfuges, vortex mixer, micropipettors, hot plate, and magnetic stirrer. The Hab weather station will be operational on 09FEB02 and will add several additional data points to the sample data.

With all components in place and the Hab laboratory relatively cleaned, we are poised to implement all three phases of the biology mission.

1. Primary biology mission is to create a photosynthetic survey of lithic microorganisms in the Hab vicinity. Samples are taken and as many data points as possible are taken at the sample site. These include GPS coor-dinates, elevation, relative light meter readings, angle of incidence of sun to sample, etc.
2. Secondary biology mission includes return of the samples to the Hab, and further analysis. The further analysis includes gross specimen microscopic evaluation for rock type and gross biological characterization, subdivision of the sample into a portion to be preserved in 2% glutaraldehyde under refrigeration, a portion to be subjected to fluorescent microscope evaluation, and a portion to subject to the tertiary biology mission.
3. In the tertiary mission, we will test each lithic organism sample for its ability to hydrolyze organophosphorous test compounds in order to detect cold-tolerant versions of the hydrolytic enzyme, organophosphorus acid hydrolase.

To keep up to date on activities at the Mars Desert Research Station in Utah, visit (and bookmark) this address for the MDRS "Construction Shack:"

http://www.marssociety.org/mdrs/2002Dispatches/index.asp

Project Greenhab is responsible for building the **MDRS greenhouse**. The purpose is threefold.

1. provide a wastewater recycling system, reducing resupply requirements for the station
2. establish a research facility for Humans-to-Mars related life support
3. simulate the appearance of a cylindrical inflated structure as a visual and operational analog to a possible Mars base greenhouse.

Segment one of a planned three-segment structure was erected at the site in November. Construction of its twin, at U-Maryland-College Park starts soon. The UMD segment will be used for testing equipment and procedures for the MDRS segment, as well as for ongoing research and class projects at the University.

SOLAR SYSTEM AMBASSADORS

Michelle Baker
Princeton/Philadelphia
chaos@cybernet.net

Bill Higgins
Chicago, IL
higgins@final.gov

Harald Schenk
Sheboygan, WI
hschenk@excel.net

Bill Hensley
Kenosha, WI
hensley@acronet.net

www.jpl.nasa.gov/ambassador

[For the Latest in the long struggle for "Cheap Access to Space"]

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Information: Henry Vanderbilt <sas@nlzero.com>

iSDC 2002 DENVER

May 23-27, 2002
Tech Center Marriott Hotel

Important Dates:
4/1/2002 last date to submit papers
5/1/2002 last date to register at the **$90** rate
($100 at the door)

The Lunar Reclamation Society, Inc.

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Ad Astra per Ardua Nostra
To the Stars through our own hard work!

LRS OFFICERS (area code 414) unless specified

LRS PRESIDENT, MMM/MMR Editor - Peter Kokh*****
<kokhmmm@aol.com> 342-0705
SECRETARY/TREAS. - Robert Bialecki***** . 372-9613
MMM Assembly/Mailing - Charlotte DuPree
<cmdupree@netwurx.net> .... [262] 677-9149
MMM Database Manager - Joe Mackowski
<jmackowski@execpc.com> 546-9520
LRS/MMM Business Manager - Mark Kaehny*****
<kaehny@execpc.com> .... [262] 424-3073
(* LRS Board Members)

LRS NEWS

• **LRS hustles to rescue Newsletter:** The continued publication Of Moon Miners' Manifesto has been seriously threatened by a continued steady stream of price increases both for printing and for mailing. All through January and February, the LRS leadership struggled with costs and ways to run a neater, and tighter ship. Our overly generous practice of sending complimentary issues to VIP's has been drastically reined in. And we are instituting measures to keep the mailing list up to date. If these measures do not succeed, the future of MMM is in doubt. Times are quite different from those when we began in 1986!

• **Standardizing dues dates:** Incoming treasurer, Bob Bialecki wants all renewals to be prorated so that in subsequent years, the dues for all members will be payable in January each year. LRS members will receive postcard instructions as expiration dates approach. Thanks to all members in advance for their cooperation on this reform issue, designed to stream-line our bookkeeping procedures. Dues have been raised to **$18** regular, **$15** student/senior

LRS MARCH / APRIL Events

Saturday, MAR 9th & APR 13th, 1-4 pm

LRS Chapter Meeting, Mayfair Mall, Garden Suites **Room G11** (lower level, NE part of Mall) near the ground-level entrance below General Cinemas. FEB AGENDA: shuffling officers' duties; 2002 events.

U.S. CHAPTERS

NSS Chapter Events
MMM
6 Chapters Strong

Space Chapters HUB Website:

http://www.nss.ac/hub/

CALIFORNIA

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OASIS: Organization for the **A**dvancement of **S**pace **I**ndustrialization and **S**ettlement

P.O. Box 1231, Redondo Beach, CA 90278

Events Hotline/Answering Machine: (310) 364-2290
E-mail: nssofla@yahoo.com

http://chapters.nss.org/oasis

Officers: Pres. Steven Bartlett; VP Diane Rhodes: Treas. Karin Ward; Secr./Database Robert Gounley; Newsletter Ed. Kris Cerone: webmaster Craig Ward

☞ **Regular Meeting 3 pm 3rd Sat. each month**

Information: OASIS Hotline, 310/364-2290; website.

MAR 16th -- OASIS Monthly Business Meeting at the home of Kris Cerone, 2703 Delaware St., Huntington Beach. *OASIS Hotline*, 310/364-2290

APR 20th -- Business Meeting at location TBD

MAY 18th -- Business Meeting at location TBD

- **Recurring Events**
  - **The Griffith Observatory** is undergoing renovations and upgrades to reopen in 2003.
  - **The Griffith Observatory** is temporarily closed to the public forrenovations and upgrades. It should reopen in 2005. More information: http://www.GriffithObs.org/renovation.html
  - **Fridays, 7 pm** "Night Sky Show." -- **8 pm** Guest lectures. Santa Monica College John Drescher Planetarium, 2nd Floor Technology Bldg, 1900 Pico Blvd. $4 per show or $7 for both. 310/452-9223 www.smc.edu/events/weeklyeven.
  - **Fridays** -- "Mike Hodel's Hour 25" webcast. The world of science fact and fiction with interviews, news, radio dramas, artists, writers, stories, reviews. Info: www.hour25online.com/.

MINNESOTA

Minnesota Space Frontier Society

c/o Dave Buth, 5120 Ewing Avenue North, Brooklyn Center, MN 55429
612-721-4772 (Dave Buth) 612-375-1539 (Jeff Root)
Email: mnsfs@freemars.org

www.FreeMars.org/l5/index.html

- **MN SFS Displays:** MN SFS has put up displays describing STS-109/HST 3B: Rejuvenating the World's Greatest Observatory, Display Info is based on the current STS press kit at:
  http://www.shuttlepresskit.com/index.html
  We've been doing this for every flight since STS-26.
- **Pix from MarsCon:** www.freemars.org/mnfan/marscon/2002/fri-parties/

OREGON

Oregon L5 Society, Inc.

P.O. Box 86, Oregon City, OR 97045
voice mail / FAX (503) 655-6189

http://www.OregonL5.org/

Allen G. Taylor <allen.taylor@ieee.org>
Bryce Walden <BWalden@aol.com>
(LBRT - Oregon Moonbase) moonbase@home.com

☞ Meetings **3rd Sat.** each month at **2 p.m.** **Bourne Plaza, 1441 SE 122nd**, Portland, **downstairs** NEXT MEETINGS: **MAR 16, APR 20**

Dues Increase: At our February 16th meeting, we voted to raise our chapter dues to **$25** to cover the rising costs of getting *Moon Miners' Manifesto.*

WISCONSIN

Sheboygan Space Society

728 Center St., Kiel WI 54042-1034

c/o Will Foerster 920-894-2376 (h) <willf@tcei.com>
SSS Sec. Harald Schenk <hschenk@excel.net>

>>> DUES: "SSS" c/o B. P. Knier
22608 County Line Rd, Elkhart Lake WI 53020

http://www.tcei.com/sss

☞ We meet the 3rd Tuesday of the month at **7-9pm**

MAR 19th UW-Sheboygan, **Sheboygan**
APR 16th MEETING at the Stoelting House in **Kiel**

Philadelphia Area Space Alliance

PO Box 1715, Philadelphia, PA 19105
c/o Earl Bennett, EarlBennett@erols.com
215/633-0878 (H), 610/640-2345(W)

NEW URL **http://pasa01.tripod.com**

Note : PASA is now on the tripod.com system

• **PASA** regular business luncheon/formal meeting from **1-3 pm**, the **3rd Saturday** of every month at the **Liberty One** food court on the 2nd level, 16th and S. Market. Go toward the windows on the 17th street side and go *left*. Look for table sign. Parking at Liberty One on 17th St. Call Earl Bennett or Mitch Gordon 215-625-0670 to verify all meetings

NEXT MEETINGS: **MAR 9th, APR 20th, MAY 18th**

• **Scheduled PASA activities:** Grorge Washington Carver Science Fair activities and award being determined, March 9th meeting. In July, members are to appear as speakers at the World Future Society Annual Convention details later.

• **February 9th Meeting Report:** We met on the 9th to accommodate several members of the board who where engaged in other things on our normal, 3rd Saturday, meeting dates. *Dorothy Kurtz* brought in pictures from her and *Larry*'s trip to England in January where they visited the location of the original Mars Invasion (H.G. Wells not Bob Zubrin!) complete with a Mars fighting machine in the town square. She also had pictures from the New Jersey site which has an artistically decorated plaque which commemorated the 1930s Orson Wells broadcast.

• **Dues Increase:** We have decided to increase dues per year to **$20.** This was to give us more to pay for an increase in the costs to *Moon Miners' Manifesto*, which we use as our public record of our activities and as a great source of information and to help with costs of various events. This works out to $5.00 per quarter which is easy to remember and handle. March is our annual renewal month. Those who have renewed earlier will be "grandfathered".

Hank Smith gave a report on *Philcon* which will be held in December this year at a center city hotel in Philadelphia. He will also participate and attend several conventions this spring including *Balticon* which *Michelle Baker*, myself, and *Dotti* and *Larry* plan to attend also in May. This is due to the strong sciences tract at this convention. *Earl Bennett* Gave a quick report on NASA's continued explorer device development in this case "Seed-Wing Flyers for Exploration" by Sarita Thakoor and Carlos Miralles for the J.P.L. of NASA. The device pictured in the January 2002 *NASA Tech Briefs*, page 47 looks like a maple seed outline which would fall from a dispenser and, given an atmosphere, disperse on wind currents. The authors speculate that this kind of device could be built with current and near term future elements (sensors, power control, radio etc).

Another article from the John F. Kennedy Space Center described "An Advanced System for Growing Plants in Microgravity" paid for by two S.B.I.R grants (us) and done by a host of researchers at *Orbital Technologies Corp.* It doesn't look like much in the photos but the engineering specs include scaling to a large chamber up to 16.5 x 37.5 x 40.4 cm. The last picture shows plants grown in the system apparently. Several people commented on doing plant growth — recycling this way, and how obviously creating an artificial/pseudo gravity by spinning would eliminate the need for this technique for most missions. The publication noted above was unusually dense with good articles but the magazine *Sensors* for February 2002 also had an interesting write up on "Micropropulsion for the Aerospace Industry" on page 43 of that publication, outlining the use of *micoelectromechanical fabrication* applied to the development of tiny rocket engines and ancillary feed equipment. (See www.sensorsmag.com)

Mitch Gordon gave a short report on NSS from their publication *Ad Astra* whose theme was "The Dawn of Astrobiology" and included articles on fleets of small rovers, including flyers, and the *Europa Penetration Probe* that would use nuclear energy as a thermal source. No report on the World Future Society Convention here in July.

• **Other Activities and Discussions:** Our members will participate in the *George Washington Carver Science Fair* again.The addition of the elementary school division for *The James H Chestek Award*. This use of the award was suggested by *Mike Fisher* who, with *Michelle Baker* will judge for this award at *The Academy of Natural Science* location. The middle and senior award will be *The Oscar H. Harris Award* for our late member who worked closely with the science fair organization and with educational institutions here over the years. Oscar was our Educational Outreach Coordinator and was working on our being part of the Fair and developing a *Space Architecture* dialog with *The Charter High School for Architecture* in Philadelphia at the time of his death. Our Special Awards Judges for the prize will be *Gary Fisher* and *Mike Fisher* (not related) at the Temple University site. Two *Intel Play QX3 Computer Microscopes*, by *Mattel*, will be given with the senior group winner also getting a check. We also had a guest, Dr. Janet Guidotti, who was a participant.

Report submitted by Earl Bennett

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Send proper dues to address in chapter news section

=>*for those outside participating chapter areas* <=

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