

“Towards an Earth-Moon Economy – Developing Off-Planet Resources”

Moon Miners’ Manifesto

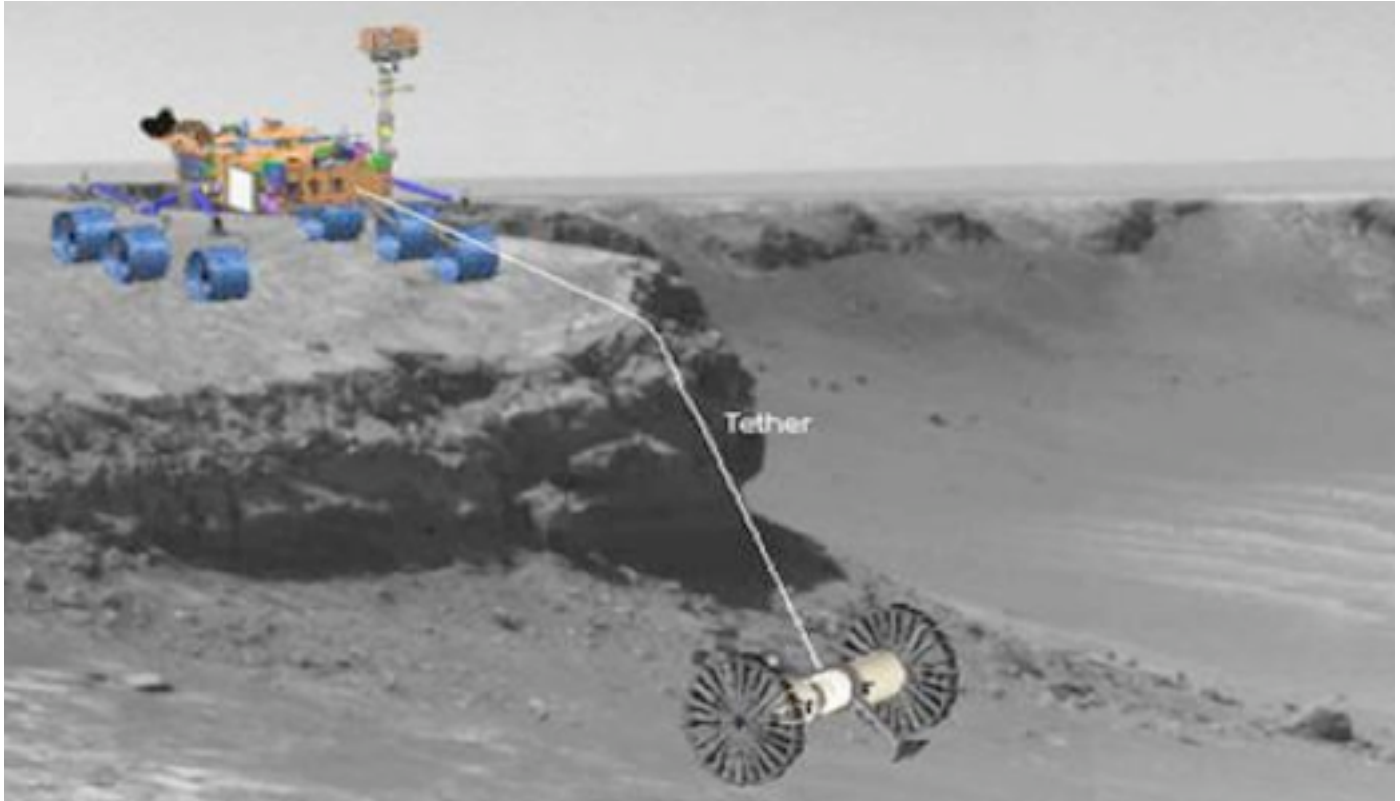
& The Moon Society Journal

www.MoonMinersManifesto.com

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This issue begins MMM’s 25th year

DECEMBER 2010



NASA-JPL’s “AXEL” can winch itself down into a crater – *Next, one that could descend into a lava tube Skylight?* ⇒ p 9

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A Farside Radio Telescope Array & S.E.T.I.

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Orion, saved for ISS Crew Return, over Farside➔

President Obama’s decision to save the Orion Capsule, and all the work gone into it so far, may be the key to sneaking in a Moon Mission into the “Flexible Path” as dress rehearsal for Asteroid and Mars moon missions. This is an ingenious proposal and apparently one with no obvious downsides for all concerned, And we stand to learn much more about the Moon and its mysterious farside secrets, increasing public awareness. Pages 5-7.

IN FOCUS “Space Travel” Revisited

Back in 1947 when the “flying saucer” (later the “UFO”) craze began, I was nine years old, and already into aviation, rocketry and science fiction. We were experimenting with captured German V-2s then, and I recall the excitement when we got one up to 60 miles high. Two years later, in 1949, I really got excited when we bounced a radar signal off the Moon and got it back: for me, that first “interplanetary feat” was the beginning of the space age. [→ p. 2, col. 2]



Moon Miners' Manifesto

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www.MoonSociety.org/publications/mmm_classics/

• **MMM Glossary: new terms, old terms with new meanings:**
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• **MMM's VISION:** "expanding the human economy through off-planet resources"; the early era of heavy reliance on Lunar materials; early use of Mars system and asteroidal resources; and establishment of permanent settlements supporting this economy.

• **MMM's MISSION:** to encourage "spin-up" entrepreneurial development of the novel technologies needed and promote the economic-environmental rationale of space and lunar settlement.

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• **The National Space Society** is a grassroots pro-space membership organization, with 10,000 members and 50 chapters, dedicated to the creation of a spacefaring civilization. National Space Society, 1155 15th Street NW, Suite 500, Washington, DC 20005; Ph: (202) 429-1600 - www.NSS.org

• **The Moon Society** seeks to overcome the business, financial, and technological challenges to the establishment of a permanent, self-sustaining human presence on the Moon." - Contact info p. 9.

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

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⇒ In Focus Editorial continued from p. 1.

Space Travel in pre-1960s Science-Fiction

What developed in the real world did not at all follow the prevalent Sci-Fi script in which all rockets were "atomic" and went intact from one planetary surface to another, no castaway "stages", few transfer hubs. And with few "launchtrack" exceptions ("When Worlds Collide") they were what we now call VTOVL - vertical take-off, vertical land - except there were no gantries. Rockets were self-sufficient and stood on their tailfins, of course.

Once we decided to try to put things in orbit, we soon realized that our rockets were not powerful enough unless we built them in stages: when the bulk of the launch fuel was expended, we jettisoned the fuel tank that had held it, along with the motors that burned it, continuing on our way with a smaller rocket that had been carried aloft on top of the "first stage." We didn't have "atomics" yet. And thus was born the culture of "throw-away" rocketry.

Von Braun realized, that if we were going to go beyond orbit, to the Moon or Mars, we would need bigger ships than could be launched from Earth as a third stage, that is if our crew was going to be expedition-sized. It never occurred to him that we could do something useful with a crew of two. But then we were suddenly in a space race with the Soviets and we couldn't take time to build an orbital assembly and refueling operation to launch his lunar fleet of three ships, all with sizable crews, and surface tractors. So we had to go direct, in order to win, not realizing that in doing so, in the long term, we lost. Not that anyone else won. We all lost, sucked into a paradigm that was impossible to maintain.

Analogies from rail travel

For those of you who do not remember the pre-Amtrak days, there were many independent passenger railroad companies, some semi-continental, others very regional. Chicago was the predominant hub, where one transferred from one railroad and train to another. But here and there, local lines collaborated. I recall taking a train from Pittsburgh to Cleveland in the late 1950s. The engine out of Pittsburgh belonged to one rail line, the engine pulling into Cleveland to another. The passenger cars made it through but the engines were switched at some point in between (Youngstown?)

Now for Moon-bound passengers, that is one analogy that might work. One vehicle takes the passenger cabin from Earth's surface to a LEO hub, another rocket takes that same cabin to the lunar L1 hub, and a third takes it down to the lunar surface.

But considering that at both ends there are multiple destinations, the airline model of feeder lines from Earth's surface to a LEO hub, then one jumbo carrier from LEO to L1, then multiple shuttles from L1 to various destinations on the lunar surface. So passengers would change cabins at each hub. Unless there was a way to gang together the various cabins coming from Earth and barge them in tow to L1 where individual tugs would take them to various points on the Moon.

Either way, *until we have those mythical atomics*, the idea of going in one vehicle from Earth's surface to the Moon doesn't look feasible.

What has this to do with today? Perhaps nothing, but it is holiday time, and something light and interesting seemed to be appropriate. *Blessings to all!* **PK**

Outer Space Resources or Bust!

"All the elements needed for
Solar Power Satellite construction
can be found on the Moon and in asteroids"

By Dave Dietzler

Foreward

In a nation where women spend \$100 billion a year on fashion, half the people are overweight or obese, and debate rages over global warming despite the fact that the majority of the world's scientists agree that man-made global warming is real, a few of us think about the future and the creation of a space faring civilization. Ominous clouds hang over this future, but there can be no doubt that the technologies exist to prevent the downfall of civilization.

Options and Alternatives

Nuclear fission, breeder reactors and thorium could power civilization for centuries if we are willing to tolerate a meltdown now and then and underground disposal sites for nuclear waste. Geothermal energy might "save the day" in a non-polluting way, but we must wonder if a geothermal well can compete with a 10 GWe SPS. At five cents per kilowatt-hour an SPS construct could sell \$4.38 billion worth of electricity per year! 10,000,000 kilowatts * 8760 hours/year * 0.05 dollars per kilowatt-hour. Only 30 of them could deliver \$131.4 billion per year worth of electricity. A thousand of them could provide half the world's energy demand in 2050 if all consumption was electric rather than thermal. The profits from a small number of SPS could be reinvested in the construction of larger numbers of SPS and conceivably a thousand or more of them could be afforded.

What it would take to build an SPS system

It is estimated that a 10 GWe SPS would amass 100,000 metric tons at least. To build merely 30 of them would require 3,000,000 tons of aluminum, silicon, glass and other materials. Mass drivers on the Moon launching 600,000 tons of material per year have been envisioned, thus it would take only five years to launch three million tons of materials into space from the Moon.

97% is not good enough

Here's the catch--I have often read that 97% of the materials needed for the construction of a SPS would come from the Moon and the rest from Earth. That means 90,000 tons of material must be launched from Earth and at the rock bottom price of \$10,000 per kilogram to GEO or L5 this would cost \$900 billion! For bootstrapping lunar mining bases we were only considering a few thousand tons at most! There can be no disagreement:

One hundred percent of the materials needed to build SPSs must come from outer space after bootstrapping up all the infrastructure needed to produce those materials from a seed of only a few thousand tons launched up from Earth.

At least that's how I see it.

Easy things first

Aluminum, silicon, glass, iron and many other materials are abundant on the Moon. Processes like metallothermic reduction with calcium or the use of electrostatic isotope separators can extract those materials easily enough.

The harder part

What about copper, zinc, nickel, cobalt, platinum and other metals?

Isn't the Moon so deficient in these that we might as well "throw in the towel" and forget about Moon mining and go to Mars? The answer is a loud and resounding "NO."

Meteoritic fines

About half a percent of lunar regolith, both mare and highland, consists of meteoric iron fines that contain about 5% nickel and 0.2% cobalt. Robotic vehicles with magnetic separators can sift through vast areas and millions of tons of regolith to get those meteoric fines and they can then be processed with carbon monoxide gas or electrostatic isotope separators to get iron, nickel and cobalt separately. Nickel can be used to alloy iron and as a catalyst and cobalt can make high strength drill bits and machine tools.

Pyroclastic glass

Copper, zinc, gallium and chlorine are present in lunar pyroclastic glass. They form coatings on the surface of the glass particles and can be extracted simply by roasting or possibly with fluid solvents. From 19.5 million tons of volcanic glass, that's in the range of regolith mining schemes proposed for mining volatiles, iron fines, etc. we'd get by roasting the glass at over 1000 C. about 1.1 million tons of oxygen; 8,800 tons of sulfur; 5,800 tons of zinc; 1,900 tons of chlorine; 1,900 tons of iron; 1,500 tons of nickel, 510 tons of copper, and 310 tons of gallium [1]. That much glass could be mined from an area about ten kilometers square to a depth of about one or two meters in one of the glass fields near Aristarchus or in Mare Serenitatis. That's about 2500 acres and a rancher or farmer would not find that intimidating. Launching 510 tons of copper up from Earth at \$10,000 a kilo would cost \$5.1 billion and that is intimidating. As for roasting at over 1000 C., some would ask where all that energy would come from and I would simply say that large parabolic foil reflectors and solar furnaces would be called for. Certainly we could bootstrap up the industry required to produce all these materials on the Moon rather than spend \$58 billion to get 5,800 tons of zinc into outer space!!!

PGMs

What about platinum group metals? The lunar regolith is actually somewhat enriched in these elements; a result of eons of meteoric bombardment. Clever chemical engineers should be able to figure out how to extract these.

Capturing a suitable half-megaton mini-asteroid

If PGM extraction on the Moon is too challenging, we could mine asteroids for them. In Wikipedia we read, "A NASA design study evaluated a 10,000 ton mining vehicle (to be assembled in orbit) that would return a 500,000 ton asteroid fragment to geostationary orbit. Only about 3,000 tons of the mining ship would be traditional aerospace-grade payload. The rest would be reaction mass for the mass-driver engine, which could be arranged to be the spent rocket stages used to launch the payload.

"Assuming that 100% of the returned asteroid was useful, and that the asteroid miner itself couldn't be reused, that represents nearly a 95% reduction in

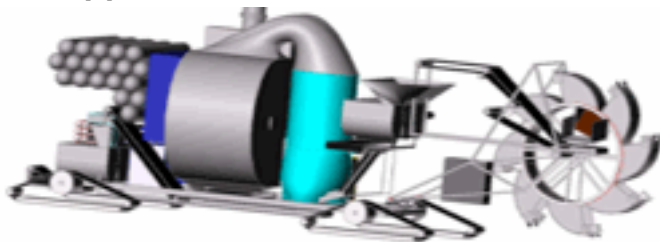
launch costs. However, the true merits of such a method would depend on a thorough mineral survey of the candidate asteroids; thus far, we have only estimates of their composition."

Finding just the right asteroids

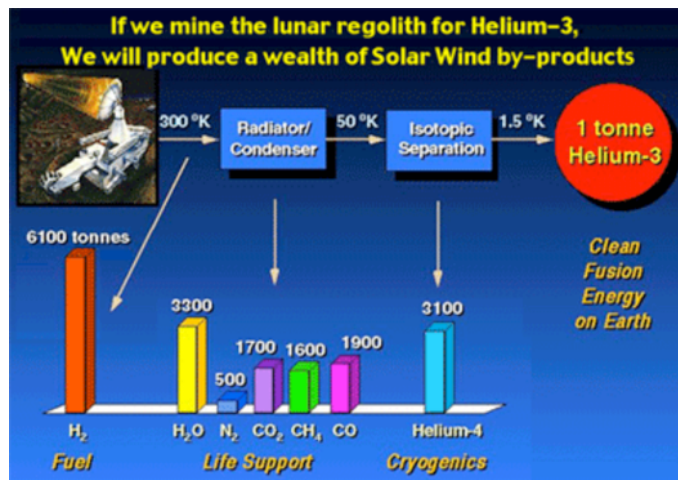
There is no reason in the world why we cannot do thorough mineral surveys of NEAs with telescopes and space probes to determine their precise composition. With lunar industry, the construction of robotic ships with lunar materials becomes more inviting. Certainly, we can acquire PGMs from outer space for use in space and on Earth.

Solar Wind Volatiles

What about light elements like carbon, nitrogen and hydrogen? These do exist in the lunar regolith and their production along with helium 3 has been studied. One Mark 3 miner like that proposed by Dr. Kulcinski and others at the University of Wisconsin could produce 109 tons of H₂O, 201 tons of H₂, 16.5 tons of N₂, 56 tons of CO₂, 63 tons of CO, 53 tons of CH₄, 102 tons of He₄ and 33 kg. of He₃ in a year's time. That's 82 tons of carbon contained in CO₂, CO and CH₄. If 201 tons of H₂ is combined with 1600 tons of O₂ that's another 1800 tons of H₂O [3].



The Mark-3 Miner



Polar Cold Trap Ices

There are richer sources of water and carbon in the permanently shadowed craters of the lunar polar regions. Millions of tons of ice containing water, carbon dioxide, ammonia and other compounds and elements have been proven to exist on the Moon. The "cryotechnologies" needed to mine in these super-cold craters must first be developed, but where there is a will there is a way. Expect this new technology thrust to be a major direction for NASA and other space agencies in the coming decade, as "ground truth" landers follow orbiters.

Carbonaceous asteroids and old burned out comets might also be sources of light elements.

KREEP

Rare earth elements also exist on the Moon, mostly in KREEP terranes. The term KREEP stands for K-potassium, REE-rare earth elements, and P-phosphorus. Do not be misled into thinking that these minerals are purely potassium, REEs and phosphorus. They are mostly SiO₂, Al₂O₃, FeO and other constituents of most lunar rock, but the KREEP minerals are richer in these elements than typical lunar rocks. It would then be logical to mine these minerals and extract the K, P and REEs. Rare earth elements are used for optical glass, electronics, lasers, magnesium alloys, electric motors, magnets, computers and cell phones. Certainly they will find their way into the high power electronics of SPSs and it would be more cost effective to mine them on the Moon rather than ship them up from Earth.



This rock is rich in KREEP Potassium (K), Rare Earth Elements (REE) and Phosphorous (P) elements rare on the Moon but abundant in the splashout from the impact that created Mare Imbrium, the nearside "Sea of Rains" - This resource may be vital to lunar industries and is not found at the poles.

All we need is out there

In conclusion, all the elements needed for SPS construction can be found on the Moon and in asteroids. Sophisticated robotic machines that can dig through millions of tons of dry lunar regolith every year and roast out solar wind implanted volatiles or boil metals off the surfaces of volcanic glass particles will be needed. Artificially intelligent space ships will be needed to mine asteroids. Bioleaching might be used to extract elements present in low concentrations from lunar regolith. This will require water, nutrients, salts, temperature control etc. Environmentally controlled habitat will be needed to use bioleaching.

Decades of development ("bootstrapping") on the Moon will be required to build industry up to a point at which these machines and other equipment can be manufactured on the Moon with onsite materials and enormous quantities of materials can be extracted from lunar regolith and asteroids to supply a large SPS construction project.

- 1) www.moonminer.com/Lunar_Volcanic_Glass.html
- 2) http://en.wikipedia.org/wiki/Space-based_solar_power
- 3) www.moonminer.com/Lunar-Water-and-Carbon.html

About the writer: For nearly a decade, Dave Dietzler, co-founder of Moon Society St. Louis, has contributed quality articles on the possibilities for Lunar industry. **MMM**

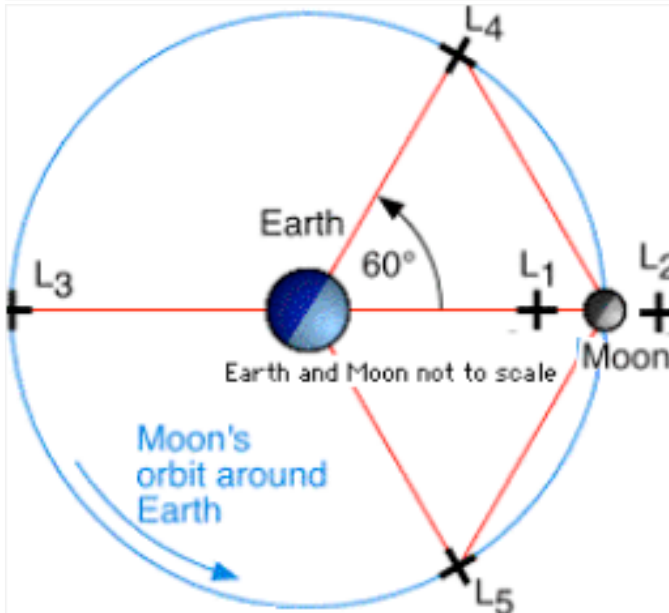
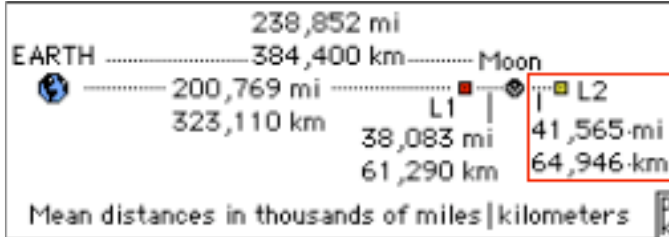
Lockheed-Martin Proposes Tele-Robotic Exploration of the Moon's Farside From the L2 "Perch" using its Orion Crew Capsule

By David A. Dunlop and Peter Kokh

Proposal to Send Astronauts to Moon's Far Side

By Leonard David: 23 November 2010

<http://www.space.com/news/moon-far-side-astronaut-mission-101123.html>



This proposal is a clever bit of "space strategy" in the context of the US political climate.— D. Dunlop

An L2 Mission and the new "Flexible Path"

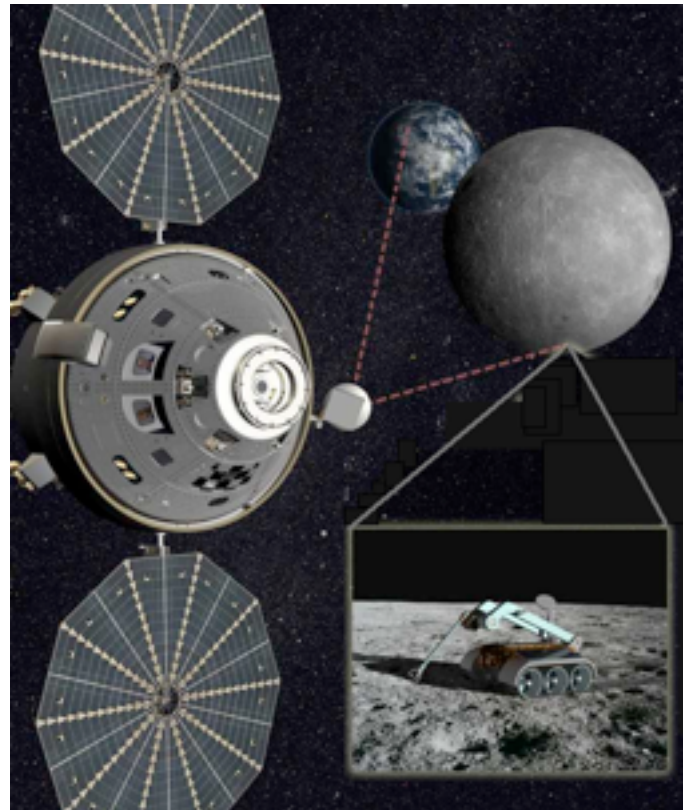
Instead of a Manned Space Program focused on the Moon, the new space paradigm is a "Flexible Path" that would use deep space missions of increasing difficulty to advance our capacity to operate beyond Earth orbit. Missions to near Earth asteroids, then to the moons of Mars have been identified as consistent with this goal.

But there just may be a neat way to sneak in a manned Moon Mission. LockMart would not send its craft and crew to the Moon's surface but rather to the stable L2 point some 40,000 miles above the Moon's Farside. Here the crew would be able to stay in contact with Earth but also teleoperate rovers on the Moon's farside surface that would investigate some of the Farside's secrets and mysteries. These science goals are at the top of the wish list of many, if not most, lunar scientists, as Farside is notably different from Nearside in several ways.

Lockheed-Martin cites these mission plusses:

- It could sharpen skills and technologies needed for a trip to an asteroid
- It showcases techniques useful for exploring Mars by teleoperation as astronauts orbit the red planet.
- It would serve as a "shakedown cruise" to practice medium duration missions and the higher-speed reentry needed for exploration missions before the next step – missions to asteroids.
- It would demonstrate additional capabilities for longer and more distant exploration before the Mars orbit mission.
- It would prove out the Orion capsule's life support systems for a one-month duration
- It would measure astronauts' radiation doses from cosmic rays and solar flares to verify that Orion provides sufficient protection, as it is designed to do

All of these demonstrations need to be done at any rate, and doing them from a point beyond the Moon, increasing our knowledge of the Moon and our operating abilities on its surface seem to this writer as a bouquet of plusses. Not to support this mission, because it is not the lunar human return mission we want, would be foolish.



Above: The Orion craft left, with a view of farside while in line of sight with Earth, teleoperating surface rovers.

This proposal reinforces the Obama Administration's space goals of advancing NASA's mission to go *beyond LEO to the asteroids and Mars* while actually first going to the Moon to pursue lunar exploration goals that would otherwise be abandoned. This nicely positions it to be supported by the Republicans in control of the House and who favored the Constellation Moon program. It ensures continued funding for the Orion capsule, which is being built under Marshall Space Flight Center in Alabama, and it supports lunar lander projects.

The Advantages of an L2 Teleoperations Perch

From a "halo" orbit around the L2 Lagrange point where the Moon's and Earth's gravitational forces cancel each other out, at an average distance of 41,500 mi ~ 65,000 km above the center of the lunar farside, the Orion capsule could remain in-line-of-sight of Earth, essential for communications, while being able to teleoperate robotic equipment anywhere on the lunar farside surface below, something that otherwise cannot be done directly from Earth or Earth-orbits. The lunar "farside" is the side of the Moon never visible from Earth, as the Moon turns on its axis in the same period of time that it orbits Earth, always with the same "nearside" facing us. It is sometimes erroneously called the darkside of the Moon but Farside takes its turn in the sunlight just as does the familiar Nearside and on the same 29.5 day cycle.

The point is that there is much on the farside that has our scientific curiosity aroused. Lunar probes in low lunar orbit have mapped this whole area in visual light and other revealing wavelengths. But such craft, being out of line-of-sight of Earth at the time, cannot be used to relay teleoperation commands to robotic equipment on that side of the Moon. If we want "ground truth" landers and rovers to tell us more, we either have to fully automate them, letting them download their findings to orbiting craft when they pass overhead, for delayed relay to Earth, or we have to have such a perch as L2 from which human teleoperators can work directly.

Beyond operation of ground truth probes, at some time we might want to preconstruct landing areas, and places to store supplies for future manned surface missions. From L2, all this is possible. From L4 and L5 we can see 60° around the limb of each side of the Moon, but cannot see the central Farside 60° slice.

Having a lunar lander vehicle (which had been eliminated with the cancellation of the old Constellation program is also another way to "practice for Mars". The lunar exploration roadmap calls for a sortie mission capability to sample areas of the Moon other than those visited by Apollo. So these are "face-saving" ways to consider putting back the human lunar lander module in the NASA budget. In essence this is a way to have a Moon Program without calling it a Moon Program! *But this is not part of the Lockheed-Martin Proposal.*

Hardware: Getting Orion to L2: Heavy-lift vs. Delta-V

Another fight in Congress is about the development of a heavy lift launch vehicle versus man rating the Atlas V. *This scenario show that it could be done either way.* If an Atlas V was used to boost Orion into LEO then another vehicle (Centaur) would have to rendezvous and dock with it to boost it beyond the Moon. The Orion capsule is too heavy to be boosted by the Falcon 9. So using Orion in essence makes the Atlas V the key launcher system for manned operations beyond LEO. It also creates a requirement for secondary launches to fuel these missions. That also is something *that justifies fuel depot requirements*, which is yet another strategic piece that is needed to routinely go beyond LEO and the ISS.

Salvaging parts of the puzzle

Rendezvous and docking is another one of the strategic capabilities covered in the new Obama budget. Development of an unmanned heavy lift vehicle that uses shuttle-derived technologies and infrastructure is what Congress demanded and which keeps up employment

levels at Marshall, Johnson, and Kennedy space centers. It would continue to use the space shuttle main engines, the external tank, and solid rocket boosters like the old shuttle system. It would however have a top mounted large (15 m diameter) faring. This is in essence the Direct Proposal that was an underground rebellion against the old Aries V design.

This is also a political fight within NASA and within Congress. Some at NASA want to see everything contracted out while others want to preserve a NASA government launch capability with its associated infrastructure and employment.

Political suspense

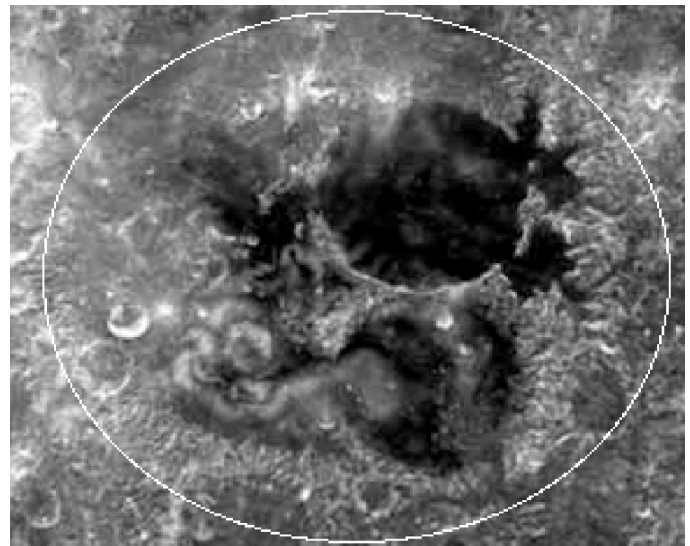
The real issue is whether NASA will be deeply slashed and cut back to 2008 expenditure levels of \$17.4B from the recently agreed \$19B level or continued on the current spending level on a continuing resolution basis in Congress if no political agreements are reached.

Our curiosity about the Moon's Farside

If you look at a globe of the Moon, the farside and nearside look like parts of two different planets. Some 2/5th of the nearside is covered by the dark lava plains, called maria (MAH-ri-a) or "seas." Lava basalt products will be a key early industry, and the pre-sheltered subsurface lavatube networks that are found in these "seas," may become the major areas for human settlement. The farside, in contrast, has a much smaller share of such dark, basaltic terrain.

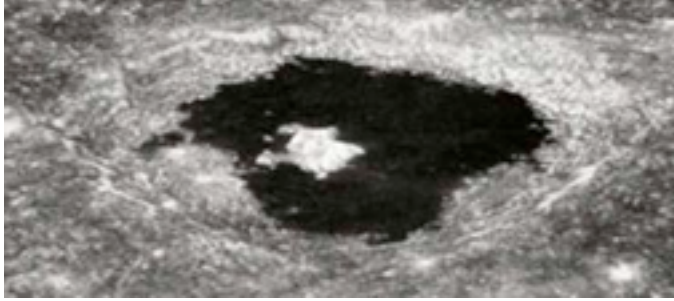
And between the equator and the South Pole on farside, lies the deepest and largest lunar basin. As there are only scattered areas of subsequent lava flooding in this basin, it is expected that some of the basin floor may be covered with lunar mantle material, so far unsampled. However, some central peaks of larger craters may contain upthrust mantle material as well, and there are plenty of these on the nearside. But we won't know until we go there in person or with teleoperated mining equipment and samplers similar to Mars-bound Curiosity.

The growing interest in the Moon's farside is thus mainly a scientific one. But make no mistake; the farside will see its share of human frontier activity. Some of the relatively flat lava sheet areas may make ideal sites for extensive of radio telescope arrays, future successors to those at Socorro, NM and the larger array now being built in Chile's Atacama Desert: ALMA. [following article]



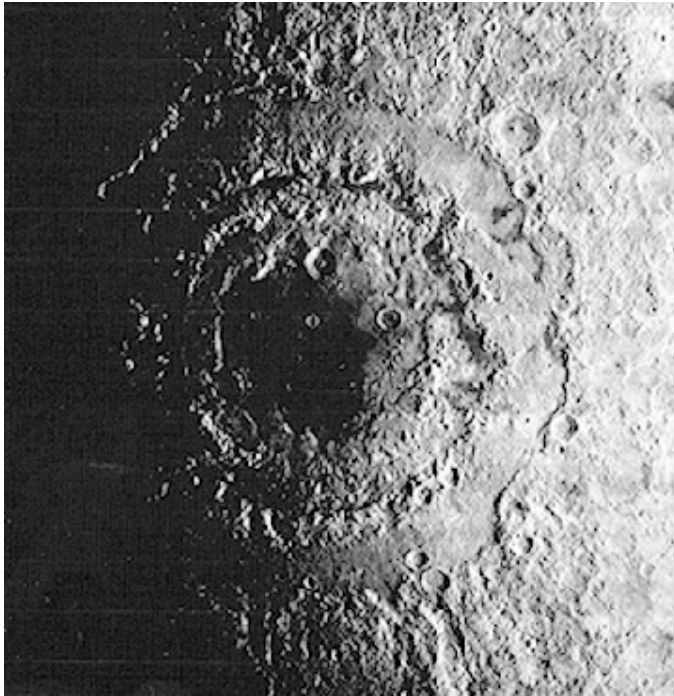
Bottom previous page: Mare Ingenii, which could host such an array, is of special interest because it has a small local magnetic field” antipodal to the point of impact that created the great nearside Mare Imbrium basin. The ionized plasma cloud from that impact surrounded the lunar globe in minutes, converging over Mare Ingenii.

Below: The Crater Tsiolkovsky has a dark sheet of lava covering it, with a magnificent bright central massif, Mt. Nikolas (if we follow our suggestion to name central Peaks with the first or given name of the person in whose honor the crater has been named) From a distance, such as from L2, this crater will stand out, proud.



Some very low altitude areas in the Apollo crater might have mantle material on the surface.

And then there is the most spectacular multi-ringed “bullseye” impact basin on the Moon, Mare Orientale, just beyond the limb in Farside – *below..*



Additional Science Goals on Farside:

The International Lunar Network Commitment

There are international agreements NASA has signed for the development of an International Lunar Network. This initiative is also located a Marshall. It involves placing four different landers on the lunar surface. There is also a push for a lunar lander sample return mission at the South Pole Aitken Basin in the Science Mission Directorate competition for a large new mission. This proposal ties that mission to the manned mission so a number of lunar related missions are involved.

http://en.wikipedia.org/wiki/International_Lunar_Network

”The **International Lunar Network** or **ILN** is a proposed network of a series of landed stations of the **United States** and the other **space-faring countries** on the lunar surface in the 2010s. Each of these stations will act as a **node** in a lunar **geophysical** network. Ultimately this network could comprise 8–10 or more nodes operating simultaneously. In the ILN concept, each node will have a minimum of two core capabilities. These capabilities include seismic sensing, heat flow sensing, and laser **retro-reflectors**, and will be specific to each station. Because some nodes are planned to be located on the **far side of the Moon**, **NASA** will study a lunar communications relay satellite capability as a part of its contribution to this project.[1]

“Individual nodes launched by different space agencies can and likely will carry additional, unique experiments to study local or global lunar science. Such experiments might include atmospheric and dust instruments, plasma physics investigations, astronomical instruments, electromagnetic profiling of lunar **regolith** and crust, local geochemistry, and **in-situ resource utilization** demonstrations.[1]”

Lunar Science Program, Science Mission Directorate, NASA.Solicitation Number: NNH09ZDA005L. Release Date: November 17, 2008

While we are there: a Farside Phase Photo Set

This Mission as proposed would last two weeks, allowing the crew to teleoperate probes and rovers on the surface for the full 2-week long dayspan duration at any one place. But we might want to teleoperate more than one rover at more than one place, mutually displaced east-west from one another, the mission would need to be longer to fit in partially overlapping local dayspans.

But for however long the crew is hovering over the farside, they could take daily Moon Phase photos. These photos are useful for the enriched long-shadow terrain details they show along the day/night and night/day terminators. We have no such photos of the farside, and this inexpensive frosting project would contribute to public familiarity with “the rest of the Moon.”

Close-ups of areas ideal for a farside Radio Telescope array dedicated to the S.E.T.I. would also increase public interest; also photos of farside lava tube skylights.

The farside has much fewer lava flow mare areas; its crust seems to be notably thicker than that on the nearside; its southern South-Pole Aitken (“SPA”) basin is the largest and deepest on the Moon and may expose deep mantle materials not sampled by the Apollo crews.

Where does advocacy come in?

While such a mission would not put humans on the Moon, it would increase our knowledge of the Moon and could fill in many blind spots in our grasp of the Moon’s history and future potential. *Further, it would keep the Moon in the public eye, increasing support for a future manned return.*

The Moon Society has yet to consider taking a position on this option! We do not know if there is an NSS position. Speaking for myself, this sounds like a win-win proposal for both lunar and Flexible Path advocates. Time will tell if it goes anywhere. But we see no downsides.

MMM

A Farside S.E.T.I. Radio Telescope Array

By Peter Kokh

In the previous article, we suggested that the deployment of a major array of cutting edge state of the art Radio Telescopes could most easily be done through teleoperation of robotic construction equipment from a perch in the Earth-Moon Lagrange 2 position some 45 thousand miles ~ 65 thousand kilometers above the lunar Farside surface. Such a facility has been the dream of many for several decades. As a boy in my teens in the 1950s, I dreamt of being assigned to such a facility and making a career of it (I have a monastic side).

For most of us, the special appeal of such a location is not for radio astronomy itself, but as the most radio-quiet place within a few light years from which to listen to the “sussuri” – [Latin] “whispers” from the stars, from other intelligent species out there. Yet these days, there is a quite premature discouragement settling in among SETI advocates – those focused on Searching for Extraterrestrial Intelligence, or clear signs thereof.

Why haven't we found any “others” yet?

“We should have heard something by now!” This is a common complaint among the impatient. Yet as the same time, the odds of the existence of other “Earths” out there have never seemed greater. “Nature never does anything once,” I quote. But people forget that *Time is as Vast as Space*. That a civilization would be found that was not only “nearby” but also “contemporary” with ours is asking to win the cosmic lottery twice in one dice roll.

The difficulty barrier

But there is more to consider. For the most part, we have only been listening, and briefly, with many intermissions. If every species that wanted to broadcast their existence also did so intermittently and for short periods, it is easy to see how we could have missed their signals. If a race wants to be heard, to be found, it should occur to them that broadcasting must, once begun, continue indefinitely: not for a few days, not for a few years; not for a few centuries. Broadcasting must be a species “cathedral-building” class endeavor, absorbing considerable resources of power and cost.

Simply put, it is *orders of magnitude easier to listen than to broadcast*. The upshot is that it is not unlikely, given the cathedral-building demands cited, that “*everyone is listening, no one is sending.*”

Whom would a sender want to reach?

I'm not afraid to tell anyone that I am a romantic; it doesn't pay to be anything but. So it is not surprising that I find a universal logic in the Star Trek myth (if you will) about the “Prime Directive.” A superior civilization should avoid contact with inferior ones, as that contact could destroy them, snuffing out their own native inventiveness and originality. Human history is full of examples where contact between unequal civilizations has meant the death of the inferior one. *This is ongoing!*

It is not likely that there are any inhabited worlds where such unequal cultures *have not* come into contact. So as a culture matures, it must come to the conclusion that premature contact is not a friendly thing to foist on inferior civilizations, no matter how eager individuals of an inferior civilization may be to skip painful progress on their own, and beam ahead historically through access to advanced technologies.

What is a “primitive” technology?

Well certainly any civilization, which has not come to caring terms with its own environment, must be judged as primitive. Ours certainly qualifies, as those who care about preserving the health of the environment, which nourished us, are still in the minority, effectiveness wise. We still decide things by armed conflict or by financial battles. Face it, as far as we have come, *we are very much an adolescent species.*

Now it could be that one reason our ventures into space have been so discontinuous, halting, unsure, is that we simply do not have our act together yet. Let's suppose that a mature, environment-conserving species able to resolve all issues by a process that sidestepped conflict and aggression and resulted in widespread consent, wanted to reach out to other species, but only to species at its own state of maturity. *How would they filter out signals from getting through to those who were not ready for them?*

Well, picking a wavelength that could not pass through a breathable atmosphere (oxygen, water vapor) might be one way. If you sent signals that not only could not be picked up on the surface of a habitable planet, but could not even be picked up where radio-noise from an adolescent civilization was pervasive, then you might have reason for confidence that no one would detect or read your message who was not ready for it.

Not all habitable worlds are going to have moons of size that are rotationally locked, as is our Moon. But perhaps, one could hope, that a civilization mature enough technologically, culturally, environmentally, etc. to deploy a radio array on the farside of such a moon, just might be mature. By this argument, it is not at all surprising that we have heard nothing, but that on the other hand, once we are advanced enough to build a major radio array on our Moon's farside, we just might, with a lot of luck, pick up intelligent signals. Now the chances are greater that such signals reach us from far away in space-time, and are not those of a nearby and contemporary civilization.

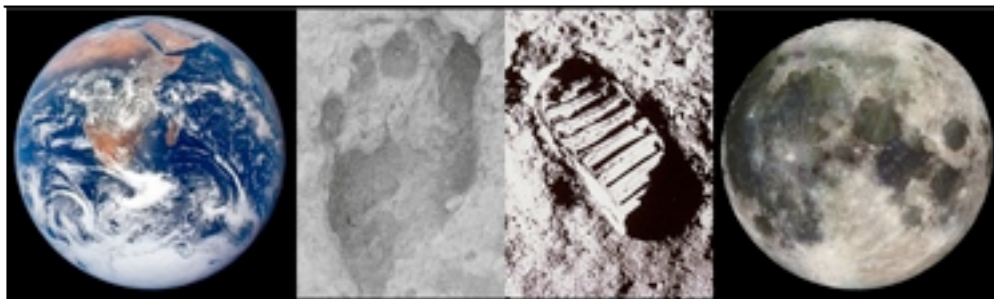
Recently, we have grown more optimistic that the our galaxy has many millions of solar systems, and that there may be many worlds able to sire intelligent species sooner or later in their history. Top this by adding that the number of galaxies outnumbers the stars within our own. The universe must be full of life, the vast majority of such instances effectively isolated and out of contact with others by the barriers of time and space. For me it is enough to know that there must be others, virtually everywhere and everywhen, however mutually remote. Here and there will be pairs of civilizations that beat the odds and find themselves neighbors in both space and time. For me, it is enough to look up at the stars and say “Hi,” fully confident that all over space *and time* there are others looking up in wonder and doing the same.

Building first a Radio Array on farside and then finding wavelengths that can go the distance but not be picked up by those not ready for them, and then building a facility to send out messages of our own: “Hi there, we made it! You can too! Life is worth it! May you find all the richness that we have found and continue to find. We go through life apart in space and time, but together in spirit. Peace, love, courage, persistence!”

After many decades of contemplating “SETI” this is where I'm at.

PK

From Africa
to the Moon,
the Human
Epic, told in
footprints,
continues
to the Stars!



Our Goal is
Communities
on the Moon
involving
large scale
industriali-
zation and
private
enterprise.

Objectives of the Moon Society

include, but are not limited to:

- Creation of a spacefaring civilization which will establish communities on the Moon involving large-scale industrialization and private enterprise.
- Promotion of interest in the exploration, research, development, and habitation of the Moon, through the media of conferences, the press, library and museum exhibits, and other literary and educational means
- Support, by funding or otherwise, of scholarships, libraries, museums and other means of encouraging the study of the Moon and related technologies
- Stimulation of the advancement and development of applications of space and related technologies and encouragement their entrepreneurial development
- Bringing together persons from government, industry, educational institutions, the press, and other walks of life for the exchange of information about the Moon
- Promoting collaboration between various societies and groups interested in developing & utilizing the Moon.
- Informing the public on matters related to the Moon
- Providing suitable recognition and honor to individuals and organizations which have contributed to the advancement of the exploration, research, development, and habitation of the Moon, as well as scientific and technological developments related thereto.

Our Vision says Who We Are

We envision a future in which the free enterprise human economy has expanded to include settlements on the Moon and elsewhere, contributing products and services that will foster a better life for all humanity on Earth and beyond, inspiring our youth, and fostering hope in an open-ended positive future for humankind.

Moon Society Mission

Our Mission is to inspire and involve people everywhere, from all walks of life, in the effort to create an expanded Earth-Moon economy that will contribute solutions to the major problems that continue to challenge our home world.

Moon Society Strategy

We seek to address these goals through education, outreach to young people and to people in general, competitions & contests, workshops, ground level research and technology experiments, private entrepreneurial ventures, moonbase simulation exercises, tourist centers, and other means.

Monthly Moon Society Progress Reports: visit our Homepage <http://www.moonsociety.org> and scroll down the center of the page to the prominent [yellow Frontlines link](#). This report has been issued monthly since April 2008.

Our Lavatube Skylight Explorer Engineering Concept Competition

By Peter Kokh, President

When I first saw the image (see front cover) of the novel JPL AXEL probe, I knew right away that this was a concept that might be adapted to probe into the several lavatube “skylights” we have been finding on both Moon and Mars these past few years! There would have to be design changes and adaptations. The cable, in order to allow the probe to winch itself down some hundreds of meters into a lavatube skylight, not just down a few meters into a small and shallow crater, would have to be lighter weight, thinner, and stronger so as not to increase the AXEL-probe’s weight. And it would have to carry data, sending back measurements and readings taken to the rover anchored above on the skylight rim, should the probe not be able to winch itself back up to the surface.

The winch has to be on the probe, not on the surface rover, to avoid the cable rubbing and possibly fraying on the skylight’s rugged edge. And quite a bit is at stake. *In the public mind*, both the Moon and Mars are barren, dusty rubble-strewn worlds with no “safe harbors.” Such a modified probe could send back data providing glimpses of *the vast underground sheltered spaces that exist on both worlds*, ready to house acre-hungry industries, warehouses, farms, archives and settlements, – that both worlds had extensive, safe, and friendly “*Hidden Valleys*.” This might change public perceptions to the point that the idea of human exploratory expeditions and even permanent outposts, would receive much more support. And we all know that public indifference is the core problem we face.

The weekend of November 5-7, Moon Society Director of Project Development David A. Dunlop and I drove down to the University of Illinois’ campus at Champagne-Urbana to take in the annual SpaceVision conference of the Students for the Exploration and Development of Space – SEDS. NSS was on hand as well. We had a chance to present our idea of a Lavatube Skylight Explorer Engineering Concept Competition to a room full of students and the reception was terrific.

You can download our PowerPoint presentation from www.moonsociety.org/competitions/engineering/

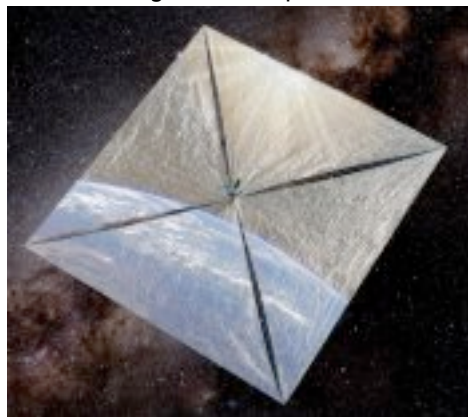
The Moon Society, the Lunar Reclamation Society, and the National Space Society have each pledged \$500 in prize money towards this project, and we hope to bring other sponsors and co-sponsors online as well. As we have to time this with the fixed academic school year, we expect to have the competition rules and constraints ready by the spring to allow faculty to line up what support they need, aiming at demonstrations and prize awards in the following spring of 2012. This seems a long time to wait, but we want results that will catch NASA’s interest, encouraging them to fly this mission! ●

A Student Solar Sail Competition

At the SEDS SpaceVision event, for an Encore, Dave Dunlop presented his proposal for a student engineering competition to design a CubeSat-type Solar Sail-powered communications satellite that would use the power of sunlight to drive it moonward, visiting one of the Earth-Moon Lagrange points, such as L4 or L5 before going into low lunar orbit.

Spacecraft in low lunar orbit have a hard time staying there. Dense mass concentrations, “mascons” below the lunar surface, whether the remnants of large dense impactors, or upwellings of denser mantle material on the impact rebound, function as attractors on anything in low orbit. The effect is to lower their perilune or closest point of the orbit to the Moon’s surface while raising the apolune, the highest point of the orbit. Even if the period remains the same, sooner or later, a craft’s low point will intersect with the Moon’s surface at very high speed. Oops! Most orbiters carry “course-correction” fuel to maintain a desirable minimum elevation over the surface. Dave’s idea is to have solar sails take over that function. If this approach turns out to be doable at less cost than carrying extra fuels and the thrusters to burn it, then we could put up lunar communications and GPS systems networks. So there is a lot to be gained if this type of craft proves feasible.

Phase 1 is to design such craft and their solar sails, all the time, minimizing weight, and thus the square area of the needed sails. Our fascination with solar sailing goes back some decades. It is an old proposal but we have not succeeded in flying the first one until Japan successfully launched, then unfurled, and is now sailing its Ikaros probe



The Planetary Society is getting ready to launch its first **LightSail 1**, built on a triple cubesat frame. Five years ago, the Society’s much larger **Cosmos-1** was lost in a launch mishap on a Russian rocket.

You can get a fair idea of LightSail1 from this video;

http://www.planetary.org/programs/projects/solar_sailing/video_20101018.html and you can keep abreast of this project at <http://www.solarsail.org> which redirects to: www.planetary.org/programs/projects/solar_sailing/

Back to basics

“A **CubeSat** is a type of miniaturized satellite for space research that usually has a volume of exactly one liter (10 cm cube), weighs no more than 1.33 kilogram,[1] and typically uses commercial off-the-shelf electronics components.”:- <http://en.wikipedia.org/wiki/CubeSat>

A tubesat has the same or similar volume and weight constraints but is designed to fit cylindrical payload farings. Dave Dunlop wants to find what student design teams can do within these kind of volume and

weight constraints. The shape is less important. For examples, simply do a Google Images search for “cubesat” and another for “tubesat.”

<http://images.google.com/imghp?hl=en&tab=wi>

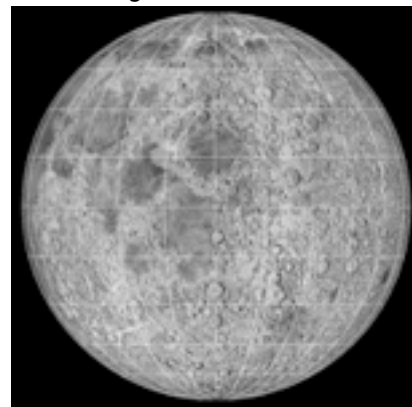
It is one thing to design and build the package itself, including solar sail, deployment mechanism, and the instruments payload package. We have no experience testing at how low an altitude we can unfurl a solar sail and have sunlight take it the rest of the way. Ikaros was unfurled well beyond the Moon, mostly because it had a free ride that far anyway, piggybacking on Akutsaka, JAXA’s Venus Climate Orbiter probe. The lower the altitude the more resistance from our atmosphere’s tenuous “exosphere.”

Along the way to the Moon

Phase 2 will be to actually build and fly the winning design. Using sunshine for power at very very low thrust, the craft would spiral its way out towards lunar orbit. The path could be chosen to pass through the L4 Earth-Moon Lagrange point, where the Earth’s and the Moon’s gravities cancel each other out. “Halo orbits” around L3 L4, and L5 are stable over long periods, the closer to the points themselves and the smaller any relative motion, the longer something stays in the area. In previous articles, going back twenty years or more, we have suggested that such areas are virtual “Sargasso Seas” of space, collecting dust and debris. There have been some observations of faintly lit ovals around L4 and L5 that would tend to confirm this theory. But to date, no craft has attempted to sample these clouds. For more, see; http://en.wikipedia.org/wiki/Kordylewski_cloud We might collect dust samples with a lightweight aerogel panel, to be checked for content at some later opportunity. A dust impact counter would provide a good idea of the size range and abundance of grains of various sizes.

While we are at L4

A small light-weight cell-phone type hi-res camera could take photos of the Moon’s phases from that angle to give us views of the Moon never before seen from a distance. Mare Crisium will be on center line.



Earth-Moon, Earth L-4, and L4-Moon are all equally distant (forming an isosceles triangle), c. 240,000 miles.

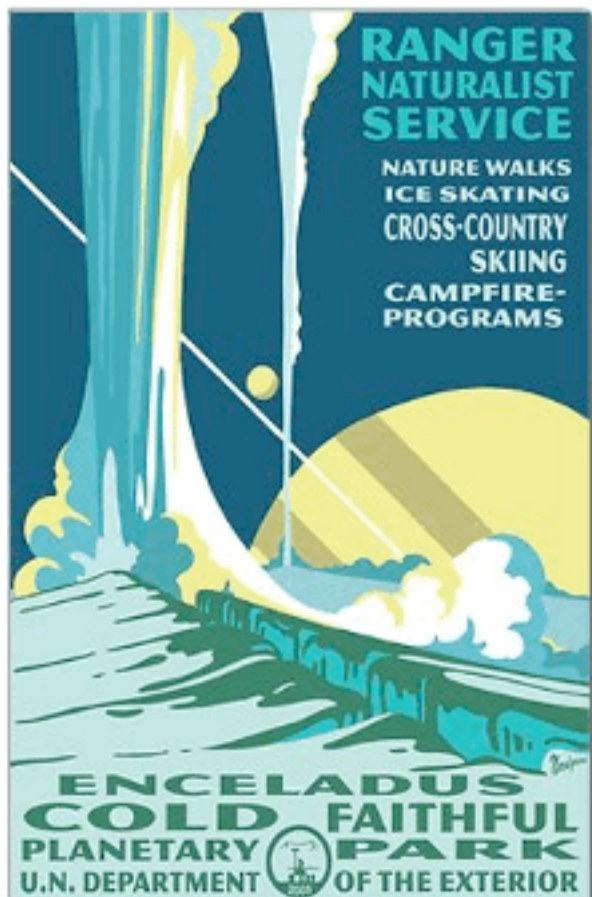
Arriving at the Moon

After a long leisurely sail from L4 the craft would spiral in to a working low lunar orbit, and demonstrate its communications relay capacities. This is an ambitious project, and we may have to settle for demonstrating the possibilities one phase at a time. That’s okay. We will be working ever so humbly towards a workable, low cost, lunar communications system for the lunar frontier.

This bold and innovative engineering competition has been floated to several student audiences and has been met with considerable interest and enthusiasm. **DD**

We are Looking for a Poster Artist

Below is one of several posters an artist created for The Planetary Society. This one features the geysers spouting from the south pole of the small ice moon of Saturn: Enceladus.



<http://www.cafepress.com/planetaryshop/7292099>

If you have this kind of talent, or know someone who does, we can think of all kinds of vistas on the Moon that would make great subjects for Tourist Posters of this sort. *Want to talk about it?*

Contact president@moonsociety.org

We could put them up for sale and split any profits. This would be a great way to spread our excitement about the Moon, and get across to the public at large that the Moon is anything but a boring place.

We might even be interested in some about Mars and in-space destinations en route to the Moon and elsewhere. Here is a chance to develop talents that might help you sell your work to more profitable outlets!

Art is a great way to get across our vision!

The Moon Society expects to announce one or more art contests in the coming year. One of these would help illustrate potential uses of lunar and Martian lava tubes. This art project would complement the Lavatube Skylight Explorer design competition announced on page 9 above.

Another might help celebrate the 40th anniversary of the Apollo 15 mission to the Lunar Apennine Mountains and Hadley Rille and the debut on this mission of the 2-man Lunar Rover. So stay tuned!

Bryce Johnson elected to Society Board. Replacing James A. Rogers

From Peter Kokh

Rogers to enter Military Service

It is with a combination of regret and best wishes that we announce to our members that we are losing our youngest Director to military service. At the November 17th Board meeting, the Directors accepted James' resignation and voted unanimously to appoint a replacement who will serve the remainder of the term ending August 1, 2011.

James has been a welcome addition to the Board, bringing not only the perspectives of youth, but badly needed talents. Among many other things, Rogers is the artist behind the left-hand and top page frame you see on almost all of our web pages other than the home page, including:

<http://www.moonsociety.org/about/officers.html>

He has contributed significantly to Lunarpedia, <http://www.lunarpedia.org> and to our MySpace and Facebook pages as well as to some of the discussion forums on the Moon Society Forum:

<http://moonsocietyforum.com/phpBB3/index.php>

We first met James at ISDC 2007 in Dallas. His Board of Directors election campaign statement was printed in MMM #225, May 2009, page 11. Now for his departing good deed, he has diligently recruited his own replacement. Bryce Johnson, whom he had met through our Facebook site.

Introducing Bryce Johnson

Bryce hails from Rockford, Illinois close to the Wisconsin state line. By coincidence, Bryce was one of the local residents we met early in 1987, as part of an NSS chapter "colonizing" effort by the Chicago Space Frontier L5 and the brand new Milwaukee Lunar Reclamation Society chapters. We have kept in touch over the years.

Astute MMM readers may recognize the name. Bryce has a special interest in the planet **Mercury**, an interest he has in common with myself, and he has contributed articles on this forgotten planet. [See Three Myths about Mercury, MMM #204] Look for more articles on this intimidating world deep down the throat of the Solar gravity well, as our Messenger probe goes into orbit about it on March 18th. 2011.

Society invites Disabled Veterans to join at the \$20 Student/Senior Discount Rate

Recently, a disabled veteran asked us if we would extend this discount rate to people in his classification. We did not need to think about this long to realize that this suggestion was a win-win affair.

The \$20 rate includes access to the newsletter pdf files, but not to mailed hardcopies of MMM to one's home. The \$35 rate allows selection of either (hardcopy subscribers retain access to the PDF files as well.

As a class, disabled vets may have more free time to get involved in the Society's projects and endeavors, and are well-educated in technological matters.

We plan to do an advertising campaign. In the meantime, if you know a disabled vet, let him or her know about us, and our discount offer!

Chapters & Outposts

Moon Society St. Louis Chapter

<http://www.moonsociety.org/chapters/stlouis/>

Contact: Keith Wetzel <kawetzel@swbell.net>

Next meetings – Dec 16th, Jan 19th, Feb 16th

Meetings 3rd Wed monthly at Buder Branch Library
4401 S. Hampton, in the basement conference room

On

Moon Society Phoenix Chapter

<http://www.msphx.org>

<http://www.moonsocphx.blogspot.com/>

Contacts: Craig Porter portercd@msn.com

Chuck Leshner: chuckmiester999@yahoo.com

Meeting the 3rd Saturday of the month

Moon Society Phoenix' next meetings are on

Saturdays Dec 19th, Jan 19th, Feb 19th

November 20th ~~misspelling~~ The regular monthly meeting was held as scheduled at Denny's at US 60 and Rural Road in Tempe.

Present at this meeting were Stuart Scott, Don Jacques, Mike Marron and myself. Old business for today included the Telepre-science RC Racing, The Lunar Habitat development and the Chapter Website.

Teleprescience Racing has 3 cars available and needs one more for the planned racing. Also available are one Remote TV camera, TV receiver and Monitor we need three more sets to complete the car modifications. We are also looking for the equipment that we will need for recording and broadcasting (internet) the races with funds being raised by the sale of copies of the races to the participants as a separate cost or as part of the entrance fees. Scheduling and Advertising have been put back until after the first of the year. Possible Venues include The Challenger Center in Peoria, Cub Scout Pine Wood Derbies, The Phoenix Science Center and others.

Lunar Habitat design and planning continue with various questions being raised and answers sought for a variety of problems. The Habitat group have opted for the lowest possible tech solutions and are building test designs for evaluations. This approach, in our opinion, allows us the position of letting nature to do its share of problem solving. We have noted the NASA 'one way' plans for Mars but are taking that into consideration in our planning. The work continues.

The Chapter Web Site continues to be a problem. Chuck has been unable to recover our original Web Site from the hackers. This leaves us with the options of starting a new site from scratch or not keeping a web site. If we choose to not keep a web site then we lose our ability to communicate with those that are interested in what we have to say and offer comments and suggestions. If we do keep a web site then that leaves us with several options, one is the old 'YAHOO' site, we could update it and go with it, or we can start a new site and go with it. Currently we are experimenting with 2 different sites, one by Mike on the carrier servicing his personal web site and Don is experimenting with a format on the same basis as Mikes, just different servers. Links to the sites will be on my blog later today or tomorrow for both sites for review and comments.

My blog site will be brought up to date and the new information will included as it is available and I will see if I can downloadable data available.

New business consists of what to have for panels and information for our outreach tables at the up coming Conventions in May and September. So far it is possible that I will be doing the "disaster Strikes" panel again with additional material included. I am thinking about presenting this same material to various groups that request it. Later this year I might even have some demonstrations on what can be done with materials around the home. Don and Patti will most likely have their Dealer's Table and do panels on Publishing and Writing and Don way have some panels on Science Topics. Craig D. Porter

Moon Society Houston Chapter

<http://www.moonsociety.org/chapters/houston/>

Contact: Eric Bowen eric@streamlinerschedules.com

The Houston Chapter's next regular meeting was scheduled for Monday, November 16 at Coffee Oasis at 4650 NASA Road 1 in Seabrook – Eric

Chapters & Outposts Map (North America)

www.moonsociety.org/chapters/chapter_outpost_map.html

Chapters & Outposts Events Page

www.moonsociety.org/chapters/chapter_events.html

===== Moon Society Outposts =====

www.moonsociety.org/chapters/chapter_outpost_map.html

Moon Society Nashville Outpost – Central Tennessee

Contact: Chuck Schlemm cshlemm@comcast.net

Bay Area Moon Society, CA Outpost – South Frisco Bay

<http://www.moonsociety.org/chapters/bams/>

Contact: Henry Cates hcate2@pacbell.net

Informal meeting at Henry Cate's home in San Jose

Now the 1st Tuesday every month

Moon Society DC Metro, DC–MD–VA Outpost

Contact: Fred Hills fred_hills@hotmail.com

Milwaukee, WI Outpost (MSMO)

www.moonsociety.org/chapters/milwaukee/msmo_output.htm

Contact: Peter Kokh kokhmmm@aol.com

The monthly Lunar Reclamation Society meeting on the 2nd Saturday afternoon every month serves MSMO also

NSS Partner Chapter News - pp. 17-19

Oregon L5 (Portland), Lunar Reclamation Society

(Milwaukee), Minnesota Space Frontier Society

(Minneapolis–St. Paul), San Diego Space Society

Moon Society DUES with Moon Miners' Manifesto

Electronic MMM (pdf) \$35 Students/Seniors: \$20

Hardcopy MMM: U.S./Canada \$35 Elsewhere: \$60

Join/Renew Online - www.MoonSociety.org/register/

Moon Society Mail Box Destinations:

Checks, Money Orders, Membership Questions

Moon Society Membership Services:

PO Box 940825, Plano, TX 75094-0825, USA

Projects, Chapters, Volunteers, and Information

Moon Society Program Services:

PO Box 080395, Milwaukee, WI 53208

< End Moon Society Journal Section >

GREAT BROWSTING

Self-explanatory Links

http://www.spacedaily.com/reports/China_Goes_To_Mars_999.html
<http://www.newscientist.com/article/dn19697-former-tenth-planet-may-be-smaller-than-pluto.html>
http://www.marsdaily.com/reports/Mars_Volcanic_Deposit_Tells_Of_Warm_And_Wet_Environment_999.html
http://www.marsdaily.com/reports/Ancient_Mars_Was_Wet_Cozy_And_Life_Friendly_999.html
http://www.nasa.gov/topics/earth/features/water_ice_as_teroid.html
<http://www.aolnews.com/science/article/new-pictures-show-jupiter-is-missing-a-stripe/19476228>
<http://www.space.com/scienceastronomy/missing-jupiter-cloud-belt-mystifies-scientists-100521.html>
<http://www.newscientist.com/article/dn19005-hints-of-life-found-on-saturn-moon-titan>
<http://www.newscientist.com/article/dn19497-outofthisworld-proposal-for-solar-wind-power.html>
<http://www.space.com/scienceastronomy/color-changing-planets-alien-life-100513.html>
<http://www.space.com/scienceastronomy/alien-contact-will-take-centuries-100429.html>
http://www.space.com/scienceastronomy/070329_double_sunsets.html
<http://www.space.com/scienceastronomy/alien-planet-formation-two-suns-101022.html>
<http://www.space.com/scienceastronomy/alien-planets-orbit-binary-star-system-101026.html>
<http://www.physorg.com/news/2010-10-martian-lakes-seas-emerging-underground.html>
<http://www.astrobio.net/pressrelease/3668/evidence-for-hydrothermal-vents-on-mars>
http://www.marsdaily.com/reports/Mars_Volcanic_Deposit_Tells_Of_Warm_And_Wet_Environment_999.html
http://www.marsdaily.com/reports/Ancient_Mars_Was_Wet_Cozy_And_Life_Friendly_999.html
<http://www.space.com/news/esa-look-to-broaden-access-to-space-station-101027.html>
<http://www.space.com/iss-international-space-station-construction-history-100806.html>
http://www.thirdage.com/news/india-and-us-harvest-solar-power-space_11-7-2010
<http://timesofindia.indiatimes.com/india/India-America-join-hands-to-harness-solar-power/articleshow/6886049.cms>
<http://news.rediff.com/report/2010/nov/02/kalam-nss-initiative-to-tap-solar-power-in-space.htm>

Additional Browsing Links

Space Solar Power and the Indian Connection
<http://www.thespacereview.com/article/1721/1>
Bigelow's ambitions growing
<http://www.thespacereview.com/article/1719/1>
Obama, NASA seek to triple planetary defence budget
<http://www.worldmag.com/articles/17299>
Akatsuki: Japan's Venus Climate Orbiter presentation
www.jaxa.jp/countdown/f17/pdf/presskit_akatsuki_e.pdf
Prospects for Britain's role in Space
<http://www.thespacereview.com/article/1640/1>
Looking forward to Transformers movie
<http://www.thespacereview.com/article/1625/1>

Better silicon-free solar panels will be made on Earth
<http://www.ens-newswire.com/ens/sep2010/2010-09-30-092.html>

Human spaceflight: diversify the portfolio
<http://www.thespacereview.com/article/1609/1>

New spirit of cooperation between NASA operational and research sides
<http://www.thespacereview.com/article/1624/1>

"In New Space Race, Enter the Entrepreneurs"
<http://www.nytimes.com/2010/06/08/science/space/08space.html>

Will frequent tourist spaceflights pollute the atmosphere?
<http://www.thespacereview.com/article/1723/1>

GREAT SPACE VIDEOS

MOON COLONY VIDEOS - The Moon Society

The Lunar Greenhouse
<http://www.youtube.com/user/mooncolonytv#p/a/27CD52E1AB65BF59/0/F4Dbh0nvh-4>

ASSORTED SPACE VIDEOS

http://planetary.org/programs/projects/solar_sailing/video_20101018.html

Asteroid Discoveries 1980 to 2010 (last 30 years)

http://www.youtube.com/watch?v=S_d-gs0WoUw&feature=player_embedded
<http://www.spaceref.com/news/viewpr.html?pid=30992>

Spaceport America Takes Shape

<http://www.thespacereview.com/article/1716/1>

Video of EPOXI probe flyby of comet Hartley2
http://epoxi.umd.edu/3gallery/vid_20101104_approach_shtml
<http://itn.co.uk/a81b6c261166a53bba287f3372614a03.html>

Help us put MMM in a Library near You!

Whether you are a member of an NSS Chapter or of a Moon Society Chapter or Outpost, or a Moon Society member at large, you all get Moon Miners' Manifesto as a membership benefit.

A library subscription to a library in your community will help spread the word about Moon-focused programs and projects.

For chapters and outposts such subscriptions will be good advertising for your local efforts.

For Society members, as all copies of MMM include the Moon Society Journal centerfold section, community library or school library copies of MMM will grow name recognition, inviting readers to join.

As membership services are not involved, the cheapest way we can do this is by submitting these subscriptions directly to the publisher at a cost-minus rate of \$13 a year, available for libraries only.

How to participate in this program

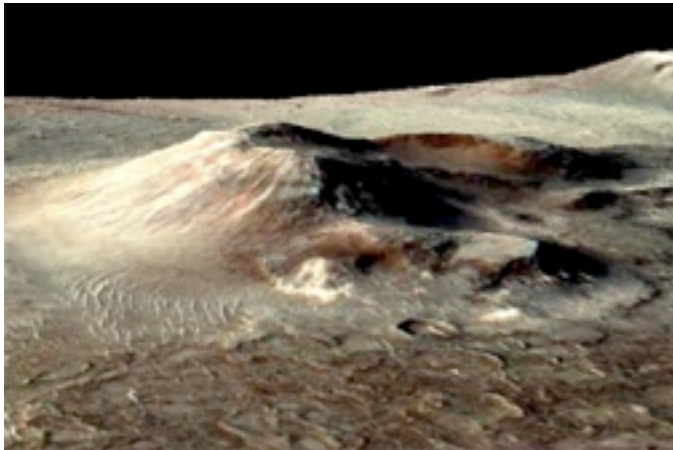
- Send *by postal mail only*
- Your check or money order for \$13.00/per year
- With the complete name and address of the Library,
- Made out to "Lunar Reclamation Society"

Attn: Library Subscriptions
PO Box 2102
Milwaukee, WI 53102

MMM PHOTO GALLERY



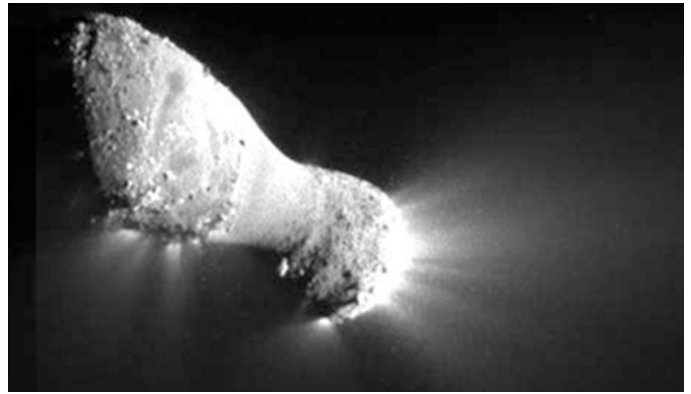
Valentine Cave in Lava Beds National Monument, CA has **classic shape** with wall curbs marking former flow levels. Lavatubes on **other worlds** will be larger as the gravity is less: very large on the Moon; intermediate size on Mars.



A 5km wide volcanic cone in the Nili Patera caldera on Mars: It has hydrothermal mineral deposits on the southern flanks and nearby terrains. Evidence for a warm and wet or steamy past, possibly microbe-friendly.



http://www.spacedaily.com/reports/Using_Planet_Colors_To_Search_For_Alien_Earths_999.html



Comet **Hartley-2** seen outgassing in flyby

For an animation of the EPOXI flyby, check out:

http://epoxi.umd.edu/3gallery/vid_20101104_approach.shtml



Canada's **Dreamspace** tourist ship

http://sync.sympatico.ca/news/canadian_space_flight_dreams_live_on/25d12b97



Earliest concept for a Lunar Analog Research Station?

http://www.popsci.com/files/imagecache/photogallery_image/articles/globe.jpg from

<http://www.popsci.com/technology/gallery/2010-10/archive-gallery-space-colonies>

This 1959 concept came from the Martin Company, now part of Lockheed Martin.

Key: 1 Lunar "Simulator" Globe – 2 Electric Power Plant – 3 vacuum pumps – 4 ring circle – 5 supporting struts – 6 access tunnel – 7 airlock – 8 vacuum area for space suit practice

Note: No lunar analog research station proposal to date has included vacuum as something to be simulated!

MDRS 2011 Field Season Schedule

by [Freya Jackson](#) — last modified 2010-11-19 11:15

The schedule for the Mars Desert Research Station 2011 field season has now been finalized. There will be 8 mission simulation crews, commencing January 1 and ending May 7. Seven of the crews will be of two weeks duration while one will be of 4 weeks duration.

There will also be an engineering team crew to prepare the hab for operation December 28-January 1. Beginning with the engineering team at the end of December, daily crew reports will be posted at the MDRS website, which will link from www.marssociety.org.

The rotations will be as follows:

- Crew 96 Dec 28-Jan 1 MDRS Engineering team
- Crew 97 Jan. 1 -15 Mars Society crew
- Crew 98 Jan 15 - 29 Romanian crew ROMARS
- Crew 99 Jan 29 - Feb. 12 NASA Ames Space Academy Crew LAMBDA
- Crew 100 Feb. 12 - 26 ESA Crew EuroGeoMars
- Crew 100 Feb 26 - 12 March ESA Crew EuroGeoMars
- Crew 101 March 12 - 26 Georgia Tech Crew
- Crew 102 March 26- April 9 Mars Society crew
- Crew 103 April 9-23 JUMP_Catholic U. of Louvain
- Crew 104 April 23-May 7 NASA crew DOMEX

Editor's Notes:

It is not surprising that there are only two crews made up of Mars Society volunteers this year. Many of those willing have already been to MDRS. And it is our expectation that the recent demand that each volunteer pay not only his/her round trip airfare to the staging point in Salt Lake City, but an additional \$1,000 to cover food and other expenses. In the past these "other expenses" were paid for by the Society. Perhaps the majority of past volunteers would not have been able or willing to serve under these new requirements, ourselves included.

Note that of the remaining non-member crews, 2 are NASA crews, 2 European Space Agency, and 2 other European ones. That NASA has fielded crews here every year should shut up those who dismiss the Mars Society's Analog Research Program as "let's pretend for adults or something to that effect.

Nonetheless, the program has been unnecessarily constrained by a procrustean Hab design and a no-expansion policy. Any real outpost on Mars would be continually expanding to allow more and more kinds of research at ever-greater depth.

The very origin of the Hab design, constrained by volume and shape allowed on a Mars-bound vehicle puts form before function, which any architect worth his price knows is totally backwards. The lessons learned will hopefully be reflected in a vastly superior design and functionality of the proposed Moon/Mars Atacama Research Station to be deployed near the ALMA Radio Telescope Array in northern Chile.

Preserving the Record – an MDRS Veterans Group

Sadly, while many think that such a group would be worthwhile, no one, ourselves included, has had the time to make such an organization become a reality.

Again, we are proud to have served on two MDRS crews and treasure every moment, and the camaraderie with past crew mates, and other MDRS vets. **PK**

Space-Based Solar Power News

From Al Globus; a paper on how to demonstrate Space Solar Power "Soon and Cheap"

The paper describes a radically smaller and lighter PowerSat -- possibly permitting deployment of a 5MW operational system with a single launch. The design is based on solar power collection currently operating in space and power beaming demonstrated on the ground. <http://space.alglobus.net/papers/SSI2010SSPaper.pdf>

Al Globus is Senior Research Associate for Human Factors Research and Technology at San Jose State University at NASA Ames Research Center. He was previously visiting research associate at the Molecular Engineering Laboratory in the chemistry department of the University of California at Santa Cruz. He is also on the National Space Society's Board of Directors, and a member of NSS Space Settlement and Space-Based Solar Power Committees.

Quotes from the paper:

"Space Solar Power (SSP) can supply massive amounts of electrical power to Earth with no greenhouse gas emissions and no dependence on the Persian Gulf. The basic idea: gather solar energy in space and transmit it to Earth. Today's satellites already use solar energy and transmission has been demonstrated with 90%+ efficiency. If the space segment is built from lunar materials, SSP may be the cleanest possible energy option since most of the work is done in space. The energy available is far, far more than used today, more than enough for everyone." - <http://alglobus.net>

Dutch to Advance Role in Space Based Solar Power

On November 23, the Dutch Space Based Solar Power (SBSP) Consortium sponsored an SBSP workshop in Haarlem, Netherlands. The Consortium, made up of Dutch companies TNO Industry & Techniek, Dutch Space, Ecofys, Altran, JIVE and ECN, is a forum for participants to discuss SBSP as a potential business for the Dutch market as well as to survey international space community partnerships to advance renewable energy sources. The event focused on the key role of the Dutch technological market in the field of solar PV and receiver / transmitter technology. With the world energy usage projected to increase 87% by 2035, the need to develop alternative energy sources will be inevitable. However, harvesting solar energy from space still poses a challenge since converting beamed energy from space into electricity in a power grid has not been successfully demonstrated.

(Credit: Space Horizon, JIVE, Altran, ECN, Dutch Space, TNO, growth5, cleartechnica)

No MMM Newsletter next month

Our schedule is 10 issues a year, with a break in January and July – the editor's burnout prevention breaks, and time to renew and refresh.

MMM returns in February with issue #242

Coming Soon to a Theater Near You A New Sci-Fi Thriller



Note; the human footprint has company
<http://apollo-18.movie-trailer.com/>

There's a reason if we've never gone back to the Moon.

Plot:

"A quintessential Cold War story, Apollo 18 casts light on the covert and undocumented lunar mission that officially 'never happened'. Bekmambetov, hired by Russia to shoot a documentary about the Russian space station, recently came across footage in its space [archives](#) that bolsters the idea that an Apollo 18 mission did, in fact, take place, and reveals startling evidence of extraterrestrial life forms. This actual footage will be part of Apollo 18, a paranormal thriller that will interpolate fact and fiction."

Background

What is Apollo 18? In the 1970s, NASA shut down the Apollo 18 moon mission but some skeptics believe that the mission actually did happen(?) that it was all a cover up. The movie incorporates this conspiracy theory and alien life into its thriller-based plotline. Trevor Cawood, who worked on the visual effects of the Matrix sequels, will direct from a script by Brian Miller;

Bekmambetov will produce. The movie is already slated for a March 4, 2011 release date.

<http://www.collider.com/2010/11/06/apollo-18-timur-bekmambetov/>

Are bad Moon movies better than no moon movies?

National Space Society Announces the Kalam-NSS Energy Initiative

Webcast of NSS-Kalam Energy Initiative Press Conference

Video of the entire press conference on the NSS-Kalam Energy Initiative is available at the following URL:

<http://www.nss.org/news/releases/pc20101104.html>

Press Kit is available at

<http://nssdocs.xisp.net/nsswiki1/KalamNSS>

Washington, DC -November 4, 2010

Today, the National Space Society held a press conference at the National Press Club to reveal one of the first initiatives ever undertaken by a non-profit American organization and a former head of state. That initiative pairs India's eleventh President, Dr. A.P.J. Kalam with America's National Space Society.

Its name? The Kalam-NSS Energy Initiative.

The Kalam-NSS Energy Initiative's goals?

- To solve the global energy crisis.
- To solve the global carbon crisis.
- And to solve America's next generation jobs crisis. How? By harvesting solar power in space.

Mark Hopkins, CEO of the National Space Society, says,

"The Kalam-NSS initiative is a transformative idea that can upshift the US and Indian economies by meeting the urgent global need for a scalable, carbon-neutral, green, 24-hr renewable power source. It is a game-changing technology that addresses energy security, sustainable development, climate change, and multinational cooperation." Concludes Dr. A.P.J. Kalam, "I am convinced that harvesting solar power in space can bring India and United States of America together in whole new ways. I am certain that harvesting solar power in space can upgrade human living standards."

<http://www.nss.org/news/releases/NSS-Kalam-Energy-Initiative-Oct-30-2010.pdf>

History behind this collaboration

Mindful that no world leader has given more support and enthusiastic support at that, to the concept of Space-based solar power than India's former President **A.P.J. Abdul Kalam**, the 2010 ISDC Committee pulled out the stops in endeavoring to get Dr. Kalam to attend this annual event, being held this year in Chicago. While he was unable to adjust his schedule to make an in-person appearance, he did speak to the ISDC by teleconference.

Dave Dunlop summarized Dr. Kalam's talk in *Moon Miners' Manifesto-India Quarterly* #7 pp. 27-29.

Subsequently, Dave went to Toronto to meet Dr. Kalam on September 30th, to present him the **University of Luna Award** on behalf of the Moon Society, which is an NSS Affiliate. Dave Dunlop reported on this presentation in *Moon Miners' Manifesto-India Quarterly* #8 pp. 8-9.

Download: www.moonsociety.org/india/mmm-india/

Working together, the National Space Society and the Moon Society are working with Dr. Kalam to bring this bold plan to get our civilization on the road to a bright future with abundant clean energy, and a healthy green environment. The Goal is to bring this plan to the attention of the G-20 Nations. Any collaboration, even if short of a unanimous or even a majority one, will help! **MMM**

The Moon/Mars Atacama Research Station

Progress Report by Peter Kokh

The bold plan to build what could become the world's premiere center of Moon and Mars Analog research in the Atacama Desert of Northern Chile hit a big bump in the road last year with the major earthquake in Concepcion, Chile's second largest city. The 8.8 Richter scale event was shattering, and absorbed all that country's attention for some time. But recovery was well underway, and spirits in Chile were mending.

Then came the mine disaster and a successful rescue after weeks of drilling. With the recovery of its miners, the nation has been riding a crest of can-do self-confidence. Meanwhile, Chile had launched its own space agency. It was time to turn attention back to the MMARS proposal, and some key changes were made. The lead institution would not be the University of Atacama in Copiapo, but the University of Antofagasta in the coastal city of that name, further north. And the proposed location of MMARS shifted north too, to land held by the European Southern Observatory, which operates the new ALMA Radio Telescope Array. This site is near where the borders of Chile, Argentina, and Bolivia come together.

http://en.wikipedia.org/wiki/Atacama_Large_Millimeter_Array

In the works is an expedition to pick out the exact site. This could happen in late March and/or early April 2011. Some hope to deploy the station core at this time, but that seems to us impractical. The core unit is a surplus Chilean Air Force Hercules C130B now in storage in Santiago, some 700 miles to the south.



Even without wings and tail, which had been removed, towing it north will be quite an operation. And the expectation that we can just look at photos and design an outfitting package, without taking measurements and without knowing what components are available, is quite unrealistic.

The expectation that this fuselage can serve as a working station in the short term is also unrealistic, as the square footage as best as we can determine is on the order of that of just one floor of the 2-floor Mars Desert Research Station, where space was quite tight. In our opinion, the fuselage needs to be mated to one or more additional modules to create a minimal station. We have suggested Quonset huts which are available as cheap surplus structures, and which deployed, can be seen as the upper half of horizontal half-buried cylinder modules. The huts are easily taken apart, trucked to location and reassembled and offer a wide variety of outfitting options and floor plans.

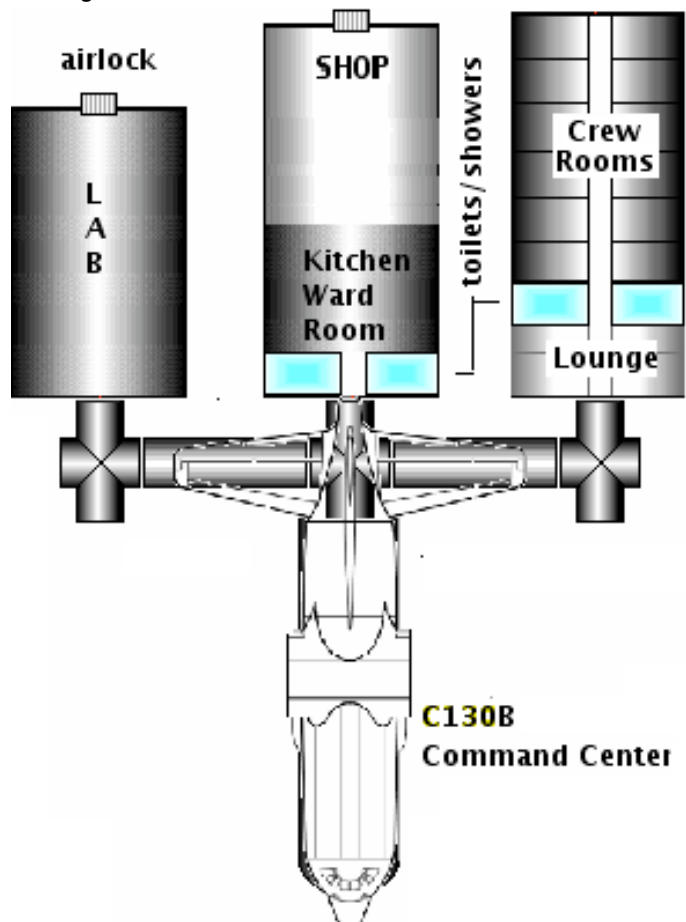


Video Scan: <http://www.youtube.com/watch?v=aboyS67MFow>

The ESO site, on the **Chajnantor Plateau** (above) ranges from 9,000 to over 16,000 ft in altitude, and we hope that they are thinking of locating at the lower range. Otherwise crews will waste half their time becoming acclimatized to the lower air pressure. The ALMA Operations center is at 9,500 feet while the remotely operated telescopes are much higher up where the air is thin, dry, and clear.

As you can see, the coloration of the plateau is that of Mars. It was somewhat of a challenge for the Moon Society crew (MDRS #45) to pretend that we were on the Moon. Large green lens sunglasses helped by neutralizing the orange hues, whitening them out a bit. But then the awesome deep blue skies belong to neither!

Below: A concept for modular expansion using the C130 fuselage as core module for command & communications



The bottom line is that everything is still in flux. As in all group efforts, compromises are made, not all of them with any rhyme or reason. Stay tuned. PK



**Lunar
Reclamation
Society, Inc.**
P.O. Box 2102
Milwaukee
WI 53201

www.lunar-reclamation.org

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

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 TREAS./ Database - *Robert Bialecki
bobriverwest@yahoo.com 414-372-9613

LRS News

- **Holiday Folk Fair Nov. 19-10th at State Fair Expo Hall:** Charlotte and Gene arranged for us to piggyback on their Astronomy exhibits for the Northern Cross Science Foundation (amateur astronomy group in the northern suburbs) Peter, Bob, and James helped man the exhibits; We contributed our Gravity Bricks, and two recent "regolith impressionism" paintings (Lunar Folk Art!)
- **Peter to speak in Sheboygan:** Harald Schenck of the Sheboygan Space Society, has arranged for Peter Kokh to talk to his Astronautics class at UW-Sheboygan on Tuesday, Dec. 7th, 4 to 5:15 PM. Harald has 23 students.

LRS Upcoming Events

Saturdays: 1-4 pm

Dec. 11th - Jan. 8th - Feb 12th - Mar 12th

LRS Meeting, Mayfair Mall, Garden Suites Room G110

AGENDA:

www.moonsociety.org/chapters/milwaukee/meetings.htm

Saturday, December 11th 1-4 pm

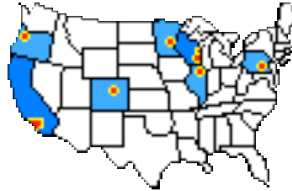
**Our 24th Anniversary & Holiday Party
Potluck Luncheon & Exhibiits**

Sci-Fi Movie (2 pm sharp)

SPACED INVADERS (1990)

When one saucer of an invasion force has engine trouble, it lands on Earth. It happens to be Halloween and it happens the invaders are only about 4 feet tall. As the bumbling aliens wander around the countryside they are taken to be children and they make friends with two children, one of whom is the daughter of the sheriff. As their troubles mount (it's difficult for five aliens to conquer a world) they begin to give up their plans of conquest, but then there is that nasty killer robot.

**January 8th and February 12th Meetings
Check our website (page above)**



**News & Events
of NSS
"MMM" Chapters**

Space Chapter HUB Website:

<http://nsschapters.org/hub/>

OREGON



Oregon L5 Society

P.O. Box 86, Oregon City, OR 97045

voice mail / (503) 655-6189 -- FAX (503)-251-9901

[<http://www.OregonL5.org/>]

Allen G. Taylor allen.taylor@ieee.org

Bryce Walden moonbase@comcast.net

(LBRT - Oregon Moonbase) moonbase@comcast.net

* **Meetings 3rd Sat. each month at 2 p.m.**

Bourne Plaza, 1441 SE 122nd, Portland, downstairs

Dec 18th - Jan 15th - Feb 19th - Mar 19th

MINNESOTA



**Minnesota Space Frontier Society
c/o Dave Buth 433 South 7th St. #1808
Minneapolis, MN 55415**

David Buth (w) (612) 333-1872, (h) (763) 536-1237

Email: info@mnsfs.org

www.mnsfs.org/

Calendar: MN SFS 2010 Past & upcoming chapter events
www.freemars.org/mnfan/MNSFS/2010-12-Review/

Ben's pix from St. John's Lutheran Science Fair
<http://freemars.org/mnfan/St-John%27s-Sci-Fair/2010/>

The December MN SFS business meeting will take place
 Monday, December 13, 2010 at 7:00 pm

Craig Rostal residence:

Centre Village, 433 S 7th St Minneapolis, MN Apt 1808

Ben's December Meeting Pix

<http://freemars.org/mnfan/MAS/2010-12-Dec-Meeting/>

ILLINOIS

Chicago Space Frontier L5
610 West 47th Place, Chicago, IL 60609

Larry Ahearn: 773/373-0349 LDAhearn@aol.com

WISCONSIN



Sheboygan Space Society
728 Center St., Kiel WI 54042-1034

c/o Will Foerster 920-894-2376 (h) astrowill@tcei.com
SSS Sec. Harald Schenk hschenk@charter.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 Thurs even # months 7-9pm
At The Stoelting House in Kiel, WI
 - **Saturday December 11th, 1-4 pm** - in lieu of a meeting in Kiel, we are all invited to the annual holiday/LRS/MMM/ anniversary party in Milwaukee. See the Lunar Reclamation Society News above for details.
- 2011 Meeting Schedule: Next February 17th**

COLORADO

Denver Space Society
(FKA The Front Range L5 Society)
1 Cherry Hills Farm Drive
Englewood, CO 80113
<http://www.angelfire.com/space/frl5/>

Eric Boethin 303-781-0800 eric@boethin.com

Monthly Meetings 6:15 PM on 2nd Tuesdays
no current information available

Englewood Public Library, Englewood, CO 80110
1000 Englewood Parkway, First Floor Civic Center

PENNSYLVANIA



Philadelphia Area Space Alliance
928 Clinton Street, Philadelphia, PA 19107

c/o Earl Bennett, Earlisat@verizon.net
856/261-8032 (h), 215/698-2600 (w)
[<http://pasa01.tripod.com/>]
<http://phillypasa.blogspot.com>

- PASA regular business luncheon/formal meeting 1-3 pm, the 1st Saturday of every month at the Liberty One

food court on the second 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/Mitch 215-625-0670 to verify all meetings.
Note: Our December Meeting will be on the 2nd Saturday, the 11th, at the Liberty One Food Court, for election of officers. **No further information available.**

CALIFORNIA



San Diego Space Society
<http://sandiegospace.org>
info@sandiegospace.org

Check the Calendar Page for upcoming events:
<http://sandiegospace.org/calendar/>

CALIFORNIA



OASIS: Organization for the Advancement of Space Industrialization and Settlement
Greater Los Angeles Chapter of NSS
P.O. Box 1231, Redondo Beach, CA 90278

Events Hotline/Answering Machine:(310) 364-2290
Odyssey Ed: Kat Tanaka - odyssey_editor@yahoo.com

<http://www.oasis-nss.org/wordpress/>
oasis@oasis-nss.org

Odyssey Newsletter Online
<http://www.oasis-nss.org/articles.html>

Regular Meeting 3 pm 3rd Sat. each month

Next Meetings: Oct 16th 17th, Nov 20th, Dec 11th

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

Saturday December 11, 3 pm

OASIS Board Meeting and Holiday Party
Home of Bob Gounley and Paula Del Fosse
1738 La Paz Road, Altadena, CA 91001

Saturday, Jan. 15, 1 pm - OASIS Board Meeting
Home of Steve Bartlett and Tina Beychok
7108 East Peabody, Long Beach, CA 90808

Saturday, Jan. 15, 3 pm - OASIS LECTURE SERIES
"A Day Without Space" - We take for granted so many inventions based on space technology. What would our lives be like without these benefits?
LOCATION TBD

Feb. 18-20, 2011 - Gallifrey One: Catch 22

This is the annual **Dr. Who** convention for which we provide space programming. Join us as we discuss the Physics of Dr. Who, among other topics.

More info at Gallifrey One Website

<http://www.gallifreyone.com/>

Moon Miners' MANIFESTO



Lunar Reclamation Society Inc.
PO Box 2102, Milwaukee WI 53201-2102

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Moon Society dues include <i>Moon Miners' Manifesto</i> Electronic MMM (pdf) \$35 Students/Seniors: \$20 Hardcopy MMM: U.S. & Canada \$35 - Elsewhere: \$60 P.O. Box 940825, Plano, TX 75094-0825, USA
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Member Dues -- MMM Subscriptions: Send proper dues to address in chapter news section ----- => For those outside participating chapter areas <= • \$15 USA MMM Subscriptions; • US \$25 Canada; • US \$55 Surface Mail Outside North America Payable to "LRS", PO Box 2102, Milwaukee WI 53201 -----
CHICAGO SPACE FRONTIER L5 • \$15 annual dues -----
LUNAR RECLAMATION SOC. (NSS-Milwaukee) • \$15 low "one rate" -----
MINNESOTA SPACE FRONTIER SOCIETY • \$25 Regular Dues -----
OREGON L5 SOCIETY • \$25 for all members -----
O.A.S.I.S. L5 (Los Angeles) • \$28 regular dues with MMM -----
PHILADELPHIA AREA SPACE ALLIANCE • Annual dues for all with MMM \$25, due in March or \$6 times each quarter before the next March -----
SHEBOYGAN SPACE SOCIETY (WI) • \$15 regular, • \$10 student, • \$1/extra family member "SSS" c/o B. P. Knier, 22608 County Line Rd, Elkhart Lake WI 53020