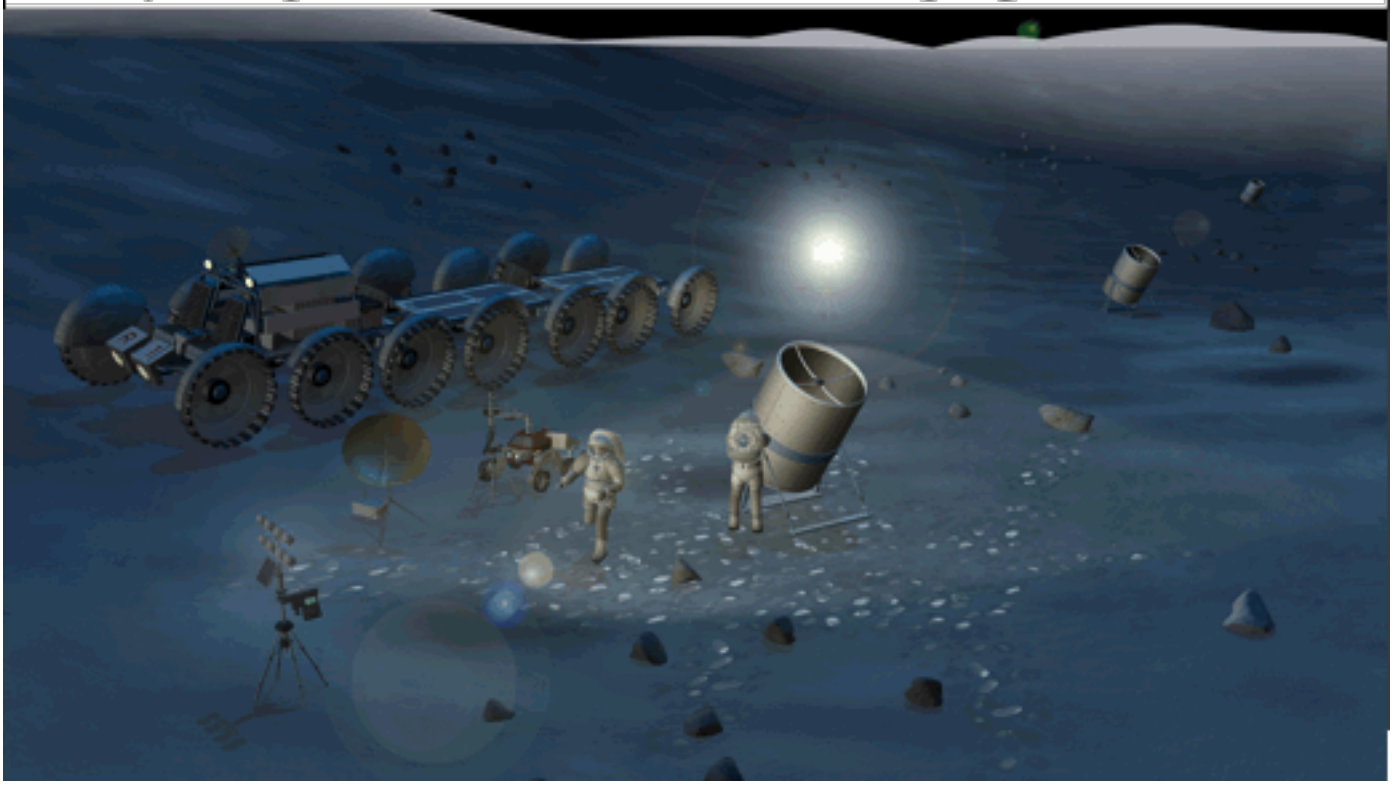
"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

Moon Miners' Manifesto

India Quarterly Edition

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



Caption: Astronauts deploy array of small telescopes on the Moon's surface. Pat Rawlings

MAJOR ARTICLES in this issue - (Full Index on last page)

About The Moon Society - http://www,moonsociety.org

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 every-where, and 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 people of all ages, through contests & competitions, workshops, ground level research and technology experiments, private entrepreneurial ventures, analog research and other means. ***We collaborate with Mars-focused and other organizations*.**

About Moon Miners' Manifesto http://www.MoonMinersManifesto.com

MMM is published 10 times a year The December 2011 issue began its 26th year of continuous publication.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home.** This will involve psychological, social, and physiological adjustment**.**

Some of the points made will relate specifically to **pioneer life** in the lunar environment. But much of what will hold for the **Moon**, will also hold true for **Mars** and for space in general. We have one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. International memberships are $35 US; $20 students, seniors – join online at: http://www.moonsociety.org/register/

MMM Classics: All the "non-time-sensitive articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. These issues are freely accessible, no username or password needed, at: www.moonsocietyorg/publications/mmm_classics/

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About MMM-India Quarterly - http://www.moonsociety.org/india/mmm-india/

This publication was launched with the August 2008 issue. This issue begins our 3rd year. The Moon Society was founded as an International organization, but in has few members outside the United States, mostly solitary and unorganized.

Background - The Moon Society and The Planetary Society of Youth (TPSY) in India, http://www.youthplanetary.org/ in December 2003, put together a "Design a Mission to the Moon" category in TPSY's student design contest -- "A Mission to the Moon and Beyond." The contest was designed to help students learn about various objects in the solar system as they compete in the design of a mission. www.youthplanetary.org/moon_mission_contest.html

Why an MMM - India Quarterly?

India is a very populous country, and one in which, through the heritage of the British Raj, English is the almost universal medium of higher education. It is likely that English-fluent Indians outnumber English speakers in the United States. More books are published in English than in any other country. And – ***India has now gone to the Moon!***

We want to share with space-interested and space-enthused people in India, our vision of the possibilities for Exploration and Utilization of the Moon, development of lunar resources, not just to support a permanent population on the Moon, but to help better address chronic clean energy supply problems on Earth and to help slow and reverse our home planet's environ-mental degradation in the process. In short, we would like to share our glimpse of an emerging greater Earth-Moon Economy.
This vision was well-expressed by the former President of India, Dr. A. P. J. Abdul Kalam in a speech at The Symposium on "The Future of Space Exploration: Solutions to Earthly Problems" to mark the occasion of the 50th Anniversary of the dawn of Space Age, Boston University, Boston, MA, April 12, 2007. In this speech, Dr. Kalam made the point that to fully industrialize and become an equal partner in the future of our planet, India needs to access the unlimited clean undiluted solar energy available in space. We agree with this bold vision and want to share it with the forward-looking people of India.
Free Access: MMM-India Quarterly issues are available as a free access pdf file, downloadable from the address above
We encourage readers to share these files with others freely, and to use this publication to grow and cultivate wide-spread interest in the open-ended possibilities of space among the people of India, and to encourage the rise of additional citizen support space organizations within the country.

Indian Space News

Highlights of Indian Space Spending in the coming year: Mars; Crew Module

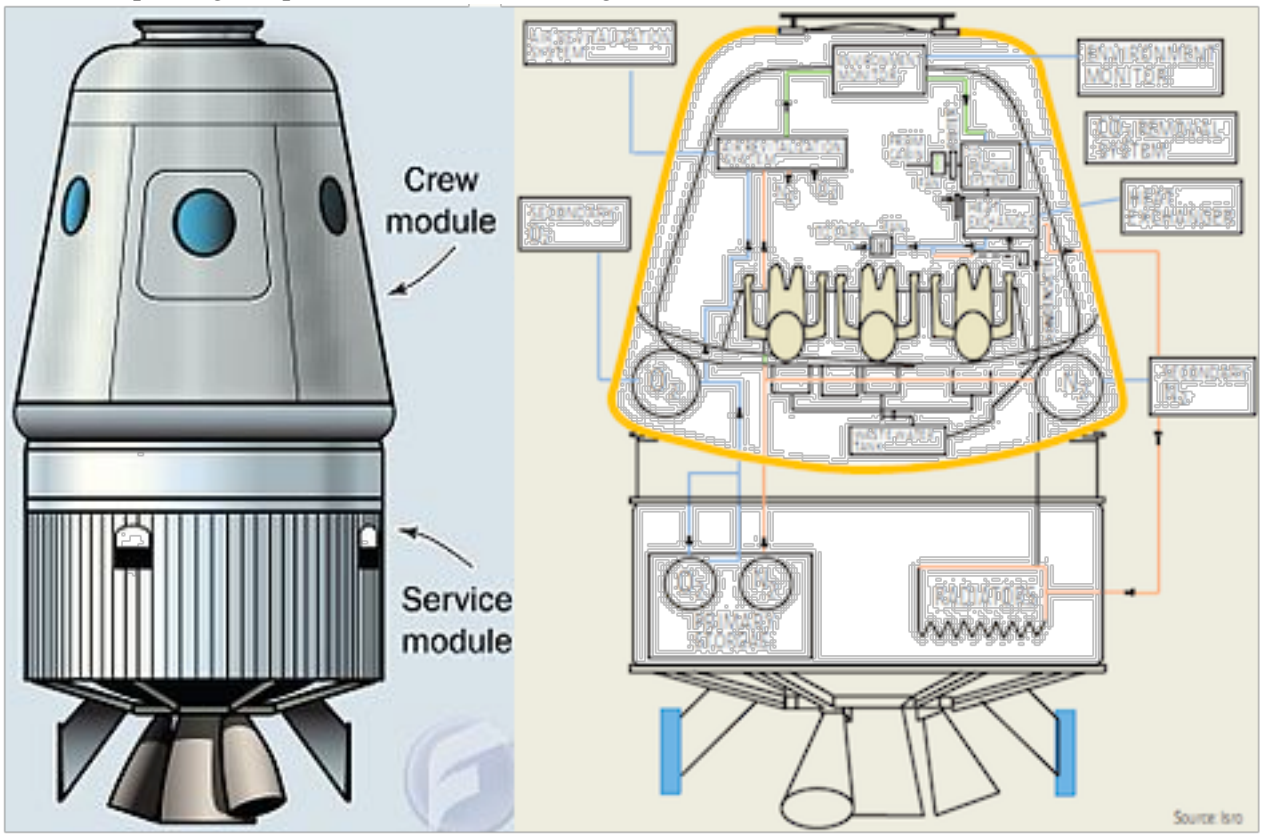
http://www.spacenews.com/civil/120321-india-increase-space-spending.html (excerpts quoted below)
http://zeenews.india.com/news/space/budget-2012-isro-get-rs-125-crore-for-mars-mission_764214.html
http://www.marsdaily.com/reports/Mars_missions_race_India_takes_lead_999.html

Mars Mission:

"The budget also includes 1.25 billion rupees for the **Mars Orbiter Mission** that ISRO intends to launch in November 2013 aboard India's Polar Satellite Launch Vehicle. The spacecraft will be placed in an orbit of 500 kilometers by 80,000 kilometers around Mars and will carry up to 25 kilograms of scientific payload, according to ISRO documents accompanying the budget presented to the Parliament."

The research goal is to study Mars' atmosphere, but ISRO has not yet finalised the scientific experiments for the Mission which has been advanced from the 2016 launch window. Some ten experiments was proposed by scientists, with some of these to be chosen for the mission. See Srinivas Laxman's article on India's Mars Mission in M3IQ #13 (January 2012 issue, page 4). which lists all ten of the proposed instruments.

ISRO Crew Module - http://en.wikipedia.org/wiki/ISRO_Orbital_Vehicle - "India also plans to spend more than 600 million rupees for early work on **a Crew Module System**, a "fully autonomous orbital vehicle" to take a crew oe 2 or 3 to a 275-km orbit and return them safely to Earth. This is funded as part of a broader 1.45 billion rupee investment in human spaceflight capabilities. An unmanned flight will be launched in 2013 with a manned mission in 2016.



Other Budget Items

"India's space budget also includes funding for continued development of a follow-on to the Chandrayan-1 lunar orbiter, which in mid-2009 shut down less than a year into its planned two-year mission. Chandrayan-2 is expected to launch during the 2013-2014 budget year, according to the documents. ◘

Elsewhere in Asia

Chinese National Space Agency

CNSA Publishes Very High Resolution Map of entire Moon

http://www.chinadaily.com.cn/china/2012-02/06/content_14544522.htm

2012-02-06 BEIJING - China on Monday published a set of full coverage of Moon map and Moon images with a resolution of seven meters captured by the country's second lunar orbiter, the Chang'e-2.

The map and images released by the State Administration of Science, Technology and Industry for National Defence (SASTIND) are the world's highest-resolution lunar images ever published that cover all of the moon, said Liu Dongkui, deputy chief commander of China's lunar probe project.

The images were photographed by a charge-coupled device (CCD) stereo camera on Chang'e-2 from the heights of 100 km and 15 km over the lunar surface between October 2010 and May 2011. The resolution of the images obtained from Chang'e-2 is 17 times finer than those taken by the its predecessor Chang'e-1."If there were airports and harbors on the moon, the Chang'e-1 could just identify them while Chang'e-2 could detect planes or ships in them."

Scientists also made some adjustments to the original data to more accurately reflect the topographic and geomorphologic features of the Moon, and have produced 746 pictures with the resolution of seven meters, and the total volume of data is about 800 GB, the statement said.

The satellite is now orbiting the Earth-Sun Lagrange Point L2 more than 1.5 million km behind Earth. ◘

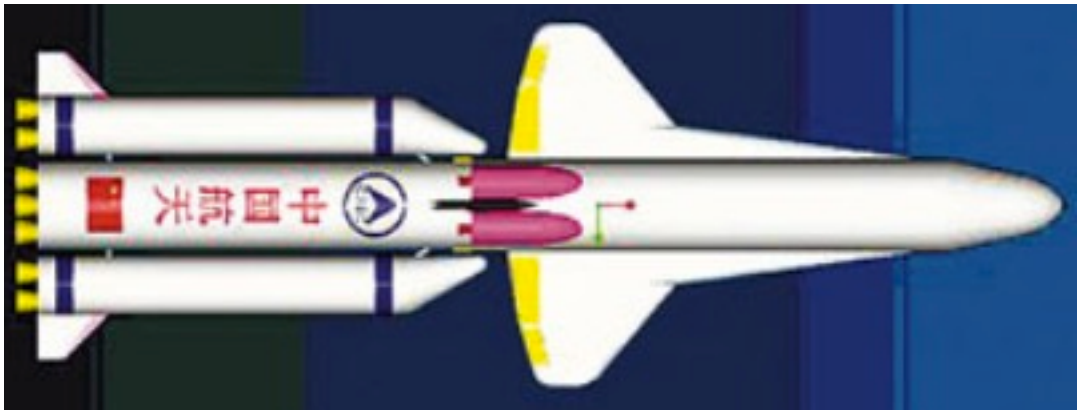
China considers building a "Space Plane"

http://www.strategycenter.net/docLib/20111024_ChinasSpacePlaneProgram.pdf - illustrations
http://www.strategycenter.net/research/pubID.253/pub_detail.asp

China is aggressively pursuing a reusable launch vehicle (RLV) program of research that could lead to two early RLV concepts under consideration.

- The first could be similar in size in the U.S. Space Shuttle, but with less than a third of its cargo capacity.
- The other RLV proposal would not leave the atmosphere but would carry a second rocket stage that would put a small payload into Low Earth Orbit (LEO). [Such a "reusable" booster was part of the original NASA Space Shuttle design, but was never built.]

China's RLV program, however, is not very transparent and its current status is not known. Data suggests that RLV research is well under way and that a smaller space plane called the Shenlong has been used to validate many space plane technologies. Pending a decision to proceed, its space plan could be ready about the time it constructs its planned 60 tonne Space Station. But in China's official media the space plane gets little attention compared to the Space Station. That could be because it is part of a more ambitions military hypersonic vehicle program. ◘



early concept

That China's Shenzhou 9 June launch will be unmanned raises questions

http://www.spacedaily.com/reports/Is_Shenzhou_Unsafe_999.html - Morris Jones, Sydney Australia

"Shenzhou 9 will be launched in June, as suspected. But (instead of the three astronauts announced in February) there will be no astronauts on board. This is probably the greatest shock that space boffins have seen from China in years. Why the sudden change? It seems clear that there must be technical issues at work, and they must be fairly serious.

"Statements in the Chinese media hint at performing tests on the small tunnel connecting the Shenzhou spacecratt to the Tiangong module after docking. If we decode the typically vague reportage, it seems fair to assume that there could be some sort of technical problem with the pressurization of this tunnel. This problem could have been exposed during the Shenzhou 8 docking.

"There's no doubt that Shenzhou 8 was able to dock successfully. We saw it. But establishing an hermetic seal and a pressurized connection between the two spacecraft is vital. Otherwise, hatches cannot be opened and astronauts cannot move between the two vehicles.

"This is a serious problem that could prevent a Shenzhou 9 crew from boarding Tiangong. But that's not really enough reason to remove the crew entirely from the spacecraft. China had previously hinted that the Shenzhou 9 crew could possibly dock with Tiangong but not enter the station."

"Shenzhou 8 was the first "production model" Shenzhou spacecraft, different in design and manufacturing from previous Shenzhou vehicles. After countless modifications, China had apparently frozen the design of Shenzhou. It had also taken the bold step of manufacturing Shenzhous 8, 9 and 10 nearly simultaneously."

There is some speculation that models 9 and 10 have a shared defect. ◘

China's plans for a Chang'e 5 lunar sample return mission advancing

http://www.spacedaily.com/reports/Chinas_Lunar_Docking_999.html

Beyond the **Chang'e 3 and 4 lunar lander/rover missions** scheduled for 1913 and 1915, reports of a **Lunar Sample Return mission for Chang'e 5** show an evolution in design. At first the design followed closely that of the four Soviet lunar sample return missions, Luna 16 (1970), 20 (1972) 23 (unsuccessful), and 24 (1976).

"The sample would be placed in a small capsule on top of the rocket, which then lifted off on a direct return to Earth. Approaching home, the capsule would separate from the rocket and parachute to the ground. Chinese artwork, animation and models of their own proposed sample-return mission looked very similar. It seemed reasonable to develop a similar mission architecture, as it is simple and proven.

"Now, Chinese media reports suggest that there has been a re-design of the whole sample-return mission. It's more ambitious and more complex ... a major change in the basic mission architecture. Instead of a direct return to Earth, the Chinese sample-return mission now uses **Lunar Orbit Rendezvous**, the same type of mission architecture used by the Apollo missions. Basically, a spacecraft that is departing from the surface of the Moon enters lunar orbit, where it joins up with another spacecraft already in lunar orbit. ..... China apparently intends to launch a robot sample-return spacecraft from the surface of the Moon, then stage a docking in lunar orbit with an Earth-return spacecraft. The samples will be transferred to this second spacecraft launched on the same rocket, then returned to Earth.

Advantages of Lunar Orbit Rendezvous

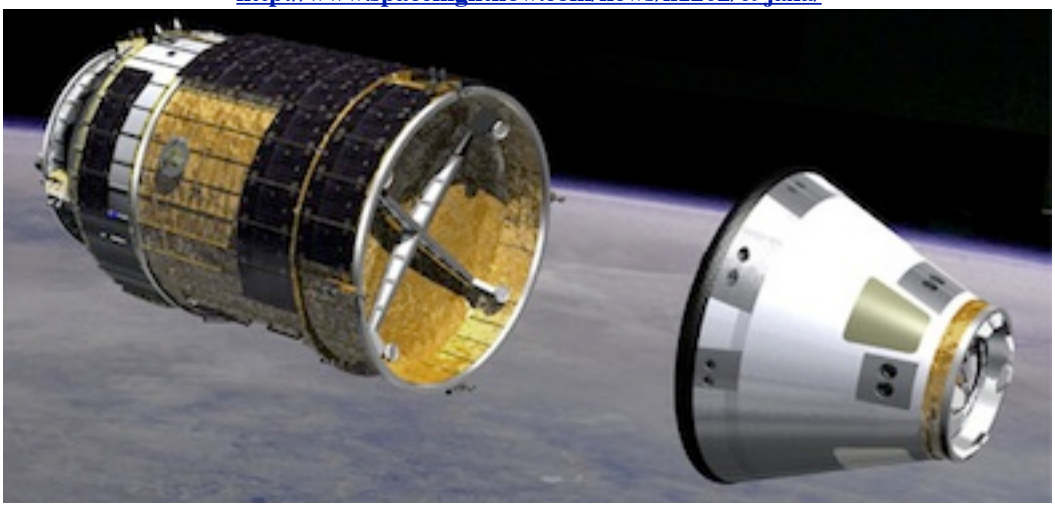
"One immediate reason would be a potentially larger cache of samples. Lunar Orbit Rendezvous reduces the amount of mass and fuel that must be landed on the surface of the Moon, and launched afterwards. This could permit more mass to be retrieved from the surface. Samples from the Soviet Luna missions were very small, and this new architecture overcomes this problem. ..... the added complexities of the mission will probably push back the launch date by a year or two.

"There's another potential advantage in flying a Lunar Orbit Rendezvous mission in the near future. It gives China further experience in technologies that will be needed to land Chinese astronauts on the Moon." ◘

Japan Aerospace Exploration Agency

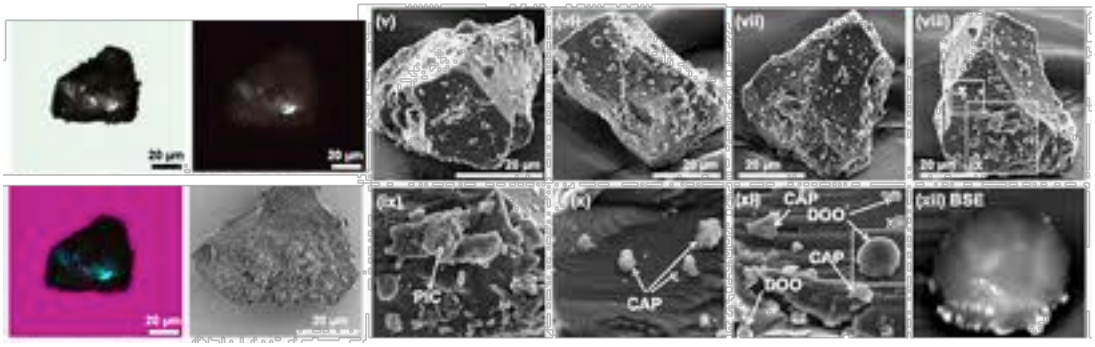
Japan plans to add Earth-landing capacity, human crew capability to HTV

http://www.spaceflightnow.com/news/n1202/09jaxa/



As part of its financial support obligations to the International Space Station, JAXA plans to upgrade it HTV (H2 Transfer Vehicle) module, which now delivers cargo to ISS with about one flight a year, so that on return it can deliver cargo intact, instead of disintegrating in descent. JAXA has also announced its plan to design and build a crew capsule for the HTV. The target dates are stretched out considerably, in large measure because the nation's first priority is recovery from the major damage done to Japan's infrastructure by last years's 9.2 Richter Scale Earthquake and subsequent Tsunami, and nuclear plant meltdown. The Crew capsule may not be ready until 2025, another 13 years. This project assumes that the life of ISS will be extended beyond 2020.

JAXA releases findings from Hayabusa Itokawa Sample Return Grains



http://www.space.com/14691-asteroid-impacts-hayabusa-meteorite-samples.html

Above: microscopic views of Hayabusa sample show tiny bits adhering to it from impacting meteriorites. Hayabusa succeeded in returning more than 1,500 grains of dust form asteroid 25143 Itokawa in the capsule that parachuted safely into the Australian desert. scientists analyzed the size, mineralogy, shape and geochemistry of five dust grains, all of which had many fractures from high speed impacts (18,000-36,000 kph). The smallest of these was just 40 microns, or millionths of a meter, in diameter — less than half the width of a human hair — and were cut into pieces using focused beams of electrically charged ions for analysis under microscopes. ◘

NEC Begins System Design of the Next "Hayabusa" Asteroid Explorer

http://www.streetinsider.com/Press+Releases/NEC+Begins+System+Design+of+the+Next+"Hayabusa"+Asteroid+Explorer/7113151.html

Tokyo, Jan 25, 2012 - (JCN Newswire) - "NEC Corp. announced today the beginning of system design of an asteroid explorer for the Japan Aerospace Exploration Agency's (JAXA) "Hayabusa 2 Project," a successor to the original "Hayabusa" asteroid explorer. NEC's responsibilities include the system design of asteroid explorer and subsystem designs, such as the Ka-band communication subsystem and intermediate-infrared camera, for the Hayabusa successor under the direction of JAXA.

The next "Hayabusa" is scheduled to be launched by JAXA in 2014. The new asteroid explorer will arrive at the asteroid "1999 JU3" in mid-2018, and then return to Earth by the end of 2020. The explorer's primary mission is to collect and return samples from 1 km wide Apollo-class asteroid "1999 JU3" that may help to explain the origin and evolution of the solar system, as well as to gather organic matter and hydrated minerals that can assist in studying the raw materials of living organisms." See: http://en.wikipedia.org/wiki/(162173)_1999_JU3

Russian Space Agency

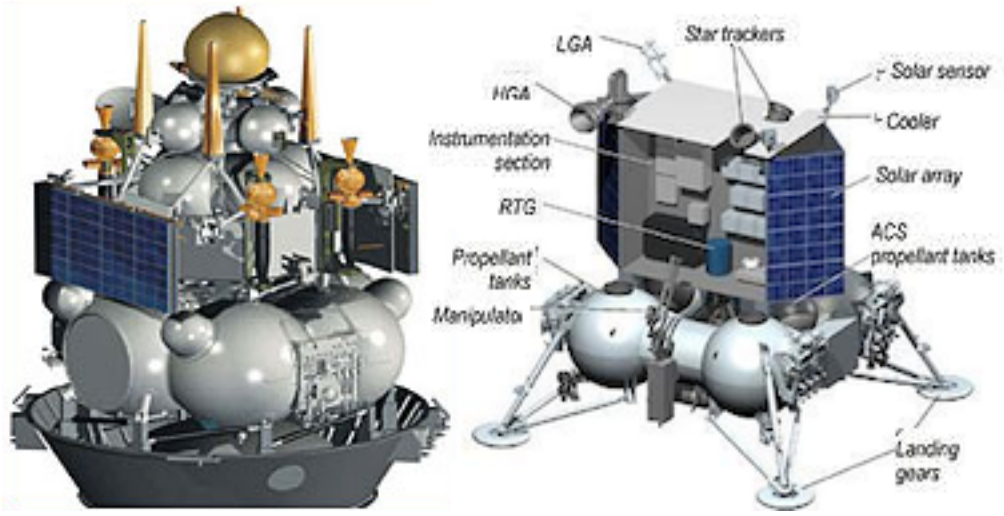
ROSCOSMOS

Russia looks back to the Moon: ILN Network, Lunar Glob, and Humans

http://www.universetoday.com/93384/russia-sets-its-sights-on-the-moon-for-2020-2/

After canceling its lunar Zond program in early 1970s, the former Soviet Union took aim elsewhere in space. In 1998, Russia jumped back in the Moon game with Luna Glob, a series of robotic missions to the Moon that could come together to make a lunar orbiting space station or a base on the surface. But Russia is looking beyond: "Man should return to the Moon," head of Roscosmos Vladimir Popovkin "And not just like in 1969, to leave a mark. We can do important work there."

In 2008, NASA proposed The creation of an International Lunar Network, a set of interconnected manned bases scattered over the LUNAR surface of the Moon. Russia may coordinate with the European Space Agency and join the ILN. Russia's announcement comes on the heels of five lost missions in 2011, including the Phobos-Grunt targeted for Martian moon. Luna Glob is technologically similar to that and may share the same vulnerabilities. This is likely to push back the dates of any future launches, particularly of the Luna Glob modules" said Lev Zelenkin, who is closely involved with both projects.



Left illustration of a Luna Glob landing module. Image credit: RussianSpaceWeb ◘

Roscosmos to replace NASA as partner in ESA "Exo-Mars" mission

The ambitious mission would look for signatures of microbial life in Mars' atmosphere and surface

http://www.marsdaily.com/reports/Russia_and_Europe_give_boost_to_Mars_robotic_mission_999.html

http://news.discovery.com/space/exomars-mission-europe-russia-nasa-mars-120410.html

Recently, due to funding decisions by the United States Congress, and in a climate of extreme disagreement in the US over budget priorities, NASA was forced to pull out of its partnership with the European Space Agency Exo-Mars mission. At the same time, Russia had not launched a successful planetary mission in two decades and badly needed a new mission in the wake of the very disappointing failure of the Phobos-Grunt mission to Mars' small moon Phobos. Taking up the slack by NASA's pullout made partnering in ESA's Exo-Mars mission a welcome reprieve. ESA made the first move, inviting Roscosmos officials to a meeting on April 6th, now passed, to work out the details of this partnership. As NASA was to supply both the rocket launcher and some of the science instruments, Russia seems to be a good choice to fill both roles.

The timetable for launch will have to be rethought out from scratch. The ESA/NASA partnership would have sent the Trace Gas Orbiter to the Red Planet in 2016 to search for atmospheric methane -- a potential signature for microbial life -- as well as an advanced astrobiology rover to drill into the surface in 2018, with the hopes of determining if life ever evolved on Mars. The new partnership may provide a great recovery for both ESA and Roscosmos. ◘

New Russian Far-East (Vostochny = Eastern) Spaceport progressing

http://www.cbc.ca/news/technology/story/2012/04/12/technology-vostochny-cosmodrome-space-russia.html
http://en.wikipedia.org/wiki/Vostochny_Cosmodrome

• Left = Baikonur • Right = Vostochny

The first rocket launch from the Vostochny cosmodrome is set to be conducted by 2015, and in 2018 the new cosmodrome should launch a first manned mission. Construction began lin 2011. The cosmodrome project is estimated to cost US $10 billion by the time it is completed.

In the meantime, Russia continues to rely on the Baikonur cosmodrome the old USSR had built in Kazakhstan. Vostochny would allow Roscosmos total control, and thus has a strategic purpose. But it will also allow launching over the Pacific. A new town is being built nearby, and may grow to a population of 40,000.

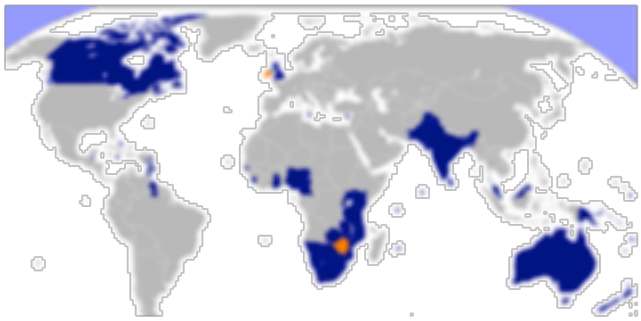
At 52° N, compared to 46° N for Baikonur, rockets will not be able to launch as much payload to orbit from the new spaceport, but the loss is judged an acceptable tradeoff for total control, easier access, and the chance to launch over water. Soviet/Russian manned capsules have up until now always landed on ground. It is possible they may now be redesigned to land on water, as have all NASA manned capsules (and shuttles. ◘

Roscosmos Ready to Give Phobos-Grunt a Second Try

[Per a side comment on http://www.marsdaily.com/reports/Mars_Astronauts_Could_Risk_DNA_Damage_999.html]

Moscow (RIA Novosti) April 24 - Russia's space agency Roscosmos is backing an initiative to give the Phobos-Grunt project a second chance. "We've backed it [a proposal from the institute of space studies on the Phobos-2 project]. We agree with their position. The new project will not be a simple repeat of Phobos-Grunt 1. ◘

Elsewhere in the Commonwealth



Australia - Canberra wins right to broadcast Mars Curiosity Landing

http://www.abc.net.au/news/2012-04-03/**canberra-lab-to-broadcast-mars-landing**/3930118

The Canberra Deep Space Communication Complex has secured exclusive rights to broadcast the Mars landing of the world's largest robotic laboratory. NASA's $2.5 billion Mars Science Laboratory mission is expected to reach the red planet on August 6, and the complex at Tidbinbilla will broadcast the event worldwide. The complex is expanding to help monitor 50 existing space missions that will be clearer from the southern hemisphere than the northern hemisphere. The missions include the touchdown of NASA's Pluto spacecraft by July 2015.

For an amazing video of how Curiosity will be "landed" and go about exploring, watch:

http://www.youtube.com/watch?v=P4boyXQuUIw&feature=player_embedded ◘

Canadian Astronaut to Command International Space Station in 2013

http://www.space.com/14638-**chris-hadfield-canadian-commander-space-station**.html

VANCOUVER, British Columbia — Astronaut Chris Hadfield will become the first Canadian ever to command a spaceship when he takes the helm of the International Space Station in 2013. He is currently is spending most of his time in Russia preparing for the mission. At 52, he is a veteran of two space shuttle flights, and will launch on a Russian Soyuz spacecraft in November 2012. He will take over control of the space station's Expedition 35 mission the following March. One of nine Canadians to fly to space, he will be the first to serve as commander. ◘

Canada takes lead in development of satellite refueling technology

http://www.space.com/14592-space-robot-gas-station-satellite-refueling.html

"Currently, most satellites last only as long as their stores of onboard propellant allow. When a spacecraft runs out of fuel, it essentially turns into a very expensive piece of space junk, adding to the massive cloud of debris already clogging Earth orbit. By the middle of the decade, it may be possible to salvage satellites that run out of fuel or suffer minor malfunctions in orbit.

"Canada-based aerospace firm MacDonald, Dettwiler and Associates Ltd. is designing a spacecraft that will serve as an orbiting gas station and mechanic. The robotic vehicle will be able to top off satellites' fuel tanks and perform minor repairs as needed. MDA's first servicing satellite could be ready to go by 2015 or 2016, if a suitable customer steps up, company officials said.

Canadian firm MDA "wants to change this by developing a refueling spacecraft called **the Space Infrastructure Servicing vehicle**. The unmanned **SIS** would be an orbital mechanic as a well as a gas station attendant, using its robotic arm and tool kit to make minor repairs to stricken satellites."

Watch this video to see how the system would work.

http://www.space.com/11130-orbit-satellite-servicing-work.html

Satellite Services from Geosynchronous Orbit now account for over a quarter billion US dollars of gross economic product annually. An ability to refuel (instead of replace) such satellites will spur further growth, which in turn could be greatly accelerated by use of simple but serviceable building materials produced on the Moon if transportation becomes the major cost factor, as it takes only a 20th of the fuel to transport a given item from the Moon to GEO as it does from Earth's surface to GEO. From the Moon, it is a matter of coasting "downhill." ◘

Canadian Mining Firms Eager to go to the Moon

http://www.ctvbc.ctv.ca/servlet/an/local/CTVNews/20120226/
bc_mining_moon_canada_space_race_120226/20120226/?hub=BritishColumbiaHome

When and if we return to the Moon to do more than explore, that is to access lunar resources to enable major expansion of economic assets in Geosynchronous Earth Orbit - GEO - Canadian mining companies may be key partners. On March 1st, leaders of the top five international space agencies met in Quebec City to discuss future roles for the International Space Station. And here is where Canada comes in.

Nine of the world's forty major mining companies are headquartered in Canada. Canada is also prominent in robotics technology, having produced the famous Space Station "Canadarm." NORCAT [http://www.norcat.org/] the Northern Centre for Advanced Technology in Sudbury, Ontario is one of these firms. Since 2004, ***NORCAT*** has hosted the ***Planetary and Terrestrial Mining Sciences Symposium*** (PTMSS). The **PTMSS** is the only venue in the world which attempts to address the parallels between Earth based mining and space mining. This conference is now cosponsored by the Space Resources Roundtable has been held outside Sudbury since 2009 in Toronto, Montreal, and Ottawa, Canada and this year in Golden, Colorado. Sudbury is a world-famous mining center of copper and nickel and the site of a major asteroid impact 2 billion years ago. Also prominent in mining technology is South Africa. ◘

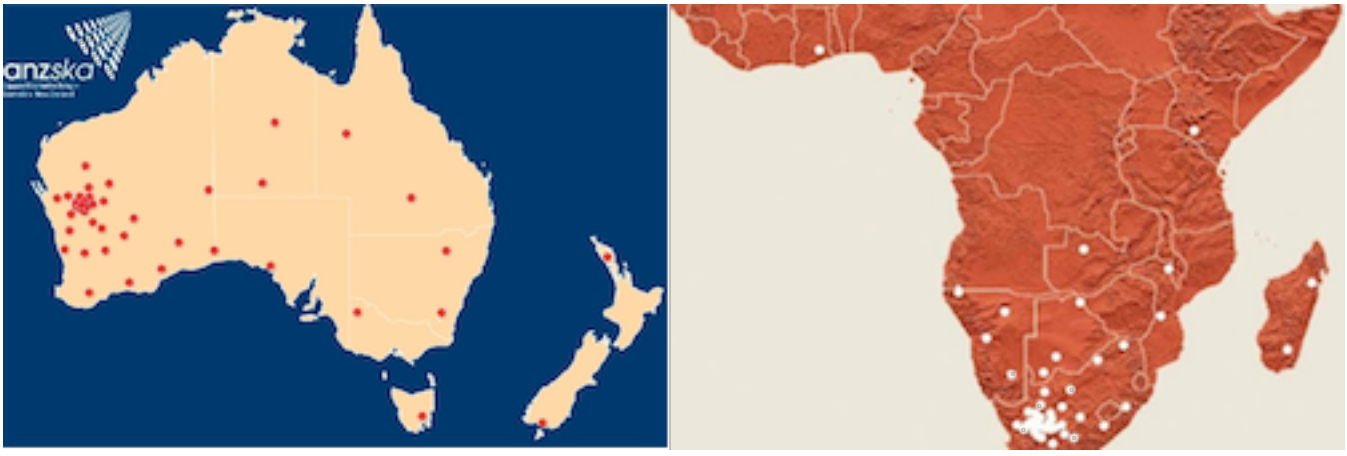
Australia and South Africa
Square Kilometer Array Members meet to discuss Site Selection

http://www.skatelescope.org/news/ska-members-meet-discuss-site-selection/

4 April 2012, Amsterdam, the Netherlands – The Members of the SKA Organisation met at Schiphol, the Netherlands, on 3 April 2012, for their first General Meeting. They noted **the site selection advisory committee's report a**nd the associated commentary that had been passed to them by the SKA Organisation's board following the board meeting in Manchester last month.

The Members wished to move ahead with the site selection process, and recognised that it is desirable to maintain an inclusive approach to SKA. "**It is important to maximize the value from the investments made by both candidate host regions**." They therefore agreed to set up a small scientific working group to explore possible implementation options that would achieve this. This working group will **report back to the members at a meeting in mid-Ma**y; **its report will provide additional information to facilitate the site decision for SKA.** The Board of the SKA Organisation met on 4 April, following the Members meeting, and discussed progress of the project.

India Connection: The Board approved an application for Associate Membership in the SKA Organisation from India (represented by the National Centre for Radio Astrophysics).



In both proposals, outlying installations would complement a central concentration, for sharper resolution

About the Square Kilometer Array: - http://en.wikipedia.org/wiki/Square_Kilometre_Array

"The **Square Kilometer Array** (SKA) is a radio telescope in development which will have a total collecting area of approximately one square kilometer.[1] It will operate over a wide range of frequencies and its size will make it 50 times more sensitive than any other radio instrument. It will require very high performance central computing engines and long-haul links with a capacity greater than the current global internet traffic. It will be able to survey the sky more than ten thousand times faster than ever before.

With receiving stations extending out to distance of at least 3,000 km from a concentrated central core, it will continue radio astronomy's tradition of providing the highest resolution images in all astronomy. SKA will be built in the southern hemisphere, where the view of our own galaxy, the Milky Way, is best and radio interference least." (Ed.: until we set up shop on the Moon's farside where all electromagnetic interference from Earth will be blocked.)
The long famous **Jodrell Bank Observatory,** England, UK will be the **headquarters** for the project. ◘

Elsewhere in the World

EUROPE-ESA

New German Drill Could Seek Life inside Saturn moon Enceladys

http://www.space.com/14692-alien-life-saturn-moon-enceladus-ice-drill.html

Above: testing the IceMole drill on Morteratsch Glacier in Switzerland

German scientists are developing a powerful drill that can melt and bore its way down through the ice crust of Enceladys to see if life lurks below. The moon is known for its periodic geysers spewing out of "cryovolcanoes." When the Cassini probe flew through one of these sprays, it detected organic compounds. Ice-crusted watery moons like Europa and Enceladys may be quite common through the universe, and some of them could harbor life forms. The trick is to determine if life exists in these hidden oceans without destroying or contaminating it.

"The concept is to establish a base station that is a safe distance from a cryo-volcano on the surface of Enceladus. This base station would power a probe dubbed IceMole, which is designed to melt and drill its way down to a depth of 330 to 660 feet (100 to 200 meters) at speeds of about 3 feet (1 meter) per hour." ◘

ESA's 3rd ATV, bound for ISS, named after Edoardo Amaldi

http://www.esa.int/esaHS/SEMMZ8ZXHYG_index_0.html

ESA's Automated Transfer Vehicles (ATVs) are an essential contribution by Europe to running the International Space Station. Each one has been named for a prominent European scientist. The first Automated Transfer Vehicle (ATV), which made a flawless flight in 2008, was named after French science fiction writer **Jules Verne**. ATV-2 in 2011 was named in honour of German mathematician and astronomer **Johannes Kepler**. ATV-3 launched March 5 this year, was named after the Italian physicist and space pioneer **Edoardo Amaldi**. ATV-4 to be launched early in 2013 will be named after **Albert Einstein**. ATV-5, the last one planned, will be named after Belgian physicist **Georges Lemaître**, father of the Big Bang theory.

Since 2008, every year and a half, an ATV has delivered about 6 tonnes of cargo some 400 km above Earth. After launch on an Ariane 5 from Europe's Spaceport in French Guiana, ATV automatically navigates to a precision docking with the Station's Russian Zvezda module. Each ATV remains attached to the ISS for up to six months before reentering the atmosphere and deliberately burning up together with several tonnes of Station waste. ◘

Towards a European Multi-Task Space Vehicle - "APEX"

http://www.thespacereview.com/article/2046/1

March 18, 2012 - France is set to put a proposal before the 17 member states of the European Space Agency (ESA) to develop an entirely new unmanned spacecraft. **APEX—for Advanced Platform for EXploration**—will be designed chiefly for the types of missions now performed by the European ATV (Automated Transfer Vehicle), which is slated to make its fifth and last flight in 2014.

Serving the International Space Station

APEX will dock with the International Space Station (ISS), ferryiequipment, fuel, water and other supplies, raise ISS' orbit, retrieve the station's waste before making a controlled return to Earth.

Space Debris Removal

In addition to in-orbit rendezvous capability, it will be equipped to capture debris that might be difficult to grapple, such as tumbling objects. It could conceivably resupply satellites before they run out of fuel. APEX could get close to orbital debris such as spent launcher upper stages, map them in 3D using lidar and cameras, and assess their attitude before grabbing them. It could then deorbit the debris or carry them to a graveyard orbit, out of harm's way for the ISS and operating satellites.

Use in Moon and Mars missions

APEX could help assemble spacecraft in Earth orbit bound for Moon or Mars. It could also be used in Martian orbit to retrieve samples collected from Mars' surface.

Illustrations?

There do not seem to be any illustrations of the French-proposed APEX vehicle as yet. [There are several illustrations of an "Apex" vehicle proposed by SpaceHab some years back, but the two vehicles are unrelated.] It is perhaps too early in the conceptualization stage for illustration. ◘

North and South America

USA - NASA awaits arrival of 1st Commercial Cargo module at ISS May 7th

http://www.msnbc.msn.com/id/47067510/ns/technology_and_science-space/#.T5MPf1F5nzI

Video: http://www.floridatoday.com/article/20120422/SPACE/304220028/SpaceX-grows-up-ISS-test-key-next-step

The first private commercial spaceship mission to the International Space Station is on track for a planned April 30 launch. If successful, this will mark a historic first for the orbiting laboratory.

Until now, all launches to ISS have been by NASA, Rosccosmos, ESA, and JAXA. Space-X, a private for profit company founded by Elon Musk (founder of E-Bay.com) will launch its privately developed **Dragon cargo module** aboard its on Falcon-9 rocket, from Cape Kennedy - http://en.wikipedia.org/wiki/Dragon_(spacecraft)

When the capsule arrives at the station, an ISS crew will use the robotic Canadarm 2 to grab it and secure it to an available dock port so that its cargo can be unloaded.

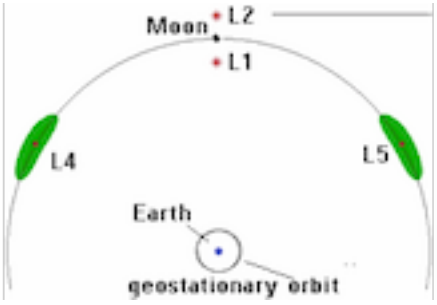
This will be a great day and vindication for NASA's COTS [Commercial Orbital Transportation Services] program - http://www.nasa.gov/offices/c3po/home/cots_project.html - But this step is only the beginning.

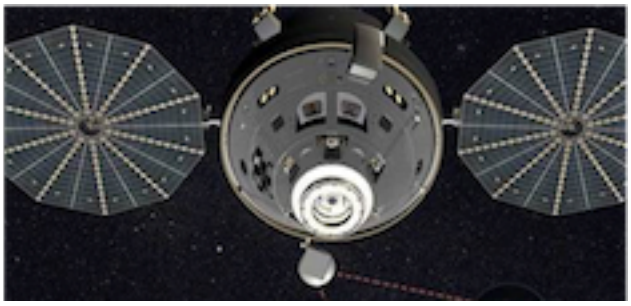
"Additionally, NASA awarded SpaceX a Commercial Crew Development (CCDev) contract in April 2011. http://en.wikipedia.org/wiki/Commercial_Crew_Development#CCDev_2

The Dragon 7-seat Crew version of the capsule is planned to be able to carry up to seven astronauts, or a mixture of personnel and cargo, to and from low Earth orbit. The Dragon's heat shield is designed to withstand re-entry velocities from potential Lunar and Martian space flights." - Wikipedia Dragon source above. ◘

NASA Identifies Earth-Moon L2 point as Next Manned Mission Destination

http://www.space.com/14518-**nasa-moon-deep-space-station-astronauts.html**





The memo spells out six strategic principles to help enable manned exploration beyond low Earth orbit

√ Incorporating **significant international participation** that leverages **current ISS partnerships**.

√ U.S. **commercial business opportunities** to further enhance the space station logistics market with a goal of reducing costs and allowing for private sector innovation.

√ **Multi-use or reusable in-space infrastructure** that allows a capability to be developed and reused over time for a variety of exploration destinations.

√ The **application of technologies for near-term applications** while focusing research and development of new technologies to reduce costs, improve safety, and increase mission capture over the longer term.

√ **Demonstrated affordability** across the project life cycle.

√ **Near-term mission opportunities** with a well-defined cadence of compelling missions providing for an incremental buildup of capabilities to perform more complex missions over time.

Quiet zone

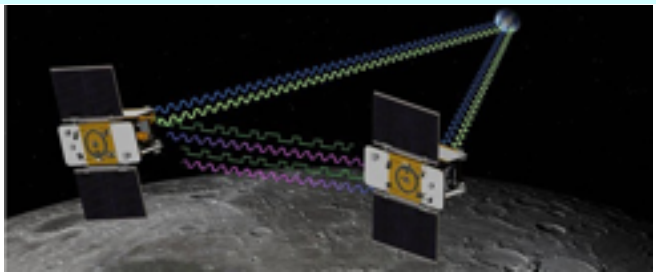
According to strategic space planners, an EML-2 waypoint could enable **significant telerobotic science on the far side of the Moon** and could serve as a platform for solar and Earth scientific observation, **radio astronomy and other science in the quiet zone behind the Moon**. Furthermore, this waypoint could enable **assembly and servicing of satellites and large telescopes**, among a host of other uses. **Lockheed-Martin** had earlier presented its plan to develop such a mission around the **Orion Crew Capsule** now in advanced stage of construction.

http://www.space.com/9583-**mission-proposed-send-astronauts-moon-side.html**

www.lockheedmartin.com/content/dam/lockheed/data/space/documents/**orion/LMFarsideWhitepaperFinal.pdf**

Note: The farside of the Moon is the only place in the Solar System - *and beyond* - that is shielded (by the Moon's bulk) from radio and other electronic noise emanating from Earth in all directions. Thus it is THE ideal site for advanced radio astronomy, including S.E.T.I. - the **S**earch for **E**xtra-**T**errestrial **I**ntelligence. ◘

NASA **GRAIL Probe Mapping Moon Interior - Mission Extended**



http://www.spaceflight101.com/grail-mission-updates.html

March 2, 2012 - "After starting its Science Phase on March 7, the GRAIL Mission is proceeding as planned with both Spacecraft in identical Orbits around the Moon and in excellent condition." By the end of February, it had become "clear that the Mission Extension for the GRAIL Mission has been approved allowing the Spacecraft to continue data acquisition **until December 2012**.

Originally, the Science Phase of the Mission was planned to last 3 Mapping Cycles or 82 Days for Spacecraft Decommissioning in late May and Mission Termination by July 13," five months earlier. This is good news, hinting that GRAIL is performing well beyond expectations.

Read the Revised Mission Timeline: http://www.spaceflight101.com/grail-mission-timeline.html ◘

Chile: The Mystery of the Missing Space Agency

Report and Speculation By Dave Dunlop

One of the political mysteries of concern to M3IQ is that of the disappearance of the Chilean Space Agency (ACE).

http://www.oosa.unvienna.org/pdf/pres/copuos2011/tech-02.pdf

http://isulibrary.isunet.edu/opac/doc_num.php?explnum_id=342

Chile Budget Problems?

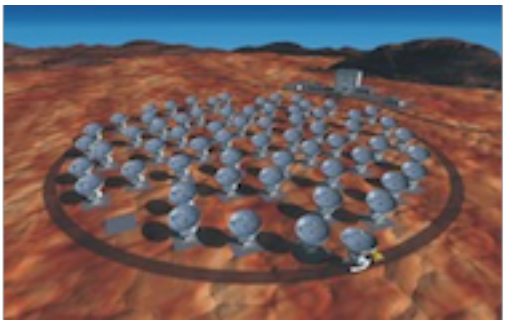
It seems that this agency was defunded in the latest Chilean budget for 2012 with no prior announcement, leaving a vacuum with regard to many activities and projects associated with this small agency and catching many in the country by surprise. ACE was a subcomponent in the Department of Economics and some have speculated that it might be resurrected in the Department of the Air Force. M3IQ was surprised to learn of this change and some blogs have anticipated that the issue of the legal status and future of a Chilean Space Agency might be addressed in a forthcoming Presidential address.

Chile and Astronomy: In areas such as astronomy Chile punches far above its weight as a small country. Its "galaxy of observatories" is the envy of the world. Its Atacama Desert offers the driest, clearest skies in the world.

http://en.wikipedia.org/wiki/Category:Astronomical_observatories_in_Chile

http://www.spaceref.com/news/viewpr.html?pid=7914

European Southern Observatory



ALMA Radio Array

Cerro Telolo

Chile and Space: Chile also has constructed and successfully launched a number of small satellites. It has signed a number of agreements with other countries with regard to space activities. It's universities have supported work and development of small satellites as well as investigations in Astrobiology in the unique region of the Atacama desert.

Chile and Analog Station Research: In 2009-11, the Moon Society had been involved in designing and making recommendations for a Moon Mars Analog Station and program in Chile's Atacama Desert region over a two year period. But this project is now stalled by issues involving intellectual property rights, problems in administrative controls, and shifts in administrative personnel - since its adoption by the University of Antofagasta near the proposed location.

Involved in that project were Maria Catalina (Team leader), Peter Kokh and Dave Dunlop of the Moon Society, and Paul Graham of the Open Luna Foundation. All but Dunlop had experience at the **Mars Desert Research Station**, with Graham having had by far the most experience as long time leader of the MDRS Engineering Team. Kokh had served under Graham on one crew, and later commanded a Moon Society crew at this facility.

http://www.younoodle.com/startups/mmars_moon_mars_atacama_research_stations

http://www.swri.org/9what/events/confer/nsrc/2011/abstracts/international/28919342-2214460.pdf

http://www.mmars.cl/

http://spacechronology.com/forum/showthread.php?1290-Agencia-chilena-del-espacio#4 - U. Antofagasta version

Atacama location The high Chadnantor Plateau (near ALMA site) was a location favored for MMARS

Chile and the Google Lunar X Prize effort: Early last year a Google Lunar X-Prize Team was registered in Chile, **Team Angelicum**. - http://www.googlelunarxprize.org/teams/angelicum

Another GLXP team, **Odyssey Moon** was looking at a working arrangement with a Chilean University.

http://www.googlelunarxprize.org/teams/odyssey-moon

Comment: We are disappointed to see a country with such promise and a history of many scientific achievement embroiled in confusion and disarray and hope that things will sort themselves out to the advantage of the countries economic, scientific, and educational advantages. Stay tuned as this story develops. **DD**

Recent activities of the Chilean Space Agency

http://www.sscspace.com/nasa-thanks-ssc-chile-for-space-shuttle-support

The **Santiago Satellite Station** (above) had participated in the Space Shuttle Program since 1981. SSC Chile supported the historic last space shuttle mission (STS-135, Atlantis spacecraft). The Santiago Satellite Station with a 9 meter dish, finished tracking orbit 91 of the space shuttle on Thursday 14 July 2011. ◘

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The Loss of the Night Sky affects People and Nature Alike

By Peter Kokh

Above: Pakistan, INDIA, Bangladesh, Myanmar city lights from space

In some remote areas of the United States, one can still enjoy the stupendous sight of thousands of stars above in the night sky. But in many metropolitan areas, one is lucky to see a hundred of the brightest ones. Meanwhile, any nighttime clouds have their undersides lit up in pinkish tones, making one who remembers when it was not so, wonder if they had been transplanted to some exotic alien planet. It might be pretty, but the effect is to cheat us of something that has been ours since the dawn of time: the view of the awesome star-studded heavens at night. Some city dwellers who born in these present conditions, and have never seen how different the heavens look far outside the cities, must wonder if those who talk of exploring the heavens: the Moon, the planets, and someday the stars, are not insane! We talked about this in M3IQ #12, pp. 14-15 "**Leveraging the Sky.**"

This phenomenon is a "problem to be solved" and not something we have to take as "the new reality." Many cities in the US have bowed to pressure from organized groups of students, teachers, and amateur astronomers, and successfully argued for different types of lighting systems that did not waste light and electricity illuminating the undersides of clouds, but yet did a better job of illuminating roads and streets - all for less energy expenditure. By showing how the city could save money by making the switch, they overcame opposition. That young people would be able once again, as had innumeragle generations before them, enjoy and wonder and speculate at the awesome sight of countless stars, may have energized these "activists" but they won their case on other grounds: showing that the cities could save considerable sums of money.

An article in Space Review written two years ago that addressed this question came to our attention. It was a review of an 84 minute film entitled "The City Dark" - http://www.thespacereview.com/article/2017/1 - The story describes two opposite experiences, the first of a young city-dweller when he first got to see the skies on a moonless night far from a city; the second of a lad who grew up enjoying star-studded skies in the country side and then moved to the big city where all this was lost. We thought that some of our readers in urban India and elsewhere might appreciate reading this review.

It is not too late to recover the heavens that have inspired our ancestors for thousands of years. That sight should be our privilege. We cannot understand Earth apart from the Solar System, much less apart from the universe at large. And if we want to re-acquaint our young people with Earth's greater context, we owe it to them, and ourselves, to agitate successfully for sky-respecting urban lighting systems. It will also benefit urban and suburban wildlife and vegetation which had evolved in the natural darkness of the night. The clinching argument is that it will save money, *and taxes*.

Most of us know one or more amateur astronomer friends, who are oddly aloof to the cause of the space frontier, if not openly hostile. For those of us who come to the space movement out of a prior interest in astronomy, myself included, this seems puzzling indeed. ***To us, studying the stars and wanting to go out there are one and the same.*** But there are reasons for the uneasiness some of these fellow spirits show around us, and with a little self-examination, they are not hard to find. ***If we love the stars, we should spare no effort to preserve our ancestral right to see them.***

Which bring us to a point well taken by Diane Fearne-Desrossiers of Lansing L5, Michigan: "how can we expect city dwellers to be interested in space, when we can no longer see the stars from within the city? *We ought to join ranks with those in the astronomical community fighting sky pollution* from unnecessary use of unshielded and high-pressure sodium vapor city lighting." If those in San Diego and Tucson who have fought the good fight and won would be so kind as to give the rest of us a primer (background knowledge so that we will know what we are talking about, plus campaign methods) we'd be on our way to restoring dark skies and the lure of the stars to all our land.

Let's Take Back the Night! **PK**

Community - From Taking back the Night, to the Moon

By Peter Kokh

A campaign to Take Back the Night, whether it be undertaken in a large urban area or in small towns and villages, has the capacity to bring together people from many walks of life and with many professions and affiliations. Teachers, Boy scout and girl scout leaders, artists, photographers, nature-lovers might be eager to participate - not just astronomers and space enthusiasts. And whether the effort has some measure of success, succeeds wildly, or even, we hope not, fails to change the situation, one result will be a broadly based team that has learned to work together to get things done. Not all of this varied gathering of leaders will be interested in space exploration and human achievements in space. But some might, and together, using techniques and methods with which they have had some

encouraging results, you will not only have earned community good will, but you will have built a core around which to build a local space interest organization.

It is best to keep the focus broad: all things space, pushing all destinations, all projects, even if the group chooses to focus on one limited narrowly-defined goal at a time. And if all such groups born of an effort tot take back the night form some sort of national alliance, well then this broad-based organization will speak with a voice that commands respect and has influence.

The National Space Society is such an organization with its members having a variety of special interests, while the organization at large pushes "all things space" - various destinations (Moon, Mars, Asteroids, Europa, Titan, etc.) and various technologies (rockets and rocket propulsion, life support, energy production with space resources, etc.) Even the Moon Society promotes opening of Mars and the Asteroids and the Solar System in general for a lunar frontier which trades goods and services throughout the solar system will be much healthier and more robust than one which stands alone!

You will need people who enjoy working with politicians (many do not), researchers in various laboratories, professors with various specialties, teachers, writers, artists, agricultural specialists, materials scientists: the list goes on and on as almost everything has some mutual relevance. And many projects require a strategic mix of talents that complement each other one way or another.

India may not have a tradition of "grass roots politics," but having been a young man when Mahatma Gandhi was in the thick of his struggles, I beg to differ with that assessment. The point of this essay is that it may be hard to put together a local, regional, or national organization of people interested in promoting India's future in space (or that of any other country.) But here is a cause that many people from a great variety of backgrounds and with a great variety of talents and with varying levels of expertise can come together and rally around: "**Taking Back the Night**!"

The spread of excess urban lighting has been going on for some time, all around the globe. Yet many people in India of various ages must still remember the awesome beauty of the night skies. Perhaps many of those who grew up in already brightly lit cities, may have traveled in rural areas on cloudless nights. They will remember the awe they felt, and come to regret that this experience has been taken away from them as city dwellers.

This is a cause that can unite generations, young and old, city dwellers and country folk, the educated and less-educated. This is a movement that can start small, fail here and there, but if it succeeds somewhere, anywhere, that will embolden everyone else. Indians, and people of all nations, should ask: Is it our national priority to be extra prominent from space on cloudless nights? Or is it our priority to have our people grounded in the splendor of the heavens, their feet on the ground, but their vision and dreams knowing no bounds.

Many cities in India may have growing air-pollution problems. Light pollution should not be overlooked even if its causes are different.

City dwellers have as much right as anyone to see the stars, and to reach for them! **PK**

Relevant Light Pollution links:

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

International Dark Sky Association - http://www.darksky.org/

The Night Sky in the World - http://www.lightpollution.it/dmsp/

Eastern USA, Central Europe, Japan are by far the worst! http://www.lightpollution.it/worldatlas/pages/fig1.htm

http://www.starrynightlights.com/lpIndex.html

For relevant Videos enter "l**ight pollution of night skies videos**" in Google Search

Needless Light Pollution - http://www.need-less.org.uk/

Light pollution dulls the night sky for stargazers - and drains city funds
http://news.medill.northwestern.edu/chicago/news.aspx?id=165102

Capital "M" for Moon

By Peter Kokh

[Many readers, who learned in their years of schooling that the Moon should not be capitalized, and thus always referred to as "the moon," may have been puzzled to notice that we always capitalize this word in MMM-India Quarterly. The following piece, written by us in 1989, will shed light on this issue.]

Some (twenty plus) years ago, a letter in *Ad Astra* [The Magazine of the National Space Society] took exception to this writer's insistence that "Moon" be capitalized, The writer rested his case on several all too common misconceptions. Perhaps it would be helpful to discuss the salient facts.

Like the Moon, Julius Caesar is an original.

First, from time immemorial up until 1610 when Galileo first trained a telescope upon Jupiter and discovered it had four "moons," only one moon was known to mankind. Similarly, until even more recent times when it became apparent that the Sun and the stars were members of the same class of celestial objects, we knew of only one "Sun". Until these recent discoveries, Moon and Sun had perhaps never been used in the plural. In one language version or another, since the dawn of language, *these were their names***.** When we suddenly needed "class" names we borrowed these names from the sole objects we had ever known of each class. Ganymede, Titan, Phobos and company are thus "moons," only and simply by analogy or by extension. The Moon, the satellite of Earth, remains the original.

Certainly, in such a phrase as "the innermost moon of Mars," "moon" is a common noun. But it is transparent nonsense to say that even when referring to the original and privileged bearer of that appellation, "Moon" is a common noun. It would be just as silly to insist that since, in the history of the old Roman Empire, there had been dozens of "caesars" (and kaisers and czars, all the same word) in addition to the original Julius, we should decapitalize Julius' surname. Like the Moon, Julius Caesar (not "Julius Caesar") is an original.

Nor, as some are tempted to think, does the presence of the definite article "the" mean that "Moon" must be a common noun. If so we had best use the bahamas, the phillippines, and the hague. But we don't, do we?

"Luna" is simply "Moon" in another language (Latin)

It has been an unfortunate common gripe among science-fiction authors (spread thereby to uncritical readers) that "the Moon" is at best an informal and colloquial name, and that it should be replaced by "Luna. "While overdue international standardization of its name is certainly a worthy goal, "Luna" is simply "Moon" in Latin.

Most importantly, contrary to popular belief, there is no such thing (and never has been) as "correct English." There are only judgment calls as to what is most widely "accepted" and thus "standard" usage, something subject to change. All reputable dictionaries contain a disclaimer to that effect. Living languages are continually changing because they are **alive and** *ever regenerated* ***by their current speakers.***

We are already seeing a strong movement from "the earth" to "the Earth" and indeed to simply "Earth" i.e. no "the," though less pervasive. Awareness is slowly growing that the contemptibly familiar apparition in the night sky (the moon) is in truth another world-to-be (the Moon) upon which to continue the epic human drama. Newspaper editors and those English teachers wistful of the prerogatives of ancient priestly classes notwithstanding, the growing frequency with which "Moon" is capitalized expresses this new appreciation of the dawning "world" potential of the old queen of night. We might go so far as to predict that in time, just as "Earth" is now slowly but surely doing, "Moon" will shed the archaic "the."

While some may shrink in abject horror at the idea of such "linguistic activism," there is certainly nothing reprehensible about trying to guide inevitable linguistic change to suit the purposes of those seeking to better express themselves. Language is a tool, *and we, not it,* must be master. If we, as space advocates, want the public to become truly conscious of the Moon as a new world for realizing the human potential, we ought to take the lead in capitalizing its name, even daring to drop the "the."

Ultimately, this question will be decided, once and for all by the first lunar settlement government to arise. Just as most of us have learned to say Sri Lanka instead of Ceylon, if such a government decides our neighbor world should henceforth be known as Luna, Selene, Artemis, Diana, Chandra, or Chang'e, we'll all fall into line. We do realize that to those who have a native mother tongue that does not use the articles "the" and "a," this may all be confusing. The important thing is to realize that self-appointed guardians of the English language who insist that "moon" not be capitalized, even when it refers to a definite and unique world, are simply *discrediting themselves*. If this essay embarrasses them, good! They need to be embarrassed! **PK**

Antarctic and Space Precedents for an International Lunar Research Park

By Peter Kokh

Despite the Cold War rivalries between United States and the Former Soviet Union, and now the one-sided rivalry between the friendly International Space Station Partners and a suspicious China, international cooperation in space has a strong history. We will not try to provide a complete list. Examples will do.

The Apollo Era

Several nations around the world helped by monitoring the paths of US spacecraft and relaying messages so that NASA had a global link. Jodrell Bank in the UK, Muchea in Western Australia. But perhaps the classic example was **Apollo-Soyuz in 1975** when a NASA Apollo and a Soviet Soyuz docked together, with the Americans speaking Russian and the Russians speaking English, a failsafe way (the only way) to avoid misunderstandings as each side would only use words native to the other. Another example was the setting of a world-wide standard for docking apparatus design so that crews of one nation could come to the assistance of those of any other nation in space. Unfortunately, China has not followed suite, perhaps paranoid about being boarded, an adolescent attitude.

http://en.wikipedia.org/wiki/Apollo-Soyuz_Test_Project

MIR and NASA's Shuttle-MIR program

http://www.nasa.gov/mission_pages/shuttle-mir/ http://spaceflight.nasa.gov/history/shuttle-mir/

Mir was not the world's first space station, but it was the first to be long-lived. Here the shining example was the highly successful **"Mission to MIR" program**. We had the Space Shuttle, but nowhere for it to go. For several years, American and Russian astronauts worked together. Mission to Mir was very popular with US Space enthusiasts and the public. By all means get the IMAX video. Delightful! http://www.imax.com/mission2mir/

The "I" In "ISS"

At first a NASA Program, the proposed US Space Station was on the verge of being shot down by Congress until Bill Clinton proposed that a joint station might be the only way to keep Russian scientists and Engineers productively busy in the wake of the collapse of the Soviet Union, rather than selling their services to the militaries of other nations. Adding the I to SS, convinced enough congress people to save the program. The Russian contributions to ISS, both in modules and in supply missions and periodic reboosting (to higher orbits) has been essential.

But the European Space Agency (ESA) joined the effort as did Canada (CSA) and Japan (JAXA). Canada and Japan added modules and/or other hardware. ESA and Japan contributed Freight modules. International crews man the station and work together.

Note that not all nations participating in the International Space Station program are "spacefaring" in their own right, at least not in the sense of having the capacity to send humans into space on their own vehicles. ESA, Canada, and Japan have relied on US or Russian crew transports. The lesson here is quite clear. Nations that are not spacefaring by themselves can certainly play a big role in any future International Lunar Research Park.

Brazil and India, both invited, have yet to accept a role in ISS, though three astronauts of Indian origin have been in space as well as one from Brazil. Astronauts from other nations can train either with NASA or Roscosmos.

One ILRP core component is missing: Commercial contributions

Once Bigelow Aerospace's BA 330 inflatable modules are ready, we could see the first commercial contribution to ISS. That is an event that many of us in the space movement have pushed for over the years. Such a unit could be unstructured within and used as a free fall gym for the station crew. A structured one could be a sort of space hotel annex for VIP and other visitors. Adding berth space to allow expansion of the crew beyond 6 is also an option. The proposal for such an addition predates the launch of ISS. NASA itself thought of adding an inflatable TransHab unit to the proposed station. Congress nixed TransHab and NASA licensed the technology to Bigelow.

http://www.ilcdover.com/Transhab/

http://farm1.static.flickr.com/195/512805504_5d3504e3db_o.jpg

ILRP Phase I on Hawaii Island

Already several nations are involved, US (NASA, State of Hawaii), Japan, Germany, Canada. Others are invited and most welcome. Corporations are involved as well (Boeing: a key member of the world's largest international research Park in Stratford, England, UK.) A commercial company could provide supplies and key services (waste management, warehousing, transportation, etc. as well as house VIPs and other guests.) Contractors could provide all the habitats and other structures. Corporations are very much involved in the Antarctic, demonstrating

their value. This writer will not be convinced that ILRP Phase I on Hawaii is on the right track until contractors and other commercial concerns are involved.

NASA already relies on contractors for many things. While some designs originate within NASA, often enough they are just suggestions to guide contractors in putting together concrete proposals. **PK**

Antarctica as a Model for International Moon and Mars Outposts

By Peter Kokh

In many ways, a hundred years of human experience in Antarctica can be seen as a prelude to human exploration of the Moon and worlds beyond. And the cooperative spirit that pervades human activities at the bottom of our world is a good recommendation for following suite on the Moon. We will more throughly explore the Moon together, than as rivals. And that collaboration will be most essential in learning how to make practical use of lunar resources: the number one goal of the proposed International Lunar Research Park.

In Antarctica, many national stations are isolated from one another, but not all, and it is those exceptions we are interested in. See this map: **http:/www.scar.org/information/Antarctica_stations_map.png**

The hub of activity in the continent is the 56 year old US **McMurdo Station** (100+ buildings, summer pop. 1,200+). Built on the bare volcanic rock of Hut Point Peninsula on Ross Island, it is the farthest south solid ground that is accessible by ship. **McMurdo** has a close neighbor just next door: New Zealand's **Scott Station**. They share an airport (Pegasus) and the power grid. **Scott** Station recently added three high power wind mills to create the southern-most wind farm in the world. The two stations undoubtedly share other resources and services, and they have been close partners in Antarctica from the start. The US supports McMurdo out of Christchurch, New Zealand.

http://www.antarcticanz.govt.nz/image-galleries/category/12-windfarm

Concordia Research Station, which opened in 2005, is **a research facility shared by France and Italy**, 3,233 m above sea level at a location called Dome C on the Antarctic Plateau. On the coast south of South Africa, in an ice-free rocky area known as the Schirmacher Oasis, the **Russian station Novalazrevskaya** and **India's Maitri station** are neighbors, sharing the Russian built airport. Elsewhere on the continent, there are several locations where different national stations are located close enough together to share resources and services, at least in emergency situations. This is especially true in the Antarctic Peninsula where many outposts are clustered.

Where possible and practical it makes sense to share infrastructure and services needed in common. **ShareSense:** Logistics (airfield/spaceport); warehousing (fuel, supplies) Power grid and sources and power storage;, construction equipment; hospital and other medical facilities; shared recreation and assembly space; final stage waste treatment facilities; tools and equipment used infrequently; unusual talent pool; "SuperPerk" facilities and retreats; manning joint expeditions. Such a plan and philosophy of sharing anything not needed by each full time makes economic sense.

If we can do this in Antarctica, why do so many space enthusiasts see our future in space of one of rivalries? In the light of our experience with the International Space Station and in Antarctica, that makes no sense. No country can afford to throw away money out of spite or rivalry. We are in Antarctica together. We can be on the Moon together! Ditto for Mars. Moreover, international facilities will more quickly lead to local autonomy and eventual home rule as international settlements grow. Nationalists, and there are still many in every country, are living in the past as a hundred years of collaboration in Antarctica demonstrates. Finally, international efforts are notably more resistant to government budget shrinkage or cancellation than purely national programs.

There are many things done in Antarctica which could be done much better: another article to write!

Above: the extensive dormitory residential buildings at McMurdo: Insulated but without visible protected pedestrian passageways between them. Built underground or at skywalk level, they would not interfere with surface vehicle access. This is the prefect place to demonstrate the merits of an interconnecting "**Middoors**" environment. McMurdo could be a much nicer place, but most people are there on temporary tours of duty and have enough perks to endure. And this "oversight" is understandable as the station has grown well beyond the vision of its first planners in the mid 1950s. Growth has been haphazard and often without effective planning. McMurdo's history is lesson to be learned by planners of an International Lunar Research Park. Warehousing and storage of discarded items got very bad, but has been mitigated after a GreenPeace expedition called the "shameful mess" to the world's attention. Now the station is much more sensitive to its environment. **PK**

Virtual Tour - McMurdo Station, Antarctica - http://astro.uchicago.edu/cara/vtour/mcmurdo/

The Big Role of Sports in Antarctica (and on the Moon and Mars)

By Peter Kokh

One might think that "sports" on remote bases here on Earth as well as in space, might consist of chess, checkers, and computer gaming. Wrong! In Antarctica, at least at McMurdo Station, indoor and outdoor sports that task one's body, not merely one's brains, are a very big thing: essential in maintaining both morale and health.

http://sports.espn.go.com/espn/thelife/news/story?id=5761185

We all need time to unwind from our assigned work, whether that be purely mental, or mostly physical or a mix of both. And that unwinding is more complete if it involves the body as well as one's mind. Now we can workout in a gym, or engage in other solitary exercises. But "sports" and "sporting activities" that involve others serves a double purpose. We keep our bodies in shape, unwind from work-related stresses, and we build extra-professional relationships with other shipmates or station-mates. Thus planning for sports activities, while something that outpost designers may tend to overlook, is vitally important to the overall continued success of the outpost mission.

Some recreational sports are easier to support than others because they require less space and volume. Table Tennis or Ping Pong is an example. Wrestling is another. In Antarctica, with breathable air outside, one can engage in Nordic skiing, and other outdoor activities in the world's freshest air, on snow in ice-free areas. Sports let us unwind from the stresses of the workday and help us bond with our crew mates. Of course, we can compete against our own previous performance records, but competitive sports have a strong value too - and we don't mean watching others compete while we drink beer. They feed our need for competition, and they let us keep fit while we blow off some steam and frustrations.

McMurdo is not as isolated as the Moon or Mars, but is the only community of size on a continent as big as the U.S. and Mexico put together. The Shackleton-Scott station at the south pole is next in size and a thousand miles away. Here there are no "lawns to mow, children, pets or parents to care for." So crew personnel have more time and energy on their hands and need other ways to channel all this unspent energy. Of course, one can pursue one's hobbies or personal self-education in off hours. But that does not take care of the social needs and outlets. To avoid both boredom and a sense of being incomplete, interpersonal recreational outlets are essential.

McMurdo's gem, the "Big Gym," has a climbing wall, as well as courts for basketball, volleyball, soccer and dodgeball. The "Gerbil Gym," offers cardio equipment such as treadmills, bikes, and weightlifting equipment.

Can we plan for something of the sort at a multinational Lunar Research Park? Surely, larger "shared, common facilities" will be more economically feasible at such a facility than at individual isolated one-nation outposts. And that adds to the attractiveness of the ILRP concept. Not only do several nations get to share seldom used equipment, the spaceport, warehousing, etc., but besides their own individual limited recreation spaces, they will have access to a larger shared "Commons" with recreational space being one of its assets.

At an ILRP, not only will scientists and technicians be able to work with others in their field on larger joint projects, they will have access to larger joint labs, and talent pools. Such a "metro" base will be a much more attractive one, and not just for the many things that will make it more livable. It will also be much more attractive for individuals as well as national crews, because there will be much more going on, with new cross-enabled projects and experiments and explorations made possible by the "critical talent and facility mass" an International Lunar (or Martian) Research Park will allow. TV spectators on Earth could encourage by time-delayed cheering and applause.

Besides a McMurdo style big gym complex, an ILRP should be able to support a variety of experimental out-vac and lee-vac sport activities. A corner of a shielded but unpressurized warehouse would allow individuals and "teams" in less cumbersome pressure suits try their hand at a great variety of new types of sports tailored to the lower gravity as well as airless conditions. Most of these experiments will lead nowhere. But some team sports might be developed and matured in such conditions that are worth televising to Earth on the Sunday Afternoon "Wide Worlds of Sports." In indoor gyms, new 1/6th g sport forms could be perfected as well. And why not dance forms as well? If they look good on TV, this kind of exo-sport and exo-dance experimentation could grow support and interest among Earthlubbers.

The mission of an ILRP is to develop and advance manufacturing and production techniques for building and manufacturing materials made out of moondust to use not only in space construction projects but also for expansion of habitat and settlement space on the Moon itself. Anything made on the Moon for use there, is a potential money-making export for similar or analogous uses in space. This mission is a big challenge, and a multinational shared site approach seems to be the most promising way to realize such an outcome, with economic self-sufficiency as the goal. At that point, lunar settlement will grow quickly, free of massive economic support from Earth. In the process, significantly more exploration of the Moon will occur, and in greater depth and detail, than it would if we had no such economic "ISRU" local resource utilization plan as a driver.

We can see now how recreation and sports will help both develop and explore the Moon. Better yet, such ILRP experiments in sport and recreation activities will boost the "itinerary options" for lunar tourists from Earth. It all works together! **PK**

The Mars 500 Mission - How Did the Crew Pass the Time?

By Peter Kokh

First, below is some information about the Mars 500 Mission:

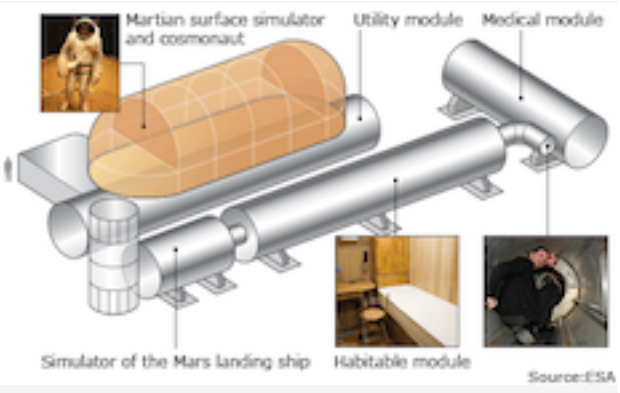
http://en.wikipedia.org/wiki/MARS-500

Mars-500 was a 520 day psychosocial experiment conducted by Russia, Europe and China in preparation for manned spaceflight to the planet Mars. The experiment's facility is located at the Russian Academy of Sciences' Institute of Biomedical Problems (IBMP) in Moscow, Russia." A 15 day and 105 day mission preceded it.

The experiment began on June 3, 2010 and ended on November 4, 2011.

http://www.space.com/13503-mars500-crew-emerges-520-day-simulation.html
http://www.esa.int/SPECIALS/Mars500/
http://www.imbp.ru/Mars500/Mars500-e.html - official website
http://en.rian.ru/photolents/20071224/93904736.html
http://mars500.imbp.ru/en/nek.html !!!

"A human is the most important element, to a large extent determining the possibility of successful realization of the mission. At the same time he is the most vulnerable unit in the system "crew-spaceship" because of his susceptibility to influence of the flight negative factors."



Outside view of the considerable complex and the Plan

Module 1: The Mars Lander (6.3m × 6.17m) will be used during the 30-day "Mars orbiting" phase. It has three bunks, two workstations, a data collection system, video communications, ventilation, water supply and fire alarm systems.
Module 2: The Technical Module (3.2m × 11.9m) will house equipment for medical examinations and telemedical, laboratory and diagnostic investigations. All experiments will be conducted here.
Module 3: The Living Quarters (3.6m × 20m) has a kitchen, living room, and main control room. Six individual crew compartments (2.8m²) will have a bed, a desk, chair and small shelves.
Module 4: The Storage Module (3.9m × 24m) features food refrigeration, clothing and crockery cupboards, sauna & gym, plus a "regenerative" life-support system and greenhouse farm. Other partitions house necessary tools for running the study (communications consoles, ventilation, water supply, electrical panels, recycling, safety monitoring, emergency equipment)
Module 5: The Surface of Mars... Oh just imagine the playtime here!

inside the main commons area: not much room, but realistic (except for the wood!)

The main stages of the experiment:

• "flight" on the route Earth-Mars - 250 days; (before the "landing on Mars" these crew members will stay during up to 30 days in conditions of antiorthostatic hypokinesia - a method of simulating the effects of weightlessness)

• Staying on the "Martian surface" of 3 crew members - up to 30 days;

• "Flight" on the route Mars-Earth - 240 days.

The main tasks:

• Studying of the influence of simulated conditions of Martian manned expedition on the **crew's health and work capability**;

• **Organization of the crew's activity** and its interaction with the Experiment Control Center;

• Verification of the principles, methods and means of:

Control, diagnostics and prediction of the **crew members' state of health and work capability**; providing of medical care, including with the use of telemedicine technologies,

Countermeasures against adverse effect of the "flight" factors on the human body,

 # Psychological support,

Environment monitoring;

• Approbation of the modern technologies and tools of the human life support and protection;

• Approbation of the elements of biomedical information-analytical system.

Crew composition:

• International; 6 persons (gender structure determined on results of the investigators-volunteers selection);

• Age - 25-50 years old;

• Preferable specialties (taking into account compatibility): physicians, engineers, biologists, specialists in computer engineering.

Scientific program

In the experiment "MARS-500" investigations were conducted in the following directions:

- Clinical-physiological investigations.
- Biochemical, immunological investigations.
- Psychophysiology.
- Small group psychology, personality psychology.
- Sanitary and hygienic, and microbiological investigations.
- Biological investigations.
- Operation-technological experiments, verification of the data bases.

Editor's Comment:

This was the most extensive, elaborate, and well-thought out space frontier "Analog" exercise to date, well beyond anything attempted by the Mars Society on Devon Island or in Utah, or anything program yet attempted on Hawaii Island.

The facility itself was elaborate, though the simulated Mars turf module could certainly have been much much larger with favorable psychological benefits of real "elbow room" after being cramped up in the confines of a Mars-bound spacecraft for 250 days!

The crew members were kept busy with tasks all through the 520 days, but the activities allowed for seem unimaginative, and do not seem to have prepared them as much as possible for the Mars surface mission itself. And "on the way home," the activities to select from also lacked imagination.

Morale is everything, and here is were I think the exercise could have been better planned if results on Mars itself are the final test and if psychological collapse on arrival back on Earth, however delayed, are the final test.

- **Read the post mission report that identified several major problems**

http://www.marsdaily.com/reports/Mars_Astronauts_Could_Risk_DNA_Damage_999.html

- **Below is a reprint of a relevant article** that I wrote over twenty-two years ago, in Moon Miners' Manifesto #30, November, 1989. In that article I predicted some of the problems that came up in Mars 500. **PK**

WANTED: Split Personality Types for a Mars Expedition

By Peter Kokh

Besides being willing and able to leave Earth, family, and friends behind for three years or more, must for the trip out and back, have **a high tolerance for sensory deprivation and thrive on boring routine tasks**; and, at the same time, for the period spent on Mars' surface, **must be thrill- and challenge-positive, keenly attuned to external situations with all their unpredictability**.

If you are such a Jekyll-Hyde combination, please send your resume to:

- **Mars Expedition Personnel Office, Mars Training Camp, Svalbard, Norway**

For as long as the era of chemical rockets lasts, interplanetary journeys to Mars or the asteroids, will be long tedious affairs that will be very trying for the kind of people ideally suited for the kind of life that awaits them at their destinations. This presents us with a choice.

- We can either look for persons with such chimeric personality combinations as suggested above who will perform reasonably well under such diametrically opposite circumstances,
- *Or we can start now to plan ways to structure the times of transit to better fit the personality traits of those best cut out for the exploratory and/or rugged pioneer life on the untamed worlds of their destination.*

The path of least effort, and a temptation to mission planners, is the former. Transit times will be filled with make-work: solar-wind measurements and other astronomical chores that could either be done just as well from LEO, or if not, by robot probes. To this will be added routine periods of exercise and other monastic treats. Meanwhile, people better suited for the planetary surface stay itself, will be bypassed if they evidence any signs of being less content than pigs in a mud hole by such a diet of time-whittling.

We need to take a creative look at alternatives. *First, we must recognize that the trip out and the trip home are radically different in the deep psychological challenges they present.* Outbound, the crew will be filled with anticipation. Homebound, they may experience both anticlimactic letdown and an impatience to get back home.

The opportunities for damping these feelings with engrossing and meaningful activities are also diverse. In the article "M.U.S./c.l.e." [MMM #18, September 1988 - http://www.moonsociety.org/publications/mmm_papers/muscle_paper.htm] we suggested that equipment manufactured on Earth for use on the Martian surface be disassembled (all parts tested and checked individually and in test assembly) to be put together in a Big Dumb Volume area. The crew would be highly motivated to put everything together right, preparing them for repairs if needed. Yet this opportunity will predictably be seen as risky business by some who may favor keeping Mars-bound crews busy performing safer make-work.

Surface expedition concluded, the crew would be similarly motivated to do preliminary chemical and physical analysis of samples being returned to Earth, along with some building materials processing experiments. NASA, however, may forbid them to touch the samples, not trusting them to handle the precious cargo and possibly invalidate intended research by more expert investigators in better equipped Earthside labs.

In both cases, there is probably a point of compromise between NASA's natural paternalistic prudence and *the not unimportant needs of the explorers-en-route*. **For example, ultra-critical equipment can be shipped preassembled, with less sensitive equipment and backup equipment shipped "KD" (knocked-down) for assembly en route.**

For the Earth-return, a similar division could be made. Surface samples could be separated into two quota portions, those held safe and untouched for labs on Earth/LEO, and those on which preliminary analysis and experimentation can proceed en route; trained geologists, chemists, and other scientists will be essential to the crew. To deny them "first rights" can only sow and nourish a festering resentment. Such avoidable psychological compost heaps should not be discounted as threats to the overall success of the mission.

If the overall spirit and atmosphere aboard the return crew vessel is positive, there will be other time-filling things to do. Debriefings and reports while experiences are fresh in their minds can be followed by *round table discussions of how the success of a follow-up mission could be enhanced (new equipment, tools, lap facilities, housing etc.; better training; additional talents represented in the crew mix, etc.)* Sensory and other impressions can be set to canvas or disk by those on board of artistic, poetic, or philosophical bent. So much for generalities.

Artificial Gravity en route?

Undetermined at this time, but absolutely relevant to the matter we are considering, is whether the voyagers will enjoy the amenities or artificial gravity for the long coast out and back. One gets the feeling that provision of at least fractional weight poses engineering challenges that neither Roscosmos nor NASA are eager to tackle. So what if the astronauts or cosmonauts can survive such long periods of zero-G without irreparable harm!

The unchallengable reality that the crew of a zero-G ship will arrive at Mars in a physical shape unequal to the demanding tasks at hand in the very limited time frame provided, should be more than enough to convince mission planners to err on the side of patience. One wonders whom they are kidding!

Mars-weight, 38% Earth-normal, can be provided by a simple tether arrangement with crew pods at one end and equipment not needed before arrival at the other. Artificial gravity can also be provided more elaborately by a fixed structure, for example by a conjoining for the Mars-bound craft as in the Case for Mars I studies. Experiments with tether-provided artificial gravity could begin soon using the Shuttle and an External Tank brought to orbit with it. (To the reader, keep in mind that this article was written over twenty years ago!) We have yet to do an EVA in an artificial gravity environment! An astronaut would have to remain tethered and would share the angular momentum that obtained at the exit lock. It would be tricky stuff at first, fraught with perils that could nonetheless become routine, even as driving in heavy traffic or flying in formation. Appropriate maneuvers and cautious could become second nature. There will be mis-moves but careful provision could minimize serious accidents.

Outside the Airlock Exercise and Sporting Activities

The point to be made here is that, to NASA's abject horror, no doubt, there is a very real opportunity for totally new tethered-EVA sports outside rotating structures. By shortening a tether to the hub, one would advance on the structure; by paying it out one would fall behind - simple conservation of angular momentum.

Using such maneuvers in tag matches might be risky, but rally-type events in which each raced the clock, one at a time, to land in the shortest time on a forward perch or tag ring, then on one to the rear, before returning 'home', all by manipulating the effective length of the tether, could provide healthy, adrenalin-racing sport. This could be welcome stuff to a crew chosen to be optimally tuned to the pace of activity of the Mars surface part of the expedition. *When such sport is embraced, either on the sly or with reluctant official consent, we'll have come a long way towards making the space lanes home.* **PK**

Is Manned Space Exploration a Waste of Money?

By David Gerrold

In another venue, someone has argued that manned space exploration is a waste of money. No -- it is not. As idealistic as it is to assume that we don't need to send men and women into space, the whole point of the effort is to make it possible to send men and women into space -- to the moon and to Mars. Not just because it is there, not just because it is a great adventure, not just because we can, not just because there are things to learn, but because it is who we are.

Along the way, what we will discover about the universe, the solar system, the planets, our home world, and ultimately ourselves, are lessons that we cannot learn any other way. What we will achieve in science and medicine and industry will be advances that we cannot accomplish any other way. What we will create -- a new network of interrelated disciplines and discoveries -- cannot be created any other way.

It's this simple. We are creatures of curiosity. We are explorers. We are at our best when we move ourselves out of the emotional terrain of petty fears and angers and into the much higher realms of curiosity and exploration and discovery. That's where enthusiasm is found, sense of wonder, awe and marvels. That's where we find our soul as a species. That's where we find a higher place to stand and a better view of the terrain still ahead of us.

The scientific and economic and technological reasons for going into space are important and compelling -- but the larger reason is that who we are is the question "who are we?" and space is part of that philosophical inquiry. We cannot even approach the question without getting up into space and looking at the big blue marble and seeing that there are no lines drawn on the continents, no borders, no signs of ownership. We are all in this together.

Space is not the final frontier. The final frontier is the human soul. Space is where we will meet the challenge.

DG

Are We Ready to Settle the Solar System?

By David Dunlop

Part I: Technologies Needed

The Historical Context of Adaptation into a Broader Set of Eco-niches

As the species which is now triumphant in its global distribution in a wide variety of terrestrial environments and which has poked its nose into the vast new environment beyond the Earth we look forward to further exploration and settlement of new territory. We have distinguished ourselves as **the** tool making and using species, not entirely unique among other species but orders of magnitude more prolific in our creation of tools and in creating a diversity of material culture.

Tool Evolution

Our tool evolution stretches from thousands of years of shaping stones and sticks and the utilization of metals to decades of using electricity and amplifying our limited physical strength with monstrous machines used in mining and moving earth, transiting the oceans, and flying within and out of the atmosphere. We have also created “the soft sciences” to understand ourselves in psychology, sociology, and blended our knowledge of physical processes impacting our bodies with a diverse range of medical techniques now informed by genetics and by the creation of a global “mind” by the development of the Internet and mobile information technologies.

Genetic Evolution of Homo Sapiens Species

Our cracking of the code of life is opening new understanding of both our limitations and our potential to change and shape our identity as a self sentient species but also the marvelous diversity of our co-dependent species. This new understanding not only illuminates our evolution in the past environments of the Earth but points to the potential of adaptation in the new environments awaiting us in the vast realms of our own solar system.

Genetic evolution of selected plants

Among the great achievements of human civilization is the shaping by selection of essential plants and the use of various complexes of food plants by many peoples across the globe as the nutritional foundation of civilization which permits the specialization of human talents. The daily struggle for survival of the natural world has been overcome an that has enabled the richness of human culture.

Evolution Shaping the Landscape

Our success in finding ways to use environmental resources has also lead to reshaping the landscape of our environments going back to the beginning use of fire. the ability to cut and shape trees and to break and till the soil. But this has lead to inadvertent changes such as deforestation, desertification following irrigation, and the destruction of grassland by over grazing, and the destruction of the most productive soils. Our advanced societies have created many "managed landscapes" but often with little practical consideration or controls on the sustainability of the practices of utilization.

Evolution of Urban Technology

Perhaps the most noticeable phenomenon of our evolution is the growth in the scale and complexity of the built environment. Our cities now sprawl across vast swaths of the terrestrial landscape and encompass millions of individuals. We seem to be evolving into a "hive species" where the great potential of design can permit maximum benefits from limited physical resources and limited energy resources. We have come from caves and huts to smart houses, skyscrapers, mega malls, urban transit networks. Our cities which have grown from unintentional patterns based on natural circumstances and advantages into most often unregulated examples of cancerous growth with unsustainable footprints on the surrounding environments.

Cities in Space

As we contemplate the deficiencies of our urban evolution we can compare our current practices with the requirements of survival outside the familiar but challenging ranges of environments we are used to on Earth. We see the requirement for the city in space an an intentional systems, designed as a largely closed environments carefully using the vast energy resources offered by solar and nuclear technology but limited in time and space to the access of critical material resources which must be preserved and recycled. **The stringencies of design requirements in space can perhaps inform us how to better manage and redesign our cities on Earth**. It is in both understanding the design requirements and modifying the practices of our existing cities that we can truly aspire to pass our species intelligence test in space. The footprints of our future cities on both the Earth and in space require a footprint that embraces the understanding the whole scopes of human and terrestrial biological evolution. It is an understanding that embraces a set of tools and material and cultural practices that enable long term "self-sufficiency" in the many environments in which we operate and plan to settle.

Pushing the Boundaries

Today there are many long term outposts on the continent of Antarctica, clearly the most challenging and "alien environments" on our home planet with the possible exception of the deep ocean. For the moment we have fore bad ourselves the "luxury" of creating true settlements in this harsh terrain but have enduring outposts for scientific study and now increasingly tourism. The antarctic enterprise shared by many nations is the best model of how we our aspire to poke our nose into new space environments. Our global Antarctic Program is The Grand Daddy of Space Settlement Initiatives but it is far from a sustainable settlement largely dependent on in situ resources.

Our little International Space Station is an enormous achievement both in international cooperation as well as in engineering and technology as an example of a permanently occupied human environment just above the edge of Earth's atmosphere. This tiny model is however an example of unsustainable extravagance and primitive in its ability to provide both an economic and sustainable design that permits large numbers of human to routinely live and work on another planet or in circumterrestrial space.

Other Terrestrial Space Analog Initiatives

Analog programs looking forward to the Moon and Mars have barely begun to address the real long term economic and operational requirements of such ambitions. To pretend otherwise is simply dishonest. But they are a start nonetheless!

The "Moon Base"

The glory of the Apollo Program remains undiminished even approaching 50 year later. For all the marvel of making these giant leaps they were however the most humble of "brief camping trips" into what remains largely a territory beyond human reach. We will be doing well to even begin to establish a robotic village on the lunar surface some 50 years later on "our eighth continent." which presents for our potential use a surface area as large as Africa and Australia combined. NASA's last gasp lunar program Constellation only aspired to a 4 person outpost, not even addressing the Presidential charge for permanent human occupancy and returning to the Moon to stay. The harsh and hostile surface of the Moon is indeed stony ground for human science and industrial outposts. Yet the ambition remains and the foundation of international participation has been increasing in the last two decades. *The vision of the Moon Society and the National Space Society is not one of sentimental or fanciful aspiration but of both technical and economic extension human civilization to this challenging environment as a place where humans can live and work with tangible value to the rest of humanity on Earth.*

The volume "The Case for the Moon- and Why We Must Return to Stay There" is really now an essential companion to the volume "A Case for the Earth and How to Survive There", which requires essential clean energy from space and the use of in situ resources on the Moon to achieve what must be obtained for terrestrial civilization. This scenario also is one which promises great economic expansion and the creation of wealth and hope on a scale previously unimaginable for the Earth's population. We do not know whether the Moon's 1/6th G will enable mankind to actually settle the Moon and thrive on Earth's alien but nearby "sister planet." We know we must use the Moon and can profitably do so but we don't know if we can actually live there as a convenient and close by "second option."

The Mars "Base"

The "man in a can" scenarios promoted as the glorious and even necessary extensions of human life to Mars are not even silly. They fall preposterously short intellectually of providing for not only "man" but also all the species on which mankind is co-dependent and which would permit our terrestrial species to "settle" on Mars. The magnificent ambition to gain a second planet and a second chance for human survival in a calamitous universe is yet a step too far at present. There **is** a case for human adventure and exploration and for the necessity for long term human survival and settlement on Mars. But,as yet no viable economic case for Mars seems more sustainable than the short but glorious campaign to visit the Moon and return safely. (1) A vainglorious ambition for Mars can delay the long term objective as we have learned from our lunar experience. That we should push the boundaries of this possibility is the grand adventure beyond the use of our Moon. Mars is a surface equal to the whole land area of Earth. Our survival on Earth however must come first and Mars is a grand second priority to the more immediate priority of the survival of our complex civilization on the Earth. We must buy the time on Earth we need to avoid climate catastrophe by creating an Earth-Moon economy to permit our next leap of **settlement** to Mars. By creating this economic and technical foundation in cislunar space we will create the tools and capability to make this formidable challenge and advance to the next terrestrial planet.

Mars is not to be underestimated in the same way that Antarctica is not to be underestimated. We have not in any honest sustainable sense "settled" in Antarctica. Our existence on that seventh continent is completely tenuous and dependent on fragile supply chains. It has only a science and tourist economy at present (even with a century of exploration initiatives from the rest of civilization.) Our existence on the Moon will be similarly tenuous even if the Moon becomes a significant industrial force in the Earth's energy, materials, and science economy over the remainder of this century. Our experience in creating that cislunar infrastructure however, will give us, the ability to go to Mars to stay. We will create an architecture for Mars exploration and human outposts. We will eventually learn in that harsh environment how to create another permanent and self-sustainable human settlement with its own economic rationale and not just a far extension of Earth's curiosity and entertainment.

O'Neill Settlements

Circumterrestrial settlements like those envisioned by Gerhard O'Neil may become a potential model for human settlement in space. They may also provide a model for expansion beyond Mars into the asteroid belt. If we develop O"Neil settlements near Earth and Mars then we may also see settlements of this sort developed near Ceres, which promises to provide a suite or resources critical to that distant ambition even at the extreme limits of the suns illumination. If it is not a waste of time to form a Moon Society or Mars Society to nurture those ambitions then perhaps it is not a waste of time to consider forming a Ceres Society as well.

These ambitions for human expand must embed the memories and lessons learned from the succession of prior expansions on Earth. We have evolved on African savanna environments and moved to river estuaries, temperate and tropical forests, and even arctic terrain, and harsh deserts. We can recreate this diversity in space as circumstance and resources permit.

Our species intelligence test is still in session and we can claim to have a passing grade only if we are around to discuss this process of adaptation to the constraints of food production, population, resources, and genetic diversity, economic surpluses, and political will to meet the challenges of long term survival as opposed to short terms advantages.

Further Challenges

We are still exploring inner space and requirements of socialization, human intellectual potential, and our ability to plan and survive in a civilization with an unprecedented technology and information matrix. It is arguable whether our human psychological and socio political structure are reliable enough to sustain human survival linked as they are to the incredible force of our technology achievements and the potential for war and even the unintended and unforeseen consequences of the technology and we create and use. To journey further we must create sustainable bioregenerative biosphere systems. This has not been demonstrated and demands considerable additional resources on Earth and in cislunar space. We have not demonstrated a mastery of the potential for commercial fusion power plants on Earth or in Space and that will be required far from the warmth of the sun at the Earth's distance. We need to create environments in space that protect our fragile genetic structure from the impact of high level radiation exposure in deep space.

At present we cannot say with honesty that "we are ready to settle space" but we can say with honesty that we are ready to begin the start the process. Our building on the success of the ISS, the challenge of developing the Earth Moon economy, and the challenge of completing the exploration of both the Moon and Mars are beckoning those bold enough to hold these visions of space settlement.

(1) Some Challenges and Assets of Mars

An entire second planet with rich resources for survival and the potential of self sufficiency but also with the significant challenges:

1. Not quite 1% of Earth atmospheric density and mostly CO2 (97%, the rest mostly N2)
2. About 38% (3/8ths) of Earth's gravity
3. In a significant deep gravity well
4. With great exposure to radiation
5. With reduced ambient solar energy
6. With Antarctic range cold temperatures
7. With soil peroxides which destroy organic molecules) with significant assets
8. Small moons that may provide natural observation stations and in situ resources in orbit
9. An atmosphere that can provide aerobraking for descent to the surface
10. An atmosphere that can be "mined" for fuel production
11. Sources of abundant water in permafrost, polar ice caps, and perhaps liquid water under ground
12. A planet with a history of hydrothermal activities which should have concentrated many mineral ores and resources in its evolution.

The expense of getting to Mars and sustaining human presence across the long supply chain makes an integration of Mars into the Earth's economic system a great stretch with todays technologies. It seems highly probably that Mars has what humans would need to use to create a permanent self-sustaining economy on its own. It will take a long lead time to create that capability on Mars in a way that is can become quite independent of the Earth's supply chain as a self-sufficient and space faring outpost of human civilization.

Part II Human Characteristics

I return to the topic of "Are We Ready to Settle the Solar System" discussed above, but with a focus different from the technologies needed in that endeavor. This time I wish to talk a look at some of our human characteristics which may initially make us very unsuited for the new opportunities of expansion. First our expansion depends on a highly engineered environment. Space ships, much less larger habitats, designed for sustain human habitation must take into account both the best as well as the worst of our human characteristics. To provide an exhaustive list is beyond the goal of this article but a few key examples will serve to demonstrate the point.

Evolutionary History

We have been shaped by an evolutionary heritage stretching back millennia. Our traits which served to advance our chances of survival in past environments may well disadvantage us in the new environments we find as well as those environments we create. Some easy examples come to mind. This is a lot to keep "in a bottle."

Aggression

As individuals we can and do become become very destructive and antagonistic toward our peers. Aggression and Territoriality: An evolutionary Imperative which plays out in both individual and group dynamics to ensure access to the resources needed for survival and propagation.

Aggression and Mate Selection:

Enhanced Prime Selection also often leads to aggression. Social Dominance Hierarchies of Alpha Males and Females often result in violent challenges by up and comers.Even though the Earth is of a vast a scale our species depredations have had an detrimental impact on many environmental systems through war, the use of fire, and other acts of aggression toward competing groups which also harm the larger environment. This is not a recipe for secure long distance travel among the stars much less even within the confines of our solar systems and the fragile outposts we now envision.

Depression

The other side of the emotional coin of aggression is depression. Murder suicide is not an uncommon phenomenon. Anger is often turned both inward and outward and lose/lose scenarios are more than just the stuff of literature but a frequent part of human culture widely seen by law enforcement and often a tragic component of family domestic violence.

Socialization & Maturation & Identity

We have a long period of dependence of our young. Their socialization requires an extended period in which necessary skill acquisition occurs. There is a long period in which emotional immaturity and deficits in judgement are overcome through experience. This make each generation a “high stakes proposition” in facing new challenges.

In the extended socialization process adolescents gain experience with practicing skill sets, which can be both constructive or destructive of their social and physical environment. We can predictably expect immature and rash impulsive judgements of our adolescents. This is also not a recipe for secure travel in highly complex vehicles which have only a tiny fraction of the room to which our species has been accustomed on the Earth. This is clearly a potential problem when the human population is confined to a constrained “built environment” where system failures as a result of social disruptions and violence could quickly spell doom for all aboard.

Spaceship Earth on which we reside is a system so vast in relationship to the scale of our species that it is hard to tinker with no matter how ill intended or ill advised the motives of the human actors. The Earth's ability to heal itself over time has cushioned the fate of homo sapiens and saved it from itself thus far. Our impact now however are not on a global scale and it is very much in question whether we (in a species collective sense) will have the sense to manage our own home spaceship with prudence. We have not seriously contemplated these characteristics of our species in our (Romantic vision of space settlement this far. Is it logical to think we could really aspire to be a star faring species if “people are just being people.?”

Evolutionary Future

We face this reality in the modern world where we have in an eye blink of geologic time created megalopolis environments which have no precedent in our evolutionary past. We have created an urban industrial civilization that lives beyond sustaining in the limited environments on Earth. It requires individuals that can assume highly differentiated roles, problem solving skills in continually changing circumstances of, and many interlinked but differing environments. It varies enormously from the more sparsely populated natural environments in which homo-sapiens has expanded, to city environments with levels of stimulation, stress, and competition, unlike the of the past. The African savanna was also an environment of stimulation, stress, and competition where the humanoid band survived and prevailed against much larger, stronger, and faster competitors inventing and passing on the tools of human culture. The tools of war have reached the point of mutual assured destruction and yet war remains a major human cultural enterprise.

We have not evolved as a “hive” species like the bees which roam freely across the environment yet live lives highly prescribed by a limited number of roles serving the reproductive needs of a solitary queen. It seems that bee violence is largely directed outward at competitor group members or other species intruding on the hive. Our increasingly complex and densely populated urban environments are envisioned as being extended into space where the environments are most unforgiving in comparison to most of those we encounter on Earth. Will our destiny be to evolve into a more hive like culture in facing the challenges of stellar diaspora?

Reinventing Ourselves

An existential question for our species is what is a “good” environment for homo sapiens? We are the product of our past environments, are shaped by our existing environments, and will be changed by the environments we design for ourselves. We are now at the stage where we can directly shape our own genetic evolution as well as the material circumstances of our future.

We have a wide range of individual intellectual talents but we have also evolved a collective consciousness through our literature, mass media, and institutions of communication. In only the last twenty years or so have we, with the growth of a global “web” evolved “a planetary mind” of unprecedented power. We now are faced with proliferating information “applications” that empower both individuals and organizations with abilities unique in human history.

We aspire to expand far beyond the surface of our planet;

*To utilize the energy of the Sun,

*To use the resources of the surface of the Moon

*To acquire and settle Mars, another entire terrestrial planet with a surface as vast as the land area of Earth,

*To use the vast resources found in the asteroid belt including the Minor Planet Ceres.

It can be argued with considerable merit that our past evolution may disadvantage us to some extent in this new ambition. But we also have the ability to effect change. To travel sustainably in space means understanding and facing the real requirements. One requirement is that we create a “built environments” to overcome the harshness of space, and the rigors of other planetary and asteroidal bodies but also to provide an environment where the existential dimension of human ambitions and identities can be fulfilled.

Whether these challenges are located on the surface of the Moon, Mars, or in our familiar home world the challenges are very similar. It is only some 50 years since the first human being left the protective blanket of the Earth's atmosphere to orbit the Earth. The ISS is the humble start of these grander ambitions of utilization, development and settlement but hardly a hint of what will fully emerge both on Earth and beyond. It is because of the design challenges of engineering habitations for ourselves in space that we can also see more clearly how we might improve our habitation designs on Earth to lessen the environmental "footprint" of human culture in balance with the resources of the Earth or those of these new environments on the Moon, Mars, and Asteroids. If all the resources we have spend on space helped us simply to face the real challenges of sustainable living on our home planet that would be justification indeed.

The breakout of European culture to fully adapt to new environments of the American Continents has consumed over 500 years. It was over a century from the first landing of Columbus in 1492 to the first landing and settlement of the English in Jamestown, Virginia in 1607. Our first steps in LEO and on the Moon have been similarly halting, perhaps more akin to those who first must have clung to a log to cross a deep river than to those who so boldly navigated the seas in proud Galleons. We are no doubt still more than two decades away from a first human visit to Mars and perhaps even fifteen years away from a human return to the Moon to stay. Perhaps at the end of this century we will have substantial presence on both the Moon and Mars and an economy and culture that can both accommodate and transcend these distant worlds in a larger human cultural and economic system. We have hardly taken even baby steps toward our destiny in space and our suitability for that journey remains to be demonstrated.

It is impossible to separate the reality that our journey into outer space is also a simultaneous journey in inner space where the questions of identity and purpose remain as challenging as the problems of engineering of the propulsion systems and the habitats that can span the distances of our solar system.

We know the Kuiper belt and the Oort cloud have large bodies which might also be targets for human utilization and places where the jump to other stars may originate. What will we be when we get there and will it be recognizably human to those of this generation? Only some chance reader of this article in the future will be able to answer that. **DD**

Financing Space-Based Solar Power and the Rest:

The Problem of Financing Long Lead Time Space Infrastructure

By David Dunlop

The 2011 IAA report The First International Study of Space Based Solar Power indicated that at present there is no business case for SBSP to supply commercially competitive baseload electrical power. The study indicated that this might with R & Development of demonstrator prototype be feasible in 20 years. So this SBSP proposition involves two assumptions:

1. That 20 years of R & D will occur in order to reach competitive cost feasibility.
2. That once competitive feasibility has been demonstrated that commercial capital could financial these space based (most likely GEO) power stations and ground rectennas. Thus putting SBSP on line would occur after 20 years of R & D and perhaps take ((if the ISS is the prototype of large space construction) another 10 years beyond that to produce a working commercial SPS.

So it might take 30 years of investment to reach the point where the first commercial watt of power is produced and therefore of the first revenues. That seems a long time to wait before even the beginning of a return on one's capital occurs. There is a time value to the use of money and this 30 year lag in rate of return for a huge cumulative investment is a problem that has to be addressed for national investors to be convinced that there is in fact even an "ultimate" rate of return for one's own retirement and the future of even one's grand children. We all want something in in the future in exchange for the financial investments of the present.

How might this obstacle be overcome financially if the competitive markets would not find this an attractive proposition? Modern capitalists are not known for their patience with regard to returns.

Perhaps there is another solution that could tie this global investment challenge to the purchase of SBSP "bonds" by the Social Security Funds of the participating international countries partners in the creation of this new energy infrastructure.. Is this risk associated with the development of a space based solar satellite a reasonable proposition? I think it could be. How so?

Solving this problem is a large part of creating a globally backed investment program by the major space faring nations.

All of these advanced industrial nations have some sort of retirement system that reflects the economic aspirations of their citizens to have an income stream after a working career of some 30 to 40 years. The funds put aside for these retirees are a significant ongoing expense. They are also part of the international competitive burden that these countries carry in there overall economy to countries that do not provide or invest in their own futures.

Having a "mega investment fund" that is essentially an internationally standardized investment pool creates a bond system that is backed by the "full faith and credit" of these space faring powers. All of these countries would face the same "buy in" as backers of these SBSP bonds in initiating these bonds. So selling the publics of these countries on the scheme that this is an economically viable strategy over the long term is a critical part of the "faith in the future" upon which any bond is based.

Fox example the US Social Security Trust Funds use current income to pay out benefits. The US government routinely withdraws funds from the SS Trust and puts in an IOU from the US Treasury. This IOU is really an act of faith that the US economy will grow and develop so that it can funds SS payments in the future. To be cynical, his Social Security can be described as a "Ponzi scheme" using revenue collected in the present to start the payout pool and promising future yields based on faith in the future of the system. As long as the funds collected equal or exceed the payout in the present the scheme can continue to operate and contributors continue to come (by the power of enforced deductions from their earnings and the companies that employ them and make payments based on their "faith in future payouts.".

Would SBSP Bonds be a reasonable purchase for national Social System Systems?
I think the answer can be yes, and actually must be yes. Why?

The global demand for power is increasing both as a function of global population growth and the increasing per capita consumption of energy.

1 Even with a focus on energy conservation new sources of electrical power will be needed around the globe . It seems incontrovertible that future demand will be strong.

2 It also seems incontrovertible that other energy technologies will be technically insufficient to meet future global energy (and particularly electrical energy) demands. Fossil fuels, wind, hydroelectric power, ground solar, biofuels will all be part of the international competitive mix of power sources. *Dr. Sergio Trinidad, an MIT educated chemical engineer (and a Nobel prize winner for his work on the International Governmental Panel on climate change), and energy expert especially in the area of biofuels, presented information at the China Energy and Environment Summit on the mix of energy sources projected forward to the year 2100. His projections (which were also the work of a European think tank) showed that*

3 *By 2100 biofuels and solar energy (both ground based and space based) would comprise 50% of the global energy supply. All other sources including nuclear fission, wind, and fossil fuels would constitute the remaining 50%.* [source: Dr Sergio Trindad, presentation at the *China Energy and Environment Summit, 2011, Beijing.]*

http://cdn.intechopen.com/pdfs/17478/InTech-Nanotech_biofuels_and_fuel_additives.pdf

We are talking about essentially a century's worth of work and investment to shift the world away from predominant dependence on fossil fuel energy sources to alternative and sustainable supplies of energy including space based supplies. This future global **Cathedral of Space Based Energy** is therefore not unlike the faith based culture of the European Middle Ages which built Cathedrals, (which were the work of generations) or for that matter like the decades long efforts which were required to build the Egyptian and American pyramids. Our contemporary capitalist global culture is based on a numerical system of calculating competitive rates of return on investments of all sorts. We do not have a faith based culture that is free of economic examination based on future rates of return.

Few have examined the long term economic viability of space based solar power. One who has is Dr. David Criswell who has projected very competitive rates of return for his proposed Lunar Power System of space based solar power. His scheme however proposes a system that would wait 15 years before the first production of power. It remains to be seen whether support for a financing system with the lag time involved is realistic. I believe that both national governments as well as commercial investors will be very conservative especially before they commit to the system he is proposing to build this on the Moon with no prior demonstration. While his Lunar Power System proposal has been attractive in terms of potential clean energy production and overall economic return, it seems to me that some more affordable demonstration first steps are needed. www.agci.org/dB/PPTs/03S2_DCriswell_0710.pdf.

The world has not rushed to invest and implement
a global system of investment to achieve this worthy objective

Unless we can solve this economic investment problem the hope of a sustainable advanced global civilization and of the supporting enormous and growing human population with a high standard 21st century life style may well

be lost to a more apocalyptic death spiral for contemporary civilization and humanity which includes depletion of essential fossil fuel supplies needed for the future, the creation of polluted clean water sources and destruction of many ecosystems needed for sustaining human survival.

The stakes are very high for solving this problem of theoretical economic investment in space based energy supplies especially because for the most part the world economic culture is based on a illusory faith in limitless economic growth based on on the very limited energy resources of a very finite Earth. The scientific elite in countries such as China, Europe, India, Japan, and the US have come to similar conclusions in studying global energy demand and the requirements for space based supplies.

This was evident at the China Energy and Environment Summit 2011 in Beijing, by presentations made by Dr. Abdul Kalam (and also in his address to the ISDC in Chicago) in 2010 and by Dr. Lin Zhiqin of the International University of Business and Economics and by Dr. Sergio Trindad who cited European studies in his presentation. Similar conclusions have been reached by Dr. Eric Hoeffer in a U-tube video clip.

The investment communities and the capital markets have not yet come to the realization that the current long term pattern of energy and resource management now prevailing is "mortally unsustainable."

We must change the current faith-based economic growth culture on Earth and replace it with a growth culture that includes a resource base and "econosphere" for human culture that extends to the whole inner solar system, or die trying.

Shifting to a faith based growth culture based on the resources of the inner solar system seems a lot more in tune with what we understand about our immediate universe including increasing understanding of the fragile energy and environmental systems of the Earth on which we depend but which we are collectively destroying at an increasingly rapid rate. In the US we are seeing a culture war between those who are comfortable and confident in the current economic systems and who are supremely cynical that there is anything globally wrong with their culture of growth and focus on short term economic gains in the Earth's global economic roulette wheel. Their fight is with those who recognize that the Earth environmental systems, mineral resources, and energy supplies are rapidly becoming both unsustainable and self destructive and changes in economic policies, practices and governmental regulations on currently profitable economic practices and industries, (that also happen to be environmentally destructive and unsustainable for future generations) must be changed and new sustainable industries and practices established. "Climate change debates about economic policies like carbon limitation strategies are one source of political and hotly contested economic policies. *The winners of this economic culture war will be those which convince "the smart money" about where future profits lie. It is not about growth versus no growth because the no growth advocates cannot sustain mass traction by depriving the Earth's billions of their illusions of a better future.*

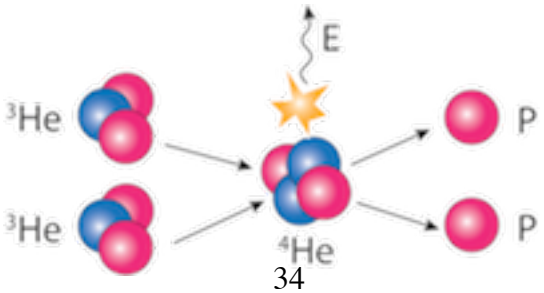
4 *Perhaps the only theoretical challenge to the economic growth and development of space based solar power as a "mega solution" to future economic growth and terrestrial economic sustainability might be a "breakthrough" of commercial fusion power.*

There is plenty of deuterium in the world's oceans as one component of commercial fusion fuels.

Fission versus Fusion Reactors:

The other component is Tritium, (also a component of nuclear weapons production) for a projected first generation of commercial fusion reactors. **Fusion reactors** are much "cleaner" (they produce much lower amounts of neutron by-products in their nuclear energy reactions) than fission reactors. By that standard, a deuterium tritium fueled reactor system would be better than a conventional fission plant.

A second generation of fusion reactors based on a Helium 3 Helium 3 fuel reaction has almost no neutron byproducts associated with it, but it requires much higher containment pressures for these reactors to work. The problem of creating the containment pressure s required for nuclear fusion reactors at an energy cost less than the power produced by the reactor is the research problem that the world's nuclear engineers have been working on for 50 years. It is a "holy grail" in applied nuclear physics engineering for it would create a clean energy supply for the world. There is currently an international collaboration on this research and development.



[Information about the Helium 3 Helium 3 reaction comes from information put out by the *UW Fusion Research Institute*. The Helium 3 Deuterium reaction is considered to be a first generation fusion reactor system because the containment pressures needed in a plasma reactor confinement system are lower the in the Helium 3 Helium 3 reaction. This later, considered a second generation reaction, however has the advantage of having minimal amounts of neutron resulting from the reaction. This as Jerry Kulcinski said would be "the pot of gold at the end of the rainbow" as far as having a clean source of commercial fusion energy.]

If this is achieved for first generation then the world would have a reprieve on its fossil fuel death spiral. A natural engineering evolution to a Helium 3 based fuel system would have its nearest supply of Helium 3 on the Moon. Thus the Earth's global clean energy supply would depend on mining the surface of the Moon for it's solar wind implanted Helium 3. The energy potential of this Helium 3 supply is estimated to be greater than all the fossil fuels that ever existed on Earth. [per a Video production of the UW Fusion Research Institute on Helium 3.]

5 *Much of the construction infrastructure that would apply to building solar power satellite could and would also apply to creating the mining infrastructure and supply chain for Helium 3 on the Moon. So the space development bonds for SBSP have a sort of 'hedge" in that much of this investment would not be lost even if commercial fusion had a break though and became a "winner" in the market place for future commercial electrical supplies*.

The resources needed for a global redundant launch system for space construction for GEO satellites is comprised of both launchers and a fuel supply chain that reaches from the Earth to the Moon. The present view of the development of space based solar power is that the economics of the future would rest on advances in reducing the launch costs to LEO. In addition this depends on finding economically viable means of using in situ resources on the Moon including using recently discovered ice found in the polar regions as sources of oxygen and hydrogen rocket fuel.

Engineering metals such as iron, aluminum, magnesium, and titanium are also found on the Moon in the alumino silicate rocks. Liberating these metals and also silicon for potential silicon solar cells would also create huge amounts of oxygen. Oxygen-Hydrogen fuels would ultimately have to be replaced with solid oxygen-aluminum fuels for a sustainable lunar economy based on in situ materials because the supply of ice while initially adequate for human bases and rocket propellant could quickly be used up with industrial scale development of the Moon's industrial economy and the associated transportation system. These technologies of developing in situ resources on the Moon also apply to the development of asteroidal materials in the inner solar system.

The National Space Society, which has chapters in many countries around the world has presented a roadmap of space settlement which is a vision the the expansion of the human econosphere into first cislunar space, the to Mars, and the asteroids. An affiliate organization, the United Societies in Space, has created a legal framework for an International Space Development Authority Corporation (ISDAC) as a beginning structure for international cooperation and investment in the growth of the space economy.

What is lacking in this legal proposition is the global investment and economic model that can meet the tests of international economic scrutiny that will be required for a multi-national sustainable program of investment in needed space infrastructure and that provides attractive and credible rates of return for the global community of investors that it needs to attract.

So we return to the issue of creating an investment scheme that is reality grounded in physics, material resources, in planetary geology, and long cycle sustainable returns on long term investments. Our faith based growth culture must shift to a "future faith" based on a much more complex understanding of all the above mentioned factors and more including a more complete understanding of human nature and culture and sustaining a global political and socio-economic infrastructure. This "future faith culture" must also be based on well educated leaders and masses who are informed about the complexities of the solar system and universe, the complexities of the Earth as our fragile threatened home planet, and of the understanding of a global culture of meaning for our human species and those other species on which we are co-dependent and who must share our destiny in space and time. Margaret Mead said that for a culture to be successful it has to teach its children to want to do what they have to do. That is no less a problem for global capitalists than the creation of investment mechanisms with a long sustainability and payment cycles.

So we have to have a future investment scheme that is not only progressive competitive rate of return for investors but which also generates the considerable surpluses that are needed to sustain a culture of information and education. The profitability then of our space based energy system must be sufficient to not only guarantee the economic necessities of the elderly and disabled with a retirement "safety net" but also an infrastructure of

socialization and education and an equitable economic distribution of benefits without which the whole socio-political edifice will also collapse.

Criswell's Lunar Power System economics are an encouraging first iteration of a space based economic system. But we have to create more detailed proposals that can be globally implemented by both governments and capital markets for "future bonds" with future returns that are clearly and demonstrably much more than "fanciful Ponzi schemes of the future." They must provide an intellectual framework and survive the strong intellectual and economic analytics that international economics demands of any economic proposition requiring major and sustained investment. These schemes will be judged in not only the schools of economics, but also in the schools of political science, the schools of technology, and perhaps most importantly in the brutal free for all of global economic financial trading and capital flows. This current global economic system is globally flawed and bringing global civilization to both environmental and economic ruin unless it is changed positively.

The best way to reform and reshape this flawed system is to demonstrate that an ultimately profitable and sustainable system can grow from policies which can be implemented global by the economically leading nations, the G-20, not because we intend to exclude those nations which are less developed (quite the contrary!), but because the G-20 now controls the bulk of the wealth of the world, the bulk of world economic and technological resources, and the economic and, military and regulatory powers which shape global economic and political existence. They have the power to set the trends and make the necessary changes for the rest of humanity that cannot immediately contribute because of lack of development and poverty.

Summary

The development of financial strategies that connect the economic present to the economic future (where space based resources of energy and materials are used in a much expanded econosphere of the inner solar system) is perhaps the greatest contemporary intellectual challenge to the fields of economics, political science, education, and the world of technology development and engineering. **DD**

Promoting Instrument Rides to the Moon via GLXP Teams

By Dave Dunlop

Background on Instruments rides and the GLXP

The prospect of using GLXP teams as a means of getting instruments to the lunar surface was for skeptics an interesting but unlikely prospect. Now, in the sixth year of this competition, it is clear that several teams have credible efforts and prospects for launching to the lunar surface before the expiration of the competition at the end of 2015. Teams such as Astrobotics, Moon-X, and Team Israel are projecting launches prior to the end of the competition. Serious interest in this potential was in evidence at the 2012 Lunar and Planetary Science Conference during a meeting with Alexandra Hall, Project manager for the GLXP, Clive Neal of the Lunar Exploration Analysis Group, and Greg Schmidt of the Lunar Science Institute leading discussion with many prominent members of the lunar science and commercialization community.

Several practical considerations dominated this discussion:

I. **Schedule:**

The timeline for action to plan to take additional instruments to the lunar surface is sufficient to do this provided activity begins now to coordinate these prospects between the lunar science and commercialization community, NASA, and GLXP teams and potentially other foreign participants.

According to Ms. Hall the most optimistic estimates of GLXP team launches might be in late 2014 with probabilities favoring 2015. This is in essence the same 3 year development timeline that participation in a Discovery Mission opportunity would require.

II. **Science:**

The NASA science community will require justification for proposed instrument payloads and the newly announced focus on Strategic Knowledge Gaps (SKG) discussed by Mike Wargo during the LEAG town meeting at LPSC. This seems a low effort hurdle for proposers in light of the extensive work done on the LEAG Roadmap and the prior detailed "Spreadsheets of Death" which have been previously prepared on lunar science in conjunction with

the work on The Context of the Scientific Exploration of the Moon National Research Council report. Conversely, without solid connections to questions of substantive scientific merit little NASA support can be expected.

"There is What We Know, What We Don't Know, and What We Know We Don't Know"

Donald Rumsfeld

III. X-Prize Foundation & Google

Alexandra Hall said The GLXP is very receptive and supportive of connecting the science community to the efforts of GLXP teams and eager to facilitate this potential. This is an "acid test" of ambitions for the both the X-Prize Foundation and the Google organization to create and demonstrate a low cost and commercialized model of lunar access. Both the X-Prize Foundation and Google are looking at how the competition can assist the achievement of a commercial access to the lunar surface beyond the end of the GLXP competition.

IV. Funding Portfolio:

While Jim Green of NASA's SMD indicated that the NASA Science Mission Directorate has no new mission funding wedge in the 2013 budget proposal. However, NASA does have budget resources in areas of technology development which may provide funding opportunities for instrument demonstrations in NASA'S OESMD.

V. Instruments:

To take advantage of the GLXP timeline scientific instruments need to be at a TRL 8-9 level. A preliminary list of feasible instruments will be considered in terms of flight readiness, mass constraints, weight constraints, power constraints, and cost feasibility. Shared international funding of proposed instruments may be considered. This may be a topic of discussion with international nodes of the Lunar Science Institute and in the context of missions such as Chandrayaan I. (A list of examples scientific instruments/payload ideas is provided at Appendix I)

"*In the next decade microlander missions to the lunar surface will be possible at a cost in the low tens of millions.*" Dr. Peter Worden, ISDC 2006

"*A $ million dollars for a lunar cube spacecraft? That sounds about right*." Dr. Bob Twiggs, 2011

"*The lunar swirls mission we estimate will cost $4 to $5 million on the two cube scale magnetometer impactors plus the mother ship and transportation cost include $30 million for the rocket*." Dr. Ian Garrick Bethel LPSC 2012

VI. Technology Opportunities:

While each GLXP team has unique capabilities several have used the **Cube Sat design paradigm** in their mission planning. This CubeSat architecture was developed by Dr. Bob Twiggs at Stanford taking advantage of the of microelectronics and miniaturization. The 10cm dimension (or 1 U) cube sat is something that both Astrobotic and Moon-X have considered as potential hitchhiker payloads. For those unfamiliar with the Cube Sat model there is the potential to string such cubes together in a 2 U or 3U (or more) configuration as hitchhiker payloads. These Cube craft or CubeLab payloads would then be deployed on the surface or launched as "Hoppers" off the larger Mother lander.

The cube sat design paradigm launcher component, the P-POD, which kicks these cube configurations off an ESPA ring, which was developed by Dr. Jordi Puig-Suari at Cal Poly.

The integration of Cubecraft or CubeLab payloads with the GLXP lander and their deployment is a key engineering challenge of sending cube scale payloads to the lunar surface.

While this is something that must be approached in the context of specific GLXP teams and their spacecraft the Cube Sat architecture standard is a strong beginning foundation.

The Cubecraft scale architecture has the advantages of being highly constrained in weight, volume, power, and cost. It also is consistent with the short development timelines involved in these GLXP flight opportunities. Astrobotics for example has quoted a $2M per kg cost for such payloads. I am not aware of a similar price point for Moon-X but do know that taking cube scale craft to the lunar surface is also part of their operations model . A 1U, 2U, 3U, or 4U instrument payload would be in the single digit $ millions range for transportation costs. With instrument development costs within a $ million or two, a mission price point below $10M is an beginning benchmark figure of merit. CubeCraft often have development timelines within an academic year or two so this also favors the feasibility of using this architecture where the scale of microelectronic instrumentation is feasible. It also favors the KISS principle of simplicity.

"Don't build a Christmas tree," Dr. Carle Pieters regarding lunar instrument proposals at LPSC 2012

Of course the Cubecraft architecture is only a subset of what might be proposed and for many potential instruments this is unfeasible. The Cubecraft architecture however is a guide to evolving standards for low cost power, mass, and volume constrained space operations which will become commercial norms. Demonstrating the cost effectiveness of these design approaches is significant for the NASA Office of Chief Technologist.

These small spacecraft designs also define the opportunities for Lunar "Hitchhiker Missions" which do not bear the full cost burden of using dedicated rockets but launch off an ESPA ring as a secondary payload to a commercial or other science mission. This hitchhiker approach drew attention from the International Academy of Astronautics during the International Astronautical Congress meeting in South Africa in October 2011 in a panel presentation involving several mission proposals unrelated to the GLXP. They are also represented by commercial providers such as Spaceflight Services established by Jason Andrews, DEO of Andrews Space. (See Spaceflight Services.com)

Additional Technology Developments

The Lunar Super Conducting Applications Conferences of 2011 and 2012 have provided information about approaches to exploration in the extreme low temperature conditions of the lunar polar regions. Ultra low temperature electronics and technologies developed for commercial super conducting power operations now have applications potential to space missions to not only the Moon but feed forward to other very low temperature destinations. These offer approaches for addressing both concerns of mission feasibility and risk management in the qualification and testing of payloads destined lunar low temperature conditions.

Flexure Engineering Engineering is offering an upcoming workshop on Lunar Cubes in Mountain View California in Oct 2012 that will address these considerations.

Future Meeting and Information Opportunities:

In the aftermath of the LPSC meeting on science payloads and the GLXP Competition I expect that additional information will be forthcoming from LEAG. The potential for virtual workshop activities in conjunction with the Lunar Science Institute were also discussed.

Some schedule context for further information and participation seems likely in upcoming forums as:

- Lunar Volatiles Meeting, June 2012 in Clear Lake, Texas
- Lunar Science Institute; July 2012 in Mountain View, California
- LEAG meeting, October 2012 in Washington, D.C.
- Lunar Cube Workshop, October 2012 in Mountain View California Flexure Engineering

Lunar Instrument Appendix:

Instruments which might be included as examples of mass constrained, and volume constrained payloads in a preliminary list of potential GLXP team payloads:

1 **Laser retro-reflectors** (Already part of the Astrobotics projected payload)

2 **Microseismometers** (Developed in consideration of the ILN mission objectives)

3 **Micro Dosimeter** for characterizing ionizing radiation (Discussed at the LPSC 2012 GLXP meeting

4 **Micromagnetometer** (Already in development for a proposed Lunar Swirls investigation and surface magnetism mission (UC Berkeley & UC Santa Cruz and also in cooperation with KARI and a South Korean University)

5 **Lab on a chip** for in situ testing of hydration reaction products of lunar surface materials (Already developed at NASA AMES)

6 **Magnetrons** for (microwave coupling to nanophase iron components of submicron regolith participles) heating regolith and driving off volatiles U of Tennessee Knoxville GeoPhysicist **DD**

The Plans of a Rising Space Power: China's Ambitions in Space

By Dave Dunlop

Foreword

At the International Astronautical Congress meeting in South Africa in October 2011 a presentation was made about China's ambitious plans in space. (1) and subsequently a Chinese White Paper was released about China's 5 Year Space Plan. (2).

China's plan reflects an ambitious and comprehensive development of the nation's space capabilities in in many dimensions. It reflect China's growing economic and political power. expressed as an integrated program of space development. China at this point is the third space fairing nations with comprehensive abilities in space:

1. A family of Long March rockets with a new Long March 5 (An Ariane V class launchers) in development).
2. Multiple launch facilities. A new launch complex is being completed on Hainan Island along with rocket production facilities and public outreach and tourism facilities.
3. Satellite production and operations in LEO and GEO.
4. A formidable lunar exploration program:
    - A history of two successful unmanned Lunar Orbital Missions a
    - A Comprehensive unmanned lunar exploration plan with:
        # A first surface rovers in 2013
        # A sample return in 2017
        # Plans for manned Moon landings
5. A Demonstrated Manned Orbital Capability,
6. An Orbital manned space lab and
7. A plan for space station development with International Participation,
8. A Plan for additional Martian Missions (in the aftermath of the Phobos Grunt Mission loss)
9. A global tracking and communication capability that is both land- and sea-based as a foundation for continued progress.

China plan Expresses the Peaceful Exploration of Outer Space

The Manned Space Program show an increasing tempo of planned space operations with two mission schedules in 2012 and others planned in the coming years in conjunction with manned labs. These missions are preparation for a planned Space Station targeted for 2020. Of significance is China's invitation for international participation as reflected with current German participation with the Tiangong lab and recent meeting with the Italian space agency. (2) (3)

Chinese Space Station Leadership

The US continues to falter in its international partnerships with recent budget cuts breaking the planed cooperation with ESA on a major Mars Mission. A shift of ESA to a new partnerships with the Chinese for this mission may result. A Chinese international thrust in the planning of a Next Generation Space Station is a strong signal of China's ascending trajectory in space (4). I would expect a continued effort to expand partners in the planning of their new space station.

For watchers of China space station development the interesting question is Who's next? China has fostered the development of the Asia Pacific Space Coordination Council Members which also includes Japan. It remains to be seen if Russia will also lend its extensive experience in manned operations to the Chinese space station initiative. Will the ESA also become more significantly involved?

Unmanned Lunar Missions

While the US seems asleep with regard to a future human return to the Moon as well as with new unmanned robotic initiatives, China's ambitious lunar roadmap may lend itself to leadership participation in the concept of the Lunar robotic village with other countries. It's announced continuing interest in the robotic exploration of the Moon may make for a natural alignment and coordination with European, Indian, Japanese, and Russian robotic initiatives with continuing participation within such groups as ILEWG.

The Chinese Unmanned lunar program includes at least one lunar rover in 2013. A lunar sample return is also projected for 2017. Other have suggested that China may follow the early NASA practice of of back-up missions as it did for Chang'e I and II. Perhaps we shall see a succession of lunar missions which provide confidence in the reliability of Chinese operations over the course of the next decade.

Launcher Development.

No doubt China's manned ambitions for a space station and unmanned lunar expeditions involve the use of the Long March V launcher now in development and the new Hainan Island facilities. The successful development of this launch system would seem to be a keystone of additional Chinese progress in LEO and beyond.

Lunar Manned Program Pre-Planning

The Space Exploration Coordinating Group of 14 nations published a Global Explanation Roadmap in 2011 (5), but only 12 nations were reflected in this effort. China and Australia were not part of this announcement. Whiled the US effort seemed focused more on Mars than on the Moon in that document the February 13th NASA budget seem to eliminate Mars Mission initiatives beyond the Missions already in the pipeline. China's pattern of measured and steady progress may well fill the void in new US exploration initiatives to the Moon and Mars, and in human space initiatives beyond LEO.

Access to Space Based Resources - SBSP

The NSS delegation to the China Energy and Environment Summit in August 2011 demonstrated to this participant that there is a strong convergence on the part of China's leading scientists with those in the US and India on the necessity for global cooperation on the topic of space based solar power. Prominent leaders from the Chinese Academy of Sciences, the Chinese Academy of Space Technology and Environmental officials participated and put forth what to an American observer seems to be convincing arguments for a leadership role in SBSP for China. It remains to be seen whether this shared perspective can be translated into more tangible efforts to share both risks and resources with other global partners.

A key consideration is whether a more commercial rather than governmental strategy can provide the mechanisms for pooling international resources and reaping international profits. Those well informed about the state of the technology and economics of space launch costs agree that there is no current business case for space based solar power. However, the potential for technological progress and launch cost reductions within the next twenty years make the prospects for SBSP a feasible goal for continuing international governmental investment.

The International Space Station evolution, the development of a Chinese Space Station, the prospects for the development of multi-purpose GEO platforms, and the demonstration of cislunar infrastructure such as orbital fuel depots, LEO/GEO/Lagrange tugs/ferries are areas where both international governments and international commercial investors may find common ground. There attraction of international capital from both government and commercial sources to bring space solar energy to a global mass market for clean baseload electrical power is the current grand strategic problem for international space development. Those nations with the technology and capital resources stand to gain enormous profit if they can effectively bring baseload power to the masses of humanity that desire a higher and more sustainable existence. The role of not only the Beijing government but Hong Kong based Chinese investors and those of the Chinese diaspora may figure prominently in this strategic development.

Chinese and Space Law

The Chinese are signatories of the Space Treaty Signatory (6). They are not however a signatory of Moon Treaty which attempted to create a socialistic and hostile climate for commercial activities and private property on the Moon. President Obama administration signed agreements with the Chinese on his visit to China in 2009 ? 2010? about Cooperation in lunar science.

The Chinese have articulated a “Peaceful Path” to Power strategy in describing their economic and political goals.

The Legal Frontiers of Lunar Exploration and Development.

The physical circumstances of recent discoveries of ice in the polar areas of the Moon will provide a tangible test of international law and national efforts to both explore and utilize lunar resources. Paul Spudis has stated, “ Yes, the Moon is a big planet, but the valuable concentrations of water lie in small areas near the poles. Water at the poles of the Moon allow a space faring entity to develop routine access to the entirety of cislunar space, where all of the economic, scientific and security space assets of many countries reside.(7)

Several factors are at play:

A. Areas of ice deposits in both North and South lunar polar areas are extensive. These areas are seemingly not limited to only permanently shadowed craters. The exact nature and concentration of deposits may be limited for practical purposes. Further assay missions will be needed to determine “ground truth.” and the technical and economic feasibility of using these ice deposits and operating in area of extremely low temperature.

B. A few locations of extended solar illumination in both North and South lunar polar regions have been identified.

C. Regions of temperature where cold traps on the one hand are balanced by relatively moderate polar temperature ranges provide advantages for initial establishment of lunar outposts and bases.

D. The choice of limited basing and landing sites that can optimize the advantageous locations of ice deposits, extended solar illumination, and moderate temperature make issues of "limited legal access, claims of "exclusive use" or even claims of predominant use by reason of exclusive investment and development tests of international law and national space policy.

The proposed International Space Development Authority Corporation of the United Societies in Space may provide an organizational and conceptual approach to resolving these issues in the context of further lunar exploration and "the investment of an shared infrastructure of investment which permits shared access to limited lunar resources and optimized lunar basing and operational sites. A lunar initiative which de facto limits shared access will create significant international tension. By contrast a lunar initiative which creates mechanisms for both shared access, shared risks and shared rewards will advance the agenda of shared investments and collaborative development.

Other practical questions of collaborative endeavors involve issues of "local Sovereignty of National Law on a national lunar base or on the other had an "International Standard" based on UN Law and and UN Bill of Human Rights for International Collaborative Bases. The "rights" of nation states and corporate states must be determined and balanced against the concepts of individual rights, and property rights which prevail in many Western democratic nations and which are in conflict with legal doctrines and practices in China.

Summary of the Strategic Strengths of China's Space Plan

The Lunar Initiative

China may also quietly assert the lead in lunar exploration by forming a lunar exploration coalition in developing lunar robotic villages with other ISS partner nations that now see the US retreating from new initiatives. China today may well have the most ambitious, integrated, and forward looking program of lunar exploration of all the major space faring nations. It is not alone however in its lunar exploration ambitions but shares them with The European Union, India, Japan, and Russia. For the present, US economic difficulties have placed lunar exploration on the back burner for the government but strong interest remains in both the scientific and commercial communities. Over the next twenty years new space powers in places such as Brazil, Korea, and other G-20 nations as well as the emergence of "commercial corporate space powers" may well enter this space exploration scenario. China's broad based space development in the 21st century may well supplant the dominant US government role of the twentieth century as its economic power equals and then surpasses that of the US.

The Chinese Space Station Initiative

The community of space faring nations has achieved a significant milestone under US leadership with the International Space Station. The Chinese may supplant the US leadership of the late 20th and early 21st century with its own next generation space station initiative based on China's growing economic leadership and new space infrastructure. Europe and India will join China, Russia, and the US with a manned capability around the same time as the Chinese develop their space station. Japan's ability to create their own independent human access to LEO by building on their HTV capability is not in doubt if the Japanese government makes this a priority. India and Russia are also developing new launchers as well as are the Koreans which may provide a broad, redundant and competitive supply chain to the service of a new space station.

China and Space Based Solar Power

Third, a strong Chinese effort to invest in space based solar power and commercial space development may be a third leg in Chinese space leadership. They are keenly aware of the importance of this new strategic opportunity and the opportunity to be the international leader in creating new clean energy supplies for the globe. This is an area not specifically addressed in the recent 5 year plan but from evidence of contacts with Chinese technical and economic leadership may well emerge in the next 5 year plan.

Solar Systems Exploration

Fourth, the Chinese also have plans to advance their exploration agenda to Mars. The loss of their equipment on the Russian Phobos Grunt Mission will not likely defeat this further ambition. This is another contrast with what seems to be the gutting of the NASA's Science Mission Directorate budget by the US.

International Benefits From Chinese Leadership

Space Development is not a zero sum game and economic vigor in China, India, and Brazil is in sharp contrast with economic malaise in Europe, Japan and the US at present. The Chinese economic momentum at present is very visible in China's new 5 year space plan. Its role as an emerging leader seems most likely. The Chinese role in this peaceful geopolitical competition in space is welcome in that a competition drives international progress more than the complacent status quo of the last forty years since the US-Soviet Moon race competition.

Perhaps the lessons the US-Soviet strategic competition in space leading to the ISS can also apply to the six way geopolitical competition of the spacefaring nations. Chinese leadership in developing the LEO infrastructure, Lunar and Mars Exploration, and Space Based Solar Power hopefully will stimulate the other powers to respond in kind and in ways that can surprise those who are cynical of additional international progress in space, of the loss of momentum in the old ISS partnership. or of the positive role of the expanding number of nations with space ambitions in the G-20.

Notes:

1. http://www.iafastro.org/index.html?title=IAC2011_Late_Breaking_News_2
2. http://www.parabolicarc.com/2011/11/23/will-italy-build-modules-for-future-chinese-space-stations/
3. German Instrument on Chinese space ship Shenzhou 8
4. http://www.nytimes.com/2011/11/04/world/asia/chinas-space-program-boosted-by-first-docking.html
5. Prior plan space station plan by China Manned Space Engineering Office by Wang Wenbao, Director. Established working relationship with France, Germany, Russian and other countries.
6. Global Exploration Roadmap by Space Exploration Coordination Group
7. International Space Treaty signatories (See Wikipedia reference)
8. Paul Spudis: "Once and Future Moon": http://blogs.airspacemag.com/moon/2012/01/china's-long-march-to-the-moon/

The Cislunar Econosphere

By Ken Murphy

Part 1: Previously published in Space Review, Monday, February 20, 2012

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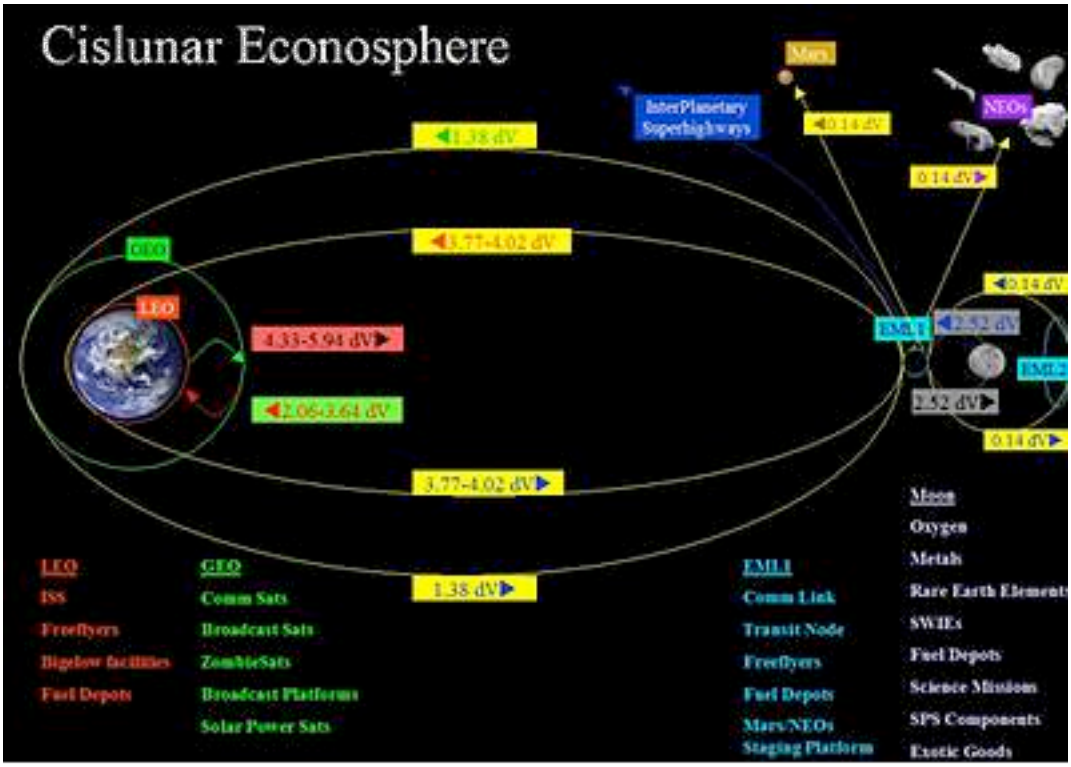

How the Cis-Lunar Econosphere might take shape

Larger Image: http://www.thespacereview.com/archive/2027aa.jpg

While there maybe those who have a preference for development of cislunar space and/or the Moon according to some plan decreed by government diktat, my years in economics and finance and banking have shown me that the growth (and death) of industries and companies is a very messy affair once you get down into the trenches. The markets that the United States provided in the past embraced the chaos and let free men trade as they would, because it was out of the chaos that the best ideas emerged through competition with other ideas in open markets where people can make informed decisions.

Bad ideas and bad practices can only occur in markets where the Sun does not shine adequately, and the participants in the market are deceived by shadows. Unfortunately, far too often, it is government itself that is casting those shadows.

As an advocate for free market cislunar and Lunar development, and President of The Moon Society, I am often asked "So what kind of business is there to do in space and on the Moon?" As if any one person would have all the answers, but research in the Lunar Library has shown that the question has certainly not gone unpondered. Too often, though, there is a fixation on one particular aspect, a particular product or service, which is thought to be the driver, the killer app that will unlock vast new wealth and make everything else happen by default. That, combined with the framework that NASA has provided for U.S. space activities over the decades, has unfortunately put blinders on what could be considered, and quite frankly has hampered our ability to move forward.

Embrace the chaos of free markets. The first thing to understand is that we are not going to go straight to the Moon and then begin backfilling cislunar space with commercial activity, although some folks advocate for such. What's going to happen is that activity is going to expand outward, and once activity has reached the neighborhood of the Earth-Moon L-1 point, the Moon (and so much more) becomes a no-brainer. EML1 is the killer app of cislunar space, to the extent one might exist.

Earth to orbit

So how is this going to happen? Suborbital gets to market first. The obvious contenders are Virgin Galactic, Blue Origin (though does anyone *really* know what they're doing?), and XCOR for crewed, and Masten Space Systems and Armadillo Aerospace for uncrewed flights, although it has been suggested that Armadillo's products could support "spacediving" activities.. After the initial round of prepaid pioneers are flown off, look for microgravity science payloads to become an increasing segment of the straight up-and-down market, and look for suborbital to expand into the point-to-point market for persons and goods. (When it absolutely, definitely has to be there today.) Expect strong seed capital from NASA in the early stages of the microgravity science utilization, just as happened back in the 1990s with NASA's Space Commercialization Centers, but really universities, foundations, and even companies should be stepping up with funding and payloads. And not just funding they've received from NASA, but with their own monies so that they really own the results.

We're already seeing excitement in this area, as exemplified by the Next Generation Suborbital Researchers Conference at the end of February. Some payloads are even getting to orbit through the CubeSat program, and NanoRacks LLC is offering commercial access to ISS, even showing their upcoming launch manifest on their homepage. A lot of folks deride microgravity science as a pointless endeavor, pointing to the general lack of results that have ended up in the consumer sector. The issue, though, is not a lack of potential in the sector, but rather the constraints in which it has operated to date. Sounding rockets are limited in what they offer, and being automated one hopes the black box works the first time. The Shuttle was never able to provide a reliable and consistent, or even frequent, launch schedule, and the demand for space always overwhelmed the limited supply. Challenger was a serious blow to the kneecaps as well.

When the author inquired about paying for a Hitchhiker payload, the reply (in 2002) was that there were over 60 GASCans waiting to go, paying your own freight did not move the payload ahead in the queue before freeriders (and if NASA felt a subsequent payload was more scientifically meritorious it could be bumped ahead of paying customers), and not every Shuttle flew GASCans. Not a promising platform for building a vacuum sphere business (glass spheres 'filled' with the vacuum of space), and what other options were there? Astrotech [NASDAQ-CM: ASTC] subsidiary Astrogenetix has had better luck recently working on vaccines against some of the more virulent staph bugs based on results from flown hardware.

Another entrepreneurial idea the author had back in the day was to go around and quietly buy up the various flown boxes. These would be refurbished and then leased to scientists who wanted to do research without having to engineer their own. The presumption was the fact that these were flown instruments, previously cleared for flight on the Shuttle, and this would help facilitate the processing for any subsequent flight, as NASA was already familiar with the instrument. Well, we all know what happens when you presume. The ultimate priority, though, is to get scientists to orbital lab benches.

First, we need to get the crew to orbit problem solved. We've got good rockets, and we're working on the crew vehicles. An optimistic timeline is within three years, but the equation involves a large NASA variable that could easily push that out to five or six or even more years. Until private industry gets to the point where it is going to space in spite of NASA, not because of it, the timeframe will tend to push outwards.

The basic solution to accelerate private sector development is to enable more direct investment by individual, but not necessarily qualified, investors, so that more investment capital can be directed into the industry. There is legislation in the works to better enable equity investment, for example through crowd-sourcing, enabled by our much more capable computing abilities (itself enabled by Apollo).

It does rather seem a shame to have to ask the government for permission to invest in a collective manner in a company and industry in which I believe and actually know something about (notice how few of the companies named have stock tickers noted). I shouldn't have to jump through a million hoops to invest in companies I see addressing particular needs for which I envision markets. Some examples of such companies include Orbital Outfitters, which develops spacesuits; Altius Space Machines, whose "Sticky Boom" technology for non-consensual docking maneuvers could also have applications for debris salvage operations; and Celestis, which takes cremains to orbit and has a 30-year legacy.

Space development is going to start out with lots of small companies exploiting particular niches. Other examples of niche exploitation include Wyle Labs, which focuses on human performance services for commercial human spaceflight customers, and NASTAR, which describes itself as "the premier air and space training, research, and education facility in the world". Ball Aerospace [NYSE: BLL] serves a variety of niches, such as remote sensing, astronomy, optics, laser communications, data exploitation, low-observable antennas and precision cameras. Draper Labs has a specialty in advanced guidance, navigation, and control systems; high-performance space science instruments; and reliable and high-performance processing systems. Honeybee Robotics focuses on developing technology and products for next-generation advanced robotic and spacecraft systems that must operate in increasingly dynamic, unstructured and often hostile environments. Stone Aerospace's Shackleton Energy Company envisions robotic access of the Lunar poles in the not too distant future. Paragon SDC identifies itself as "the premier provider of environmental controls for extreme and hazardous environments", and has partnered with Google Lunar XPrize competitor Odyssey Moon to grow a plant on the Moon. Analytical Graphics provides software for orbital analysis. MacDonald, Dettwiler and Associates provides robotic arm services for on-orbit facilities. Harris Corp. designs specialized antennas. Andrews Space offers a range of technical competencies from space system design and rapid prototyping to business analysis. There are many niches to be exploited in the still fledgling commercial space industry.

We must not shy away from fear of failure. While Beal Aerospace may have gone out of business, it did allow SpaceX to pick up nice engine test facilities outside of Waco, Texas. People will get bamboozled and they will lose money, but it happens in every industry in every country on the planet. It's bad that it happens, as it represents malinvestment, but we can't seem to make it go away.

Getting crewed vehicles online is critical to any further development. If it can't be done, what follows is meaningless. Current optimistic projections run somewhere in the 2015 timeframe for test flights; maybe a bit before, maybe a bit later. Expect at least one critical flaw or disaster that will lead to new protocols of some sort or another. The best things that NASA can do in this regard is purchase rides for their astronauts, just as they do from Roscosmos, and promulgate universal, international interfaces (in metric) like docking ports and communications standards, as well as work with industry to ensure the highest quality space product in the market.

Current efforts in the US to provide crewed vehicle to orbit capability include Blue Origin's vehicle efforts, Boeing's [NYSE:BA] CST-100 capsule, Sierra Nevada Corporation's Dream Chaser lifting body, and SpaceX's Dragon capsule. Development of all four have been supported by NASA's Commercial Crew Program through funded Space Act Agreements. SpaceX's Dragon started development through NASA's Commercial Orbital Transportation Services (COTS) program, alongside Orbital Sciences Corporation's [NYSE: ORB] Cygnus vehicle. In addition, NASA has its own Orion Multi-Purpose Crew Vehicle (MPCV) capsule program.

Offering good insight into what kinds of things private industry launch to orbit might enable are the Concept Exploration & Refinement (CE&R) studies that NASA conducted back in 2004 after the Vision for Space Exploration was released. These tapped into work done by NASA's Decadal Planning Team around the turn of the millennium, which continues in the form of the Future In-Space Operations (FISO) Working Group.

Low Earth orbit (LEO)

Once in orbit, there are more possibilities enabled. While we're limited at the moment to the ISS up in a 51.6° inclination orbit, there are other inclinations that may be of interest. Once Bigelow Aerospace is able to provide usable space on orbit with their BA330s, and transportation can be adequately provided (one of the reasons that crew vehicles should be compatible with Falcon, Delta, *and* Atlas rockets), there are a number of uses that can be imagined.

It's not clear whether Bigelow is going to adopt the current ISPR standards for equipment (which would re-open the black box leasing idea from earlier), or perhaps implement a new standard that would tie users to the BA330s. Where would these inclinations be? Where are the launch sites? Equatorial would be one, easily accessible from Kourou, but the scenery from orbit is pretty boring overall. Kennedy's inclination is an obvious choice for NASA activities. An inclination of about 40° overflies most US launch sites, from Spaceport America to MARS. And it's entirely possible that more facilities will be added in the ISS inclination. Whatever facilities are put on orbit, they will likely be in the inclinations most readily accessible from terrestrial launch sites.

What to do? What not to do? My favorite option is microgravity sciences. "Space Industrialization Opportunities" by Jernigan and Pentecost is a great academic introduction to the topic. A more contemporary introduction is "A World Without Gravity" from ESA. Ceramic metals. Glass metals. Foamed metals. Bizarre alloys impossible in the gravity well. Optics. There is so much research to be done, much of it with real market potential.

The faster that suborbital flights can provide capability to microgravity researchers, the better it can serve as a springboard to when we do get facilities in orbit. Once on orbit, things like free-flyer platforms should be considered to co-orbit with the facilities. The research to be done there will lay the groundwork for later production processes undertaken farther out in cislunar space. NASA is supporting these researchers, but more support must come from academia and industry.

Being much traveled, I understand the joy of visiting new places in person and exploring my world corporeally. It's all about the senses, and having flown a Zero-G flight (back in 2004; even got a "barf quote" in the local paper), I am sensitive to the impact of the different gravity environments and their effects on the senses. I highly recommend it, especially Lunar gravity. It's an absolute joy. Once facilities are on orbit, they will become a destination for travelers seeking new experiences, new vistas, and new destinations, plus their tickets help pay the rent. This is a proven fact by the number of non-governmental-employees who have already visited the ISS, and even Mir before that, through the work of companies like Space Adventures. Even the Shuttle had members of Congress as fellow travelers, and private citizens working for companies.

While some will purchase their ticket to orbit, others will have to work their way up there. There's no shame in being the steward of a space hotel, even if it may be rather unpleasant at times. Don't forget the movie industry, which may decide it wants to incorporate more microgravity effects in its storytelling. There will also be those who want to conduct their research away from prying eyes and corporate and governmental malefactors. Speaking of governments, if an open crew transport market becomes available, as well as usable space on orbit, expect a number of governments to consider pursuing their own national agendas from an orbital platform as a means of showing off to their neighbors their technological prowess. It may also arise that satellites and probes end up being launched to the vicinity of orbital facilities for a post-launch checkout before being sent on their way. In this way, many expensive failures can be avoided. What if, for example, Phobos-Grunt had been launched to the vicinity of an orbital facility, and for a few million dollars could have had an engineering team pay it a visit to figure out what's going on?

So there are many possibilities awaiting us just in LEO. Having an open market means that no one can predict what will happen and what whacky ideas will turn out to be cornucopias of wealth. Looking out past LEO, there are a number of possibilities, with GEO being the obvious choice. But GEO is expensive in terms of fuel, even if we are smart enough to put gas stations in the local neighborhood in LEO. For many, including engineers who have taken Economics for Engineers 101, this quickly leads logic to heavy-lift launch vehicles as the solution for providing adequate volumes of propellant. A subtler read of the situation suggests that you can't lead the market to where it's going, and what is needed now is more frequent use of existing, mass-produced launch vehicles to help drive economies of scale into a virtuous cycle of growth. Having facilities on orbit will be beneficial in that regard, but cannot provide the sole solution. Over the near term, it makes sense to deliver propellant to orbit in more frequent but smaller amounts, as that helps to make the cost of rockets cheaper for everyone. It will get to the point where "heavy" lift (let's say over 100 metric tons at a time for the sake of argument) will make sense because of the volume of traffic that is going to orbit, but that time is not now. The Russians already figured this one out years ago.

Additionally, by the time there is enough volume going to orbit to consider heavy lift that will also be the time where reusable launch vehicles (RLVs) become a compelling solution. Materials research on orbit is likely to have helped advance that field in some regard (such as, perhaps, lightweight foamed metal cores for aerospike engines). It will be a decision point, and the likelier path is RLV transport, as the economics will make as much if not more sense than HLV. Having RLV transport will also much more greatly enable further growth in LEO, and further support efforts to go trans-LEO. This could happen as early as 2020, but more likely 2030 or beyond.

A more strategic consideration is towards things like space as an export market. In principle, a product shipped from a US launch site to, for example, an Isle of Man flagged facility like those proposed by Excalibur Almaz, would be an export. Would it be possible to get EXIM Bank financing? Coupled with Zero-G Zero-Tax type initiatives that helped get Internet-based commerce kickstarted, these could significantly facilitate interest in and growth of cislunar commerce. Whatever solutions arise, it won't be an easy process, as noted by Near Earth LLC in a presentation at the NewSpace 2011 conference last July.

Geosynchronous/Geostationary Orbit (GEO)

GEO is sometimes referred to as the Clarke Orbit, after Sir Arthur C. Clarke, who noted its utility by applying some simple mathematics. While Sir Clarke envisioned large stations crewed by workers busily replacing blown vacuum tubes, what we've ended up with is a hodgepodge of telecommunications and broadcast satellites of increasing size and sophistication. The use of GEO is tightly controlled by the International Telecommunication Union, but over time a large number of inoperative objects have accumulated.

These do not go stumbling about like their name, "zombiesats", might imply. Rather, through a peculiarity of gravity (the gravitational lumpiness of Earth) and orbital energies, and centrifugal force, the objects tend to cluster in areas where there is a bit less gravitational pull from Earth, the two most obvious being the gouge dug out by India as it sped north into the Himalayas, and an area in the Pacific off the coast of the Americas. The latter, about 105° W, is an area of particular crowding and concern.

There have been ongoing efforts to address the problem robotically, such as EPFL's proposed CleanSpaceOne, MDA's [TSX: MDA] Space Infrastructure Servicing vehicle, and SkyCorp's satellite life extension spacecraft. Still, companies may prefer some on-site supervision when revenue-generating satellites are at risk.

Broadcasters are pushing for larger satellites and more power, so that your direct-to-home television signals won't fade out in a heavy rainstorm. Other interests are looking into solar power satellites, which would find an ideal home in GEO, which would allow a fixed broadcast point and constant source for the beamed energy. Most of our energy supply is second- or third-hand solar power, so why not go directly to the source?

So the basic agenda for GEO is:

1. Garbage cleanup
2. Bigger broadcast and telecom platforms
3. Space-based solar power satellites

Part 2: Expanding the Econosphere to Lagrange points and the Moon

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Earth-Moon Lagrange 1 (EML1)

The next hurdle is a difficult one. Facilities could be established in GEO orbit that would be quite useful in dealing with things in that neighborhood, like harvesting the zombiesats. However, there is a better destination a bit farther out at the Earth-Moon L-1 point. As can be noted in the diagram above, the delta-V (change in velocity) cost is less than that of going just from LEO to GEO. The delta-V cost of going from LEO to EML1, and then back down to GEO, is the same as a median delta-V from LEO straight to GEO. In the industry this little trick is known as a bi-elliptic transfer variant of a Hohmann trajectory. All values in the diagram come from Larson & Pranke's *Human Spaceflight: Mission Analysis & Design*. Actual orbital trajectories have so many variables that these should be seen as illustrative, rather than exact, values.

Staging from EML1 offers a multitude of advantages that more than overcome the difficulties of getting set up there. One of the perhaps more controversial advantages is to provide a partial solution to the orbital debris problem. One of the benefits of EML1 is that it is largely indifferent, fuel-wise, to any of the inclinations in LEO. In the diagram above this can be envisioned by rotating the ellipses on an axis connecting the center of the Earth and Moon. So not only could any of the LEO facilities mentioned previously serve as a staging point to EML1, but EML1 can serve as a staging point to any of the LEO stations, or any other inclination of interest, such as those containing objects that are a traffic hazard in their orbital neighborhood.

There is a slight penalty for the Earth's chubbiness around the middle, in terms of inclination (particularly polar orbits—curse you, J2!), but with aerobraking the job could be done for under 1 km/s of delta-V, a number that is eye-opening, but requires the use of a heatshield that has been carried out to EML1 (from somewhere). Using a direct transfer to the orbit, the cost is around 4 km/sec delta-V, but with much less of a heat-shield requirement. For debris

retrieval purposes these would likely be altitudes of 800 to 1,000 kilometers, where a lot of the Earth-observation traffic is located.

The strategy I would adopt would be to retrieve as many satellites (non-functioning and thus potential debris, obviously) near a particular inclination, perhaps with "sticky harpoons," from newest to oldest (as the older ones have demonstrated stability over time), and then take them back to EML1 for forensic analysis and repurposing of parts.

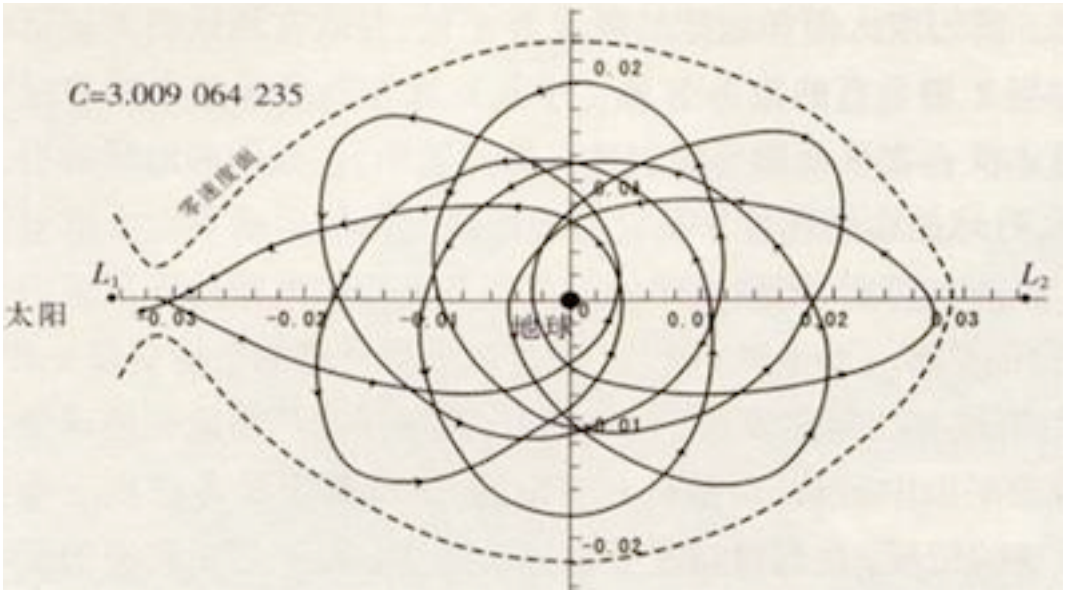
The hurdle is the trip up the gravity well. A delta-V of 4 km/sec to EML1 from LEO is not insignificant, so the trip has to be worth it through the creation of value. For LEO debris retrieval, one possible solution would be to launch a fuel payload from Earth directly to the target inclination to be retrieved by the vessel from EML1 as it collects objects of interest in LEO.

What else does staging from EML1 enable?

A) The delta-V from EML1 to GEO and back is less than the delta-V just from LEO to GEO. If you're going to be making trips to GEO, EML1 is the long-term transport solution. What would Sirius XM Radio's [NASDAQ: SIRI] financial condition be if, instead of having to build out a new satellite well ahead of schedule, and at significant cost in the capital markets, they could have spent much less to send out a technician to fix the problem? If you're retrieving salvage from GEO, you can do forensic analysis on that debris to better understand space weathering effects. You can then repurpose that debris for something else (except for the antennas and other strategic components, which DARPA is interested in), like the creation of a…

B) Solar system-wide network of data-gathering probes that provide ongoing data over decades, rather than expensive one-off missions as we do now that provide a spurt of data that is then pored over for years until the next data set arrives. EML1 can serve as an on-ramp to the Inter-Planetary Superhighways (IPS), whereby "Hubble-ized" (i.e. upgradeable) probes, likely using instruments sent from Earth and bolted on a salvaged bus and power supply from GEO, are sent out to particular stations of interest around the solar system. These would provide relays to communicate around the Sun, as in the case of probes sent to the Venus equilaterals (Sun-Venus L-4 and L-5), or keep an eye on the asteroid belt at the Sun-Mars L-2 or Sun-Jove L-1. Out-of-plane objects coming in from the Oort Cloud could be watched from a variety of locations. The point is not the utility of observations of any one kind or specific locations, but rather that with a change in our thinking we can change the way we study our Solar system. We can collect ongoing data, giving us better situational awareness, and we can service and upgrade our instruments a la Hubble by bringing them back to EML1 on the IPS. We don't have to keep throwing very capital-intensive (human and fiscal) tools into the void for intermittent datasets.

C) Remember the materials science research being conducted at facilities down in LEO? By the time you're putting facilities at EML1, there should have been some promising results, some of which may be ready to move into the production phase. Freeflyer platforms can be launched from EML1 into a trajectory constrained by the sphere of influence of the Moon whereby, after a certain period of time, it will return to the vicinity of an EML1 facility where it can be retrieved for processing. The completed production run can be harvested, and the next round of production set up before it's sent back out on its course. The finished product would then be shipped back down to LEO, to whichever particular facility had arranged for its production.



D) Eye in the Sky: in addition to trying to keep track of orbital assets and debris from Earth's surface, facilities at EML1 will offer the opportunity to see the "big picture" all the way out to GEO from a vantage point roughly 85 percent of the way to the Moon. In this way it could end up as a node in an orbital traffic control network.

E) Clutter-free work environment: EML1 doesn't require much station keeping—on the order of hundreds of meters per second per year or less—but it is required. Undirected objects won't hang around very long, getting perturbed into one of the two gravity wells on either side.

F) "Specializationator": having service facilities at EML1 provides the opportunity to modularize the traffic in cislunar space. It doesn't make much sense to carry Lunar landing legs from the Earth to LEO, LEO to the Moon, and then from low Lunar orbit (LLO) to the surface, the only time they're really actually needed. Instead, consider bolting them on at EML1. Complicated waldos and cargo racks for retrieving satellites and other debris aren't really needed anywhere other than for work in GEO and perhaps LEO. Don't carry them around when they aren't needed. Instead, get your supplies when they're needed for where they're needed… at EML1.

G) Asteroid Watch: a less popular suggestion is to have equipment at EML1 facilities dedicated to identifying and characterizing the Near-Earth Asteroids (NEAs). This would help lay the groundwork for later missions to asteroids staged from EML1.

H) EML1 also provides an ideal staging place for missions to the Moon. It offers 708/12½ (that's 708 hours per Lunar "day", 12½ "days" per year) access to the entirety of the Moon's surface. Poles, equator, mid-latitude, front side, back side, it's all about 2.5 km/sec delta-V each way, down and up. Rather than be tied to a single location on the Moon, facilities at EML1 could provide support logistics to a base at the south pole, while also providing a staging ground for sorties to areas of interest, like the skylights in Marius Hills.

Remember, all LEO inclinations of interest can get to EML1 for about the same delta-V, a little under 4 km/sec change in velocity. This helps in things like standardizing the propulsion systems and fuel depot loads for trans-LEO trips. This means that the guy who is selling orbital depots to NASA for use at their Kennedy inclination facility can also sell them to the folks with facilities at 41° inclinations, and even to the EML1 folks, as it's the same change in velocity to park back down in LEO propulsively.

There will come a day where the people who are itching to go beyond LEO will do so. Part of it will be the record-setting aspects of things, as with the Space Adventures folks, whose trip around the Moon, while expensive, might allow them to become the farthest travelers beyond Earth, ever—until the next folks to do so. Others will want to get in early on setting up facilities out at EML1 and on the Moon. While their companies may crater, they'll nevertheless be the ones with the experience, and those who come after will have to learn from them.

Once at EML1, things like zombiesats in GEO and debris in LEO can start being addressed, and this will drive demand for propellant. In the early years this will, by necessity, be shipped from Earth, but pressure arises early to source at least the oxygen component (about seven-eighths of the mass needed) from somewhere else. The logical source of this propellant will be the Moon; it's a one-day-away (from EML1) source of enormous amounts of oxygen that can be extracted by a variety of methods. At first, the main demand will come from EML1 in support of the crews dropping down to GEO, HEO, MEO, and LEO for some satellite husbandry, but eventually it will become possible to ship it all the way down to LEO for use in the fuel depots there. This would allow for much more significant shipments to orbit of hydrogen from Earth. Some of which will be shipped on to EML1.

A word on orbital fuel depots

The space community seems to like to bifurcate, and in the case of fuel depots that seems to be along the lines of LOX/LH for everything vs. storable propellants like RP-1 or UDMH, each of which have their pluses and minuses. My view is that the orbital depot solution will evolve along the lines of using long-term storables for tugboat duties, such as fetching freeflyer platforms or satellites post-launch. The kind of stuff that is done on an ongoing basis and will need ready access to propellant.

When the LOX/LH is needed, it's likely to show up at about the same time it's needed, or shortly before if it's shipped as water and needs to be cracked (which not every facility may be able to provide due to power needs). It will be more of a just-in-time process to reflect the inherent volatility, especially of hydrogen, which just loves to get through tiny gaps. A variety of methods have been proposed to allow for longer-term storage of cryogenic propellants. It's not a question of either/or, it's a question of how the people doing the work of meeting market demand actually solve the problem.

The complement of EML1 on the near side of the Moon is EML2 on the far side of the Moon. It is sometimes offered as an alternative to EML1, but in the near-term doesn't offer any particular advantages to make it a priority over EML1 as a development destination.

The Moon as anchor tenant: grayfields for development

Oxygen, which comprises some 40–45 percent of the Moon's composition, although locked up in rocks, was quickly identified as a key commercial product for cislunar and trans-lunar space activities. Production of oxygen from Lunar sources leads to the production of slag as a byproduct.

This slag is not useless, and can serve at least two functions. One is radiation cladding for vehicles operating in cislunar space. The slag can be shaped into pieces that can be bolted on facilities at EML1 and vehicles operating from there to other destinations. These would clearly be of interest to folks who are staging missions from EML1 out to nearby asteroids. The other use is as heat shields. These could be used by vehicles traveling from EML1 to LEO and want to use aerobraking to save fuel, or could be shipped down to LEO to be used as a bolt-on heat shield for vehicles returning from LEO to Earth (which would save weight on the launch phase of the taxi).

Mining oxygen on the Moon can support economic activity in cislunar space, like salvaging the zombiesats in GEO, and allow for greater shipments of hydrogen from Earth. Other materials wrested from the soil, like rare earth elements and metals, could support microgravity production facilities in cislunar space whose products, like foamed metals and unique alloys, would likely find a market on Earth.

One of the key difficulties that people have about resource utilization on the Moon is that it is going to have to be a process of aggregation of the materials desired. Mother Nature and water haven't acted on the Moon to help pool resources together. Impact violence and destruction has thoroughly distributed the constituents, and no matter what you're trying to collect, you're going to have to process large volumes of material to get any amount of usable stuff that you're interested in. The challenge then becomes how to make lemonade from that lemon.

One example is the Solar-Wind Implanted Elements (SWIEs). *The Lunar Sourcebook* by Heiken et al. notes that if one cubic meter of regolith is heated up to approximately 800°C, it will generate approximately ten atmospheres of pressure of volatile gases. These can be drawn off and treated separately, perhaps by creative use of cold traps at the polar regions to progressively liquefy and draw off successive elements from the product. This sets the stage for helium-3 (He-3) processing of the helium portion of the gases generated. This won't be generating large amounts of He-3, but if the opportunity is there as part of this process it should be taken advantage of. One consideration is that samples from each batch of regolith processed needs to be forwarded to scientists for processing in their "ice core" studies.

The regolith of the Moon contains the history of the Sun's output over billions of years (the SWIEs), as well as its journey around the galactic core (GCRs, Galactic Cosmic Rays), embedded in its grains. Scientific processing can piece together that history, in the same way the glacier core samples have given us background on the composition of the Earth's atmosphere over time. Additionally, the face of the Moon bears the scars, the astroblemes, of aeons of impacts, and can serve as a chronometer of impact objects in the Earth's neighborhood for as long as we've had the Moon. So there are valid scientific reasons, with direct impact on terrestrial life, for having equipment on the Moon. Having ready access to the Moon means that the scientists are going to want to set up shop and do research *in situ*. These are all datasets that can contribute significantly to the understanding we are developing of Earth. Other areas of scientific interest are explored in the report by the Space Studies Board of the National Academies, "The Scientific Context for Exploration of the Moon".

A longtime favorite in the scientific community is to have radio astronomy facilities on the far side of the Moon. The Moon would provide a shield against the radio pollution coming from Earth, creating the ultimate quiet zone for research. This quietude is spoiled by specular reflection of terrestrial signals off the small bodies in the solar system, but at a level of a whisper compared with the shouting from Earth. Some are concerned that facilities at EML2 (basically right above where the telescopes would be, though the halo orbit could be quite large), could more materially affect the noise environment. An alternative might be to position pole-sitting solar sails above the Lunar poles to provide communication links into the perpetually-shadowed "everdark" craters. And if that's not enough, NASA has identified a large number of things to do on the Moon to keep their scientists busy.

The products that come from the Moon will start out as very low-value-added goods, with little processing required before getting shipped up to the processing and production freeflyer facilities in cislunar space. Oxygen is one, radiation cladding another, and as we add equipment to the stockpile on the Moon we can start creeping up the value chain. One example is low-quality solar cells, produced from the abundant silicates in the soil. Extruded metal structural elements could be developed for use on the Moon, as well as in cislunar space and even beyond for things like solar power satellites in GEO,or the construction of Mars-bound craft at EML1.

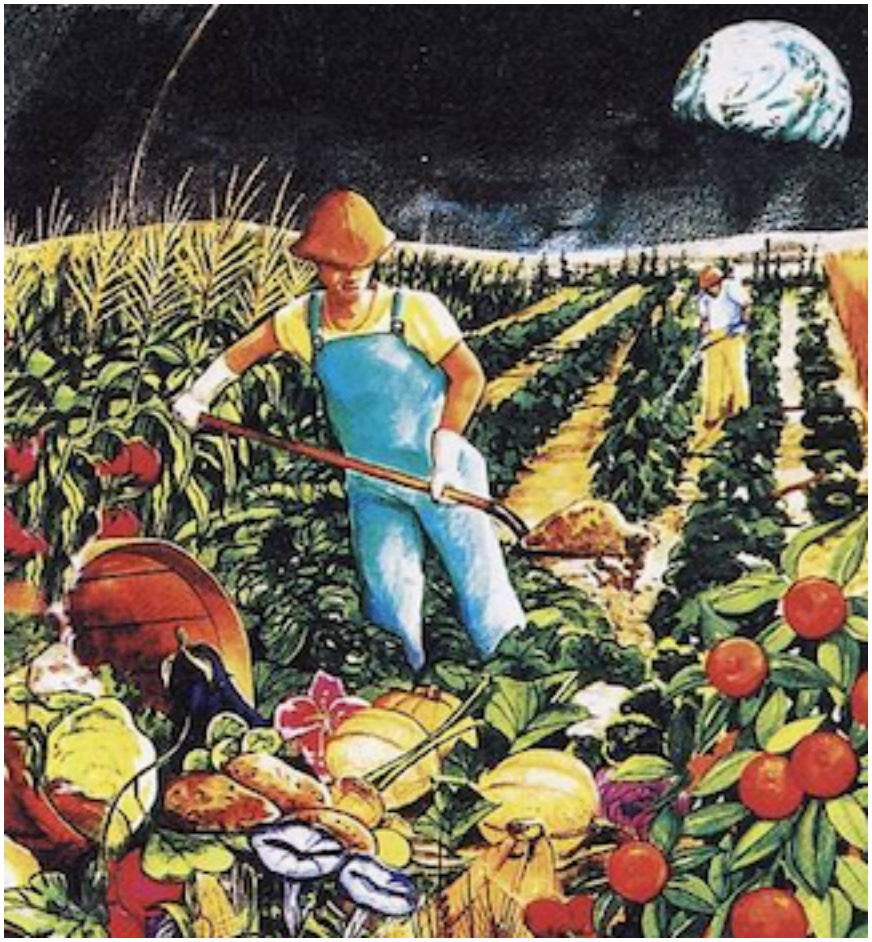
Later, as increasingly sophisticated capabilities accrue on the Lunar surface, production methods will become more sophisticated, such as breaking down the processing remnants from regolith, likely through some combination of pyrolitic and electrophoretic methods, and storing the results. Having stockpiles of vacuum-processed ultra-pure source elements (hydrogen, oxygen, carbon, titanium, etc.), and 3D printing technology may bring us one step closer to the concept of "replicators".

The environment of the Moon also creates its own unique laboratory that will be exploited in unusual ways. It has been suggested that cutting-edge nanotechnology research be moved to the Moon, providing a natural quarantine for the inevitable "oops" moment. The same holds true for the nastiest of biological research endeavors. Google Lunar X PRIZE competitor Moon Express has announced that they will include a telescope on their rover, the first of likely many telescopic facilities that will be set up on the Moon. Another competitor, Astrobotic Technology, is actively seeking payloads, and has published a price list.

The Moon can also serve as a celestial timekeeper. Many cultures around the world use the Lunar calendar, so it is not inconceivable that at some point someone builds a Solar Cathedral that marks the beginning of each Lunar month.

As more and more activities are undertaken on the Moon, the number of caretakers of the equipment is going to grow. The earliest persons spending time on the Moon are likely to be the engineers who repair the robots and scientists doing field work for calibration and verification purposes. As the numbers increase, more support personnel are going to be needed. Someone's going to build a still, and expect plants to be very popular pets. Regolith will be added to the growing medium early on, and those plants that provide foodstuffs in addition to oxygen will be particularly favored.

Eventually some of those foodstuffs are going to be exported to cislunar space: to facilities at EML1 for starters, but expect demand eventually for Lunar foodstuffs from Earth. There is likely also to be demand on Earth for raw Lunar regolith, in bulk, for use in gardens, greenhouses, and other applications.



Any process that uses vacuum—and there are many—can find a home on the Moon. Nearly 39,000,000 square kilometers are available, of a quality far superior to that which can be generally provided on Earth.

To preserve that vacuum at that level of quality, industry is going to have to figure out some best practices very quickly. It was estimated that each of the Apollo landings effectively doubled the ambient Lunar atmosphere. That speaks more to the almost complete absence of atmosphere rather than to the pollution-generating aspects of the Lunar Excursion Modules, but the point is important nonetheless. It might be wise then to consider putting outgassing operations in deep craters so that they can help serve as a sort of catchment for those gases. This would be particularly effective in the everdark craters of the poles.

In his 1965 book *The Case for Going to the Moon*, Neil Ruzic polled scientists and researchers in academia and industry. When queried about what kinds of processes might be done better or easier on the Moon, results included, for those in the vacuum industry: vacuum cast alloys, vacuum welds, electron optical systems, optical components, pharmaceuticals and biologicals, industrial chemicals, and energy conversion materials and devices. He also notes the advantages that levitation melting can provide, sidestepping the issue of crucible contamination of the product.

One example of a product that would benefit from vacuum is the production of anhydrous glass. Its mechanical properties have long been suspected of being exceptional. However, its optical properties generally haven't been considered. It may well be that an early niche on the Moon is the production of superior optical components for export to whomever wants the particular properties offered by Moonglass.

The author also points out that most if not all of the products produced on the Moon will not be for export to Earth. They will be destined primarily for use on the Moon: spare parts to fix the myriad robots, useful objects for the habitats like furniture, and new tools specific to the Lunar environment. Nevertheless, the creation of a transport network from Earth to LEO, LEO to EML1, and EML1 to a variety of destinations including the Moon, will mean that there will be the opportunity for exports, and someone is going to take advantage. Bags of raw regolith for "Moon Gardens" back on Earth. The cislunar entrepreneur producing vacuum globes may decide to add a line of regolith globes to their offerings, a unique variant of the "snow globe" so popular Earthside. Lunar handicrafts, like jewelry made of thin-sections mounted on polarized LEDs, might fetch a stiff premium, and there will always be markets for vicestuffs like moonshine and "lunajuana".

As the infrastructure develops, increasingly sophisticated and higher value-added products can be developed. New design aesthetics can be explored. Eventually there will be tourists: those who do not have a specific task on the Moon. Except for a few scattered exceptions, the facilities will be unlikely to accommodate the additional life-support strain that tourists would entail. Nevertheless, their tickets help pay the rent, so ways to accommodate them will be found. Once the tourists start showing up, you'll start seeing things like "rego-boarding" the craters, which should be encouraged as the extreme sports crowd will help drive advances in Moonsuit technology. They'll have other needs and desires to be met as well, which is the foundation of business opportunity. Many of these have been explored over the years in the pages of the ***Moon Miners' Manifesto*****.**

Conclusion

The above should not be viewed as a roadmap, but rather an exploration of the myriad ways that exist to create value in cislunar space. What finally does happen will be driven more by necessity than desire. Business grows by responding to needs. What should be clear is that economic development is not easy. It depends on complex webs of inter-relationships nurturing one another to grow the whole. It also requires an openness to pursuing things in a new way, even if they are perceived as disruptive to existing markets.

Potent forces are always marshaled to resist changes to the status quo, but if humanity desires long-term prosperity it must continually re-evaluate what it is doing, and must secure access to increasing amounts of resources, both energy and material. Those resources exist in abundance off-world. We can pursue them, or continue trying to reallocate the effectively fixed amount of obtainable resources available on Earth, pursuing increasingly marginal supplies.

We're seeing an increasing shift from viewing space as the domain of scientists and engineers alone, to a view of space as a place to conduct growing levels of economic activities to pursue future prosperity. Also slowly coming into view is the realization is that this is one industry with exceedingly high barriers to entry in which we have a clear commercial competitive advantage. The priority should be on growing that industry as a specialization in which the United States excels. The Moon Society will further explore this field with their track at this year's International Space Development Conference in Washington, D.C., which is entitled "The CisLunar EconoSphere". Speakers interested in participating are encouraged to contact the National Space Society.

It starts with assured access to orbit by several suppliers, and suborbital researchers using parabolic flights to warm up for eventual facilities on orbit. Cubesats and Nanosats can then provide design experience for future experimenters. Bigelow Aerospace modules can be leased to research consortiums for private research. Fuel depots can gas up vehicles for the next step out. This technology is not beyond our grasp, but the government cannot provide it unto the American citizenry. The American citizenry must make it happen, through their industry, initiative, and through investing in the technology and infrastructure to make it happen. We can let it wither on the vine, as we have with so many other industries, or we can make it happen and the entire world will benefit, as they have to date. The choice is entirely ours.

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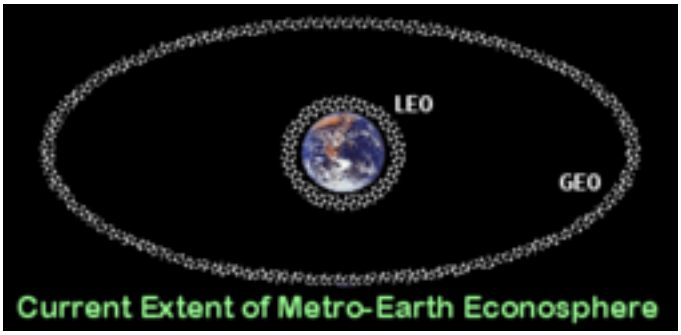
Ken Murphy currently serves as President of The Moon Society, an international organization dedicated to the education and research necessary to enable humans living and working on the Moon. He also serves as Vice-President of NSS of North Texas. He co-chaired the 2007 International Space Development Conference, and served on the NSS Board of Directors. The Moon Society is an affiliate of National Space Society. Prior work includes program support at the 2002 Goddard NASA Academy, a Master of Space Studies degree, cum laude, from International Space University [http://www.isunet.edu/] in 2001, and delegate to the Space Generation Forum at UNISPACE III. He owns Lunar Library, LLC, and blogs about the Moon as time permits at Out of the Cradle.

His day job is portfolio manager at a private bank in the Dallas/Fort Worth area of a high nine-figure portfolio of loan instruments in a variety of industries. Prior work over two decades includes investment analysis for a private investment firm, portfolio manager of pools of CLO and CDO instruments, Wall Street credit analyst for a major French bank (which included advanced capital markets training), corporate credit analyst for another French bank, middle-market financial analyst at a UK bank, and intern in upstate New York and in Paris for a long-gone brokerage firm. His Bachelors degree is in International Business & Economics, magna cum laude. ***M3IQ***



Shown above are EARTH, LEO (Low Earth Orbit), and GEO (Geosynchronous Earth Orbit)

It takes 1/23rd the amount of fuel to bring a set mass from the Moon's surface to GEO as it does to bring the equivalent mass up from Earth's much closer surface to GEO. Simply put, it takes much less energy to ship "down" Earth's gravity well, than it does to ship "up" that well.

It has become clear for some time, that the only way to build out GEO to its full economic potential is with material resources (e.g. building materials) derived from the Moon's surface rock powder (regolith) which is conveniently rich in Silicon, Oxygen, Aluminum, Iron, Titanium, Magnesium and many other useful elements.

Building materials produced on the Moon in highly automated factories could be used to make components with which to build giant platforms at each of the 180 available GEO slots 2° apart that could each host innumerable satellites, providing power, positioning, refueling, and even robotic repair services.

Lunar materials could also help build Solar Power Satellites in GEO, reducing the amount of components that must be shipped up from Earth's surface. GEO would become the cornerstone of Earth's future economy.

Satellites and Satellite Services in Geosynchronous Earth Orbit already account for US $250 billion of economic product annually and are growing rapidly. Add in the Moon, and the Future of our Econosphere becomes enormous.

As GEO lies 3 Earth diameters above Earth's surface, the diameter of Earth's Econosphere is already [3+1 (Earth itself) +3 = 7] Earth diameter's wide. Thus GEO is 87,000 km (54,000 mi) in diameter and 274,000 km (170,000 mi) in circumference.

Earth's economy has already expanded into space and it is at the point where only lunar resources can develop this Greater Earth Economy to its full potential, at a fraction of the cost of bringing equivalent products up from Earth's surface. ◘

GREAT BROWSING LINKS

INTERNATIONAL SPACE STATION + COMMERCIAL SPACE

http://www.space.com/72-**iss-module-ru**

http://www.space.com/14638-**chris-hadfield-canadian-commander-space-station**.html

http://www.space.com/14706-**virgin-galactic-spaceshiptwo-powered-flight**.html

Japan HTV upgrades to include crew capacity - http://www.spaceflightnow.com/news/n1202/09jaxa/

NSS Space Settlement Library - http://www.nss.org/settlement/

Swiss space debris effort could open political door to space debris removal - http://www.thespacereview.com/article/2032/1

SPACE TECHNOLOGY

http://www.space.com/14456-**russia-soyuz-space-capsule-infographic.html**

http://www.space.com/14430-nasa-16-biggest-space-technology-report.html

http://www.space.com/14643-**air-force-space-nuclear-reactors-power-beaming.html**

http://www.space.com/14910-**robotic-refueling-mission-demonstration**.html

The promise of Common Propulsion Module rocket architectures

http://www.satmagazine.com/cgi-bin/display_article.cgi?number=43485363

MOON

New LRO photos show features that indicate recent geological activity

http://www.nasa.gov/home/hqnews/2012/feb/HQ_12-055_**LRO_Moon_Images.html**

http://www.space.com/14627-**moon-quakes-lunar-activity.html**

The Cis-lunar Econosphere, Part I, Part 2 by Ken Murphy

http://www.thespacereview.com/article/2027/1 **-** http://www.thespacereview.com/article/2033/1

Rocket "monopropellant" fuel from Moondust - http://www.wickmanspacecraft.com/lsp.html

Using Lunar Soil for Propellants and Concrete

http://www.wickmanspacecraft.com/moon1.html - http://www.wickmanspacecraft.com/lunar.html

http://www.space.com/14955-**cosmic-rays-moon-space-radiation**.html

http://astrobotic.net/2011/11/29/**astro**

Cislunar Space and the Cislunar Econosphere

http://www.thespacereview.com/article/2027/1 & http://www.thespacereview.com/article/2033/1

Titanium paternity test fingers Earth as moon's sole parent (ruling out "Mars-sized impactor"

http://www.spaceref.com/news/viewpr.html?pid=36571

MARS

http://www.marsdaily.com/reports/**Mars_missions_race_India_takes_lead**_999.html

http://www.marsdaily.com/reports/**Russia_and_Europe_give_boost_to_Mars_robotic_mission**_999.html

http://www.space.com/14870-**mars-water-mud-signs-life.**html

http://www.marsdaily.com/reports/**Europe_hopes_to_save_Mars_mission**_999.html - (ExoMars)

http://www.space.com/14975-**europe-exomars-mars-mission-funding**.html

http://www.space.com/14970-**nasa-mock-mars-mission-space-station**.html

http://www.marsdaily.com/reports/**Red_Food_For_the_Red_Planet**_999.html

http://www.space-travel.com/reports/SciTechTalk_**Can_long_space_missions_work**_999.html

http://www.tech-stew.com/post/2012/03/24/**Strange-cloud-formations-on-Mars-a-mystery.aspx**

http://www.space.com/14694-**nasa-budget-mars-exploration**.html

http://www.space.com/15271-**nasa-mars-exploration-life-search.html**

http://www.space.com/13681-**mars-biggest-mysteries-water-life.html**

Jet engines for use on Mars - http://www.wickmanspacecraft.com/marsjet.html

Could we retrofit Curiosity to collect samples for Earth-return?

http://www.spaceref.com/news/viewnews.html?id=1618

ASTEROIDS + OTHER PLANETS + MOONS

http://www.space.com/13948-**nasa-comet-harpoon**.html

http://www.physorg.com/news/2011-12-**nasa-europa.**html

http://www.space.com/14552-**antarctica-lake-vostok-europa-life-**jupiter.html
http://www.space.com/12638-**amazing-photos-titan-saturn-moon**.html
NASA Plans for possible landing on Europa - http://www.physorg.com/news
Messenger finds hints of water-ice at Mercury's Poles -
http://www.bbc.co.uk/news/mobile/science-environment-17470151?SThisFB
Exploring Venus with Robots and Airplanes - Jeff Landis (check out Video in section below)
http://www.lpi.usra.edu/vexag/may2008/presentations/18Landis.pdf
New Geological Map of Jupiter's volcanically active moon Io
http://pubs.usgs.gov/sim/3168/ - http://pubs.usgs.gov/sim/3168/sim3168_sheet.pdf
Designing the Interplanetary Web (Internet)
tp://www.esa.int/esaHS/SEMM5IHWP0H_index_0.html

ASTRONOMY + ASTROBIOTICS

http://in.news.yahoo.com/**supernova**
http://www.space.com/14409-**photos-nasa-ibex-mission-solar-system-edge.html**
http://www.space.com/14487**-strange-life-underwater-caves.html**
http://www.ouramazingplanet.com/622**-strangest-places-life-found.html**
http://www.livescience.com/13377-**extremophiles-world-weirdest-life.html**
http://www.space.com/14652-**space-soccer-balls-buckyballs-**everest.html
http://www.space.com/14659-**red-dwarf-stars-planets-habitable-zones**.html
http://www.space.com/14667-**nomad-alien-planets-wandering-galaxy**.html
http://www.space.com/14712-**earthshine-moon-light-alien-life**.html
http://www.space.com/14927**-alien-life-photosynthesis-light-wavelengths.html**
http://www.spacedaily.com/reports/
NASA_Goddard_Glenn_Centers_Look_to_Lift_Space_Astronomy_out_of_the_Fog_999.html
http://www.space.com/15073**-ancient-alien-planets-early-universe.html**
http://www.space.com/15060**-billions-habitable-alien-planets-red-dwarfs.html**
Would intelligent "aliens" look like us? - http://www.space.com/15064-aliens.html
Did Viking Find Life on Mars in 1976 after all?
http://www.msnbc.msn.com/id/47031923/ns/technology_and_science-science/#.T4hdFFF5nzI
Finding biosignatures in earthshine reflected off the Moon may help us find life on exoplanets
http://www.spaceref.com/news/viewpr.html?pid=36262
Billions of Rocky Planets in Habitable Zones Around Red Dwarfs
http://www.spaceref.com/news/viewpr.html?pid=36565

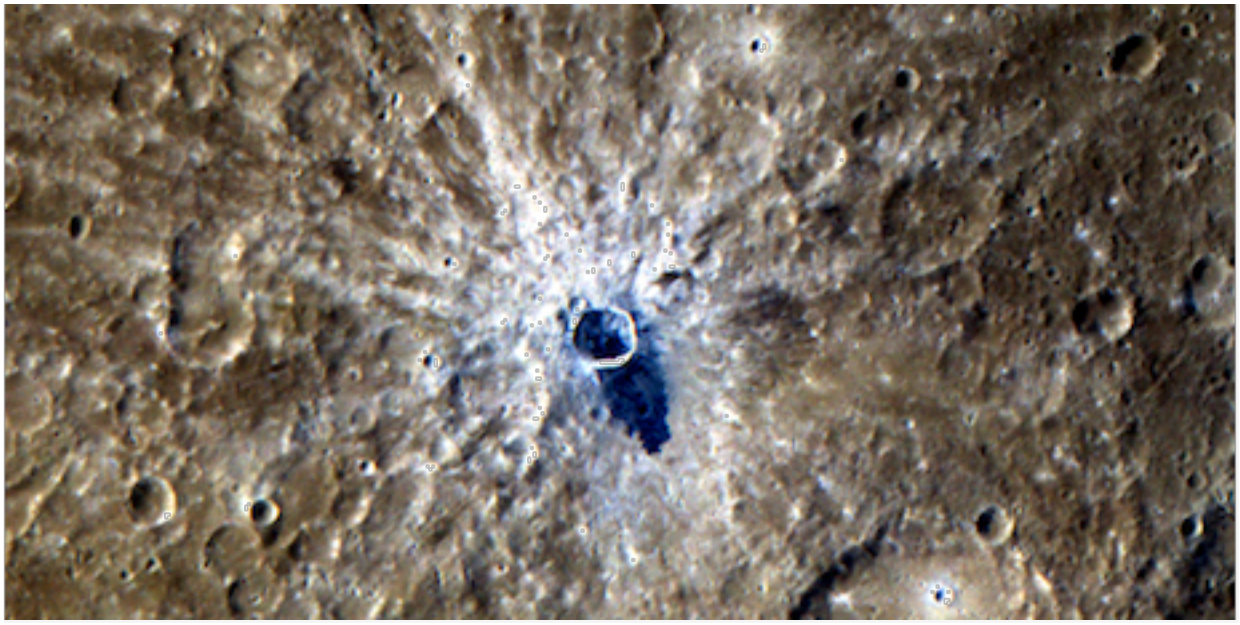
COMPUTER SPACE WALLPAPERS

http://space.desktopnexus.com/cat/**planets/ /moons/ /stars/ /rockets/ /satellites/ /space-stations/**

GREAT SPACE VIDEOS

Get your own personal jet pack - http://martinjetpack.com/video-gallery.aspx
http://www.space.com/14908**-moon-evolved-video-guided-tour.**html - **5 stars, a must watch**
Dexter, ISS robot, practices pumping gas - http://www.youtube.com/watch?v=tMImLh3t2FI
JAXA's Kaguya/Selene - Flying over the Moon's Alpine Valley
http://wms.selene.jaxa.jp/selene_viewer/jpn/observation_mission/tc/018/Alpine_valley.html
http://www.space.com/14864-**manned-asteroid-explorer-prototype-training-wheels-video**.html
Multi-probe Venus mission with drone airplane and rover/sampler byGeoffrey Landis and NASA RASC team
https://rt.grc.nasa.gov/files/venus_mission.mp4
http://www.space.com/14959-**mars-rover-curiosity-nasa-planetary-science**.html
http://www.**tricorderproject**.org/about.html#video
http://www.space.com/15257-**titan-saturn-largest-moon-**facts-discovery-sdcmp.html
http://www.space.com/15267-**elon-musk-private-space-challenges**.html
http://news.discovery.com/videos/s**pace-tumbleweed-rovers-could-explore-mars**.html

MBTQ PHOTO GALLERY

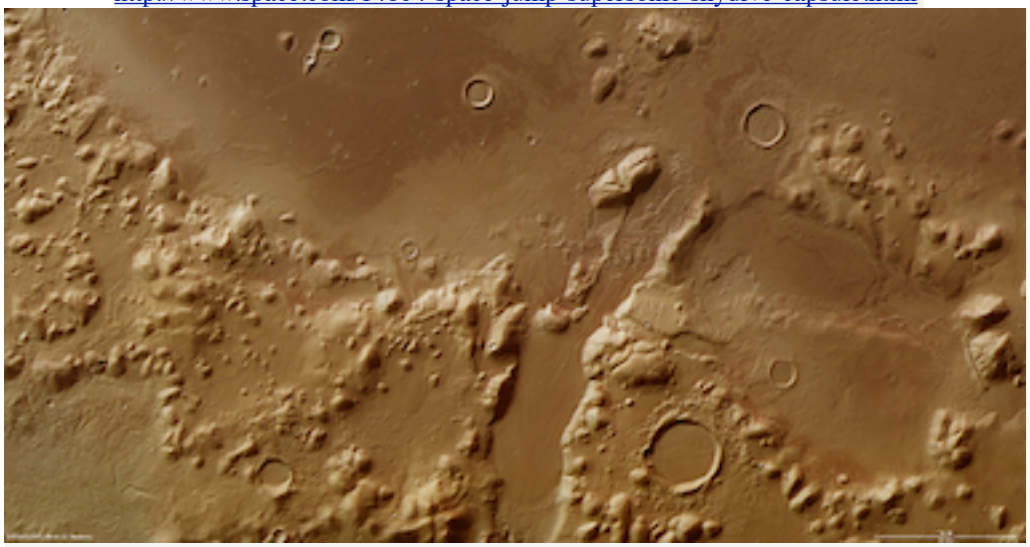


A 14-kilometer diameter crater on Mercury that is relatively young, as indicated by the bright rays that cross the neighboring features. A dark "tongue" of impact melt, which has a bluer color than the nearby surface, appears to have flowed out of the crater. - http://www.spaceref.com/news/viewsr.html?pid=40085

Italy at night from space: Milan dominates at left, Rome and Naples center
http://www.spaceref.com/news/viewsr.html?pid=40323

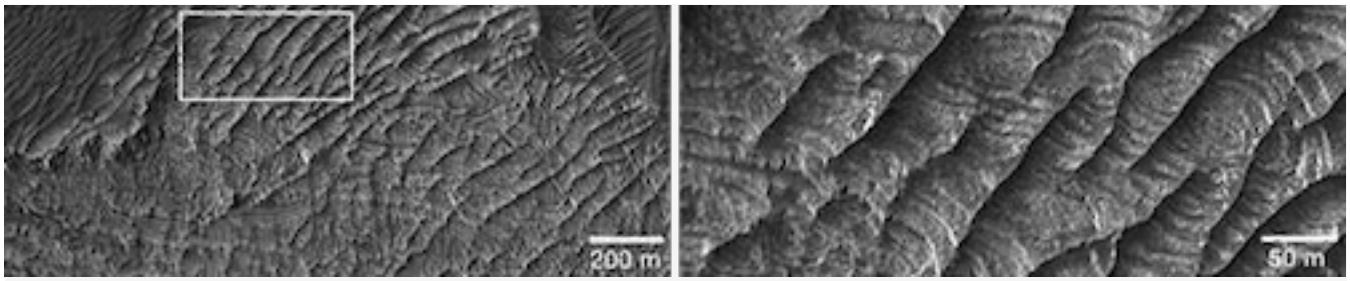
Above, city lights along the Nile, Cairo and Alexandria dominate - Right: Israel and Jordan. Cyprus at top.

Exterior-interior of balloon-borne “Red Bull” capsule for highest, fastest sky dive:
http://www.space.com/14804-space-jump-supersonic-skydive-capsule.html



Mountains and buried ice on Mars: http://www.spaceref.com/news/viewsr.html?pid=39251

100-foot-wide (30-m) dust devil and shadow on Mars, reaching 2,700 ft (880 m) high
http://www.space.com/14827-mars-twister-photo-dust-devil.html



A new type of terrain has been identified on Mars.
http://www.marsdaily.com/reports/Geologists_discover_new_class_of_landform___on_Mars_999.html

Moon Miners' Manifesto Resources

http://www.moonsociety.org/chapters/milwaukee/mmm/

MMM is published 10 times a year (except January and July. The December 2011 issue began its 26th year of continuous publication.

Most issues deal with the **opening of the Lunar frontier**, suggesting how pioneers can make best use of **local resources** and learn to **make themselves at home.** This will involve psychological, social, and physiological adjustment**.**

Some of the points made will relate specifically to **pioneer life** in the lunar environment. But much of what will hold for the Moon, will also hold true for **Mars and for space in general.** We have one Mars theme issue each year, and occasionally **other space destinations** are discussed: the asteroids, Europa (Jupiter), Titan (Saturn), even the cloud tops of Venus.

Issues #145 (May 2001) forward through current are as pdf file downloads with a Moon Society username and password. Moon Society International memberships are $35 US; $20 students, seniors – join online at:

http://www.moonsociety.org/register/

MMM Classics: All the "non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of December 2011, the first twenty-two years of MMM, 200 issues, will be preserved in this directory,** These issues are freely accessible to all, no username or password needed, at:

www.moonsocietyorg/publications/mmm_classics/

MMM Classic Theme Issues: introduced a new series to collect the same material as in the Classics, but this time organized by theme. The first MMM Classic Theme issue gathers all the **Mars** theme articles from years 1-10 in one pdf file. A second pdf file collects all the Mars Theme issues from year 11-20. The 2nd Classic Theme is "**Eden on Luna**," addressing environmental issues underlying lunar settlement. **Asteroids**, **Tourism, Research**, **Select Editorials, and Analog Programs** have been added. New Theme Issues will be coming: Lunar Building Materials, The Lunar Economy, The Lunar Homestead, Modular Architecture, Modular Biospherics, Frontier Arts & Crafts, Frontier Sports, Other Solar System Destinations, and so on.

www.moonsociety.org/publications/mmm_themes/

MMM Glossary: The publishers of MMM, the Lunar Reclamation Society, has published a new Glossary of "MMM-Speak: new words and old words with new meaning" as used in Moon Miners' Manifesto.

www.moonsociety.org/publications/m3glossary.html

The initial addition includes over 300 entries, many with illustrations. Additional entries are under construction. It is hoped that new members will consider this to be a "Read Me First" guide, not just to Moon Miners' Manifesto, but to our vision and goals.

All of these resources are available online or as free access downloads to readers.
But M3IQ does need your help!

MMM-India Quarterly Advisors, Liaisons, Contributors, Correspondents, Illustrators

If this publication is to help spread the word about Space in India, among the public at large, especially among the students and younger people, it must become a truly Indian publication. We need people from many fields in India to join our team

If you think that you can add to the usefulness and vitality of this publication, in any of the ways listed above, or in fields we had not thought of, write us at: **mmm-india@moonsociety.org** [This email address goes to the whole editorial team]

Tell us about yourself; your interest in space, and how you think you can make this publication of real service in the education of the public in India, and in the education of young people on whom the future of India and the world will rest.

Guidelines for Submissions M3IQ is intended for wide public distribution to encourage support for space research and exploration and development. M3IQ is not a scholarly review or a technical journal for professional distribution. Submissions should be short, no more than a few thousand words. Longer pieces may be serialized editorials and commentary, reports on actual developments and proposals, glimpses of life on the future space frontier, etc. Articles about launch vehicles, launch facilities, space destinations such as Earth Orbit, The Moon, Mars, the asteroids, and beyond, challenges such as dealing with moondust, radiation, reduced gravity, and more.

Help Circulate *MMM-India Quarterly*

If you know someone who might enjoy reading this publication, send us their email address(es) so that they receive notice when a new issue if published. Readers are encouraged to share and to distribute these issues widely, either as email attachments, or via the direct download address (for all issues): **http://www.moonsociety.org/india/mmm-india/**

MMM-India Quarterly will remain a free publication.

Student Space Organizations in India

Students for Exploration and Development of Space - India

http://india.seds.org/ -

http://en.wikipedia.org/wiki/Students_for_the_Exploration_and_Development_of_Space#SEDS-India

National Headquarter - SEDS VIT - C/O , Dr. Geetha Manivasagam, - Room No. 401 , CDMM Building , VIT University, VELLORE-632014, Tamil Nadu - Phone No. +919952749426 -Anmol Sharma (Director, Chapter Affairs)

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SEDS-India Chapters (currently 6):
http://india.seds.org/CHAPTERS.HTML

SEDS VIT (Vellore) (756 members)
SEDS VEL TECH (Chennai) (419 members)
SEDS GGITM (Bhopal) (136 members)
SEDS NITW (Warangal) (100 members)
SEDS KCT (Coimbatore) (100 members)
SEDS NITT (Thiruchirapalli.) (17 members)

SEDS-India Projects - http://india.seds.org/projects.html

VITSAT - 1 - series of small satellites to demonstrate miniaturization of technology and implementation of a variety of payloads

SEDS VIT UAV - automatically controlled aircraft,different sensors, servos, communication equipment, GPS, Microcontroler

CanSat - a satellite in a Tin Can - to conduct basic atmospheric studies at cloud base, provide a test for amateur communication protocols, provide basic knowledge of a Satellite to the students

Help Wanted !

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If this publication is to help spread the word about Space in India, among the public at large, especially among the students and younger people, it must become a truly Indian publication. We need people from many fields in India to join our team

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MMM-India Quarterly will remain a free publication. We will set up an online subscription service so that each issue is emailed to your email box directly, if you wish.

Printing this publication in the US would not be costly, but mailing it overseas to addresses in India would be.

If anyone in India wishes to become a Moon Society agent and publish and mail hardcopies of MMM-India Quarterly to addresses on a paid-subscription basis, please contact us at **mmm-india@moonsociety.org**

If this publication has been forwarded to you by someone else,

And you wish to add your email address o our new-issue-ready announcement list,
Write **mmm-india@moonsociety.org** Put "Subscribe" in the subject line of your email.
Include any comments you would like to make!
Feel free to send us email addresses of others - Individuals and/or organizations and/or lists.
We have been trying, without success, to find email addresses for any of the numerous Indian professional organizations in many major cities outside India (in the United States there are at least half a dozen)

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Moon Miners' Manifesto - India Quarterly #14

Engage! And Enjoy!