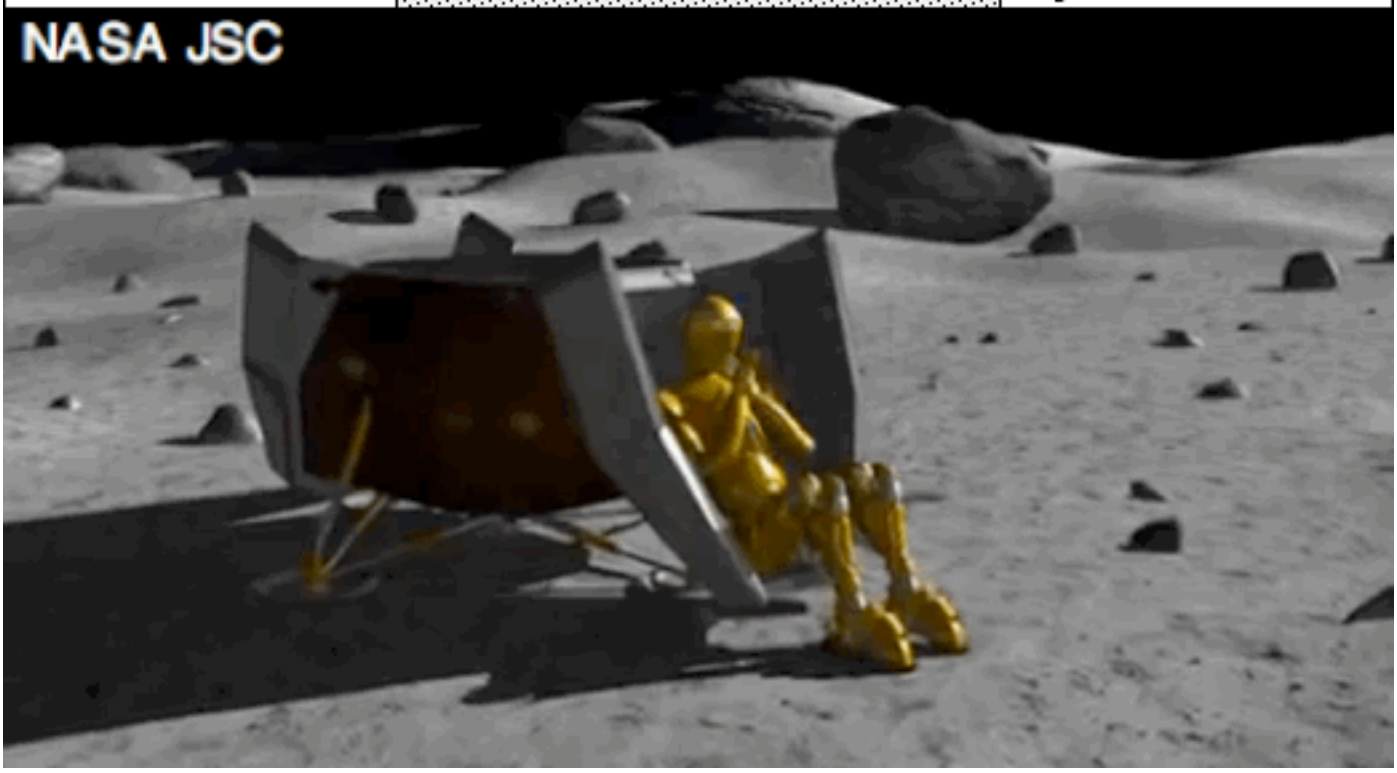
"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

# Moon Miners' Manifesto

India Quarterly Edition

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

#9 JAN-MAR 2011




***Above***: "Robonauts" or "Avatars" can Prepare the Moon for Humans via "Telepresence"

## Feature Articles This Issue



## Welcome to Moon Miners' Manifesto India Quarterly Edition #9

This issue begins "M3IQ's third year! Where has the time gone? Many developments, some exciting, some momentarily discouraging have happened. But real progress continues on the space front all over the world.

Indian hopes have had a jolt in the recent failure of the GSLV launch. But we need to put this in perspective. There is an old saying, "show me the person (or organization) that has never failed, and I'll show you a person (or organization) that has never tried." Failures are the stuff of which success is ultimately forged *by those who refuse to be discouraged*.

We have great confidence that ISRO will recover and go on to accomplish bigger and better things. NASA has had its: Vanguard, Apollo 1, Challenger, Columbia to name just a few, the last three with loss of life. All space agencies have had failures to overcome! *The Editors*.

## 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 everywhere, 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 young people and to people in general, contests & competitions, workshops, ground level research and technology experiments, private entrepreneurial ventures, moonbase simulation exercises, tourist centers, and other legitimate means.

## About Moon Miners' Manifesto

http://www.MoonMinersManifesto.com

MMM is published 10 times a year (except January and July. The December 2009 issue began its 24th 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. These issues are freely accessible, no username or password needed, at:

www.moonsocietyorg/publications/mmm_classics/

**Editors of MMM-India Quarterly:**

**Peter Kokh** kokhmmm@aol.com

**Madhu Thangavelu** thangavelu-girardey@cox.net

**David A. Dunlop** dunlop712@yahoo.com

**Pradeep Mohandas** pradeep.mohandas@gmail.com

**Srivinas Laxman** moonmission.srinivas@gmail.com

## About MMM-India Quarterly

http://india.moonsociety.org/india/mmm-india/

This publication was launched with the Fall 2008 issue. This issue begins our 3rd year. The Moon Society was founded as an International organization, but in fact has hitherto had few members outside the United States, and these are for the most part 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!*

In short, 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 his assertions and want to share that bold vision with the forward-looking people of India.

**Free Access:**

MMM-India Quarterly issues are available as a free access pdf file, downloadable from this address:

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

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

## Chandrayaan-1 Data and Paper Releases

Covering the Period October 2010 – January 2011

1. There is a NASA PDS data release on December 8: http://pds.nasa.gov/tools/subscription_service/SS-20101208.shtml.
2. SARA has bought out a paper a month since October.
   a. Dynamics of solar wind protons reflected by the Moon - http://arxiv.org/abs/1010.2065v1 (Oct. 11, 2010)
   b. The Sub-keV Atom Reflecting Analyzer (SARA) Experiment Aboard Chandrayaan-1 Mission: Instrument and Observations - http://arxiv.org/abs/1012.1527 (Dec. 7, 2010)
   c. First observation of a mini-magnetosphere above a lunar magnetic anomaly using energetic neutral atoms - http://arxiv.org/abs/1011.4442 (Nov. 19, 2010)
3. RADOM also has published results - Radiation Environment In Earth-Moon Space: Results From RADOM Experiment Onboard Chandrayaan-1 - http://arxiv.org/abs/1012.2014 (Dec. 9, 2010)

==========

## Sites picked for Chandrayaan-2/ Luna-resurs lander mission

http://www.russianspaceweb.com/luna_resurs_landing.html

The South Polar region has been the general target area. To date no probe has soft-landed within 30° of either pole. The selection was left to the Russian scientists working on Lunar-Resurs – their contribution to the joint ISRO-Roscosmos mission. Apparently, information from NASA's Lunar Reconnaissance Orbiter and from JAXA's Kaguya orbiter was helpful in determining the site.

The idea from the beginning was to touch down within reach of polar ice deposits. These are to be found exclusively in permanently shaded craters.

> Yet, "relying exclusively on solar power and in need of good communications with ground control, Luna-Resurs spacecraft had to land in view of the Earth and to have the Sun above the horizon. These seem to be mutually exclusive constraints. Shternberg Astronomy Institute, GAISh, of Moscow State University, worked in parallel with GEOKhI formulating landing site requirements for lighting and communications conditions."

The Russians developed a list of 14 locations, which seemed to meet both of these unlikely constraints. Nine of the fourteen were soon dismissed as too rugged. The landing approach required.

> "An area 30 kilometers long and 15 kilometers wide around the touchdown point, had to be free of any difficult terrain for the safe approach and landing."

"Photos from Japanese Kaguya-Selena orbiter were used to assemble a complex puzzle of the potential landing regions. Data from LOLA laser altimeter on NASA's LRO orbiter was used to compile detailed profiles of the terrain over which Luna-Resurs would be approaching its landing site." From this data, Russian scientists have picked 2 potential sites, eliminating the 3 other "finalists." But they caution that pending further orbital information, this short list must be considered "preliminary"

If NPO Lavochkin decreases the size of the (landing) ellipse, as rumors suggest they may be able to do, that might allow some additional sites into the selection process finals. But scientists would have to do a lot of simulation exercises to see how far they can minimize the landing ellipse and other constraints. There is no hurry, as one can launch to the Moon at almost any time – in that sense there is no deadline to fly this mission.

On landing, the 15 kg rover would be released, carrying a small 2 g science payload, and able to retrieve samples of frozen soil from a few dozen meters away.

**Editor's Comment:** To this editor, it seems most unlikely that frozen soil will be found so close to a sunlit area. To maintain communications, the rover must remain in line-of-sight with the lander. The odds against the success of this endeavor would seem to be enormous. But nothing ventured, nothing gained, and we can always learn from failures. **PK**

==========

## India and America team up to harness Space Solar Energy

http://timesofindia.indiatimes.com/india/India-America-join-hands-to-harness-solar-power/articleshow/6886049.cms

Some 48 hours before American President Barack Obama landed in India on a state visi†, influential Indians and Americans had joined in a space-based energy initiative that could ultimately turn both countries into "net energy exporters," This project is the brainchild of former president of India A P J Abdul Kalam and of the National Space Society (NSS), a non-profit US-based space organization with chapters throughout the world, including India.

The initiative was announced November 5th at Washington's National Press Club where Kalam and ISRO Satellite Centre director T K Alex were present. Known as the "Kalam-National Space Society initiative", the goal is learning how to economically harvesting solar power in space, where the sun shines full-strength around the clock for use on Earth.

A more immediate goal is to get the G-20 nations which collectively represent 80% of the world gross economic product, to sign on to this effort.

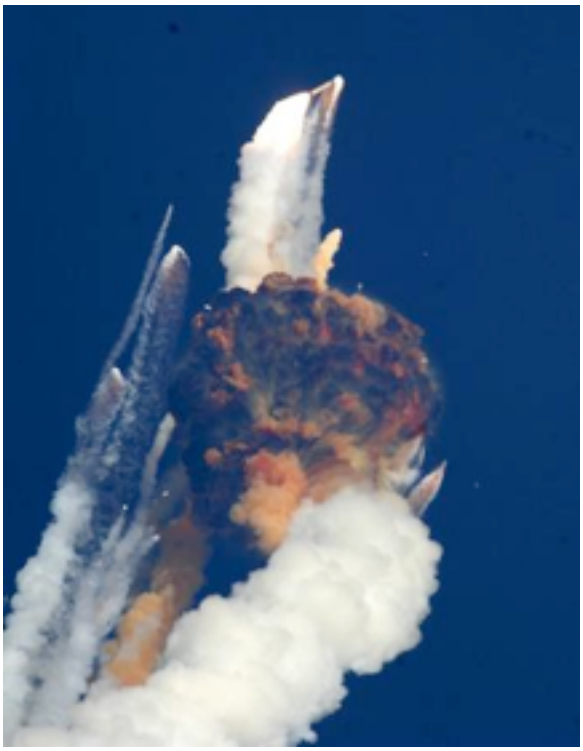
**For background on this topic, see:**

**MMM-India Quarterly #7,** pp. 27-29 Dr. Kalam's Challenge to NSS and the World, *David Dunlop*
**MMM-India Quarterly #8,** p. 8 Dr. Kalam speaks on Global Green Energy; p. 9 University of Luna Award given to Dr. Kalam

# GSLV-F06 Mission Unsuccessful

**By Pradeep Mohandas**

The Indian Space Research Organisation (ISRO) suffered a major setback with the Geosynchronous Satellite Launch Vehicle (GSLV) programme failed after the Range Safety Officer pressed the manual destruct button destroying the spacecraft. Initial reports suggested a technical glitch in the first stage of the GSLV and as the vehicle started veering off the trajectory.



After the mishap, ISRO Chairman K Radhakrishnan told media persons, "Its performance was normal for 50 seconds after the lift-off. "Soon afterwards, the vehicle's attitude was increasing, leading to heavier structural loads, higher angle of attack and breaking up of the vehicle." The Range Safety Officer in the Mission Control Centre gave the 'destruct' command to the vehicle 63 seconds after the lift-off from its second launch pad and it was destroyed."

The flight called the GSLV-F06 was carrying the 2310 kg GSAT-5P, the heaviest satellite that an Indian launch vehicle has carried. Hence the cryogenic engine had been uprated. The engine carried 15.3 tonnes of fuel as against 12.5 tonnes and had a payload fairing diameter of 4 metres instead of 2.8 metres. This uprating enabled the GSLV Mk-I to carry 2310 kg satellite against its 1900 kg capability. GSAT-5P itself is to replace INSAT-2E's services and upgrade television, tele-medicene, tele-education and telephony services.

A Preliminary Failure Analysis Committee was formed under Madhavan Nair, former ISRO Chairman. The Committee presented its results on December 31, 2010. On the event itself, the Committee said:

*"The performance of the GSLV-F06 flight of December 25, 2010 (with GSAT-5P Satellite onboard) was normal up to 47.5 seconds from lift-off. The events leading to the failure got initiated at 47.8 seconds after lift-off. Soon, the vehicle started developing larger errors in its orientation leading to build-up of higher angle of attack and higher structural loads and consequently vehicle broke up at 53.8 seconds from lift-off (as seen visually as well as from the Radars).*

*"As per the Range safety norms, a destruct command was issued from the ground a"t 64 secondsafter lift-off. The flight was hence terminated in the regime of the First Stage itself."*

After the preliminary failure analysis committee laid the blame of failure on the third stage of the vehicle. The Committee said this on the probable cause of failure:

*"The finding of the Preliminary Failure Analysis Team I"s that the primary cause of the failure is the untimely and inadvertent snapping of a group of 10 connectors located at the bottom portion of the Russian Cryogenic Stage. Some of these connectors carry command signals from the onboard computer residing in the Equipment Bay (located near the top of the vehicle) to the control electronics of the four L40 Strap-ons of the First Stage. These connectors are intended to be separated only on issue of a separation command at 292 seconds after lift-off. The premature snapping of these connectors has led to stoppage of continuous flow of control commands to the First Stage control electronics, consequently leading to loss of control and break-up of the vehicle. The exact cause of snapping of the set of connectors, whether due to external forces like vibration, dynamic pressure is to be analysed further and pin-pointed."*

After the event, ISRO has ordered for a full scale review of the GSLV programme and for a way to augment India's national communication needs. It has hence constituted 3 committees. The main Failure Analysis Committee has been constituted under the chairmanship of Madhavan Nair. This Committee will look into the cause of failure and recommend corrective action for both the GSLV flights that failed in 2010. A second Programme Review and Strategy Committee under the chairmanship of Dr K Kasturirangan. This committee will address the issue of alternatives for the lost transponder capability caused by the failure of the two GSLV missions and ageing spacecrafts. It will also review the whole GSLV programme including the Chandrayaan-II mission. Both of these two committees will submit their results to a national panel of experts and eminent scientists. Parallely, ISRO will undertake internal stock taking exercises. The whole process is expected to be completed by the end of February 2011.

ISRO has stated that some of the backlog for the loss of the communication satellites would be met by launching two communication satellites on the ARIANESPACE's Ariane-V and also a lighter communication payload launched on-board the Polar Satellite Launch Vehicle (PSLV). For any additional capability needed for national needs, ISRO will lease the same from international satellites. Testing of the indigenous cryogenic stage will be taken up through out 2011 with more static testing done. ISRO is hopeful of returning GSLV to service in 2012. ●

## Indo-French Collaboration and Possibilities

By Pradeep Mohandas

The French President, Nicolas Sarozy, visited India in December, 2010. His first stop on his official tour of India was the city of Bangalore and he stopped by at India's space agency, the Indian Space Research Organisation (ISRO). His visit was considered in India to be a sign of India's maturity in hi-tech industry. He spoke of India's cooperation in the field of space technology with France. India has depended on ARIANESPACE's Ariane-V to launch its heavier communication satellites.

The French have cooperated in working on two upcoming satellite projects Megha-Tropiques (Megha is clouds in Hindi and Tropiques is Tropical in French) and Satellite with ARgos and ALtika (SARAL). There is collaboration even at the student level, with students from the Indian Institute of Technology, Bombay (IIT-B) collaborating with the Institut de Physique du Globe de Paris (IPGP) to collect data when the satellite Pratham flies over Paris.

Megha-Tropiques is expected to fly in 2011. It is a collaborative project between ISRO and the French Space Agency, Centre National d'Études Spatiales (CNES) to study the water cycle and energy budget in the tropics. The other collaborative project is SARAL which aims to provide observations of ice, rain, coastal zones and wave heights. It would also use ARGOS (Advanced Research and Global Observation Satellite), a system used by the National Oceanic and Atmospheric Administration (NOAA) and CNES besides a satellite launched by ISRO while CNES will provide on-board instrumentation.

Besides cooperation in space sciences, India also utilises Ariane-V's capability for launching heavy payloads. It hopes to launch GSAT-8 in March, 2011 and GSAT-10 next year.

In his speech, the French President wooed Indian students to come and study in France and also hoped for more collaboration between students. This is already happening and he hopes to have more such collaborations that is mutually beneficial.

We believe in such collaboration and echoing the thoughts of various political leaders and scientists - it is the only sustainable way of exploring the solar system. France's Reunion Islands in the Indian Ocean has a Lunar Analog Research Station (covered in M3IQ-7) which could help Indian scientists test terrain maneuverability and instrumentation in Earth settings. For the French, it would be a great possibility to get their hands on some of the data on the variables directly from the Moon, which will help them improve their station. ISRO is developing such a facility in Bangalore but such an option is worth exploring in future ISRO missions after Chandrayaan-II, if it plans to have any.

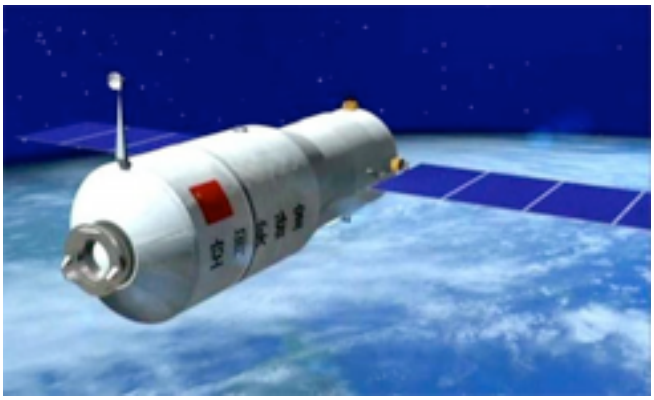
Another model for collaboration is the YouthSat, a collaboration between Russian and Indian students. Similar projects with French students is also another possible area of work. Work on sounding rockets and balloons are another area for collaboration since both France and India have a strong programme in both these areas. `

# Elsewhere in Asia

## Chinese National Space Agency

## China to Launch 1st Space Lab Module

The Tiangong-1, or "Heavenly Palace," whose construction was completed last year, will be the joined by at least two more space laboratories, Tiangong 2 and Tiangong 3, in the near future. The original plan was to place the Tiangong-1 space module in orbit late last year but this launch was postponed for non-discloses reasons.



Tiangong I is small, and does not have a dedicated airlock. No plans for the interior have been made public

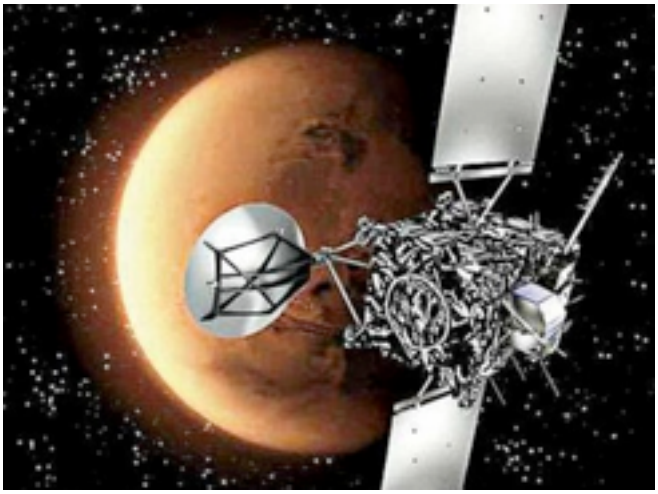
The **Shenzhou-8** manned capsule is also expected to be launched this year, and may attempt a docking with Tiangong-1. The docking feat is regarded as an essential step toward building a space station.

Construction of a much larger space station is penciled in for 2020.

## China's Mars Probe to share ride with Russia's Phobos-Grunt in October

The joint mission had been postponed for two years because of technical problems with the Russian probe. The two craft, both orbiters, will share a launch from the Baikonur Cosmodrome into a Mars-bound trajectory.

China's Yinghuo-I ("firefly") will go into orbit around Mars while Phobos-Grunt [soil] will orbit Phobos.



The probe will be 75 cm long, 75 cm wide and 60 cm high. Weighing 110 kg, it is designed for a two-year mission

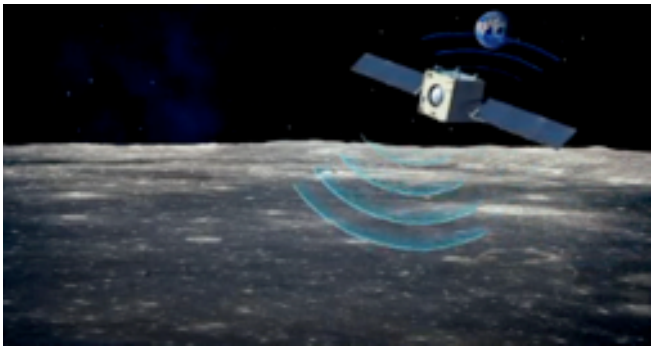
Yinghuo-1's mission is to probe the Martian space environment with a special focus on what happened to the water that appears to have once been abundant on the planet's surface. Yinghuo-1 will represent China's first mission beyond the Earth-Moon system. CNSA plans a second Mars mission, this one on its own, in 2013.

http://www.france24.com/en/20110102-china-explore-mars-with-russia-year

http://en.wikipedia.org/wiki/Yinghuo_1

## Chang'e-2 takes five Moon Videos

http://planetary.org/blog/article/00002774/



The five **engineering camera** videos include:
solar panel deployment
http://www.youtube.com/v/nMPzh79diG8?
orbit insertion burn
http://www.youtube.com/v/5rTzqkYzJto?
1st orbital trim maneuver
http://www.youtube.com/v/RiZDu7aU4qI?
2nd orbital trim maneuvers
http://www.youtube.com/v/1Vipgo5CZZY?
low 15 km altitude flight over the Moon
http://www.youtube.com/v/HcxPiZfJ0e4?

These unique videos not only include images from the Moon's surface, but of parts the spacecraft itself in the foreground. This offers a unique, first ever, perspective. Most space mission videos are taken from cameras mounted on the launch rocket

**Japan Aerospace Exploration Agency**

## Akutsuki Venus Climate Orbiter Fails to go into orbit around Venus

On December 7, 2010, Akutsuki ("Dawn") fired it rocket to lose speed and drop into orbit about the nearest planet, but unfortunately, the engine cut off prematurely after 2 1/2 minutes instead of the programmed twelve, and the probe continued to orbit the Sun instead. The course correction maneuver occurred behind Venus as seen from Earth, so the firing was preprogrammed and not under direct mission control.

The first damage assessment suggested that the probe would have another chance in 6 years. Since then, controllers have come up with a plan to modify its orbit so that the opportunity comes a year earlier.

http://search.japantimes.co.jp/cgi-bin/ed20101225a1.html

Unfortunately, JAXA doesn't suffer failures easily and despite the amazing recovery of Hayabusa against all odds, and the first and only successful solar sail launch – Ikaros - the agency is discouraged to the point of suggesting that it should not be so ambitious in the future. Let's hope that the voices of the timid do not succeed in retrenching Japan's space program. Failures remain failures only as long as one does not recover from them.

Akatsuki's engine was the world's first rocket motor made of ceramic. Whether or not that contributed to the failure is not yet know Testing of a similar engine might expose weaknesses and a path to failure, or point the finger in some other direction.

What makes this failure so discouraging is that Japan's only previous planetary mission, Nozomi, launched in 1998 to explore Mars, failed to enter the red planet's orbit in 2003. The US and USSR/Russia have had their share of failures, and got past them. But politicians can be cowards.

## Ikaros Solar Sail Success encourages more ambitious follow-up mission

There have been no updates since July 23, 2010 but JAXA is already looking ahead to a much more ambitious encore, a much larger solar sail to Jupiter and its Trojan asteroids (asteroids corralled by Jupiter's gravity into the Jupiter-Sun L4 and L5 positions, 60° ahead and behind Jupiter in its orbit around the Sun. The mission is tabbed for late in this decade. The required sail would be 50 m in diameter (vs. 20m for Ikaros) with 6.25 times the surface area. As the sail gets further and further from the sun, the power of sunlight weakens and more sail area is needed to make up for that. It is hoped that the needed R&D will lead to lower prices for solar cells here on Earth.

## JAXA-led Consortium to test Solar Power Satellite Beaming Technologies

http://www.yomiuri.co.jp/dy/business/T110122002679.htm

Jan. 23, 2011: Mitsubishi Electric Corp., Mitsubishi Heavy Industries Ltd., IHI Corp. and Kyoto University will work with JAXA [Japan Aerospace Exploration Agency] on a test to convert a strong electric current into microwaves and transmit them **10 meters** away in a simulated outer space environment at Kyoto University.

This is a first step of many to come with an interim term goal of launching a trial satellite sometime after 2016 with the goal of putting a space-based power generation system into practical use by 2025.

Mitsubishi Electric's **Solarbird Project** would consist of 40 relatively small 200-meter solar power generating satellites that could produce 1 million kilowatts of electricity, equivalent to a nuclear power plant. This system would be deployed in Geosynchronous Orbit, so that the satellite system rotates in synch with the Earth's surface below, always staying above its target service area. The receiving antenns or rectennas at which the beam would be converted into electric power would be 3 km in diameter. With the beam spread so diffusely, damage to the atmos-here, birds, and life on the surface would be nil.

The advantage in gathering sunlight in space is that without clouds, atmosphere, or nighttime, full strength sunlight is available around the clock, all year long.

To mimic the conditions of apace, this first experiment, will be conducted in a room that does not reflect electromagnetic waves. If the test is successful, the next priority will be to minimize the weight of power generation equipment and improving the transmission technology. This is necessary to minimize the cost of launching such systems into orbit. A workable space-based solar power generation system will cost about 2 trillion yen. [1.1 trillion Indian rupees]

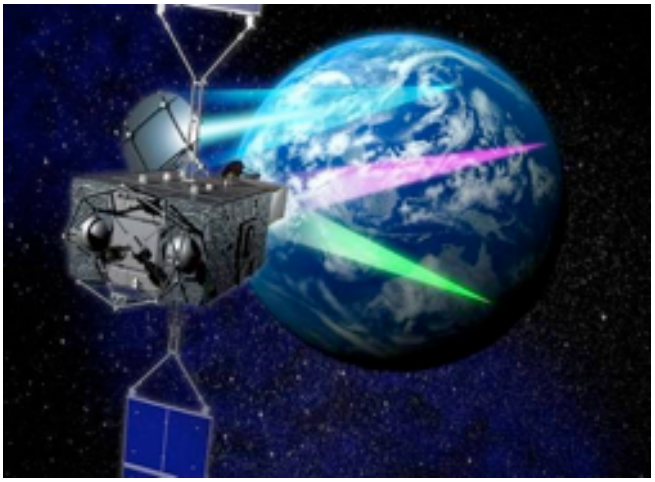


Illustration above is from the article linked below

In September 2009, Japan had announced its intention to deploy a test Solar Power Satellite system that could power 300,000 homes.

http://www.popsci.com/scitech/article/2009-09/japan-wants-power-300000-homes-wireless-power-space ###

## Turkey Pushed for its own Astronaut on ISS

http://www.space.com/news/turkey-wants-shuttle-astronaut-deal-wikileaks-110104.html

Turkey launched a modest space program in 1991. The lead agency is TUBITAK

(Türkiye Bilimsel ve Teknolojik Ara_tırma Kurumu)
http://www.tubitak.gov.tr/ (in Turkish)

(Scientific and Techno-logical Research Council of Turkey)
http://en.wikipedia.org/wiki/Scientific_and_Technological_Research_Council_of_Turkey

Space is only one concern of this broad umbrella organization. The scope of Turk space activities includes: satellite operation, but the country does not have any launch capacity, and to date, has not furnished any Astronauts. And that is where this story comes in.

In 2004, Turkey signed a Cooperation Agreement with the European Space Agency but has not taken the next two steps to become a full member. If it were a member, it would be the 2nd most populous after Germany. Turkey has applied for membership in the European Union, and is one of the G-20 nations.

**Turkey's effort to have an astronaut, and an ISS flight**

The story begins with the then US Ambassador to Turkey trying to get Turkish Airlines (in which the govern-ment has part ownership) to buy aircraft from Boeing rather than from Airbus. Bargaining is second nature to people in this part of the world. So Turkey said, "okay if you train one of our pilots as an astronaut and give him a place on the Interna-tional Space Station. Brilliant!

But the timing was bad. The Space Shuttle was being phased out, and NASA had no seats to offer, whether or not the Turk candidate had completed training. So, no was the answer as you might expect. No Boeings either of course. But the Turkish astronaut request was just a part of a broader request to help Turkey get its infant space program up and running and doing exciting things. Letters to President Obama and to the US Aviation Administration followed. It would seem, that such a request from Turkey, the most modern, secular, and advanced muslim nation should deserve consideration.

**The (temporary) response**

NASA's response was that "scheduling a Turkish astronaut on an upcoming mission would be extremely difficult, but that other technical assistance from NASA in establishing Turkey's space program might be a possibility." And "We probably cannot put a Turkish astronaut in orbit, but there are programs we could undertake to strengthen Turkey's capacity in this area that would meet our own goals for improved aviation safety in the region."

We only know about this because the diplomatic letters involved were made public by Wikileaks in an effort to emabarrass the Administration. But we should welcome Turkey to the ranks of space-faring nations. Turkey has a large enough economy, but lacks experience with the pre-requisite technologies.

Someday soon there may be a Turkish astronaut, and in time a booming Turkish Space Program. **PK**

# Elsewhere in the Commonwealth

## CANADA:

### MDA and Neptec Awarded Contracts for Lunar Exploration Light Rover Prototypes

http://spaceref.ca/missions-and-programs/canadian-space-agency/lunar-exploration-light-rover/mda-and-neptec-awarded-contracts-to-build-lunar-exploration-light-rover-prototypes.html

Neptec's lunar NRT Rover concept under development for the Canadian Space Agency.

"The awards come four and half months after the CSA issued a request for proposals" for "up to two contracts … for $11.5 million each. Each team has until December 30th, 2012 to complete work on their respective prototypes."

"focusing on tasks such as robotic operations on the Moon for human precursor mission, sample collection and scientific investigations with potential to be upgradeable **for short distance unpressurized crew transportation** for nominally one and potentially two astronauts."

"The innovative design of this new Canadian rover will **facilitate surface transportation for payloads, cargo and crew during moon exploration**."

"In addition, it will also enable **drilling and excavation, manipulator and tool integration, and vision and state-of-the-art communications systems**."

According to Neptec the Neptec Rover Team (NRT) will bring several innovations to the LELR prototype, including the use of a novel eight-wheeled skid-steer locomotion system, which is designed to ensure the safe navigation of the moon's rugged, steep slopes.

**MDA** is the contractor that designed and built the **Canadarm** and **Canadarm2,** essential operating components of the International Space Station.

==========

## ISLE OF MANN


[Wikipedia: "a self-governing British Crown Dependency, located in the Irish Sea between the islands of Great Britain and Ireland, within the British Isles. .. not part of the United Kingdom, but its foreign relations and defence are the responsibility of the UK Government."]

[The Isle of Man has a low-tax economy with no capital gains tax, wealth tax, stamp duty, or inheritance tax and a top rate of income tax of 20% ]

[The Island has become an appealing place to incorporate and do business, including for space ventures.]

### Excalibur Almaz acquires Russian Space Station Modules for Future Commercial Space Stations


http://www.parabolicarc.com/2011/01/06/excalibur-almaz-exports-space-stations-isle-man/

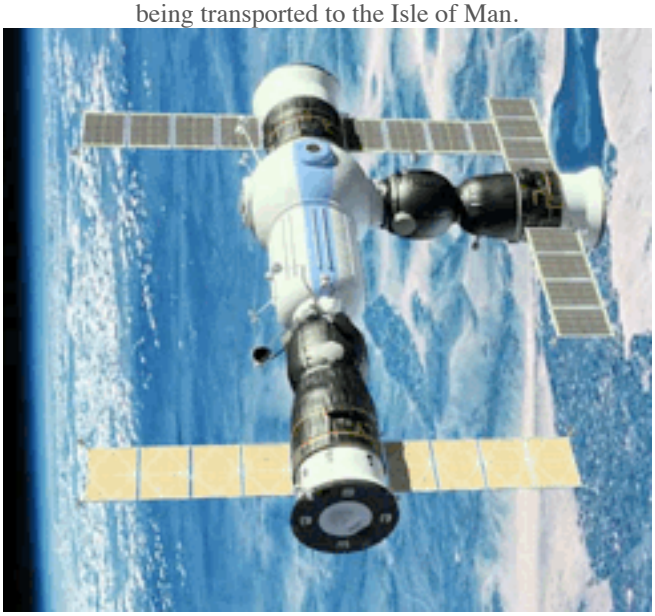
"The Almaz space stations are approximately 11 meters long and four meters in diameter; and are directly related to the module design used on the International Space Station as well as the earlier Russian Salyut and Mir space stations. Unique features include the largest window ever developed for a spacecraft, boasting over two meters of panoramic view of the Earth and stars."

Excalibur Almaz Limited (EA) is a private, international space exploration company formed in 2005 and based in the British Isles in Isle of Man.

Source: http://www.excaliburalmaz.com/

"The company was created to provide routine, affordable access to and from space for customers around the globe. Using updated and modernized proven legacy space systems and technology,"


**Above:** Partially completed Allmaz space station module being transported to the Isle of Man.



Artist's view of a deployed station with two reusable reentry capsules and an expendable freighter attached.

Almaz stations can be customized to suit customer needs. The first station could be launched as early as 2013, well before the first commercial Bigelow inflatable units.

**For more on this project, visit:**
http://www.space.com/9223-world-commercial-space-station-planned-russia.html

Cut-away illustration of an EA space station in orbit
11 meters long by 4 meters wide (36 x 13 ft)

While these modules, considered singly, are not spacious, several of them could be combined to provide customers with needed volume, and outfitted to support their needs.

==========

## More Isle of Mann Space Connections

**Google Lunar X-Prize team Odyssey Moon** is based on the Isle of Man.

**http://www.googlelunarxprize.org/lunar/teams/odyssey-moon/about**

The team was the first to complete its registration for the GLXP and is developing plans fro a series of Moon missions "in support of science, exploration & commerce." MDA Space Missions of Canada has been selected as the prime contractor for the first "MoonOne" lander which is currently under development, details kept under wraps. It would carry one or more scientific instruments.

A first landing site has not yet been selected. "Preference will be given to destinations of high scientific and exploration value; however technical risk will be a significant factor in the final selection.

==========

**Isle of Mann dubs itself "The Space Island."**

**http://www.spaceisle.com/**

# South African National Space Agency SANSA

The South African National Space Agency was established in 2009 to pull together all the existing space-related activities in the country under one banner. The new agency is to facilitate the development of space missions, develop technology platforms, and acquire, assimilate and disseminate space satellite data for any organ of state.

It will also implement the National Space Strategy, which was approved by cabinet in December 2008, to stimulate the capability to place SA among the leading nations in the innovative utilisation of space science and technology in accordance with the Department of Science and Technology's Ten-Year Innovation Plan, which includes space science and technology as one of the five "grand challenges". The hope is that these efforts will create new jobs.

South Africa has well established programs and facilities in the area of Astronomy Some of the projects the new agency will coordinate include the **Square Kilometre Array bid**, the **Southern African Large Telescope** (pictured), and the launch of SA's second indigenous satellite, Sumbandilasat.

Above: the 10 meter Southern African Large Telescope, the largest single optical telescope in the southern hemisphere

NASA Deep Space Station 51 at Hartebeesthoek [1961>]

There are some 74 companies in the aerospace and defence sector in South Africa

### Pathfinder Satellite Programme

**SumbandilaSat** is the name of the first South African built **micro earth observation satellite**, launched Sept. 17, 2009 by a Soyuz-2 launch vehicle from the Baikonur Cosmodrome.

**Sunsat**, The **S**tellenbosch **UN**iversity **SAT**ellite is the first miniaturized satellite designed and manufactured in South Africa. It was launched aboard a Delta II rocket from the Vandenberg Air Force Base on 23 February 1999. Sunsat was built by post-graduate engineering students at the University of Stellenbosch.

The 62nd International Astronautical Congress will be held in Cape Town, October 3-7, 2011. There is much more information on South Africa's space-related activities on this website: http://iac2011.com/space-south-africa

### Earth Observation Leadership

http://earthobservations.org/

Together with the United States, the European Commission and China, **South Africa co-chairs the Group on Earth Observations.** 47 countries and the European Commission are represented, as well as 26 international organisations. The function of the programme is to coordinate the strategies and systems for Earth Observations and identify measures to minimise data gaps, with a view to moving toward a comprehensive, coordinated and sustained Earth observation system.

### The South African Antarctic Base (SANAE IV)

http://home.intekom.com/sanae/


SANAE is on the coast not too far west of India's Maitri

SANAP's mission is to increase understanding of the natural environment and life in the Antarctic and Southern Ocean through appropriate science and technology. The Antarctic Research Programme is quite diverse.

We mention this station because it could be a place where South Africa could engage in some types of analog research, if so desired. **M3IQ**

## MMM-India Quarterly Editors:

**Peter Kokh**
kokhmmm@aol.com

www.lunarpedia.org/index.php?title=Peter_Kokh

Moon Society President
Editor:
Moon Miners' Manifesto

**Madhu Thangavelu**
thangavelu-girardey@cox.net
Mother from Kerala, father from Tamil Nadu, grew up in New Delhi. Now teaching at U. Southern California. Conductor, Graduate Space Exploration Concept Synthesis Studio USC Schools of Engineering & Architecture

**David A. Dunlop**
dunlop712@yahoo.com

Moon Society Director of Project Development

Exec. Director of LUNAX (LUnar National Agricultural eXperiment)

University of Luna Project

**We are proud to introduce our newest co-editors**

**Srinivas Laxman**
moonshotindia@gmail.com

Mumbai

Well-known space writer

**Pradeep Mohandas**
pradeep.mohandas@gmail.com
http://parallelspirals.blogspot.com/ - blog
*moving to Coimbatore*
Formerly President of SEDS India

## Moon Society India – 2010 a big year

From Pradeep Mohandas

We started building the organisation beginning with the announcement on November 14, 2009. On November 14, we passed the one-year mark.

Here is a look back, and a look forward. Your ideas are welcome to help us expand.

**Our achievements:**

1. 26 members.
2. 5 issues of Moon Miners Manifesto India Quarterly
3. Initiated 2 projects from Mumbai
4. We've co-conducted our first lecture in Mumbai
5. Established a relationship with SEDS India
6. Adopted Bylaws
7. Provided Moon Society (International) 2 Advisors

**Projects are essential**

To keep members, we must begin initiating projects. Since our initial talent pool is engineers, we have targetted the Lunar Analog Research Station Project (LARS) and Earth to Moon Transportation Architectures (EMTA). Both, are projects that have been studied numerous times by various organisations but we could not fathom leap froging this stage while beginning work in India.

**Lunar Analog Research**

In LARS, we begin by thinking of ways we can let school and college students do short duration LARS activities. I have shared this idea with Mamta Bharti and she has also been looking at various other education possibilities with students.

**Earth-Moon Transportation Architecture**

In EMTA, I am currently working on lunar elevators. Through my SGAC jig, I have come into contact with two students who would like to work on space elevators. They have presented papers at the Space Elevator Conference in Redmond, CA, USA and are about to present at EuroSpaceWard in Europe next year. I have given them an idea of what we're doing here and have sent them a message asking them if they would be interesting in taking forward this section of the study. There seems to be very little actual navigation happening in cis-lunar space.

**Space Law**

Also, through my space jig, I have got in touch with students in India who are interested in space law. I think it would be interesting to put together, in modern parlance a Moon Treaty 2.0 that can ensure that the Moon is not exploited whilst businesses are provided the leeway needed for them to consider lunar transportation architectures and lunar businesses. I am yet to broach them on the subject.

**Breakthrough Propulsion**

Another interesting organisation is the Tau Zero Foundation of the USA. They're looking at interstellar travel and they are headed by Marc Millis, former head of NASA's Breakthrough Propulsion Systems Centre. Traveling to the Moon more precisely and in a more controlled manner can help engineers do much more controlled gravity assist maneuvers. **PM**

## GREAT BROWSING

**Links whose subject is evident in the address**

**SPACE TRANSPORTATION**

http://www.space.com/news/**space-junk-threat-political-recognition**-101223.html

http://www.parabolicarc.com/2011/01/06/**excalibur-almaz-exports-space-stations-isle-man/**

http://www.physorg.com/news/2010-12-**discovery-molecule-efficient-rocket-fuel**.html

http://www.parabolicarc.com/2011/01/06/**cygnus-flight-iss-set-december/**

http://en.wikinews.org/wiki/**SpaceX_Dragon_spacecraft_certified_by_Federal_Aviation_Administration**

http://www.parabolicarc.com/2010/11/24/a**d-astra-rocket-company-reaches-full-power-milestone-vasimr-vx200-engine/**

http://www.ugo.com/movies/**100-best-movie-spaceships**

http://sify.com/news/**superhero-suit-to-prevent-bone-loss-in-astronauts**-news-international-kmcpOvajahf.html

http://www.bigelowaerospace.com/**history-expandable-spacecraft.**php

http://www.space.com/businesstechnology/**spacex-dragon-capsule-inside-look**-101206.html

http://www.foxnews.com/scitech/2011/01/25/**nasa-exploring-lasers-beams-zap-rockets-outer-space/**

**THE MOON**

http://www.space-travel.com/reports/**New_type_of_moon_rock_identified_**999.html

http://www.space-travel.com/reports/**New_Analysis_Explains_Formation_Of_Lunar_Farside_Bulge_**999.html

http://www.moondaily.com/reports/**Mining_On_The_Moon_Is_A_Not_So_Distant_Possibility_**999.html

http://www.universetoday.com/82250/**map-of-future-lunar-landing-sites/** [Google Lunar X-Prize]

http://www.space-travel.com/reports/**A_Softer_Landing_on_the_Moon_**999.html

**MARS**

http://www.spacedaily.com/reports/**China_Goes_To_Mars_**999.html

http://www.marsdaily.com/reports/**Mars_Volcanic_Deposit_Tells_Of_Warm_And_Wet_Environment_**999.html

http://www.marsdaily.com/reports/**Ancient_Mars_Was_Wet_Cozy_And_Life_Friendly_**999.html

http://www.marsdaily.com/reports/**Camera_On_Curiosity_Arm_Will_Magnify_Clues_In_Rocks_**999.html

http://www.space.com/scienceastronomy/**radioactive-hopper-spacecraft-mars**-101117.html

http://www.astrobio.net/pressrelease/3668/**evidence-for-hydrothermal-vents-on-mars**

http://www.marsdaily.com/reports/**Mars_Volcanic_Deposit_Tells_Of_Warm_And_Wet_Environment_**999.html

http://www.marsdaily.com/reports/**Ancient_Mars_Was_Wet_Cozy_And_Life_Friendly_**999.html

http://www.physorg.com/news/2010-10-**martian-lakes-seas-emerging-underground**.html

**ATEROIDS & COMETS**

http://www.space.com/news/**asteroid-impact-early-warning-system**-101203.html

http://elitestv.com/pub/2010/11/**nasa-spacecraft-burns-for-another-comet-flyby**

http://www.nasa.gov/topics/earth/features/**water_ice_asteroid**.html

**OTHER PLANETS**

http://www.space.com/businesstechnology/**robot-blimps-explore-other-planets**-100513.html

http://www.newscientist.com/article/dn19005-**hints-of-life-found-on-saturn-moon-titan**

http://www.newscientist.com/article/dn19697-**former-tenth-planet-may-be-smaller-than-pluto**.html

**ASTRONOMY – OTHER SOLAR SYSTEMS**

http://www.space.com/businesstechnology/**sun-gravity-possible-giant-radio-telescope**-101216.html

http://www.space.com/scienceastronomy/**color-changing-planets-alien-life**-100513.html

http://www.space.com/scienceastronomy/**alien-contact-will-take-centuries**-100429.html

http://www.space.com/scienceastronomy/070329_**double_sunsets**.html

http://www.space.com/scienceastronomy/**alien-planet-formation-two-suns**-101022.html

http://www.space.com/scienceastronomy/**alien-planets-orbit-binary-star-system**-101026.html

**SPACE STATIONS**

http://www.space.com/news/**esa-seek-to-broaden-access-to-space-station-**101027.html

http://www.space.com/**iss-international-space-station-construction-history-**100806.html

http://www.space.com/news/**international-space-station-destruction-plan-101207**.html

http://www.newscientist.com/article/dn19949-**fledgling-space-firm-will-use-old-soviet-gear**.html

**SPACE BASED SOLAR POWER**

http://www.thirdage.com/news/**india-and-us-harvest-solar-power-space**_11-7-2010

http://timesofindia.indiatimes.com/india/**India-America-join-hands-to-harness-solar-power**/articleshow/6886049.cms

**http://news.rediff.com/report/2010/nov/02/**kalam-nss-initiative-to-tap-solar-power-in-space**.htm**

http://www.newscientist.com/article/dn19497-**outofthisworld-proposal-for-solar-wind-power**.html

## GREAT SPACE VIDEOS

**Asteroid Discoveries 1980 to 2010 (last 30 years)**

http://www.youtube.com/watch?v=S_d-gs0WoUw&feature=player_embedded

**Video of EPOXI probe flyby of comet Hartley2**

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

**The Lunar Greenhouse**

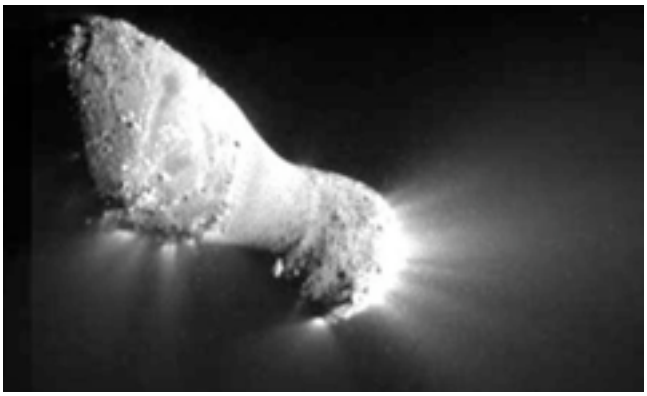
http://www.youtube.com/user/mooncolonytv#p/a/27CD52E1AB65BF59/0/F4Dbh0nvh-4

## M3IQ PHOTO GALLERY

**Valentine Cave** in Lava Beds National Monument, CA has **classic shape** with wall curbs marking former flow levels

Lavatubes **on other worlds** will be larger as the gravity is less: very large on the Moon; intermediate size on Mars.

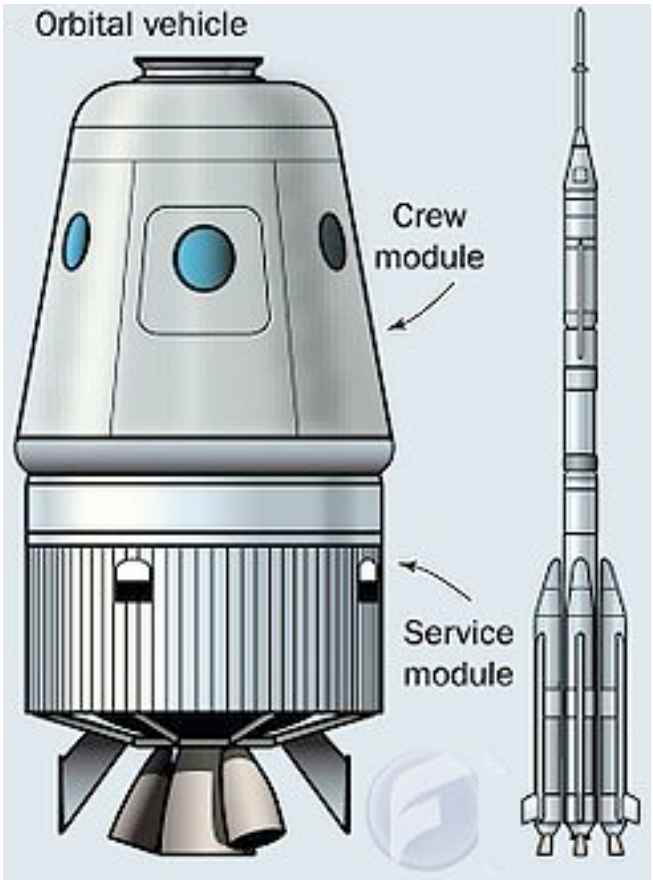
**Lavatubes in India, perhaps in the Deccan Plateau**, would make great locations for some types of lunar analog and Mars analog research activities.



Comet Hartley-2 seen outgassing in flyby

For an animation of the EPOXI flyby, check out:
http://epoxi.umd.edu/3gallery/vid_20101104_approach.shtml

Closeup photo of the lunar surface near the South Pole taken by Chandrayaan-1




Sketch of India's Manned Capsule now under construction, and the proposed launch vehicle


**ISRO's GSLV** – ***it will fly again!***

# The Google Lunar X-Prize:
## Morphing Competitions into Markets

"Our goal is to prepare the way back to the Moon, so that when we do go back, we are better prepared and able to do more."

By David A. Dunlop,
Moon Society Director of Project Development

GLXP; Google Lunar X-Prize
http://www.googlelunarxprize.org/

### Foreword

The Google Lunar X-Prize bills itself as "Moon 2.0" with a faith in the ability of competition, and human ingenuity, and non-governmental organizations to reach the lunar surface, move a short distance and transmit data including pictures back to Earth for the ridiculously small amount of a $20M (96 crore) first prize and a second prize of $5M (24 crore). I use the adjective ridiculous for the amount of prize money not because I (and most ordinary people around the world) would not consider this amount a sizable personal fortune, but because by the standards of prior lunar missions and even other planned lunar missions by space faring powers the prize is only a small fraction of the realistic cost of developing the mission.

### Strategies

**1. Leverage Investments**

Of course part of the stated strategy of the GLXP is to leverage many times the $20M in stimulating a number of teams to try new approaches to get to the Moon, with the expectation that some of these approaches will be more cost efficient than those in the existing engineering paradigm.

**2. Challenging Schedule**

Another part of the GLXP strategy is to set an ambitious time line for winning these prizes. The GLXP made this challenge in 2006 and indicated that the $20M (96 cr) first prize would be reduced to $15M (72 cr) if a winner had not emerged by the end of 2012 and the date of 2015 was noted as a potential endpoint. This prize timeline was reminiscent of JKF's challenge in 1961to send American to the Moon and safely return them "in this decade."

**3. Demonstration of Capabilities**

The GLXP is also framed in terms of specific destinations and of demonstration of specific primary and secondary capabilities.

**• Primary Capabilities:**

a. Landing on lunar surface in operating condition

b. Move 500 meters away from the lander with a rover

c. Transmit picture of lander from rover back to Earth

**• Secondary Capabilities**

d, Move 5000 meter away from the lander

e. Survive a lunar day night cycle on the surface

f. Visit the site of a previous lunar mission (A demonstration of precise navigation and landing abilities.

**4. Engage Education and both Public and Commercial Interest.**

The GLXP is also an attempt to increase public interest in a return to the Moon as well as a renewed interest in young people in breaking the cost and technology barriers that have for forty years prevented a routine and affordable capacity to follow-up on the exploits of the 1960's and 1970's when the geopolitical competition of the US and the Soviet Union fueled an undeclared but very real Moon Race.

**5. Develop a Moon 2.0 Commercial Paradigm**

The GLXP is also about an ideology of space development. It is one insistent about private investments and initiative as a more effective model of space development than reliance on governmental agencies and financing. Initial restrictions for GLXP Teams required that no more than 10% of funds for the compete ting teams could come from government sources. It is also an implicit goal of the GLXP to create a competition, which could signify-cantly reduce the price point of getting to the lunar surface and thereby enable commercial investors to create a commercial capability for transportation to the Moon that could be used to satisfy a market demand.

### Scoring GLXP Thus Far

In looking at the GLXP competition, we can use the above categories to create a scoring rubric to measure how well the GLXP program has succeeded in its strategies and goals.

**I. Scoring Leveraging Investments**

**A. Teams Engagement Investments**

It is somewhat difficult for me to make a precise evaluation of the effectiveness of the GLXP effort because the money expended by the X-Prize Foundation itself has been considerable maintaining staff and holding team meetings on at least two continents, not to mention many other public forums such as the International Space Development Conference sponsored by the National Space Society and many other such meetings by other government and private organizations. To the best of my knowledge these expenditures are not publicly available but must come to a considerable fraction of the prize itself.

*What we do know is that over 20 GLXP teams exist and that from information on the web, the plans of these teams demonstrate a wide variety of planned activities*. I am not aware of any requirement for reporting team expenditures to the GLXP or that GLXP share this information with the public. From the existence of these teams over a number of years I think it is likely that GLXP is leveraging its investment but if this information is known to GLXP it is perhaps not available due to proprietary interests as well as competition. *Let's however score a major win in leveraging its investment with the investment of 20+ GLXP teams*.

**B. Government "Data Demonstration Contracts**

What GLXP has succeeded in doing is to begin to isolate NASA from this competition. To both NASA's credit and that of the GLXP, interest has been shown in the GLXP by the NASA lunar commercialization office. Last August, NASA's Exploration Systems Mission Directorate put out a

Lunar Innovative Data Demonstration announcement, which offered a total of $30M (144 cr) with a maximum award of $10M (48 cr) to any one group that could provide NASA with the data the agency wanted. In one stroke NASA doubled the total stakes for the GLXP teams:

### The Challenging GLXP Schedule

We are still the better part of two years away from the initial 2012 deadline. We must wait to evaluate whether these deadlines succeeding in driving development and if indeed anybody gets to the Moon by December 31, 2015.

### Demonstration of Capabilities

We do have quite a lot of evidence from GLXP team postings that many teams are actually designing and building hardware. The competition has created more than a "viewgraphs" culture where pictures are cheap but there is little evidence of physical engineering. Notably the ARCA team has also been testing fight hardware systems.

The execution of NASA Innovative Lunar Data Demonstration contracts is also more than a viewgraph culture. The GLXP scored another major win since it leveraged its funds and those of its teams with government funds as a purchaser of "Data Demonstration" It succeeded in getting NASA's ESMD [Exploration Systems Mission Directorate] to match its $30M/144 cr prize pot with another $30M/144cr in data purchases.

### October 19 2010 NASA Award Announcements to GLXP teams

1 Astrobotics, Pittsburg, PA

2 Next Giant Leap, Draper Labs, Boston, Mass

3 FREDNET, Huntsville, AL

4 Omega Envoy, Earthrise Space, Orlando, FL

5 Rocket City Space Pioneers, Huntsville, AL

6 Moon Express, Mountain View, CA

### December 20, 2010 Award Announcements, $ 500,000 ~ 2.4 crore each, to GLXP teams

- Astrobotic Technologies Inc. Pittsburgh
- Moon Express, Mountain View, CA
- Rocket City Space Pioneers**,** Dynetics, Huntsville, AL

### Engaging Public Interest

It is difficult for an external observer to measure the level of impact the GLXP has had in engaging public interest. The X-Prize organization and the Google organizations certainly seem to deserve an A for effort in promoting and explaining their program.

**How can we measure public impact?**

In terms of Internet hits on websites, perhaps. In numbers of e-mail received?

In numbers of teacher presentations of these challenges in classrooms?

In terms of NASA's embrace of this approach in its own culture?

I have no source of quantitative information to answer these questions and as a "space nerd" and space activist I would have to discount my own enthusiasm as strongly biased in favor of the GLXP endeavor. Nevertheless it seems that GLXP has been changing the climate as well as reflecting the climate of a renewed international race to return to the lunar surface, following the pattern of the era of Apollo manned exploration with fleets of lunar orbiters, and landers, and yes return humans to the surface to stay in the 2020s.

Lunar mission enthusiasm is high in place like India and China. It has slowly emerged from the shadows and seeming long term indifference in Europe where now a spate of GLXP teams are working and a European Student Moon Orbiter program progresses toward a 2013 launch. This is in my opinion strong evidence that GLXP is again a winner with its education and public strategy.

### Developing a "Moon 2.0" Commercial Paradigm

GLXP scored again in that it succeeded in getting the US government to at least seek technology demonstrations from the open market place, and not exclusively from in-house NASA center development teams.

Interestingly while NASA International Lunar Network lunar lander effort centered at MSFC, which started with a $100M/480 cr, cost cap per mission quickly doubled to $200M/240 cr per mission, the $30M/144 cr Innovative Lunar Data Demonstration was supporting a number of GLXP teams. Now one might argue that comparing ILN [International Lunar (Seismology) Network] missions and GLXP missions is comparing "apples and oranges" in terms of mission requirements. But cost explosions do magnify the difference between the fixed price private initiative culture versus the NASA mission development culture. Hopefully the commercial evolution and impacts can still keep coming.

### A good idea for the ESMD could also be a good idea for the SMD [Science Mission Directorate]

A. NASA could further change it way of doing business with its Lunar Quest line item and pay for fixed cost fix schedule results in its ILN program where for example it wants to repeat a number of science measurements for seismic activities, heat flow probes, laser retro-reflectors, and surface environmental measurements and provide a schedule which also has incentives and disincentives for mission requirements tied to other international participants.

B, The SMD might also pay for lunar surface sample return and additional information about the geological context of these samples. The SMD has numerous scientific objectives carefully vetted by "the community of scholars" for scientific value and priority. Its role in the "sanctity" of this process could be more than matched by creating a market demand for its scientific priorities and requirements.

C. Not only NASA but its international space faring peers might also seek vendors for their ILN commitments and lunar surface exploration programs.

Let us hope that the GLXP will succeed again to driving NASA's SMD and its sister agencies to morph into a market driven paradigm.

==========

## National Space Faring Objectives Versus the GLXP Market Model

But let us also be candid about the world as it exists. The major international space faring powers have not really been about getting the best price from a credible market provider. They are still looking to demonstrate national technical competence, national pride of achievement, with national government expenditures, and providing national technological and scientific employment in their domestic market mostly via government agencies and their national contractor clients.

Europe for the Europeans! Japan for the Japanese! And India for the Indians. America for the Americans! Etc. The lean times of the aftermath of the collapse of the Soviet Union made the Russian government very willing to be a commercial vendor and bargain basement provider of space services even to the ISS just to keep its spacefaring capabilities alive. Similarly so with the Ukraine.

Let us hope however that some of the international teams whose "weight" for example is in Europe such as White Label Space, Team Italian, ARCA or Euroluna or Barcelona Moon Team, C-Base Open Moon, or Part Time Scientists might find the ESA offering data demonstrations purchases to these teams. Let us wish the same for Selenokhod in Russia, Selene in China, and Odyssey Moon in Canada

Purchased Technological demonstrations will improve the state of the art and the reduction of price points of these capabilities:

- Precise Navigation
- Obstacle Avoidance
- Lunar Night Survival
- Earth-Moon Communications
- Sample return to Earth
- Energy provision on lunar surface
- Lunar spatial and positioning services
- And other demonstrations that enable lunar surface operations.

### Concerns about GLXP Limiting Factors

At the 2008 ILEWG conference in Florida and again at the 2009 ISDC conference, and in an article in the Moon Miner's Manifesto India Quarterly #6, pages 26-28, I raised concerns about the aftermath of an early winner in the GLXP competition: Just because a Team was first to arrive at the lunar surface, move 500 meters, and send back pictorial evidence of these achievements *does not mean their approaches are the most innovative, or most cost efficient*.

First, an early win might be evidence of better financing, an earlier start, or a more experienced management in organizing a team effort.

Second, there is a concern that an early GLXP win might leave teams with good ideas and technical innovation "stranded on the sand" once the gold of the prize money and the glory of being "first" and "second" had evaporated.

Third, the premature cessation of work by other teams would mean the waste of all the capital expended if these "also ran teams" were not brought to fruition.

For the national space agencies, I thought losing any fraction of 20-some teams would be a terrible loss of investment, human initiative, and capital investments. Some of these teams would be the equivalent of a Phase A and Phase B awards in program development getting to at least a Preliminary Design Review if not a Critical Design review level. For this to happen to a number of team efforts would be a real loss, especially at a time when the international Moon Race has been heating up and lunar robotic precursor missions are being slated by some of the major spacefaring powers.

NASA's ESMD has responded with the ILDD program [Innovative Lunar Demonstrations Data] and the ESMD is to be commended for injecting these resources into the fertile brew that the GLXP has created. My worries as expressed above have been much alleviated. Let's hope that NASA SMD will be creative enough to do the same followed by ESA, Roscosmos, JAXA, ISRO and China.

We also note that the **Lunar Lander Challenge** has been successful in creating a successful field of challengers for lunar landing technologies.

==========

## Future Directions for Challenges by The Moon Society, National Space Society, OpenLuna, SEDS

[Students for the Exploration and Development of Space]

As a member of both the National Space Society and the Moon Society, which espouse space settlement and lunar economic development, I believe that the promising start made by the X-Prize Foundation and NASA can be continued with additional well-tailored initiatives. Our Societies and the Open Luna Foundation are proposing a pair of additional engineering competition challenges, "mini X Prize" programs if you will, intended to push the state of the art in key technologies, advance the prospects of both scientific exploration and commercial development, and encourage the participation of young people through the SEDS organization and other campus groups. These mini-prizes are also intended to leverage the interests and resources of other advocates and institutional "players."

Moon Society President Peter Kokh and I have presented these challenges to students at the November 2010 SEDS SpaceVision conference at the University of Illinois Urbana-Champaign. While there, we had occasion to also present and discuss these challenges with Will Pomerantz of the GLXP X-Prize Foundation and with Will Watson of the Space Frontier Foundation.

We hope that the initial proposals of the Moon Society, NSS, and Open Luna will generate interest and participation from these other advocacy organizations and from NASA itself. These engineering competition ideas have been first presented in the US and framed in terms of SEDS US. But there is no reason why these ideas should not also be the subject of engineering competitions elsewhere, including India. Both NSS and the Moon Society and SEDS are organizations with international membership and Open

Luna has members and participants in both the US and Canada. Neither Peter Kokh nor I are familiar with the funding resources available to student teams outside the US and/or outside NASA's funding framework. But these challenges are relevant not only to NASA but to also to CSA, ESA, ISRO, JAXA, Roscosmos, ans CNSA.

**Lavatube Skylight Explorer**

First is a competition to develop a Lavatube Skylight Explorer probe that could:

1 Move off a lunar lander platform,

2 Move over to a lavatube "skylight, "

3 Anchor itself, and release a tethered probe that could

4 Lower itself by paying out the tether cable down into the lavatube,

5 Characterize the lava tube to some extent,

6 Communicate its findings back to Earth via the tether

7 For extra points bring back sample materials from the interior of the lava tube [note that in all probability all the material on the floor of the tube below the skylight will be debris from the tube ceiling collapse that created the skylight, rather than material from inner lavatube surfaces.]

8 Note that similar parallel opportunities for lava tube skylight exploration exist on both the Moon and Mars, and for this reason, we are seeking cosponsorship of this competition from several Mars-focused organizations as well.

You aare invited to download our PowerPoint presentation **SkylightExplorer.ppt** from:

http://www.moonsociety.org/competitions/engineering/

The ultimate purpose of this effort is to catch the attention of NASA and of prospective Principal Investigators, in the hope that such a mission will someday be flown both to the Moon and to Mars. At stake is changing public perception of both worlds as "dusty rubble-strewn wastelands" to worlds with spacious, sheltered "hidden valleys" beckoning would-be human pioneers.

**Solar Sail and Communications Cube Sat**

Second is a competition to

1 Develop a cube sat class satellite

2 Use a solar sail to reach lunar orbital and L4 and/or L5 space

3 Using Weak Stability Boundary navigation techniques,

4 Maintain long term lunar orbits using the solar sail, and

5 Demonstrate both micro-electronic communications and

6 Demonstrate timing technologies that facilitate both lunar surface exploration and commercial development activities.

7 Require the development of a business model of commercial communications and a GPS system for lunar surface operations.

8 Provide a science objective via investigation of lunar dust in cislunar space

9 Return to LEO space where the cube sat could be retrieved with its payload of dust and

10 Provide a study example of how its systems endured/survived its long duration mission.

**Competition Development**

Both challenges will require a phased approach as these efforts are complex and require a number of technical areas of demonstration. We are working to develop mature competition proposals, which may include First, Second, and Supplemental Prizes in annual phases. These competitions could potentially also become the subject of Innovative Lunar Data Demonstration funding via the NASA ESMD and a similar funding program for science objectives via the SMD.

We have made initial inquiries about the potential for using NASA Glenn 510 ft/155 m drop tower test facilities in Cleveland, Ohio for the Lavatube Skylight Explorer competition. Their work and the work of other NASA Centers such as AMES, JPL, and Goddard in micro-electronics would seem a logical extension to the competition to create a Solar Sail Communications Cube Sat. as a follow on to the MSFC [Marshall Space Flight Center, Huntsville, AL] Nano-Sail 2D satellite initiative and a precursor to a cost efficient lunar communications network.

However we also hope that these ideas can become examples of the NASA's participatory exploration philosophy, and that these might also become NASA Centennial Challenges and become closely integrated with NASA education initiatives via the Space Grant Network and University partner/participants. Similarly, the commercialization objective of the Solar Sail and Communications Com Sat demonstration could be supported with NASA SBIR and Technology Transfer funding mechanisms. We only hope to succeed as well as the X-Prize Foundation and Google Inc have done in morphing their competition into a real market mechanism.

==========

## Is the Lunar Exploration Market Real?

Yet for all this promising success we must also skeptically ask is the lunar market real? Talk of the lunar market has been stock in trade for decades for space advocacy organizations and science fiction aficionados. Such talk most often creates a MEGO reaction from the general public (My Eyes Glaze Over). Until Innovative Lunar Data Demonstration became a new paradigm, the only "market" for lunar missions will continue to be restricted to national space bureaucracies trying to convince a "national customer" to purchase a mission.

The "gnomes" at GLXP at least provided a non - commercial customer cleverly offering and leveraging their "paltry" $30M when the acknowledged real costs of doing so were in the $100M to $150M range. But others such as Rob Kelso in the Lunar Commercialization Office at JSC, Robert Pittman at AMES, Greg Schmidt at the Lunar Science Institute AMES, Paul Eckhart of Boeing, Pam Clark at Goddard, Clive Neal at Notre Dame and Bernard Foing of ESA and myself were also asking about "the realities" of a lunar market.

At the LEAG [Lunar Exploration and Analysis Group] meeting in Houston in December 2009 a number of

us had lunch and wondered, How could "the commercial on-ramp to the Moon be developed?" This language was part of the LEAG Roadmap but was it based on anything substantive or solid?

When asked how big the community of lunar interest was or how one might define this "community" in several public discussions, most often in gatherings of lunar scientists there was a thunderous silence. Greg Schmidt and Rob Kelso began to put together a Lunar Orphans Flight Test list of potential lunar missions instruments without a ride to the Moon (hence "orphaned"). Similarly, Pam Clark and I brought this issue to the LEAG meeting at the 2010 LPI Annual Science Conferenceand follow-up meeting in September 2010 in Washington. We discussed creating a SPACE list, [Surface Payloads and Advanced Concepts for Exploration] which could define specific payloads and technologies that needed to reach the lunar surface. This includes not only proven technologies and instruments with a TRL 9 [Technology Readiness Level] rating but also technologies at a lower TRL level of development.

These lists could provide one way to define a community of interest in lunar missions at least in terms of specific missions, technologies, instruments, and even PIs [Principal Investigators] and their institutional programs. That's at least a start. However, just because there is interest and specific payloads to be transported doesn't mean that any money is attached. Without customers who have the ability to purchase a ride, the market remains mythological and back in the realm of science fiction and space advocacy. But before we throw up our hands because "we been here before" perhaps we can still advance our lunar market cause.

## Demonstrating A Market

The ability to quantify market demand is the first step in any business development plan. It identifies at least potential customers and specific customer interests. The LEAG Roadmap for example is a consensus product of many sub-communities of scientific interest. Its science objectives represent a reflection of real communities with long term interests and perspectives.

While this is important to a nascent lunar market much more remains to be done. LEAG is merely an advisory body to NASA. It is a case of the tail wagging the dog to presume that it can change NASA's culture. But if GLXP has impacted the NASA Exploration Systems Mission Directorate then is it is no less ambitious to work toward creating a commercial paradigm for the Science Mission Directorate and its Lunar Quest budget line item? A "SPACE List" is one way of quantifying the community of interest in a lunar transportation service. Competitions are another mechanism. They draw specific participants and proposals. They attract attention in high places and with "investor" communities. Why not purchase properly vetted science objectives and data with fixed cost competition awards and clear schedules?

## New Science Purchase Paradigms

The Google Lunar X-Prize and Lunar Lander Challenge have impacted the climate and process of public exploration. We hope that the Lavatube Skylight Explorer and Lunar Solar Sail and Communications Cube Satellite competitions can have a further impact on the Science Mission Directorate [SMD].

How SMD conducts participatory exploration and define community consensus science objectives in terms of purchase mechanisms will have a lot to do with the further growth of a genuine lunar market. There are a variety of mechanisms with which to foster such development. Some of these are fresh uses of mechanisms that have been part of NASA's arsenal:

1 Centennial Prizes
2 SBIRs
3 Tech Transfer
4 Space Grant grants
5 Satellites Test Program
6 NASA Center Funds initiatives
7 NASA Education funds.

Others may be private organizations:

8 The X-Prize Foundation is of course the prime example in this article
9 The Space Frontier Foundation is another space advocacy directed at commercialization

## New Transport Paradigms

Creating a commercial lunar market is a matter of creating a "price point" that is affordable to private customers. Hitchhiker payloads on commercial satellites have fostered an explosion of activities and research. The cube satellite and cube sat launcher mechanisms developed some ten years ago by Bob Twiggs and his collaborators at Stanford and California Polytechnic, have created a similar explosion of interest around the world and over 100 cube sats have been developed.

Perhaps a cube sat scale program for lunar surface instruments restricted to 1Kg mass and I liter volume might be proposed for all NASA lunar surface missions as a strong incentive for the lunar community of interest to respond.

One of the GLXP teams, Astrobotics I believe, has already put a $1.5M price point per kg out for prospective piggyback cargo in connection with its commercial lunar lander ambitions.

Dr. Peter Worden of NASA-AMES expressed a belief at the 2006 ISDC in Los Angeles and the 2007 ISDC in Dallas that small lunar missions could take place in the cost realm of "the low tens of millions." That remains a visionary price point challenge today.

**Perhaps a worthy successor challenge to the GLXP would be a price point challenge to get to a commercial $100,000 per kg to the lunar surface**.

At that rate, I think a lunar market would spring into being with many private sector purchasers standing in line along with a host of NASA associated scientists and engineers.

The cube sat world has shown how a lot can be done within the limits of minimal mass in minimal volume and how student engagement and university education programs can contribute. This is a model for the commercial on-ramp to the Moon as well.

**New Capabilities for the "Cryo-Universe"**

There are many technology demonstrations needed to show us how to explore the "cold universe" beyond the warmth of Earth and its tropical neighborhood in the inner solar system. The Moon is the nearest (and least expensive to access) testbed environment for these technologies which can endure "cold traps", utilize power beaming and low temperature batteries and electronics, move and navigate in dark and rough terrains, deliver and "plant" instruments, and both sample, return, and curate materials without compromising pristine cryo-environments.

The LEAG [Lunar Exploration Analysis Group] "Commercial On-Ramp" also implies ISRU [In Situ (on site) Resource Utilization] and the delivery of applied engineering packages to produce oxygen, fuels, and utilize lunar materials for a wide variety of purposes leading to commercial operations.

So the "SPACE List" is also a tool that is a way of looking at Technology Investment Requirements by NASA ESMD and other government agencies such as DOE, DARPA, USAF, NRL, etc. These technologies might also be a target for private investments if a sustainable market niche n which a return on the investment is seen as likely.

**Conclusion:** I believe that carefully crafted engineering *compe-titions can succeed in morphing the current government- purchased world of lunar mission activities into a comer-cial market using the LEAG Roadmap and NASA Techno-logy roadmaps to generate a well-defined potential market for lunar missions and transportation*. A high flight rate-low unit cost transportation system can be created in response to this potential market.

*A small low cost paradigm for lunar surface activities can also be facilitated by a $100K/kg price point paradigm for a lunar cube as a major new prize objective*. Many science activities could be purchased at this price point and the SMD can follow the good example of the ESMD's Innovative Lunar Data Demonstration program. This price point would also open participation to private purchasers as well.

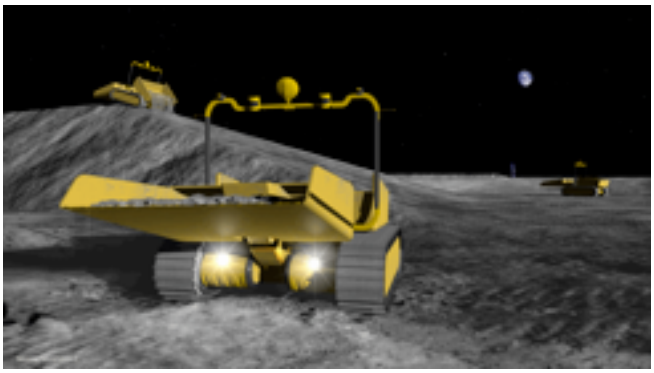
This lunar "market demand" can also create a road map for technology investments and demonstrations, which need both government and private sector capital. Thrown into this mix is the NASA paradigm of "participatory exploration" and education for engaging and developing the next workforce coming out of our schools and universities.

The evidence I see suggests that GLXP has been succeeding in morphing competitions into markets. And, as a member of the Moon Society, National Space Society, and Open Luna Foundation, I hope that our efforts and those of SEDS can result in more of the same. I welcome the participation of other who would support this vision of lunar commercialization and development. **DD**

- David A. Dunlop is a long time space advocate who is currently on the Boards of the Moon Society and of The National Space Society. He is also a member of the Open Luna Foundation. He has had careers in both public administration of community mental health services, and science education. Dave currently resides in Green Bay, Wisconsin, US.

# Teleoperated Equipment, Robots, & Robonauts will Open the Moon

By Peter Kokh



Teleoperated equipment on the Moon: Astrobotics Corp

In a recent blog and paper, Dr. Paul Spudis, a Senior Staff Scientist at the Lunar and Planetary Institute in Houston and author of "The Once and Future Moon", laid out the role for robotics in preparing the Moon for human explorers, as the only "affordable" way "back to the Moon."

**Sources:**

http://blogs.airspacemag.com/moon/2010/12/can-we-afford-to-return-to-the-moon/

http://www.spudislunarresources.com/Papers/Affordable_Lunar_Base.pdf

In his blog post "Can We Afford to Return to the Moon?," he makes the case for the need to "design ***an architecture that accomplishes the mission in small, incremental and cumulative steps.***"

> "The key to making all this work," Spudis says, "is the use of teleoperated robotic machines. We go to the Moon robotically first and later with people. These robots are controlled by people on the Earth. They prospect for resources, test techniques, evaluate product yields, set up processing plants, and begin harvesting lunar resources almost immediately. The extracted products are cached on the surface for future use. The entire lunar outpost is set-up and made operational by these robotic machines."

**Why Robots and Robonauts first?**

That's simple. It is cheaper to transport them to the Moon, and cheaper to support them once there. These devices can be shipped in tightly packed unpressurized containers. Robots and robotic equipment can be designed with higher radiation tolerance; and can work in a wider range of thermal extremes.

They need no food, no air, no water, no rest, no habitat space, no recreation. They experience no boredom (repetitive tasks), no distraction, no fatigue. They can perform well "24/15" i.e. continuously through the 354 hour long dayspan (14.75 days), and possibly at lower levels of activity into the equaly long lunar nightspan,

They take up less transit space, have no need to return. Further, they have no requirement to be of "human scale" and weight, and can be sized as appropriate for the tasks they are to perform.

**What can they do?**

They can repare the site, construct a landing/launch pad and constructg a berm around it, to protect the base and other installations from dust bullets scattered by the exhaust of rockets landing or taking off. They can installl beacons, solar arrays and power storage system. They can scoop out trenches in which to set human outpost modules, and then shield with the removed moondust. They can create a warehousing area, set up life-support systems, etc. In short, we can entrust to these hardy and tireess servants everything needed to construct an outpost for humans that is ready to occupy and operate. Indeed, we can use them to support all activities for which humans on the scene are needed.

**Teleoperated Equipment, Robots, and Robonauts: What is the difference?**

**Teleoperated devices:** The simplest form of robotics is teleoperated equipment. On Earth, a person, or team of persons relieving one another, can teleoperate rovers, bulldozers, cranes, and all sorts of construction equipment on the Moon. Once a human outpost is up and running, teleoperators could take care of many "chores" such as those involved in growing plants in a lunar greenhouse or food growth chamber, storing or retrieving items in an external warehousse, etc. freeing persons on the Moon to do what they came to do..

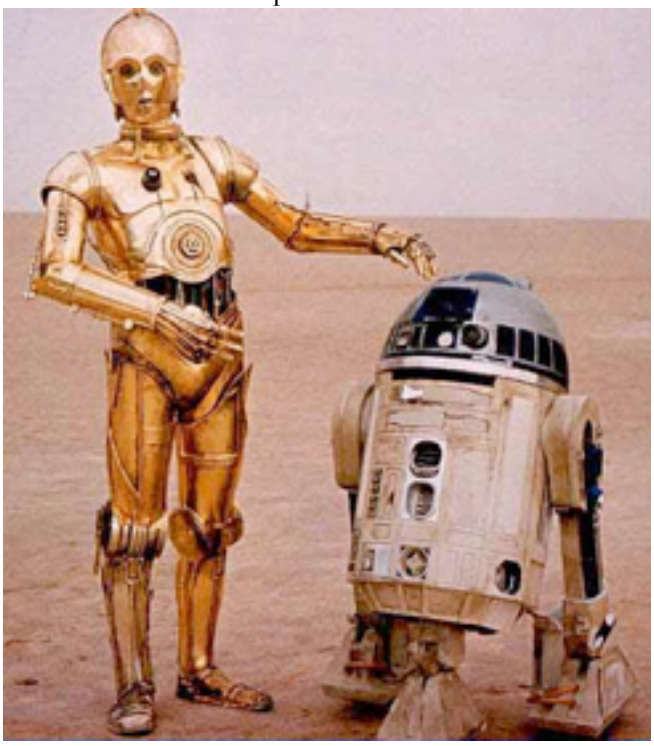
**Scarab,** the moon miner, was developed at the Robotics Institute of Carnegie Mellon. He's an awesome little guy designed to mine "hydrogen, possibly water, and other volatile chemicals" for use at a future moonbase.

This is vastly easier on the Moon where the time-delay imposed by the speed of light (teleoperated instructions) is about two and a half seconds. The round-trip Earth-Moon distance is on the order of 770,000 km. The Moon's distance varies somewhat and also involved is where on Earth is the signal coming from, whether from the side currently facing the Moon, or from the side currently facing away from the Moon, requiring a satellite relay, lengthening the loop time.

In comparison, teleoperators sending instructions to Opportunity of Spirit on Mars must work with a time delay of from 6 to 40 minutes, roughly 150-600 times longer - a very tedious process. This situation could be overcome by using self-sufficient robots, or by setting up a forward human teleoperations perch in Mars orbit. Such a station could be shielded if built into Phobos or Deimos, and control devices all over the Martian globe via satellite relay.

If a human outpost, temporary or permanent, is deployed at the Earth-Moon L1 Lagrange point, where Earth's and the Moon's gravity cancels out, this 2.5 second time delay will be reduced to a fraction of the second, close enough to "real time" control. Such a station could be shielded in a jacket of water-ice or liquid Oxygen and liquid hydrogen derived from water.

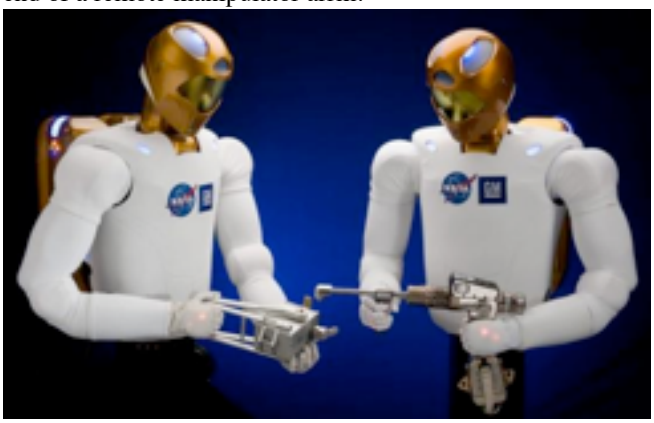
**Robots and automated devices:** These are devices, whether they look human or not, have artificial intelligence programs which allow them to work on their own without routine control from teleoperators on Earth.



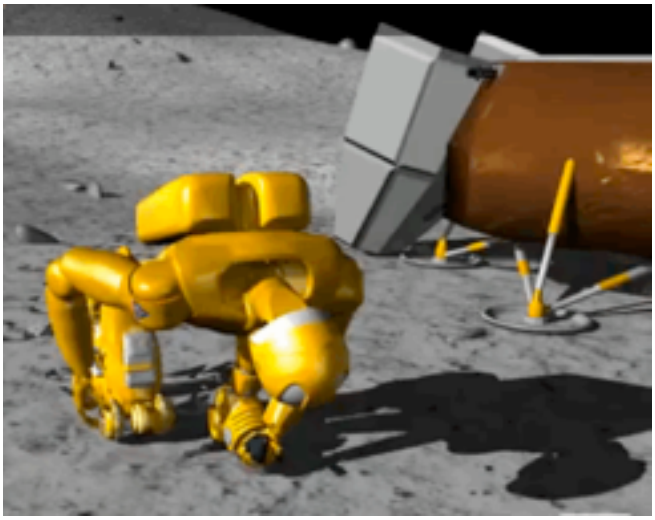
Star Wars C3PO and R2D2 on Tatooine

Many robots are involved in modern manufacturing, but or a narrow set of routine tasks, and no general intelligence.

**Robonauts:** This is the name given by NASA to its new-human looking device that will work outside the ISS at the end of a remote manipulator arrm.



Robonauts do not hae an autonomous intelligence program but are operated by a person inside the station (or on Earth or form L1 or L2, for lunar robonauts). The human wears a special visor and gloves which allow him/her to see what the robonaut sees, feel what it feels, and direct its actions accordingly. Robonauts have arms and hands that mimic human ones in all degrees of motion, but may have legs or wheels or some other means of getting them into position to do their work. They many have "heads" that look human, or just a set of eyes and other sensors.

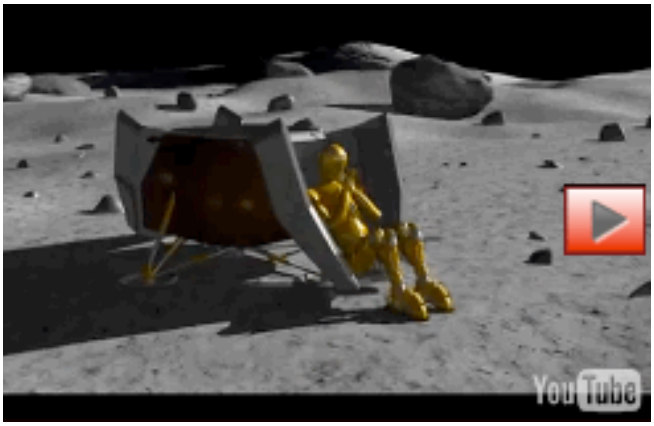


A scientist on Earth sees and feels what his/her robonaut sees and feels on the Moon, enabling him/her to do field science "directly."


Another name in use for "robonaurs" is Avatars, following the use of the word in the recent hit film, **Avatar**. An Avatar (Sanskrit origin) is the name for a reincarnation, or projected presence.

**Robotics and national space agency plans**

Paul Spudis is an American, but while NASA had integrated some robotics into its manned moon mission planning, the agency did not have an approved plan to send robots first, at least not a plan as thorough and far-reaching as the one outlined by Spudis. However, NASA's Johnson Spae Control (JSC) center in Houston had been working on a "Project M" which would put a telepresence-controlled robonaut on the Moon. ***Do watch this video: it is awesome and encouraging.***




**http://www.youtube.com/watch?v=kFPNcWN7QnM**

(For best effect, click the icon at right on the video control bar at the bottom of the screen)

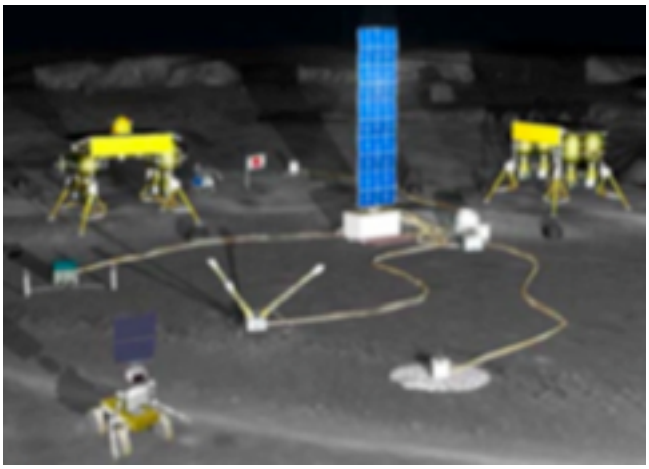
Actually, a growing number of males around the world have undergone telepresence-robotic surgical procedures in the area of urology (bladder and prostate surgeries.) Indeed, telepresence has many applications outside the field of space exploration, such as hazmat applications, including handling radioactive materials and wastes!

But approved NASA human Moon mission plans (prior to NASA's recent redirection to a non-lunar "Flexible Path') would just send humans to the Moon and take some robotic equipment along. To be fair, some U.S. Space Contractors and firms have been thinking ahead, such as Carnegie-Mellon Institute and Astobotics (see the image at the head of this article). There have been similar robotic site preparation suggestions put forth in Europe.

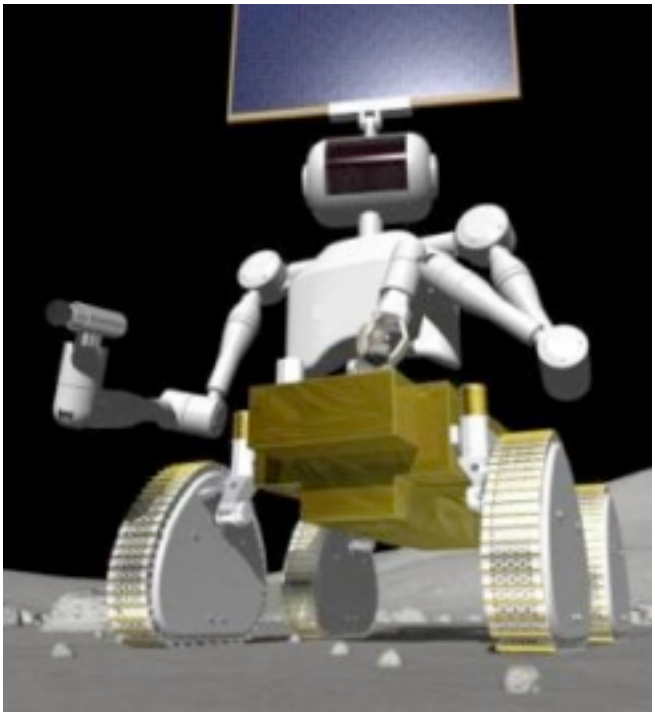
Project M boasts that given approval and money, they could have such an avatar or robonaut on the Moon in "1,000 days" - under 3 years! But no such approval is in the works, and that clearly creates a need for activist lobbying of the U.S. Congress, currently in a Procrustean budget-cutting mindset. Yet, such an effort is clearly worth the try.

Only Japan and Russia have announced plans to set up ***robotic*** lunar bases ***first***. These plans differ from one another, as the available illustrations suggest.

**The JAXA Plan** http://www.space-travel.com/reports/Japan_experts_call_for_robot_expedition_to_moon_999.html

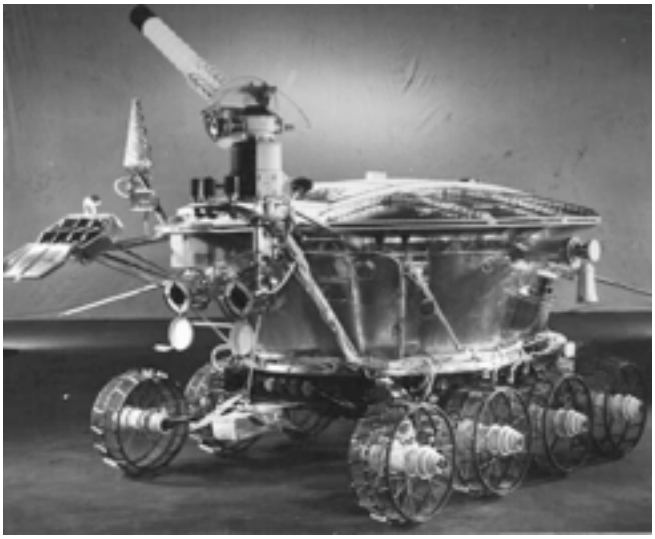


**JAXA lunar advanced wheeled robot concepts**

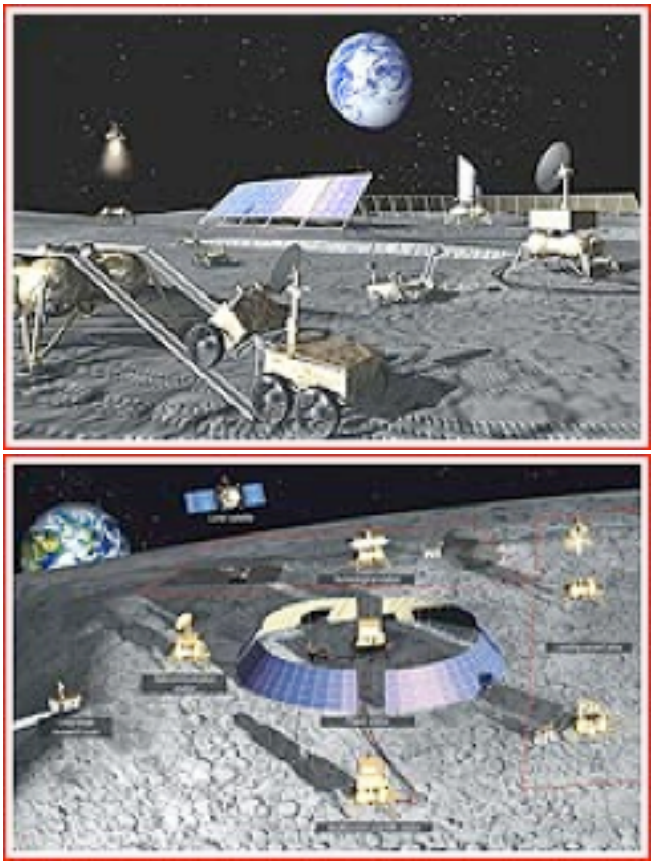


Under the JAXA plan, the robot's tasks would include setting up an observation device and gathering geological samples for sending back to Earth. The robot would also set up solar panels to generate energy." Why wheels and not legs? JAXA "initially considered sending a two-legged humanoid but judged a "rover-type" robot more practical due to the bumpy surface.

**The Russian/Roscosmos Plan** The first robot lunar rover to land on the Moon was the Soviet vessel Lunokhod 1 on November 17, 1970 as part of the Lunokhod program. Russia is ready to build on that precedent.



The **Lunnyj Poligon** robotic lunar base that follows the Russian Luna Glob (sphere) and Luna Grunt (soil) missionswould be a "Robotic proving ground", consist of several components: solar power station, telecommunication station, technological station, scientific station, long-range research rover, landing and launch area, and an orbiting satellite. This project is planned for 2020.



Above; illustratins of the **Lunnyj Poligon** base

Not much additional information about this plan is available

**What about India's plans for people on the Moon?**

It would seem that India might likewise do best to send robots to the Moon first to prepare the landing site for its first human mission. But unless India plans to set up a permanent base there, (not just do a science picnic in Apollo fashion) that would be an extra expense. But if India sees a long term science outpost on the Moon, in the tradition of Maitri in Antarctica, such tele-robotic and telepresence tools could make this goal a reality for less money and sooner, as well as safer. Telerobotic and telepresence preconstruction of lunar facilities makes elegant sense from all vantage points. It is something that few may have thought of, back when robotics and telepresence were science fiction terms!

There are several companies and universities in India that are on the pioneering edge of Robotics technologies. But we could find no indication that any company in India is working in the field of telepresence. However robotic (telepresence) urology surgeries (bladder, prostate) are being perfomed in India in increasing percentages, as elsewhere around the world, and with great success. (This writer underwent such a procedure in 2009.)

**International efforts –** The Moon Society (International) is on record as supporting International Lunar Research Parks. There can be more than one, so as to extend human pesence and operations to more than one location.

http://www.moonsociety.org/reports/beyond_nasa.html

The International Space Station project is an example, though one with flaws that can be corrected, of how to proceed. In the Moon Society plan, corportations

and private enterprises would be among the partners, and not just in an auxiliary manner. A corporation or consortium of corporations would prepare the site, including facilities to be shared in common such as powr generation, power storage, communications, spaceport, warehouse operations, initial road network, and possibly waste treatment. Much of these facilities would be constructed telerobotically and be telepresence robonauts.

The ILRP space agency partners from various participating nations, could then simply "plug in" their own outpost complex, and be ready to do science, on site materials research, and more.

This plan was the subject of an article in M3IQ#2, February 2009, p 20 An International Lunar Research Park. A following article, p 24 The Developer's Role, should be reread and perhaps recast working telerobotics and telepresence robotics (robonauts / avatars) into the plan.

This is an encouraging Game Plan, as it is emminently "affordable" and can be accomplished in a series of bite-size missions, as Paul Spudis has suggested. **PK**

## Role of Robonauts & Robots on the Moon Once Humans have settled in to stay

By Peter Kokh

We have realized for a long time, at least since the early Apollo mission days, that radiation exposure on the Moon from cosmic rays and solar flares was a big problem. The week or so of unprotected vulnerability could be tolerated. But it would be better to provide some sort of shielding for persons intending to stay a while. Two meters of moondust overburden should protect those within habitat modules for stays up to a few months. But long term, 4-5 meters would be better.

We've known that for some time and most moon-base plans have some sort of shielding as part and parcel of the plan. This need has also made the possibility of locating human installations within lavatubes very appealing. These voids, whole networks of them, are common in the lava flow sheets that filled most large nearside basins, creating the maria (MAH-ri-a, singular MAH ray, mare). But these handy hollows are not to be found at or near either lunar pole, both poles being located in highland areas.

The inspiration out of which the original Moon Miners' Manifesto was born, was that while we had to live "underground", we would not have to live like moles, as Robert A. Heinlein had suggested in his classic novel: "The Moon is a Harsh Mistress," as there were ways we could take the sunshine and views "down under with us." See: http://www.moonsociety.org/chapters/milwaukee/mmm/mmm_1.html

But surely we have business out on the naked, radiation-washed surface! We need to explore, to prospect for minerals, to build roads, to trade with other settlements! No people, and surely not the Moon's people, will freely be virtually imprisoned. How do we handle this? *Read on*.

### Radiation Exposure Limits and Monitoring

Perhaps every Lunan settler or pioneer or visitor will be required to wear a wristband which monitors one's accumulated radiation exposure. Those whose exposure is under set levels will be allowed to go "outside" – "out-vac" on the exposed, vacuum and radiation-washed surface for limited times, and on limited occasions.

### Jobs and Careers

There are those in any population that feel most at home "outdoors" and/or "on the road." But living such a life-style – having such an occupation, could result in radiation sickness and even premature death. *Unless!*

There are three ways to sidestep this nasty fate.

(1) Outside jobs could be managed from the safety of shielded habitat spaces, by telepresence operation of robonauts or avatars.

(2) The cabs of over-the-road trucks, motor coaches, trains and construction equipment could be jacketed by water (somehow kept from freezing or boiling). The jacket need cover only that portion exposed to the sky.

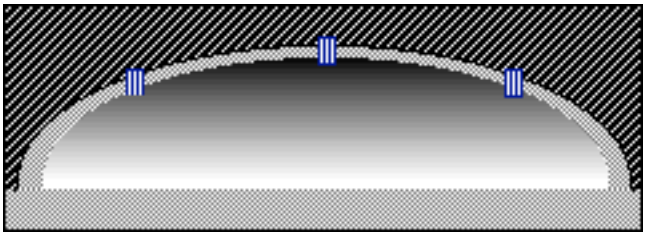
At left, a concept for a protected railroad passenger wagon to be used by frequent travelers at a "first class" rate. Infrequent travelers could safely make overland trips without such protection.

(3) Outside jobs could be filled by rotation from among a large pool of persons, who would do safe "inside" work most of the time. This would not suit those who wish to be out on the surface regularly, but such types could work in jacketed conditions as described in (2) above.

### Recreation and Sports

In this situation, out-vac leisure activities such as rock collecting, hiking, road rallies, camping out under the stars, and prospecting for the fun of it, would have to be exercised with caution and sparingly. We won't become "Lunans" until we are "at home" on the Moon, and that means "at home" out on the surface as well as in cozy urban burrows. Even so, the availability of a mobile shelter when not actually engaging in the out-vac surface activity in question would make for good policy.

As to sports, the out-vac provides not only one-sixth gravity, but also vacuum, and pioneers will invent interesting and fun sports for such conditions. But here too, there is a way out: pioneers could build a shielded but unpressurized stadium in which low-gravity vacuum sports could be played.



Cross-section of a shielded but unpressurized sports arena

**A lesson some have not learned**

At the 2010 International Space Development Conference held in Chicago last May, a speaker confident of what he was saying, crossed off Moon and Mars as future settlement territory on the grounds of surface radiation exposure unless we wanted to live underground full-time. Nonsense. If there is one thing the history of the human Diaspora beyond Africa, and even within it, has amply demonstrated, it is that a resourceful, ingenious, and determined people can learn to make themselves "at home" and comfortably so, in the most seemingly inhospitable environments. Settlers on Moon and Mars will defy the warnings of such persons, even as have the Eskimo and Inuit of our Arctic regions. "Where there is a will, there's a way. And we will find ways to survive in environments much more unforgiving and hostile than Moon and Mars.

On frontier after frontier, we have been faced with new climate conditions, new geological and mineral resources, new plant and animal species. Where old tools did not work, or work well, we forged new ones that did. True, some frontiers would not support large populations. But everywhere, people have learned to live happy and productive and fulfilling lives.

Radiation will be a problem for those living and working on the Moon or Mars only until we have learned to deal with it "as if by second nature." Sure Arctic and Antarctic temperatures can kill! But who would go outdoors in those places without adequate clothing and protection!

Lunan pioneers will soon learn what they can and can't do in their challenging environments. More, they will continue to find new ways to push "this envelope" ever further and further, to the point few would see surface radiation as a game-stopper. Doing the right think, the safe thing, will have become second nature. The pioneers will have become Lunans. And the same transition will occur on Mars and other even more challenging locations.

Take anyone "as they are" off the streets of Mumbai or Cairo and set them down in Antarctica, and we have a problem. But someone from Edmonton or Irkutsk might fare better.

Unlike specialized animal species, humans cannot be defined by their habitat. We are adaptable, and neither the Moon nor Mars defines the limits of that adaptability.

To coin a word, we are a prokalo-trophic species: ***we feed on challenges.*** And those who warn us that we "can't" do this or can't do that, do us all a favor, by spurring us on to prove them quite wrong. And in that sense, science-fiction stories, which can get pretty wild, do us a service. They make us, even if only some of us, confident and determined to spread the human ecumene – the human ecosphere – beyond the four corners of Earth, beyond the seven continents and the seven seas, to wherever our ingenious heavenly chariots will take us.

And the Moon, as a human world, will become more interesting and nourishing a life-environment because we have radiation-protection as a challenge. The more formidable the challenge, the sweeter the victory.

So thanks for the warning. "Bring it on!" **PK**

# Learning from Failures: The History of NASA

By Peter Kokh

We can sense the discouragement in India after the second failure in a row for the GSLV rocket, the Geosynchronous Satellite Launch Vehicle. Yes, failure means delay, delay while investigations pin down the problem or problems and more delays while ways to deal with the problem are identified, engineered, and tested.

In the end, the delay will prove to have been not only necessary but also helpful. Fifty-some years of NASA, the US National Aeronautics and Space Administration, have been marked with equally discouraging delays. But every time the result has been improvement and triumphs.

We are a species that learns from our mistakes – that is what makes us humans great. But when unwanted things happen, often with terrible timing, It is hard to see ahead with confidence, until – until it has happened so many times only to lead to brilliant recovery, that we come to know "the drill." With each recovery from failure, we become ever more confidant that we can overcome anything and survive anything.

As counter-intuitive as it may seem, "failures are the stuff out of which success is forged." Here are some of many "failures" in NASA's continuing saga.

**Vanguard –** (source Wikipedia)

"In 1955, the USA announced plans to put a scientific satellite in orbit for the International Geophysical Year (IGY) in 1957-1958. The goal was to track the satellite as it performed experiments."

Three available military rockets were considered, and rejected.

"Vanguard was a project of the Naval Research Laboratory (NRL), which was regarded more as a scientific than a military organization. This helped to emphasize the non-military goals of the satellite program. This was considered important, because a discussion of whether overflights of foreign countries by satellites were legal or illegal was to be avoided."

The Martin Company, now part of Lockheed-Martin was the contractor. By the time Vanguard was ready, the Soviet Union had already stunned the world with Sputnik on October 4, 1957. The rush to be a "close second" was on.

"On 6 December the US Navy launched a Vanguard rocket carrying a 1.3 kg (2.9 lbs) satellite from Cape Canaveral. It only reached an altitude of 1.2 meters (4 ft), fell and exploded. The satellite was thrown clear, bleeping pathetically as it rolled away. The American press called it *Kaputnik*." And the American public felt enormous humiliation. We had won World War II but couldn't win this peaceful race.

The US Army finally put up Explorer 1 using one of its Redstone military rockets. When John F, Kennedy announced we were going to the Moon, the Army's Von Braun was in charge.

**Apollo 1** – The drive to the Moon began with the Mercury and Gemini programs, one-man and two-man vehicles respectively. No catastrophes, but one embarrassing mishap when Gus Grissom had to abandon his sinking vehicle after it landed in the Pacific.

On to Apollo, the 3-man capsule that would take the first crew to the Moon and bring them safely back. On January 27, 1967, the first of the series, Apollo 1, was ready to test. The crew climbed aboard and shut the hatch. For some reason there was a spark, and in Apollo 1's pure oxygen mixture, every-thing combustible, including the three hapless astronauts, were incinerated. (Wikipedia: "the astronauts' deaths were attributed to a wide range of lethal design and construction flaws.") The nation was devastated.

**Apollo 13 – the tragedy that refused to happen**

The Story of Apollo 13 is known and heralded worldwide as an example of refusal to accept an unhappy ending. There have been many books and a great film about this episode, perhaps the most encouraging and heroic "failure' in American history. Apollo 13 was to be the third mission to land on the Moon. But an explosion in the Service Module left the crew safe for the moment, but unable to land on the Moon and unlikely to survive the trip back to Earth. If you are unfamiliar with the story, you owe it to yourself to read up, or watch the film, not because it shows American can-do attitudes at their best, but because it shows humanity's can-do attitude at its best.

**Challenger – the first Space Shuttle launch failure**

Like many of us in the U.S., I was watching the launch from Cape Kennedy live that day, January 28, 1986. I knew the instant I saw the first irregularity in the contrail just 72 seconds into the flight, that something was horribly wrong, Then the "poof." The announcement more than a minute later was unnecessary. We all knew. And a brave crew was dead, every last one of them. Within an hour, 86% of Americans knew about what had happened. The news spread just as it had when Kennedy had been assassinated (and when Gandhi was assassinated. I recall that day also.) But we made them heroes. It's the human way.

It was an avoidable failure, and people who put schedule ahead of safety were to blame. Alas, that too is a human characteristic along with greed.

It would be more than 32 month's before another shuttle lifted off the pad, but not the last Shuttle tragedy.

**Columbia – a "Rube Goldberg" shuttle thermal tile system that begged to fail**

I will be soundly criticized for that remark but I stand by it. From the moment I learned of how the proposed shuttle would be protected from the heat of reentry into Earth's atmosphere, I sensed that the system's insane complexity could spell catastrophe. But that is not the lesson.

When Columbia's reentry trail split into a number of trails, most of us did not have to be told that something had gone terribly wrong and that the craft had disintegrated. It was impossible that the crew could have survived. Well, we learned form this too. Not that the tile system was too complex. No one wanted to admit that. But we learned that we had to check the tiles before attempting re-entry. If something were wrong that we could not fix in space, another shuttle would be sent to pick up the crew. And if that shuttle's tile system was at the point of failure too?

The Space Shuttle as originally conceived was a great idea. But we have a saying in English, "too many cooks spoil the broth. The Shuttle was built so that the Air Force could use it too, if need be. So it ended up being "designed by committee" – just begging for problems. And this was an example of political interference. Sometimes it is tempting to feel that "nothing intelligent can come out of the political process" because that process involves compromises that have nothing to do with intelligent design.

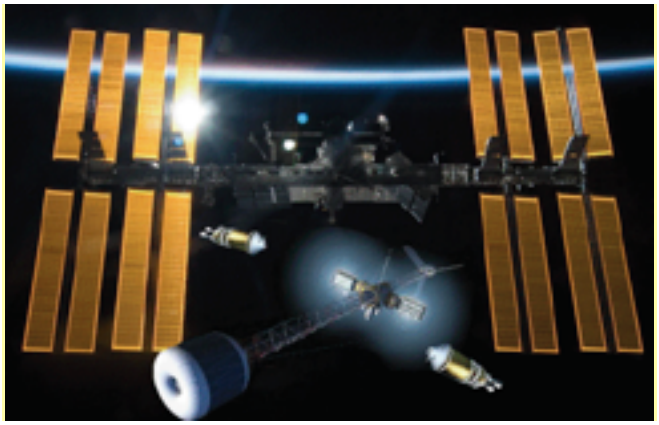
So that may be a lesson too, but unfortunately, one that is unlikely to be learned, either in the US or anywhere else. For not only are we pioneers and masters of adversity, we are political too. And that allows temperament to select what is rational and what is not.

It is the political process that has the US space program in an unsettled mode right now. But as humans, we will overcome and go on. And hopefully in concert with others around the globe. Space is the frontier for humanity as a whole. And adversities and setbacks and conflicting purposes of individuals and groups cannot keep us from exploring and eventually mastering the possibilities.

We trust that India will follow, and that every setback will make her even more determined "to have the last word." As long as for every step backward, we take two forward, we will get there! And every fresh success will dull the pain of past failures.

Recovering from reversals is what we humans do! **PK**

# Earth Station: Global ISS Marketing - The Future of Human Spaceflight



M3IQ co-editor **Madhu Thangavelu** conducts the ASTE 527 graduate Space Exploration Architectures Concept Synthesis Studio in the Astronautical Engineering Department within the Viterbi School of Engineering at the University of Southern California. The most recent session concluded with final presentations on December 14th, 2010.

**Introduction: ASTE-527 Course Description:** ASTE-527 provides students with programmatic/conceptual design synthesis/choice creation methods for complex space missions. It is designed to give Aerospace System engineering/Architecture tools to the students so they can create innovative projects. The Student Projects are evaluated by faculty, industry, and NASA experts. Twelve students submitted abstracts. The following two abstracts have been selected by MMM-India Quarterly Editor Peter Kokh for inclusion in this issue of the Quarterly.

## ISS Co-orbiting SBSP Hotels

**By Pez Zarifian** pezhman.zarifian@gmail.com

The idea of using solar energy to produce power for use on Earth is a well known concept which is being utilized by many these days. Despite their lower efficiency, solar arrays provide a relatively simple and cost-effective way of producing clean energy here on Earth. However, the Earth's atmosphere, rain and snow as well as the lack of sunlight during night hours are additional limitations for harvesting the enormous energy produced by our Sun. The idea of utilizing solar cells placed in LEO for a more eficient production of power in outer space has been around for many years. Feasibility studies have proven that large fields of solar panels in space could produce substantial amounts of energy which could then be safely beamed down to Earth using current technologies.

Space Based Solar Power (**SBSP**) has been studied by NASA, DOD as well as other government organizations all over the world for many years and numerous technology demonstrations have been conducted on Earth to prove the viability of this concept .Many believe SBSP to be the only realistic way to sustain the anticipated growing demand for clean energy in the upcoming years, yet due to economical constraints no SBSP testbeds have yet been placed into orbit to demonstrate the true potential of this concept.

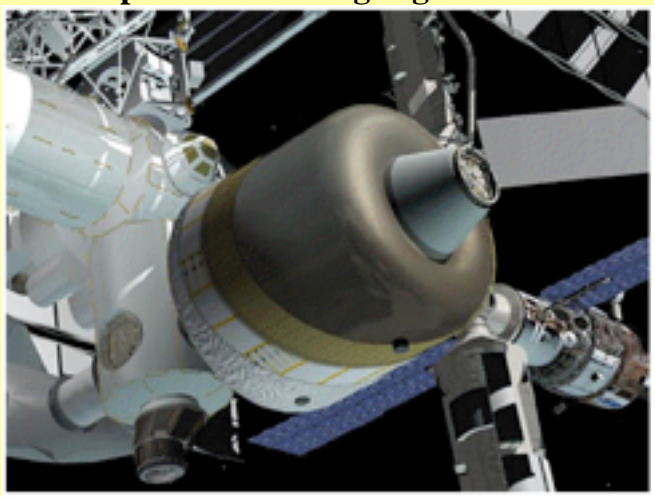
ISS Co-orbiting SBSP Hotels are facilities which are meant to utilize Bigelow Aerospaces Sundancer modules as hotel rooms for the customers of the up-and-coming space tourism industry while utilizing the revenue of this business to demonstrate the viability of the SBSP technology. Solar panels are transported to the stations using autonomous cargos and used in constructing larger panel segments which will then in turn be sent to GEO via a Centaur upper stage rocket one-by-one and docked together to construct a larger field of solar panels. Future space tourists can enjoy their stay in spacious modules with views of Earth on one side and the construction of the arrays via the robotic arm on the other while contributing to this green and Earth-friendly e˚ort which allows further research and technology demonstrations with the end result of producing clean energy for the generations to come. **PZ**

**Editor's Comments:**

- It is perhaps **more advantageous to place Solar Power Satellites in Geosynchronous Earth Orbit** [GEO] far above the level at which ISS operates, and in an equatorial plane, rather thatn the highly inclined (51°) orbit in which the International Space Station operates.
- Stations designed as **assembly points and depots** for spacecraft bound to the Moon or elsewhere beyond Earth are best placed in Low Earth Orbits, like that of the Space Station, but **in an equatorial plane** (not like ISS.)
- However**, for scenic purposes**, tourist hotels would best be placed in **orbits similar to that of the Space Station** so tourists get to see all of Earth between say 60° North and 60° South, covering all of the inhabited southern hemis-phere and most of the inhabited northern hemisphere.
- However, **ISS orbit is not stable** as there are still traces of atmosphere at that level, causing the orbit to slowly decay. That is why the Russia Progress freighters always

arrive with extra fuel, so that they can give the station an upwards boost as they depart. For co-orbiting stations of any type to continue to coorbit, they would have to be **separately boosted in concert**, at the some "delta V." Otherwise they will drift away from one another.

## ISS Expansion Utilizing Bigelow Modules



By Krystal Puga krystalvp@gmail.com

The ISS should be used as a global first step towards follow-on space endeavors such as, module design improvements, space tourism, co-orbiting stations, moon vacations, etc.

The current features and resources of the ISS need to be utilized to the fullest extent possible to maximize the international investments already made, and global investments being actively sought.

This concept will explore the evolution and continued use of the International Space Station utilizing several Bigelow Sundancer Modules. The primary goal is to demonstrate that the ISS can be used as a testbed enabler to assess and improve the interior design and configuration of the Bigelow Modules (BMs) for space tourism.

As a secondary goal, another BM will be berthed to the ISS and used as a commercialized Earth Observation and Space HW testing laboratory. Thus this proposal seeks to show two clear parts: an ISS national Lab segment and an ISS commercial testbed segment.

The testbed expansion of the ISS will involve two separate segments attached to existing Nodes with the new LIDS docking system already in production. The first module will replace the proposed and later cancelled Habitation Module (HAB) and ISS TransHab programs. The Crew Habitation Test Module will provide the necessary sleeping cabins for crew members but will abandon the congested, rack-size Crew Quarters (CQ) concept in favor of a configuration that can later be applied to space hotel designs.

The second segment will be the Earth Observation and Space HW Testing Laboratory. This nadir pointing BM will be modified to include several Cupolas to serve as viewports for Earth sensing instruments. These viewports will be available for leasing to the commercial, scientific and educational communities. External platforms will also be available to space qualify S/C hardware.

BMs have been selected for the ISS expansion because they o˚er the highest useable volume, have demonstrated two successful flights, are moderately priced and the Sundancer version will be available for launch and testing in the 2014/2015 timeframe. BMs holds promise to relieve congestion on the ISS as the facility gears up for more occupants and diverse commercial activity in the next decade. **KP**

All the submitted abstracts can be found at:

http://docs.google.com/viewer?a=v&pid=explorer&chrome=true&srcid=0B50RwU5oIdDENT+NiNzc1OTQtZDM0My00YjY4LThiNWEtZWRjNWMxYmI2YzI3&hl=en&authkey=CJCPu0M&pli=1

**Editor's Notee: TrasHab** was developed to fit the need for as large a size Mars Habitat module as could be shipped by rockets currently operating. TransHab developer William Schneider in an interview The Space Review 08.21.2006:

http://www.thespacereview.com/article/686/1

"The original purpose of the TransHab design was for a Mars mission. The habitat for the Mars mission was required to be 600 cubic meters. For an aluminum shell structure—the type that had been conceived—to be that large while being launched (enduring high launch acceleration loads plus high launch vibrations) required a thick wall and heavy wall stiffening. Because of the large surface area the entire habitat became prohibitively heavy. An inflatable, however, could be launched in the collapsed configuration, *strapped tightly around a central core so that it could easily withstand the harsh launch environment;* once in orbit, where the acceleration and vibration loads are zero, it would be inflated to the required volume."

Several people proposed that the ideal place to test a TransHab's systems and general space-worthiness would be as a new module attached to the Space Station. Now more than a decade earlier, Bigelow Aerospace, having licensed the prototype TransHab technology from NASA, and having tested two protytpes in orbit, and looking for customers, the idea of using Bigelow modules to further expand ISS capacity at a much lower cost, is receiving fresh attention. So this abstract by Ms. Puga is quite timely.

Of course, these inflatable modules wll also be combined in separate space station and tourist center complexes, each in its own orbit. And now that a number of viable commercial human-rated transport capsules and space planes are nearing flight-readiness, such developments have begun to appear inevitable. We should see steadily declining launch and operational costs, as well as the opening of near-Earth space to commercial activities.

Space will no longer be the privileged domain of a few national space agencies. The real Space Frontier will have opened its doors a crack! But there could be a fly in the ointment if we do not soon get a grip on the problem of space debris, which could create an impenetrable barrier around the Earth preventing manned space passage. **PK**

## Upcoming Conferences & Events

http://www.spacecalendar.com/downrange/

**INDIA**

**Feb — ISRO, Launch PSLV / Resourcesat-2, Youthsat, X-sat,** *Sriharikota, India:* ISRO to launch Resourcesat-2 to provide replacement and data continuity for Resourcesat-1, the Youthsat micro-satellite and 1st local made X-sat from Singapore.

**May 20 — Committee on Space Research, Indian Space Research Organization,** *Online:* Deadline for Main Scientific Organizers to upload event descriptions for Call for Papers for the '39th Scientific Assembly of Committee on Space Research (COSPAR)

**Aug 19 — Committee on Space Research, Indian Space Research Organization,** *Online:* Webpage open for abstract submission for the '39th Scientific Assembly of Committee on Space Research (COSPAR)

**ELSEWHERE** – a selection by the editor

**Feb 10 ESA,** *Moscow, Russia:* Mars500 mission 'arrival' on Mars to begin surface operations.

**Feb 15-17 - International Space University,** *Strasbourg, France:* '15th ISU Annual Intern'l Symposium: International Space Station: Maximizing the Return from Extended Operations.'

**Mar 7-11 Lunar and Planetary Institute,** *The Woodlands TX*: 'The 42nd Lunar and Planetary Science Conference.'

**Mar 14-16 — The SETI Institute, Ames Research Center,** *Moffett Field CA:* '2nd International Conference on Phobos and Deimos

**Apr 6-7 — Explore Mars Inc,** *Washington DC*: 'The International Space Station and Mars

**Apr 11-14 — University of Hawaii, National Science Foundation,** *Poipu Koloa Kaua`i HI*: '5th Workshop on Titan Chemistry: Observations, Experiments, Computations and Modeling.'

**Apr 11-14 American Inst. Aeronautics & Astronautics,** *San Francisco CA*: '17th AIAA International Space Planes and Hypersonic Systems and Technologies Conf.

**Apr 28-30 Space Tourism Society,** *Los Angeles CA*: 'Space Tourism Symposium 2011

**May 10-13 International Academy of Astronautics,** *Bucharest, Romania*: '2nd IAA Planetary Defense Conf'

**May 18-22 International Space Development Conf,** *Huntsville, AB,, US:* – National Space Soc., Moon Soc

**May 30-Jun 1 — International Academy of Astronautics,** *Arcachon, France*: '2nd Symposium On Private Human Access to Space.'

**Jun 13-15 — Lunar and Planetary Institute,** *Houston TX*: 'A Wet Vs. Dry Moon: Exploring Volatile Reservoirs for the Evolution of the Moon and Future Exploration.'

**June 19-22 - Planetary & Terrestrial Mining Sciences Symposium/Space Resource Roundtable,** Ottawa, Ontario, Canada

**July 28-31 – New Space Conference**, Mountain View, CA

**Jun 27-30 — International Academy of Astronautics,** *St. Petersburg, Russia*: '3rd IAA Symposium on Searching for Life Signatures.'

## Moon Miners' Manifesto Resources

http://www.MoonMinersManifesto.com

MMM is published 10 times a year (except January and July. The December 2010 issue will begin its 25th 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 2010, the first twenty-one years of MMM, 200 issues, are 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 Clasics, 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 of MMM-India Quarterly**

## Student Space Organizations in India

### The Planetary Society of Youth (TPSY)

**http://www.youthplanetary.org/**

**Shri: R.V.Burli, President**
The Planetary Society of Youth
Opp. VRL Office - Bagalkot - 587101
Karnataka - India
Tele: (R) +91-8354-222725
(M) +91-9343110567
**E-mail:** president@youthplanetary.org

**Mr. Amrut Yalagi, Secretary**
The Planetary Society of Youth
21st, Main Road, VIjay Nagar, Near Engg.College
Bagalkot - 587 102, Karnataka - India
Tele: (R) +91-8354-233911
(M) +91- 9880071339
**E-mail:** amrut@youthplanetary.org
amrut1243@gmail.com

### Astronautical Soc. of India Student Chapter (ASISC) http://www.indianspace.in/

175 Bussy St, Pondicherry 605 001 175, India.
Phone: +91 0413 3246999,
email: mail@indianspace.in

Fax: +91 0413 3000222.
Head Office: ISRO Satellite centre, Airport Road,
Vimanapura, Bangalore - 560 017. India.
Phone: +91 080 25205257. Fax: +91 080 25082122.

### SEDS-India - http://india.seds.org/

(**S**tudents for the **E**xploration & **D**evelopment of **S**pace)
**National Headquarter - SEDS VIT,**
C/O , Dr. Geetha Manivasagam,
Room No. 403 , CDMM Building ,
VIT University,
VELLORE-632014, Tamil Nadu
Phone No. : +91-9952281231
Anmol Sharma (Director, Chapter Affairs)
**President:** Sabyasachi Bhowmick
bhowmick.sabyasachi89@gmail.com

**SEDS-India Chapters:**
http://india.seds.org/CHAPTERS.HTML
SEDS VIT (Vellore) (473 members)
SEDS Veltech (Chennai) (419 members)
SEDS Savitha (Chennai)
SEDS NITW (Warangal) (100 members)
SEDS GGITM (Bhopal) (89 members)
SEDS KCT (Coimbatore) (27 members)
SEDS ISM (Dhanbad)
SEDS NIT Trichy (Trichy) (17 members)
SEDS NIT (Nehru Institute of Tech, Coimbatore)
*See map on last page of this issue*

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

## Help Wanted !

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

If this publication is going to help spread the word about Space in India, among the public at large, and especially among the students and younger generation, 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

This publication is intended for wide public distribution to encourage support for space research and exploration and development.

It is not intended to be 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.** 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**

## MMM-India Quarterly #9 – Jan-Mar 2011 Index - Table of Contents



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

and you would like to add your email address to 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.

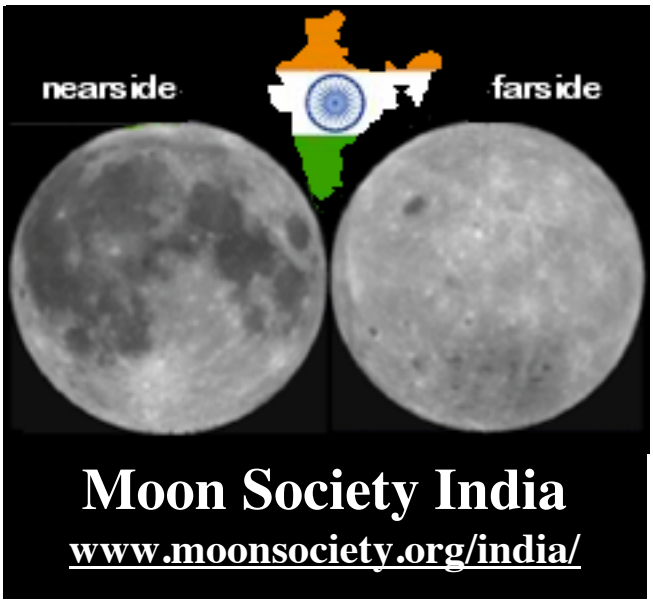
Apollo left no occupiable structure on the Moon. There is no 'friendly' place to return to, no place where we can go and pick up where we left off. We have to start over, from scratch, this time with a plan!

- Simon Cook

From now on, we live in a world where men have walked on the Moon. And it wasn't a miracle! We just decided we wanted to go.

Jim Lovell, in "Apollo 13"


**Key:** ISRO Centres; Moon Society; SEDS; NSS




Engage! And Enjoy!