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

Moon Miners' Manifesto

India Quarterly Edition

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

Clear pre-sunset sunny skies over India as seen from Space.

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

Time for a change! - In this issue we introduce a new format

There are two stories behind this change. **First**, the Moon Society (International) has decided to make some of its publications available on Amazon.com's electronic reader tablet, Kindle™ . We will start with the Moon Miners' Manifesto Classics issues - http://www.moonsociety.org/publications/mmm_classics/ - which gather all the "non-time-sensitive" articles from the past twenty-plus years in volumes for each publication year (currently 25), The "catch" is that Kindle requires us to submit them in "one-column format." So we have decided that it would be good to start formatting future issues of MMM and M3IQ in such a format. Even though Kindle is not widely available in India, we thought it a good idea to start formatting future M3IQ issues in Kindle™ -compatible format as well. **Second**, the Editor's Macbook laptop was stolen, and the replacement Macbook Pro would not run the software we had been using (MS Office for Mac) so we have done this issue in I-Works "Pages" word processor. We are learning! Comments on this issue welcome! - mmm-india@moonsociety.org (to all M3Q ecitors).

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

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

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

Moon Society Strategy -We seek to address these goals through education, outreach to people of all ages, through contests & competitions, workshops, ground level research and technology experiments, private entrepreneurial ventures, analog research and other means. ***We collaborate with Mars-focused and other organizations*.**

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

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

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

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

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

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

Editors of MMM-India Quarterly:

Peter Kokh kokhmmm@aol.com - **David A. Dunlop** dunlop712@yahoo.com

Madhu Thangavelu thangavelu-girardey@cox.net

Pradeep Mohandas pradeep.mohandas@gmail.com - **Srivinas Laxman** moonmission.srinivas@gmail.com

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

This publication was launched with the August 2008 issue. This issue begins our 4th year. The Moon Society was founded as an International organization, but in has few members outside the United States, mostly solitary and unorganized.

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

Why an MMM - India Quarterly?

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

We want to share with space-interested and space-enthused people in India, our vision of the possibilities for Exploration and Utilization of the Moon, development of lunar resources, not just to support a permanent population on the Moon, but to help better address chronic clean energy supply problems on Earth and to help slow and reverse our home planet's environ-mental degradation in the process. In short, we would like to share our glimpse of an emerging greater Earth-Moon Economy.

This vision was well-expressed by the former President of India, Dr. A. P. J. Abdul Kalam in a speech at The Symposium on "The Future of Space Exploration: Solutions to Earthly Problems" to mark the occasion of the 50th Anniversary of the dawn of Space Age, Boston University, Boston, MA, April 12, 2007. In this speech, Dr. Kalam made the point that to fully industrialize and become an equal partner in the future of our planet, India needs to access the unlimited clean undiluted solar energy available in space. We agree with this bold vision and want to share itwith the forward-looking people of India.

Free Access: MMM-India Quarterly issues are available as a free access pdf file, downloadable from the address above We encourage readers to share these files with others freely, and to use this publication to grow and cultivate wide-spread interest in the open-ended possibilities of space among the people of India, and to encourage the rise of additional citizen support space organizations within the country.

Indian Space News

An Indian Space Station?

Conference on Space Transportation Systems: Opportunities and Challenges http://indianspacestation.com/

Dec 16-18, 2011 - Looking at India's future needs in its accelerating Space Program, and the need for "new technologies for safe, cost-effective on-demand access to space" brings up many options for discussion on a common platform to consider strategic areas and directions for future space programs. "This, in turn, can ignite the imagination and instill a spirit of inquisitiveness and adventurism in the youth on cutting edge technologies" and "creative ideas on the advanced trends in Space Transportation." ◘

Chandrayan-2 may not launch until 2016

http://www.thehindu.com/news/international/article2854134.ece

According to Academician Lev Zelyony, head of the Russian Space Research Institute, "The dates may have to be moved, as the technical solutions that were used with NPO Lavochkin's Phobos-Grunt were also to be used in the lunar projects and these solutions clearly need to be reviewed." The Phobos-Grunt spacecraft, launched in November to retrieve soil samples from the Martian moon Phobos, became stuck in Earth's orbit after its engines failed to fire, and crashed back to Earth last month.

This review will not affect scientific instruments of Luna-Resource and Luna-Glob, but only their control systems and the spacecraft. While the Luna-Resource lander is to travel to the Moon aboard the Chandrayaan-2 spacecraft and put an Indian rover on the lunar surface, the identical Luna-Globe will be an entirely Russian mission, which is to carry a boring system for taking Moon rock samples.

ISRO continues to be optimistic, however, about the prospects for a launch in 2014. Unlike missions to Mars which can only be launched in narrow windows 25 plus months apart, missions to the Moon can be launched at almost any time, though for lunar landers ideal surface lighting conditions occur 29.5 days apart. ◘

India's 2011 Space Achievements

http://economictimes.indiatimes.com/news/news-by-industry/et-cetera/how-indias-space-missions-fared-in-year-2011/articleshow/11252856.cms

CHENNAI: Some of this past years space highlights include

- Launching of nine satellite - eight satellites on the Polar Satellite Launch Vehicle (PSLV) and one communication satellite GSAT-8 on Ariane 5 at Kourou, French Guiana.
- Formulation of a policy for managing remote sensing data
- Commissioning of the country's fastest supercomputer - I
- Launch of Indo-French satellite Megha Tropiques to study the tropical weather system made India only the second nation in the world to launch such a space mission.
- India's most successful rocket, the PSLV, exceeded a half century of satellite launches when it slung four satellites into orbit in October. The PSLV rocket has now launched successfully 52 satellites out of 53 it carried - majorly remote sensing/earth observation satellites both Indian and foreign - and has been a major revenue earner for ISRO.
- ISRO decided on a detailed relook of its heavier rocket Geosynchronous Satellite Launch Vehicle (GSLV) to carry communication satellites. This followed the loss of two rockets and the satellites in 2010.
- In order to augment the transponder capacity of Indian National Satellite (Insat) system, ISRO launched two communication satellites in 2011 - GSAT-8 and GSAT-12 boosting ISRO-owned transponder capacity went up to 187, while it has leased 86 transponders. It is estimated there is an unmet demand for 170 transponders.
- to increase the frequency of satellite launches and to cash in on the international market for launching remote sensing satellites, ISRO bdgan planning another space port while beefing up the facilities at the existing launch site in Sriharikota. A feasibility study on building second space port like the one in Sriharikota will be made during the 12th (Five Year) Plan (2012-17) period. The study will look at the need, economics, safety and other aspects," ISRO chairman K. Radhakrishnan said.

- The year also saw the formulation of a Remote Sensing Data Policy governing the modalities for managing, permitting acquisition/dissemination of data generated by remote sensing or earth observatory satellites.
- In May, ISRO commissioned at Rs.14 crore India's 2nd and fastest supercomputer at Vikram Sarabhai Space Centre (VSSC) in Thiruvananthapuram, Kerala. for solving complex problems and studying computational fluid dynamics of ISRO rockets.
- The first batch of graduates from ISRO's Indian Institute of Space Science and Technology inducted into service.
- Students of Indian Institute of Technology-Kanpur (IIT-K), Anna University of Chennai and SRM University won the US space agency NASA's student competition in the foreign category - the Environmentally Responsible (Green) Aviation College Student Challenge.
- IIT-K and SRM University launched their small satellites-Jugnu and SRMSAT using the PSLV rocket. City-based Anna University is the first Indian university to have fabricated a satellite - Anusat - in 2009. ◘

An Indian Mission to Mars?

Indian Scientists Propose 10 Experiments for 2013 Mission To Mars

By Srinivas Laxman - January 9, 2012

Ahmedabad: Unknown to many a silent space race is on, but of a different type; not the usual one between the US and Russia, or among the Asian space powers.This race is taking place in India within the corridors of the Indian space establishments, particularly at the prestigious Ahmedabad-based Physical Research Laboratory (PRL), an affiliate of Isro, where the Indian space programme, which will be celebrating its 50th year in November 2013, had its early lift off.

The race is between two groups of Indian space scientists, with one section lobbying for the Moon and the other for Mars. The Mars group believes that an Indian mission to the Red Planet must now get precedence over the country's second lunar mission, Chandrayaan-2, tentatively slated for launch in 2013, since India has already launched a successful flight to the Moon.

But, the moon group counters this saying that since preparations for Chandrayaan-2 were now at an advanced level, there should be no change in its launch schedule. This correspondent during a recent visit to PRL saw two instruments of the seven being developed. As this debate goes on an Indian mission to Mars is steadily taking shape with space scientists proposing 10 experiments, mostly related to the study of the Red Planet's atmosphere. Interestingly, they have suggested these experiments even prior to Isro giving its formal green signal for the project.

The fact that this challenging mission is no more a dream is clearly evident in a report of a conference on "Planetary Sciences and Exploration," which had been organised by PRL's Planex (Planetary Exploration) group between December 12 and 14, 2011. It shows that scientists from various Isro centres and the PRL are extremely enthusiastic about the flight to the Red Planet since it has a lot of science to offer.

As precursor to the mission, a "Mars Mission Study Team," has already been formed to prepare the science and mission scenarios for Isro. In addition, a brainstorming session on Mars science and exploration was held at the PRL on March 24 and 25, 2011, as a preparatory step for Isro's Mars exploration plans. This two-day session served as an initial platform for scientists and students to fuel up their ideas, proposals and plans for an Indian Mars mission. Scientists said that PRL will be organising more Mars-related brainstorming sessions in the days ahead.

The December conference report states that the 10 Indian Martian experiments suggested are:

***Probe For Infrared Spectroscopy** for Mars (Prism) which will study certain aspects of the Martian atmosphere and "spatial and seasonal variations of these gases over the lifetime of the mission"

* **Mars Exospheric Neutral Composition Analyser** (Menca) which will analyse the Martian upper atmosphere-exosphere region above 400 km from the surface.

* Another instrument (**Tis**) will measure the thermal emissions from Mars' surface of the Red. Its primary science goals include mapping the surface composition and mineralogy of Mars and understanding the dynamics of the Martian atmosphere by monitoring carbon dioxide.

* **Using radio signals to study the atmosphere.**

* **Mars Colour Camera (MCC)** which can image from a highly elliptical orbit of 500 km X 80,000 km. It will be designed as a multipurpose instrument which can image the topography of Mars' surface and map the polar caps. "It is expected to observe and help in furthering our understanding of events like dust storms and dust devils. From an elliptical orbit around Mars, the camera will return high quality visual images of Mars, its moons, asteroids and other celestial bodies from close quarters."

***A Methane Sensor For Mars (MSM)** has been recommended for detecting methane in the Martian atmosphere.

***A Mars Radiation Spectrometer (Maris)** will measure and characterise the charged particle back ground during the cruise and orbit phase of the spacecraft. This instrument will play an important role for a possible future human mission to Mars as it will determine the radiation dose en route.

***A Plasma and Current Experiment** (Pace) that will assess what is known as "atmospheric escape and processes of the Martian atmosphere and the structure of the Martian tail.

***A microwave remote sensing technique** for sounding the Martian atmosphere. Scientists connected with this instrument say that it will be so designed that it will be least affected during a dust storm.

***A suite of instruments to detect plasma waves** in the Martian atmosphere.

If this much-awaited mission finally gets off the ground with the approvals of ISRO, the Space Commission ,and finally the government of India, only some of the 10 experiments and payloads will be selected. "We will focus on those experiments which have not been done before," a PRL scientist told Moon Miners' Manifesto India Quarterly (M3IQ) on condition of anonymity.

Mars fever has gripped many of our scientists at the PRL and we hope it spreads to the ISRO headquarters in Bangalore soon," said another scientist. Interestingly, an Indian chapter of the Mars Society has been formed at IIT-Mumbai.

If the Mars mission gets the much-awaited okay, the launch from Sriharikota, India's main spaceport near Chennai, could be either in the 2013, 2016 or 2018 Earth>Mars launch windows 25+ months apart, providing an energy-saving trajectory to Mars.According to the scientists, if the launch takes place in November 2013, then the Indian spacecraft will enter the orbit around Mars in September 2014. It will be an orbiting mission and not a landing one. On reaching Mars after a 10-month flight, the spacecraft will operate in a highly elliptical orbit of 500 km X 80,000 kmspicking up scientific data. **SL**

Ladakh to get world's largest (temporarily) **Solar Telescope**

http://zeenews.india.com/news/technology/ladakh-to-get-world-s-largest-solar-telescope_751030.html

January 07, 2012 - Jammu: Ladakh will host the world's largest solar telescope. The Jammu and Kashmir government will be cooperating with the union Department of Science and Technology to set up a solar telescope **at Merak on Pangong Tso Lake** in the cold Ladakh desert.

Location in Jammu and Kashmir and in India

Beautiful remote Pangong Tso Lake

http://thinkingparticle.com/articles/enchanting-pangong-lake-leh-ladakh

Google images has more views of "Pangong Tso Lake"

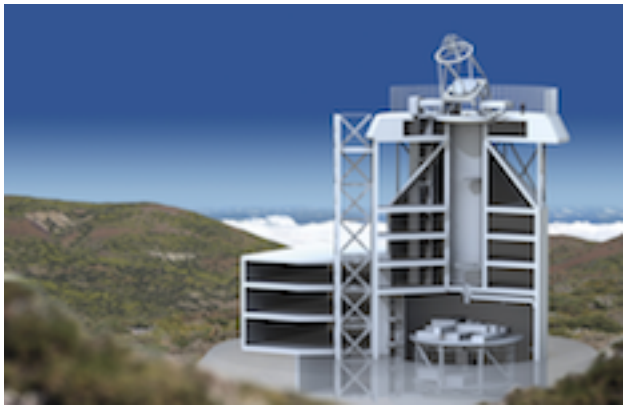
Environmental Considerations

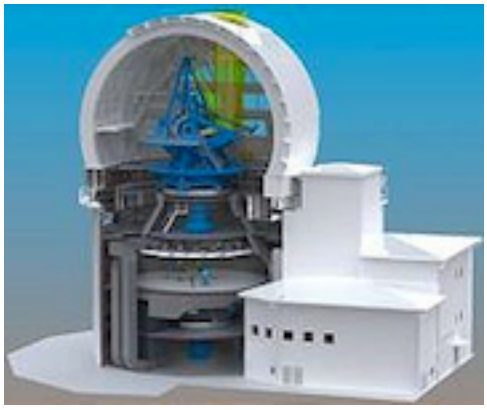
The "**National Large Solar Telescope**" (**NLST**) will need strategies that will ensure that the "construction, as well as operational phases of the project can be undertaken with minimal disturbance to the local flora and fauna". The site was selected after carefully studying various scientific and environmental aspects. It emerged from the studies that Pangong Tso Lake site at Merak is "very promising and offered longer sunshine hours." The lake is 4346 m above sea level, 134 km long and 5 km wide.

About the telescope http://mixnews.blogdetik.com/index.php/2010/09/indias-largest-solar-telescope/

Other leading and Proposed Solar Telescopes

2.0 m National Large Solar Telescope in Ladakh **L** **R 1.6 m** MacMath Solar Telescope in Arizona





4.0 m European Solar Telescope, Canary Islands **L** **R 4.24 m** COronal Solar Magnetism Observatory**.** Maui Island, Hawaii

Technological progress does not rest! http://en.wikipedia.org/wiki/List_of_solar_telescopes

Nonetheless, all these new solar telescopes will see full time use. As our world becomes ever more electronically integrated, and as we consider human missions to Mars and the asteroids that will take many months, knowledge of the Sun's more active periods and the capability to forecast accurately its occasional "temper tantrums" (solar flares and coronal mass ejections) will be essential.

Not all research focused on the Sun is being done from Earth. NASA and other space agencies are focusing on the Solar System's parent star from various probes now in space or planned for future launch.

Solar missions and Probes:

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

NASA "Stereo" Mission

http://stereo.gsfc.nasa.gov/ - http://www.nasa.gov/mission_pages/stereo/main/index.html

http://www.nasa.gov/mission_pages/stereo/news/five-years.html

NASA - http://solarprobe.gsfc.nasa.gov/solarprobe_mission.htm

NASA - http://solarprobe.jhuapl.edu/

NASA - http://www.smartplanet.com/blog/pure-genius/solar-probe-first-mission-to-sun-scheduled-for-2018/5748

ESA/NASA - http://www.esa.int/esaSC/120373_index_0_m.html

ESA - http://en.wikipedia.org/wiki/Solar_and_Heliospheric_Observatory ◘

Elsewhere in Asia

Chinese National Space Agency

Italy might build Modules for China's Space Station

http://www.parabolicarc.com/2011/11/23/will-italy-build-modules-for-future-chinese-space-stations/

Report with commentary

On November 23, 2011 China signed a deal with Italy that could see the Italians helping to build future Chinese space stations and flying their astronauts to them. It makes sense to "internationalize" China's station just as NASA's station benefited from making it a partnership effort with other nations. Such a deal could be especially attractive because it allows a way to detour around U.S, restrictive "ITAR" regulations. And that may work to bring those regulations to an overdue end. Italy is the first ESA member nation to enter such a collaboration, and has a very respectable space program of its own. Italy's experience in building modules for the International Space Station was cited as the factor behind China's invitation.

The three **Shuttle** **MPLM** cargo containers ***Leonardo, Raffaello*** and ***Donatello***, were built for NASA in Turin, Italy by Alcatel Alenia Space, now Thales Alenia Space. They provide a key function in storing equipment and parts for transfer to ISS

A number of ISS modules have also been built in Italy. As part of ESA's contribution to the costs of the International Space Station, Alcatel Alenia Space built **Tranquility**, **Harmony** as well as **the Cupola observation deck** for NASA.

ESA's **Columbus module**, Western Europe's primary scientific lab on board the ISS, was again built in Turin based on Italy's previous experience in space station module construction. http://en.wikipedia.org/wiki/Tranquility_(ISS_module)

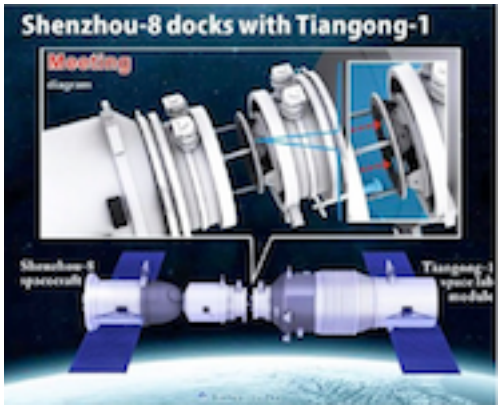
Five Italian astronauts have flown in space. As it was, the deal was comprehensive, involving science and exploration, space transportation, Earth observation, telecommunications, satellite navigation, and education (ASI press release).

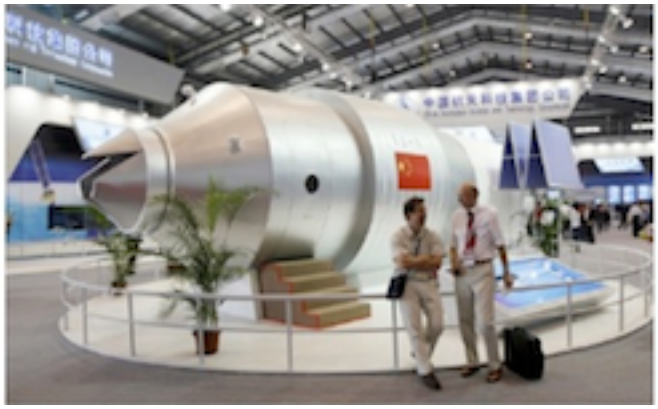
A Chinese-led international space station will earn China considerable respect. ◘

China's in-space Docking Maneuvers are Successful

http://www.khaleejtimes.com/displayarticle.asp?xfile=data/international/2011/November/international_November560.xml&section=international&col=**Shenzhou-Tiagong 2nd docking**

14 November 2011 - The first docking effort being a success, after 12 days of flying linked together with the Tiangong 1 space lab module, the unmanned Shenzhou 8 craft disengaged and then re-docked with the space lab module. That module may form part of a future space lab,. Xinhua dubbed the Shenzhou 8 mission had "a solid steppingstone for deep space exploration."





Right: Museum model shows size - no interior view are available.

"The autonomous docking know-how enables China to build space stations, resupply them, transfer astronauts and rescue them. Not needing to have crews on board when docking spacecraft was a big step toward building a space station and developing a manned space program." Without need for expensive man-hours in space, crews are freed for in-space research.

Shenzhou 8 was launched Nov. 1 and China's first space docking maneuver took place in an orbit 213 miles (343 kilometers) above Earth, The craft returned to Earth on Thursday, November 17th.

"The docking mechanism, composed of 10,000 parts, and the more than 600 instruments aboard Shenzhou 8 were all developed and made in China, China will conduct two more space docking missions next year, and plans to establish its own space lab around 2016 and a manned space station around 2020.

"China launched its own space station program after being rebuffed in its attempts to join the ISS, largely on objections from the United States. The U.S. is wary of the Chinese program's military links and the sharing of technology with its chief economic and political rival. "Tiny adjustments" could make the Chinese docking mechanism compatible with the ports of the ISS and U.S. space shuttles. "China has allowed Germany to conduct biological experiments in a docking vehicle — the first instance of international cooperation since the beginning of China's manned space program." ◘

Docking part of China's 3 Phase Program

http://www.spacedaily.com/reports/**China_celebrates_success_of_space_docking_mission**_999.html

- The 7.7-Metric Ton **Tiangong-1** ("Heavenly Palace") unmanned space station lab module had been launched from the Jiuquan Satellite Launch Center in the Gobi Desert, in Shanxi province.
- **Shenzhou 8** featured a modified Russian androgynous docking module capable of coupling with Tiangong-1 in both manual and automatic modes.

2011.12.19 - **The first phase to send the first astronaut to space and return him safely** - was fulfilled by Yang Liwei in the Shenzhou-5 mission in 2003. After two more astronauts successfully completed extravehicular activities in the Shenzhou-7 mission in 2008, China entered the **2nd phase** of its space program: **space docking.**

According the program, China will conduct two more docking tests on Tiangong-1 with Shenzhou-9 and Shenzhou-10 - hopefully with an astronaut on board – by the end of 2012. China intends to conduct its space docking tests in a cost-effective way by docking a single Tiangong-1 module with multiple spacecraft. If the first two steps succeed, China plans to develop and launch multiple space modules, with a goal of assembling a 60-tonne manned space station around 2020 in which Chinese astronauts will begin more research projects in space. ◘

Shenzhou-8: 17 China-Germany Experiments

http://en.ce.cn/National/stech/201111/03/t20111103_22812222.shtml

2011.11.03 - China's unmanned spacecraft Shenzhou-8 was loaded with an experiment device with which Chinese and German scientists were able to carry out joint life-science experiments, said Wu Ping, a spokeswoman for China's manned space program. She said that the 17 life-science experiment projects conducted via the loaded device, included ten Chinese projects, six German projects, and one jointly-developed project.

China and Germany had signed an agreement in May 2008 to make concerted efforts to conduct life-science experiments during the Shenzhou-8 space mission. It was the first time that China's manned space project carried out international cooperation in the field of space science application. Wu noted that the cooperation between the two sides was "very good."

China wishes to continue with international exchanges on the basis of mutual respect, win-win cooperation, transparency and opening-up in constructing space labs and space stations, Wu said.

The space lab module Tiangong-1 also carries several scientific experiments, including those on remote sensing, space material science and space environment. ◘

China Lunar Exploration Phase 2 Update

Chang'e 2 Update: http://en.wikipedia.org/wiki/Chang'e_2 (lunar orbit portion finished, L2 orbit portion in process)

The second Chinese unmanned lunar probe was launched on 1 October 2010 as a follow-up to the Chang'e 1 lunar orbiter, which had been launched in 2007. Chang'e 2 was part of the first phase of the Chinese Lunar Exploration Program, and conducted research from a 100-kilometer-high lunar orbit in preparation for a 2013 soft landing by the Chang'e 3 spacecraft. Chang'e 2 was similar in design to Chang'e 1, although it featured some technical improvements, including a more advanced onboard camera with a resolution of one meter.

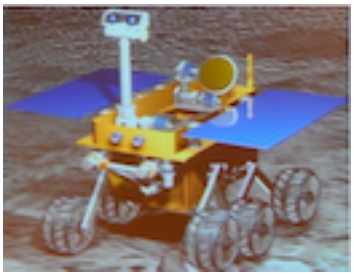
After completing its primary objective in six months, the probe left lunar orbit for the L2 Lagrangian point, 96,000 km above the center of the Moon's farside hemisphere, to test the Chinese tracking and control network. It entered orbit around L2 on 25 August 2011, and is expected to remain there until the end of 2012.

Chang'e 3 Update: http://en.wikipedia.org/wiki/Chang'e_3

Chang'e 3 is a Chinese lunar exploration mission, incorporating a robotic lander and rover. Scheduled for launch in 2013 as part of the second phase of the Chinese Lunar Exploration Program, it will be China's first lunar rover, and *the first spacecraft to make a soft landing on the Moon since the Russian Luna 24 mission in 1976*.

Some key experiments for the Chang'e-3 mission, part of the second phase of the Chinese Lunar Exploration Program, have recently been completed. These experiments include obstacle avoidance and soft landing, as well as field and laboratory

experiments on the mission's lunar rover. The Chang'e-3 mission is a critical mission as it will witness breakthroughs in key technologies used in the soft lunar landing, lunar surface exploration and experiments, deep space communications and remote control, and the sending of a launch vehicle directly into the earth-moon transfer orbit, and will mark China's first direct exploration of an extraterrestrial object. The rover mission is expected to last 3 months.



Chang'e 3 Lunar Rover (illustration) **Mass Comparison:** Chang'e 2: 2,500kg: Chang'e 3: 3,500 kg

Loss of China's Yunghuo Mars Probe

http://en.wikipedia.org/wiki/Yinghuo-1

China's Yinghuo-1 and the Russian Fobos-Grunt spacecraft were launched together aboard a Ukrainian Zenit rocket with a Fregat upper stage from Baikonur Cosmodrome, Kazakhstan, on 8 November 2011. Shortly after launch, Fobos-Grunt was expected to perform 2 burns to depart Earth orbit and begin its journey to Mars. However, these burns did not take place, stranding the two spacecraft in their parking orbit. Despite repeated efforts to contact Fobos-Grunt and rectify the problem, the spacecraft continued to lose altitude, risking deorbit if the malfunctioning engines could not be restarted. On 17 November, Chinese State media formally declared the probe lost. http://www.spacedaily.com/reports/Yinghuo_Was_Worth_It_999.html

For China, this was a double-blow to their effort to collaborate with Russia. Yunghuo-1 had been set to launch 25 months earlier along with Fobos-Grunt, but Russia had not been ready to launch the host craft, and launch windows to Mars are 25 plus months apart The failure was that of the Russian host craft and does not in any way reflect on the "hitchhiking" Chinese craft. China does not have a launch vehicle cable of flights to Mars, but this failure is now a strong incentive for CSNA to develop a launcher of its own powerful enough to accomplish such interplanetary missions. Meanwhile, Russia's record for Mars missions remains dismal, including an earlier effort to reach Phobos: http://en.wikipedia.org/wiki/Phobos_2

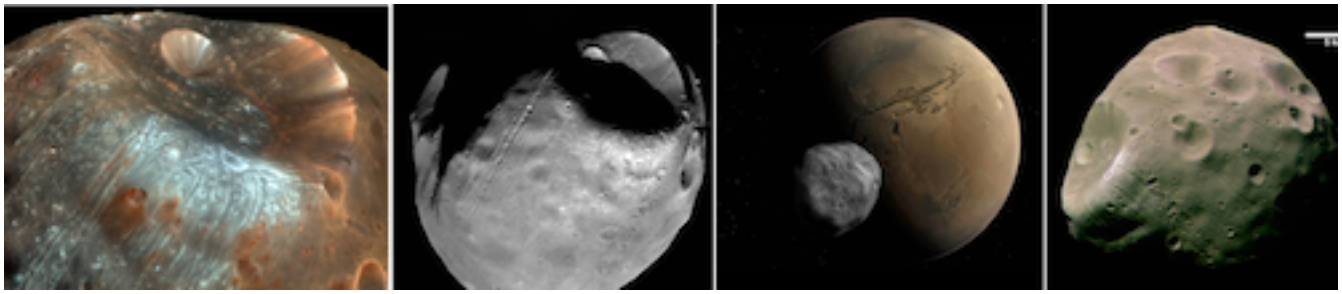
US-NASA missions to Mars have also counted some very embarrassing failures. Two thirds of all Mars missions to date (all nations) have ended in failure. There are so many ways a mission can go wrong, so many single points of failure.

Yunghuo-1, weighing only 115 kg, was a very modest craft in comparison with the significantly larger Fobos-Grunt. But China had looked for an easy way to build the prestige of its space program. Meanwhile, China's Moon missions and manned space programs are advancing steadily with success after success.

Many proposed missions to Phobos: http://en.wikipedia.org/wiki/Phobos_(moon)#Proposed_missions

Search for Phobos articles in past issues of MMM http://www.moonsociety.org/publications/mmm_themes/mmmc_Mars1.pdf

http://www.moonsociety.org/publications/mmm_themes/mmmc_Mars2.pdf **Images of Phobos below** ◘



Japan Aerospace Exploration Agency

Playing baseball all by oneself on ISS; Video

http://abcnews.go.com/GMA/video/japanese-astronaut-plays-baseball-space-15023128

Japan to build and launch Satellite for Vietnam

http://www.spacenews.com/civil/110413-japanese-space-commitment-strong.html

Oct. 31 – (Excerpts) Vietnam will buy a pair of Japanese-designed Earth observing radar satellites under a deal representing Japan's first export of a remote sensing satellite system, The satellites will be based on Japan's new **ASNARO - Advanced Satellite with New System Architecture for Observation — remote sensing platform**

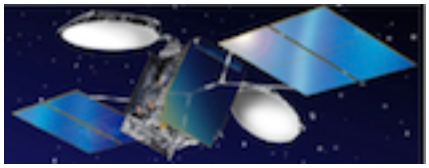
The ASNARO program will consist of multiple *500-kilogram-class satellites*, some equipped with *optical sensors capable of resolving images less than half a meter across*, while others will carry radar imagers offering slightly lower resolution. The first ASNARO satellite, an optical observation craft, is slated for launch around the end of 2012 on a Russian Dnepr rocket.

Japan will finance the satellite project through overseas development assistance loans it is providing to Vietnam as part of a broader 92.6 billion yen ($1.2 billion) package that includes the building of a major shipping port, a highway project and efforts to bolster flood-prone Vietnam's ability to respond to natural disasters.

About half of the total aid package, or 46.4 billion yen, is earmarked for the satellite project, a decade-long undertaking that will see *Japan build a ground station and train Vietnamese engineers and ground controllers*. Japan will provide an initial 7.2 B yen over the next two years to begin work on the X-band satellites, the first of which will be built in Japan and launched in 2017. *The second satellite, slated to launch in 2020, will be assembled in Vietnam*.

In addition to funding a joint effort between Vietnam and Japan to establish payload specifications for the satellites, *some of the initial money will be used to begin setting up an assembly, integration and test center in Vietnam and to start training Vietnamese technicians,* This is Japan's 1st export sale of an Earth observation satellite.

http://en.wikipedia.org/wiki/Vinasat-1 http://space.skyrocket.de/doc_sdat/vinasat-1.htm http://www.vietnamspaceagency.com/



Vietnam's first satellite – Vinesat 1 [below] April 18, 2008 ◘

Iran Monkey Launch Fails

http://news.discovery.com/space/iran-launch-monkey-rocket-fail-111012.html

In M3IQ#11, we reported that Iran was preparing to launch a Monkey into space in a Kavoshgar-5 rocket sometime during Shahrivar," an Iranian calendar month spanning Aug. 23 to Sept. 22. The plan was to launch the monkey, one of five "in training", inside a capsule with life-support for a 20-minute flight to an altitude of 120 km (75 mi.) That flight evidently "did not accomplish all its goals." The launch had not been publicized. Other countries sent monkeys into space before humans, including the US and the old Soviet Union (USSR).

On October 3, Iran indefinitely postponed plans to send another live monkey into space, without giving any reasons.

History of Monkeys and Apes in Space http://en.wikipedia.org/wiki/Monkeys_in_space "Baker" rode Jupiter IRBM in 1959.

Breaking News: February 2, 2012 http://www.space.com/14464-**iran-launches-small-satellite**-orbit.html - 50 k

Iran to Train own Astronaut Team

http://www.today.az/news/regions/99919.html

A first team of astronauts from Iran will be chosen by late this year, (In Iran, the year changes on 21st of March). The astronaut team will be compiled from fighter pilots. Iran is negotiating with several countries, which can provide our future team with necessary training. China and Russia are among them. After the team is selected, they will be sent to one of those countries for specific education and training. Russia has apparently indicated its willingness to provide the training.Iran hopes to put a man in space by 2017. ◘

Russian Space Agency

ROSCOSMOS

Failed Fobos-Grunt Mission to Phobos

It is a big disappointment to many who have been looking forward to this mission since it was first announced in 1999, with an expected launch in 2009. Roscosmos was not ready as that launch window came and went, resulting in a 25-26 month delay to the next opportunity. Two previous Russian Fobos missions Phobos 1 and 2 had successfully launched in July of 1988 but were not fully successful.

As the November 2011 launch window drew near, enthusiasm was high. "Grunt" is the Russian word for soil or dirt, and this mission was a sample-return mission which we all hoped to be more successful that Japan's Hayabusa probe which returned a few microscopic grains from asteroid Itokaya.

The probe, carrying China's Mars orbiter Yunguo-1 along for the ride, launched successfully but then went dead, silent, and unresponsive in an orbit too low to be long lived. All efforts to regain control of the craft failed. The probe reentered the atmosphere and burned up over the Pacific on January 15, 2012.

The blame game http://au.ibtimes.com/articles/265148/20111211/russian-scientist-sorry-phobos-grunt-failure-mission.htm

There could be many reasons for failure, even if the probe itself were flawless. Lev Zelenyi, director of the Space Research Institute and Chair of the Russian Academy of Sciences' Solar System Exploration Board, expressed regret for the failed mission, noting that the reason for the failure has yet to be determined.

Zelenyi mentioned Russia's space science agenda, including a plan for robotic moon missions **Luna-Glob** and **Lunar-Resource**, and a possible collaboration between Russia, ESA and NASA on the **ExoMars** and Russian **Mars-NET** missions. He saluted the assistance of ESA, NASA and U.S. military space trackers in trying to establish communication with the doomed spacecraft. http://www.redorbit.com/news/space/1112441373/russia-blames-haarp-transmitter-for-phobos-grunt-failure/

Lt. Gen. Nikolay Rodionov, a retired commander of Russia's ballistic missile early warning system, said US technology could have been the cause of the malfunction. "Powerful American radars" in Alaska "could have influenced the control systems of our interplanetary rover," referring to Alaska's High-frequency Active Auroral Research Program (HAARP) transmitter. But NASA had every reason to see this mission succeed, and no previous interference by the HARP transmitted had been reported.

See the Mosaic of photos and images of Phobos at the bottom of page 9

Launch window to Mars:

General explanation: http://en.wikipedia.org/wiki/Launch_window

For Mars: http://en.wikipedia.org/wiki/Exploration_of_Mars#Launch_windows

http://athena.cornell.edu/mars_facts/sb_launch_window.html

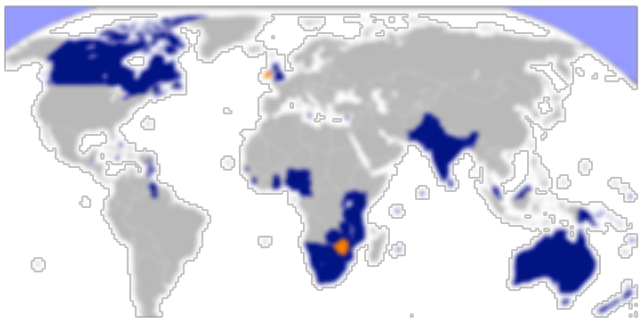
http://mydarksky.org/2011/12/04/when-to-launch-spacecrafts-to-mars/

Estimated Future +/- Launch Widow Dates:

January 14, 2014 "+/- a few days"- "safest radiation wise until 11 years later"

Early March 2016 - Mid May 2018 - early July 2020 - mid August 2022 - early October 2014, etc. ◘

Elsewhere in the Commonwealth



AUSTRALIA

Australian Satellite set for Arianespace Launch

http://www.spacenews.com/launch/111209-startup-picks-arianespace-launch-comsat.html

2011.12.09 – "Startup satellite operator NewSat of Australia announced Dec. 9 it has selected Europe's Arianespace consortium to launch NewSat's Jabiru-1 Ka-band broadband satellite, to be built by Lockheed Martin, in late 2014 for coverage over the Middle East and South Asia

"NewSat has been trying to stitch together the necessarily financial and regulatory pieces for its Jabiru-1 satellite for several years. The company announced a breakthrough in February when it said it had purchased rights to seven geostationary orbital slots from AP Kypros Satellites Ltd. of Cyprus.

"Access to orbital positions and broadcast frequencies is coordinated through the International Telecommunication Union (ITU), a Geneva-based United Nations affiliate. Reservations placed in the ITU's master register of satellite networks are generally on a first-come, first-served basis. Once a satellite network has registered with the ITU, it must build and launch its satellite within a certain period of time or risk losing its rights."

CANADA

CSA Invests in "Exploration Ideas"

Montreal 2011.10.17 The Canadian Space Agency (CSA) has awarded six contracts to four organizations to develop concept studies in areas related to future space exploration ventures. The studies are part of the CSA's strategy to invest in emerging ideas that could become Canada's next revolutionary technologies, such as:

- a **high resolution** Canadian-led **space telescope**
- **robots to remove space debris** and **tune-up ailing satellites**
- an **instrument to measure the composition of the atmosphere of planets**
- a **device that measures radiation exposure more accurately.**

The contracts are valued at C$250,000 each. The telescope, smaller than Hubble, would offer wider panoramic sharp views and could survey the deep reaches of the Universe in unprecedented detail ◘

Canada's "Rock Analyzer" on Curiosity

http://www.cbc.ca/news/technology/story/2011/11/20/f-gellert-mars-rover-curiosity-apxs-canada.html

http://sync.sympatico.ca/news/mars-bound_rock_analyzer_a_new_step_for_canada_in_space/fd8f5e67

2011.11.25 - University of Guelph professor's contribution to a NASA mission to Mars another milestone for Canadian involvement in international space research and exploration.

When NASA's car-sized **Curiosity** rover lands on Mars in mid 2012, the 17.8 million C$ APXS (alpha particle X-ray spectro-meter) is expected to play a significant role in the mission to determine if Mars has ever been able to support life.

"APXS, which was built by Richmond, B.C.-based MacDonald, Dettwiler and Associates Ltd., - **MDA** -will be used to identify chemical elements in Martian rock and soil." In exchange for this modest investment, CSA will have access to all the data sent back to Earth by the probe. MDA used "stimulus" money from the Canadian government to ensure Canadian involvement in this Mars mission, Canada's second. For the Phoenix Mars lander, which arrived on the Red Planet in 2008, Canada provided the meteorological station. ◘

UNITED KINGDOM

UK launches Space Radar Project

http://www.bbc.co.uk/news/science-environment-15899186

http://www.spacenews.com/civil/111130-britain-backs-radar-sat.html

2011.11.30 - The UK government is to kick-start an innovative project to fly radar satellites around the Earth, with an initial investment of £21m. The £200m investment boost for science to be be matched by industry.

Radar spacecraft can see the planet's surface in all weathers, day and night. A series of satellites could eventually enable any place on Earth to be imaged inside 24 hours. Radar is one of the most useful tools in Earth observation because of its ability to track objects and events on the ground even when there is a thick cloud cover. The project has been developed by Surrey Satellite Technology Limited (SSTL), which specialises in building small, low-cost spacecraft, and its parent company, Astrium, which makes some of the biggest satellites in orbit today.

The two firms have produced a compact radar platform they believe could win many overseas orders. A four-satellite constellation could be placed in orbit for around 200 million pounds.An Astrium payload to provide maritime surveillance and coastal monitoring with a radar imager that has a ground-sampling distance of between 6 and 30 meters.The 6-meter imagery will be provided with a swath width of 12 to 20 kilometers. The 30-meter-resolution products, including maritime surveillance services, will have a swath width of 750 kilometers. The Novisar platform should last seven years. ◘

SOUTH AFRICA

South Africa to Build its 3rd Satellite

http://www.southafrica.info/about/science/satellite-071011.htm

http://www.southafrica.info/about/science/satellite-071011.htm#ixzz1hNxl1HEm

2011.10.07 – This mircosatellite, building on the existing SumbandilaSat platform, will form part of a new African satellite constellation, in a government drive to grow the country's share of the global market for small-to medium-sized space systems. The country's second satellite, the two-year-old SumbandilaSat, has been out of commission since a blast of solar radiation damaged its on-board computer in July."

Artist impression of **SumbandilaSat above left** **above right** Map showing location of Dend Overberg Test Rang

A **South African "Spaceport"?** http://en.wikipedia.org/wiki/Overberg_Test_Range

"The **Denel Overberg Test Range**,[1] until 31 March 2011 it was known as the Overberg Test Range or OTB (Afrikaans abbreviation for *Overberg Toetsbaan*), is a suborbital rocket launch site and weapons systems testing facility in the Overberg region on the south coast of South Africa, near Arniston, Western Cape." This "missile test range" is located on the coast near Arniston at 34°36 S and 20°18 E and has a reserve area of 420 km^2 ◘

Elsewhere in the World

EUROPE-ESA

ESA to include 10 more EU nations

http://www.spaceref.com/news/viewpr.html?pid=35311

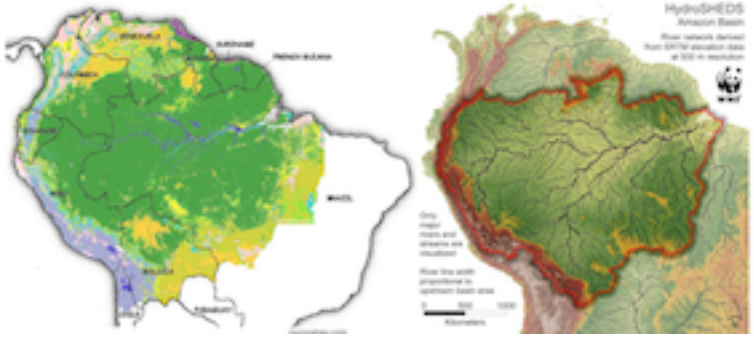
Ten states that are members of the EU [European Union] but not of ESA: **Bulgaria**, **Cyprus**, **Estonia**, **Hungary**, **Latvia**, **Lithuania**, **Malta**, **Poland**, the **Slovak Republic** and **Slovenia**. In addition, Bulgaria and Malta are discussing Cooperation Agreements with ESA. [European Space Agency\ In the ESA Council, the 29 Member States of ESA and the EU are also joined by Canada, which attends thanks to its long-standing cooperation agreement with ESA.

SOUTH AMERICA

Brazil wants Indian Satellites to Study Amazon

http://www.businessweek.com/ap/financialnews/D9QSN2G00.htm

2011.11.08 – The goal is to improve the monitoring of deforestation in the Amazon rain forest. Brazil is negotiating to use satellites from India **to improve monitoring of the deforestation in the Amazon rain forest**. Luis Maurano, a member of Brazil's National Institute for Space Research says a satellite recently launched by the ISRO could vastly increase Brazil's ability to combat deforestation in the region. **The IRS-6 satellite would locate deforested areas much faster than with the satellites currently used.** The alternative is to wait until the launch of a satellite in partnership with China at the end of 2012.



Brazilian astronaut is Goodwill Ambassador for UN industrial development body

http://english.sina.com/world/2011/1130/419158.html

2011.12.01 - The United Nations Industrial Development Organization (UNIDO) has announced that it has appointed Marcos Pontes, the first Brazilian astronaut to go into space, as a Goodwill Ambassador.

Pontes began life in poor living conditions in the suburbs of Sao Paulo, He went on to reach his dreams through basic education and professional skills training that enabled him to commence subsequent studies in aeronautical technology and engineering, He was introduced as “an example of how basic education and professional skills can make a real difference, an inspiration for many people around the globe.” Pontes described his role as ”an Ambassador for a better future on Earth”, and remarked "we need to get together and prepare the new generation to be citizens of one world.”

Since created in October 2004, UNIDO's Goodwill Ambassador Program has tapped various public figures, eminent businessmen and industrialists from various regions of the world to improve the agency's visibility, profile and global reach, both with governments and business circles. They also have an advisory role and support the agency's activities in its **three thematic priorities: poverty reduction through productive activities, trade capacity building**, and **energy** & **environment**.

ESA's Kourou Spaceport expands to accommodate Russia's Soyuz ST Rocket


Russian rocket Soyuz ST lifts off from Kourou - http://en.rian.ru/science/20111021/167930237.html
http://english.ruvr.ru/2011/10/21/59090387.html

The Guiana Space Center near Kourou
http://en.wikipedia.org/wiki/Guiana_Space_Centre

A French spaceport near Kourou, French Guiana. Operational since 1968, it is particularly suit-able as a location for a spaceport due to its proximity to the equator, and that launches are in a favourable direc-tion over water. The European Space Agency, French space agency CNES, and the commercial **Arianespace** company conduct launches from Kourou

The location was selected in 1964 to become the spaceport of France. When the European Space Agency (ESA) was founded in 1975, France offered to share Kourou with ESA.[1][2] Commercial launches are bought also by non-European companies. ESA pays two thirds of the spaceport's annual budget, and has also financed the upgrades made during the development of the Ariane launchers.

Why Kourou? The near-equatorial location of the launch facility in South America enables *a dramatic increase in the payload mass* delivered into space by the veteran Russian rocket, compared to cargo delivered by that same vehicle from Russia's northern sites in Plesetsk and Baikonur.

France and Russia agreed to this arrangement on November 7, 2003. The Soyuz complex is near the launch pad for Europe's heavy-lift **Ariane-5** rocket. Construction of the Soyuz pad in this jungle area took years longer than expected and thus the Soyuz ST launcher must attract enough commercial customers to pay back the investment. The expectation is that there will be 2-4 Soyuz ST launches a year from this facility.

Why Russian Crews in Soyuz Capsules won't be launching from Kourou

The Soyuz crew capsule is designed to land on land, not on water. So if there was an abort early in the launch, the capsule would come down in the Atlantic and sink. ◘

UNITED STATES

Mars Science Lab "Curiosity" is enroute to Mars - arrival August 9

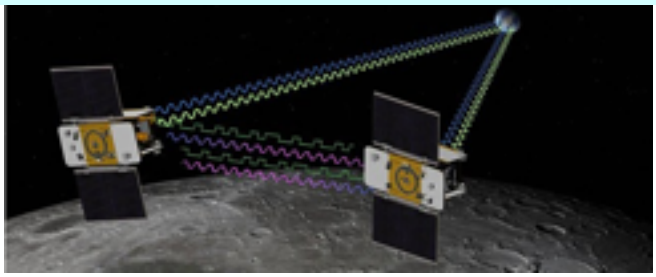
http://www.space.com/13689-nasa-amazing-mars-rover-curiosity-science.html
http://en.wikipedia.org/wiki/Mars_Science_Laboratory

2011.11.26 – The largest, most complex, most capable science rover yet sent to Mars is on its 9 month long journey.


L: Spirit or Opportunity - C: Pathfinder - R: Curiosity

NASA's Curiosity has a special landing system, never before tried except in the laboratory. It will be lowered by cable to Mars' surface from a hovering platform so that the descent rockets cause minimum damage or alteration of the surface. The landing spot was determined by a long selection process aiming at a location from which we stood to gain the most new knowledge, insights, and answers. ◘

Grail Probes to Begin Mapping Moon Interior



http://www.dailymail.co.uk/sciencetech/article-2078904/**Twin-Nasa-spacecraft-swing-orbit-look-inside-moons-core.html**

From just 50 km above surface, Grail [Gravity Recovery and Interior Laboratory] will map the Moon's interior 100-1,000 times more accurately than any previous mission, starting in March. ◘

NASA awards Lava-tube Robot Team Contract

http://astrobotic.net/2011/11/29/**astrobotic-wins-nasa-contract-for-robot-teams-to-explore-martian-and-lunar-caves/**

2011.11.29 - Long before Japan's **Kaguya** lunar orbiter spotted the first lava tube skylight in the Ocean of Storms, those convinced from the evidence of numerous sinuous rilles that the lunar maria or seas must be hiding extensive networks of intact linear caves or lavatubes, have been trying to brainstorm how we might explore them. Now that several more skylights have been found, that brainstorming is picking up momentum. Such tubes are evidently much larger in cross section and length that their counterparts on Earth in lava sheets in Oregon, the Deccan Plateau and on the slopes of shield volcanoes in California and Hawaii.

M3IQ Editor Peter Kokh had the privilege of touring two parallel tubes near Bend. Oregon in 1992. Lavatubes offer thermal stability – a relief from dayspan heat and nightspan cold, and shelter from the cosmic weather that constantly washes the lunar surface with cosmic rays, solar flare radiation, and micrometeorite rain. They would be optimum places for land-hungry activities such as warehousing, industrial parks, agriculture, archiving, and even someday lunar cities.

In the Spring of 2010 we had the idea of developing the NASA Jet Propulsion Laboratory's "axel" rover" to explore labatube skylights. Astrobotics may or may not have picked up on this. "Their Skylight and Lava Tubes Exploration student group presented their concept rover design and skylight terrain model. The rover is designed to descend by cable into the cave and effectively navigate rocky terrain."

http://astrobotic.net/2011/12/19/exploration-of-skylights-and-lava-tubes/

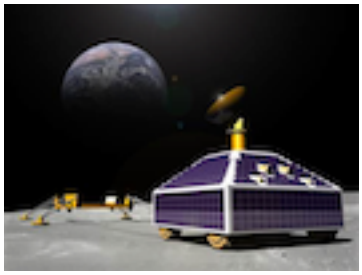
To our delight, NASA has now awarded **Astobotics** of Pittsburgh, Pennsylvania, with a contract to develop concepts for robot teams that would explore accessible lavatubes on the Moon (or Mars) in what would be NASA's first application of the concept of robot-ants (see M3IQ#5 "Beyond Simple Rovers: Robo-Ants" pp. 22-24. Astrobiotics is also one of the more promising Google Lunar X-Prize contending teams.

http://www.googlelunarxprize.org/teams/astrobotic

"Through a subcontract to Carnegie Mellon Univ., the research will build on multi-robot and subterranean robot research pioneered at CMU to improve capabilities and reduce risk of failure relative to single-robot missions."

In team exploration one may supervise and direct, "some do the heavy work, and others are sufficiently nimble to reach the farthest pockets of the cave" said Steve Huber, Astrobotics' principal investigator for the contract."'

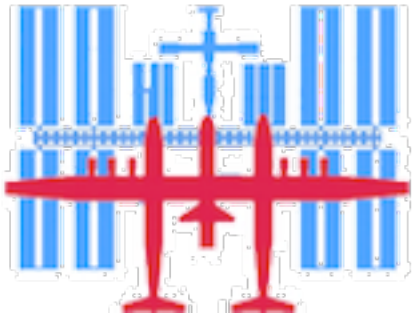
"NASA officials see Astrobotics as a key option to get their payloads to the Moon at a cost the agency can afford in this tight budget environment," said Astrobotics President David Gump.



◘

Microsoft's Paul Allen & Burt Rutan plan to build StratoLaunch super fly-back booster

http://www.wired.com/autopia/2011/12/rutan-allen-musk-team-up-for-orbit/ - article and video



2-fuselage fly-back carrier (cockpit left) sporting 6 Boeing 747 engines, payload Space-X rocket suspended at center

At right the **StratoLaunch (red)** is shown in comparison to the **International Space Station (blue)** (PK illustration)

The game changing switch in the United States from NASA to Commercial Space companies who are demonstrating that they can do much more for much less without inefficient overpriced bureaucratic programs seems to be gathering momentum. Space-X Falcon Heavy can deliver very large payloads more often for a "sixth" of NASA's cost, and its Dragon cargo capsule will soon make its first docking at the International Space Station. Now Paul Allen and Burt Rutan propose the largest aircraft ever to take to the air, dedicated to launching payloads to orbit at lower cost, including to ISS but also point to point on Earth. The craft could also carry crewed rockets, and larger yet tourist rockets. Stratolaunch's maiden flight is anticipated "before the end of the decade."

Getting off the ground, the job of the "first stage," is the most costly part of launching payloads to orbit, *and the dirtiest,* in terms of rocket exhaust in the atmosphere, the Space Shuttle's solid rocket boosters being the dirtiest of all. Another and exhaust-free alternative would be a maglev sled on a track up a mountainside – an old idea never tried. The sled would be propelled by electricity and return to the start point after releasing the payload at its maximum speed.

Stratolaunch will use a launch system similar to what was developed for Rutan and Allen's SpaceShipOne project. But it will be much, much bigger. "The mothership will have a wingspan of 118 meters — more than 36 meters greater than an Airbus A380, currently the largest commercial passenger plane in service. The airplane will have a gross weight of 545 tonnes, including a 223 tionne booster rocket being developed by SpaceX." *S*

THE PLAN

Stratolaunch, the new Paul Allen space company, will aim for 2016 rocket launch

http://blog.al.com/space-news/2011/12/stratolaunch_the_new_paul_alle.html

The Flight Plan - http://www.tech-blog.net/wp-content/uploads/2011/12/stratolaunch-580x481.jpg

IMAGES

http://www.space.com/13918-images-paul-allen-stratolaunch-systems-private-space.html

VIDEOS

Stratolaunch Systems Space Aircraft Brings Paying Passengers Into Orbit With 6 Boeing 747 Engines

http://www.youtube.com/watch?v=iwptYPpdPLY

http://www.space.com/13919-dream-team-announces-cheap-access-space-venture.html

World's largest Airplane - Statolaunch - http://www.youtube.com/watch?v=tJyoARQDmao

Stratolaunch Systems, A Paul G. Allen Project: - http://www.youtube.com/watch?v=sh29Pm1Rrc0

Burt Rutan Talks about Stratolaunch - http://www.youtube.com/watch?v=nbd7TwYVuOA

Former NASA astronaut Jim Halsell on Stratolaunch - http://www.youtube.com/watch?v=EGhFoQLWsJU

Mike Griffin, former NASA Administrator, talks Stratolaunch - http://www.youtube.com/watch?v=ns71qKqlhGI

MMM-India Quarterly Editors



L>R: Peter Kokh - kokhmmm@aol.com - http://www.lunarpedia.org/index.php?title=Peter_Kokh
Moon Society Secretary - Editor Moon Miners' Manifesto - Milwaukee, Wisconsin US
Madhu Thangavelu - thangavelu-girardey@cox.net - Mother from Kerala, Father from Tamil Nadu - grew up in Delhi - now teaching at the University of Southern California - Conductor, Graduate Space Exploration Concept Studio USC School of Engineering & Architecture - Los Angeles, California US
David A. Dunlop - dunlop712@yahoo.com - Moon Society Director of Project Development - Executive Director of LUNAX (LUnar National Agriculture eXperimnet) - University of Luna Project - Green Bay, Wisconsin US

L>R: Pradeep Mohandes - pradeepmohandas@gmail.com - Mumbai - Formerly President of SESDS India
Srinivas Laxman - moonshotindia@gmail.com - Mumbai

Indian Student Team wins Design Award

YouTube Space Lab Announces 60 Finalists in Competition to Send Students' Experiments into Space
http://www.spaceadventures.com/index.cfm?fuseaction=news.viewnews&newsid=855
Thousands of Entries From More Than 80 Countries: U.S. Leads in Number of Finalists Followed by India

January 17. 2012 - YouTube, Lenovo, and Space Adventures in cooperation with space agencies including the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), and the Japan Aerospace Exploration Agency (JAXA), today announced the sixty finalists of YouTube Space Lab (youtube.com/spacelab), the global science competition that challenges 14-18 year-olds to design a science experiment that can be performed in space.

YouTube Space Lab received thousands of video submissions from more than 80 countries, a remarkable number given the unique challenge of designing an experiment that could actually be carried out in space - something that has traditionally been the mission of qualified astronauts and scientists. Entrants not only described their science experiment ideas via video, but demonstrated and animated the procedures they were submitting.

YouTube Space Lab Finalists: Abhishek Shastry and Animesh Shastry - Megha Sharma and Karan Sapolia Sharma - Nitya Raju - Bhoomika Agarwal and Shruthi C. - Mohit Singhala - Nesar M.N. - Kavin Sundar Nath - Sachin Kukke - IShri Shankari

SEDS India International Conference - March 2-4, 2012 - http://www.sedsic12.com

Host: VIT University, Vellore, Tamil Nadu, India.

Video: http://www.youtube.com/watch?feature=player_embedded&v=Kga65nvFj1o&mid=57659

SEDS organizes International Conference (SEDSIC) each year as an annual get-together of SEDS members' worldwide to share their knowledge with regard to the current development in the field of aerospace and astronomy. VIT University, Vellore has been chosen as the venue for 2007. The conference was held on 22nd to 23rd September.
Conference Theme: "**Students vision for global space sciences and technology**" - http://www.sedsic12.com/#
SEDSIC'12 wis intended to bring synergy between the global space professionals, eminent personalities and students. It will showcase the cutting edge innovations and technologies in space industry. There will be keynote address and invited lectures from leading personalities besides the contributed paper presentations.

Lunar Perigrine Introduction:

This time it gets tougher and more competitive. With expeditions to moon gaining ground, an ideal moon rover would be the primary objective of scientists. It's your chance to take your shot at designing an ideal moon rover with materials of your choice. An artificial terrain would be constructed to test your moon rover. The terrain would be full of obstacles, from mountains to craters to low gravity, your moon rover has to battle it all and withstand the conditions on the moon. Create, innovate and control your moon rover to battle it out against a vast number of teams. Teams will be judged on the basis of feasibility of the design of their moon rover and how efficiently the obstacle course is completed by them.

Squirtile's Archery - http://www.sedsic12.com/Frame%20Content/event1.html

DESCRIPTION OF EVENT - ROUND I: a test of range of the rocket.
JUDGING CRITERIA: the maximum range achieved by the rocket, the design of the rocket and the design of the launcher. The split up is as follows: • Range: 30% • Design of Rocket: 45% • Design of Launcher: 25%
The judging for Round 2 is based on the following:
• Relevance and accuracy of the calculated parameters to support the launch.
• Proximity of the hit to the target. Maximum points if the rocket hits right on the target. RULES AND REGULATIONS
• Participants with a valid Identity Card of their respective institutes are eligible
• A team shall consist of a maximum of three members. • Total time of the event is six hours.
• No metal parts should be used in the making of rocket. • Joining together two pet bottles will not be allowed
.• Maximum volume of the rocket pet bottle should not exceed 2 litres. • The launcher should stand on its own,
• After setting up the rocket on the launcher, participant is not allowed to touch the rocket; one can only pump the air into the rocket. • The rocket cannot have any sharp edge, so as to avoid any kind of injur
• A maximum of two rockets for shooting during the course of entire event. • The nozzle to pump the air CANNOT be directly fitted to the rocket. The launch mechanism should be in such a way that the mouth of the bottle stays on the launcher and the nozzle for air delivery be connected to the launcher.
• In any case, launcher will not be allowed to change, so a proper mechanism should be employed in the design of the launcher to change the angle of the launch.
• In case any dispute, the decision of the judges will be FINAL • Participants must adhere to the rules of VIT University, Vellore.

COMMUNITY - Growing a Local Chapter by Collaboration

By Peter Kokh

Foreword - While there might not be a local space chapter in your community, do not hesitate to read what follows as you may get ideas that will help you to find one or more kindred souls and to organize one successfully.

Potential Collaborating Organizations

• **Local astronomy clubs –** In issue #12, we talked about "Leveraging the Sky" to focus interest on space. But there may be other "special interest" groups or clubs in your area with whom it may also be fruitful to collaborate.
http://www.astronomyclubs.com/country/India

• **Local science fiction societies** – Some larger urban areas may have organized clubs whose special interest is science fiction. **-**

• **Local geological societies** might be interested in presentations about the very different geology of the Moon, Mars, the asteroids, and "moondust." You just might attract one or more "rockhounds" to join the chapter. **- http://www.geosocindia.org/**

• **MENSA chapters -** these are organizations of intellectually gifted persons with an A-Z spread of interests. They may be fascinated by your presentations may even join, bringing useful talents and connections **http://www.mensa.org/country/india**

• **Other local space chapters –** No matter how cozy or strained relations between your National organization and other national space-interest organizations may be, you will find that individual members are largely disinterested in such non-productive politics. You can trade presentations with other local space groups, put on joint exhibits and events, and share talents. Send out invitations to attend any of your meetings when you have a special speaker or presentation, whether it is about space in general, ISRO plans, India's astronauts, International Space Station, Moon, Mars, Asteroids, or any other space destination or topic. Most of us are interested in all things space.

http://chapters.nss.org/a/lists/International/ChapList_IN.shtml

• **Local Libraries –** The central library in your community may have a **list of local organizations** of various types. *(And if your startup group is not listed, have them add it to the list so others can find you!)* If so, go through the list and brainstorm possible common points of interest. For example an auto club may be interested in a talk or presentation on the Apollo moon rovers, and ideas for pressurized lunar coaches. A fashion club may be interested in a talk about what lunar pioneers might wear. A sports club may be interested in a speculative talk about what shape sport might take on the Moon in 1/6th gravity or on Mars with 3/8ths gravity. A law or legal club may be interested in legal issues that will come up on the space frontier. No matter what groups you find in your community, if they are looking for speakers, there is probably z space frontier topic that will be of interest to them.

If you can't think of a topic, or need a list of god talking points, email me at kokhmmm@aol.com and I will make suggestions and provide background material or existing presentations. "Nothing to lose and much to gain!" Making a presentation will improve your speaking skills. Don't be nervous. You will know more about your topic than your audience!

Making the first move

If you learn about a group of whatever focus that is looking for speakers – *every group is!* - **pick a topic or list of topics that has aspects that might appeal to them**, You may have to learn about them first to find that common ground. Then write, email, or call and offer to be a featured speaker. If your talk is favorably received, and they invite you back, do accept that invitation, and invite their members to attend one of your events.

Get acquainted with their movers and shakers and with the talents they have. This could lead to your chapter cosponsoring one of their events, and with their group returning the favor, and perhaps offering you a speaker in turn.

Keep a detailed contact directory/address book of each group's leaders, specifying role, and useful talents. Offer to exchange courtesy newsletters and publications. Put them on your mailing list for your chapter's events and efforts. Undoubtedly, you will find some groups to have less collaboration potential than others. But becoming known to any group can turn out to be an asset someday, when they realize that you have something of value for them.

Study each group's successful ventures for clues about how to improve your chapter's efforts. In other words, become acquainted with your community's amateur talent pool and their activities.

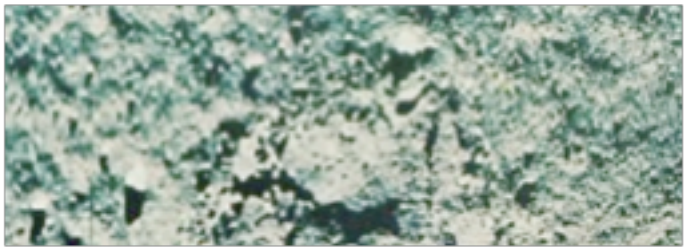
Before you take it upon yourself alone, see first what connections to other groups other chapter leaders and members maintain, and ask them give a preliminary report. That can lead to group brainstorming of how to establish working connections with this group. The more brains exploring the options, the more likely you will come up with a promising "first contact".

As your chapter is undoubtedly looking for meeting speakers as well, invite speakers of other clubs to tell your members all about their activities. Follow yup with an open floor discussion that identifies areas of common interest to pursue together. Collaboration is a two-way street.

The **"Undiscovered Country"** - to borrow the title of a Star Trek film - is waiting for you to explore it! ⊠

Rock, Rubble and Regolith

By Ron Brooks



1. Introduction: “soil” vs. “regolith”

When we look at our Moon, what we are seeing is a type of “soil” covering resulting from billions of years of a complex “space weathering.” Meteoritic impacts have played a major role in this unique space weathering process that has molded a soil-like covering consisting of a fragmented, unconsolidated mass of rocky rubble, sandy grains, and dust. By no means should this “Moon soil” be compared to or thought of as the soil covering found on Earth, which was produced by processes uniquely terrestrial with the presence of oxygen and the additional influences of wind, water and the activities of life. In contrast, on the lifeless and airless Moon, the “soil” is a result of a very different unique process (McKay, et al., 1991a). To describe the concoction of material that covers almost all the Moon’s surface more adequately, researchers generally use the term "regolith" – [Greek for blanket [rego) - rock [lith] or rock-derived surface layer.

To those interested in the Moon, the Moon’s regolith has been an investigative and problematic topic for many years. As research into the lunar regolith proceeded, many ideas were proposed over the years; especially prior to the Apollo flights in anticipation of the upcoming lunar landings. One such idea was the questionable rigidity of the surface regolith and its capacity to support not only a landing module but the astronauts themselves. (Some thought that the surface was covered with a loose dust blanket that would swallow anything attempting to land on it or traverse it – cf. Arthur C. Clarke’s novel “A Fall of Moondut”) (Another idea was a concern that the astronauts may encounter debilitating physical problems or that their equipment and instruments might malfunction due to the extreme dusty consistency of the regolith. Some of these ideas were confirmed, some were altered, and some discarded with the information gained from research leading to and following the Apollo landings and up to the present day.

The reader needs to keep in mind that almost all we know about the Moon has been derived from its regolith (McKay et. al., 1991b). Great research efforts have been made and a great deal of data has been complied about the Moon through its regolith. Some research findings have been inconsistent from one individual to another. However, the reader needs to appreciate that the Moon is a very complex world, and obtaining sound, consistent, and verifiable information is a slow and demanding endeavor. This is not troubling to those with a real interest in our Moon, but it presents a challenge and adds an element of adventure in revealing the mysteries of our curious companion world.

We need to reset our thinking and accept that our companion is truly another world and does not follow, or need to follow, our earthly conceptions. Hopefully this article will provide the reader with a better understanding of another piece of the puzzle of our magnificent Moon’s unique structure and environment.

This is the second in a sequence of readings about our Moon’s structure, geology and environment authored for the Moon Society. As with the first article, "Lunar Mascons, Masterpieces of Complexity," which appeared in the May 2011 issue of MMM, this article is written for those with varied levels of knowledge in lunar science. The information offered is not intended to be exhaustive or definitive. The references can provide a basis for anyone wishing to pursue more in-depth reading

2. The Difference between Soil and Regolith

As the reader will discover, the word "soil" is not the best to describe the unconsolidated material that covers the Moon’s surface. Even here on Earth we would not call such debris "soil." Because of that, as mentioned earlier, most researchers use the word "regolith" when describing this comprehensive covering. Regolith was first used to define the loose, unconsolidated material covering the bedrock on Earth and over time has been used for the Moon.

Regardless of its definition and descriptive inaccuracies, lunar "soil" has become synonymous with lunar "regolith" (Taylor, 2008a). With this synonymous use, most researchers work interchangeably with both soil and regolith with a general understanding that "regolith" more effectively conveys the idea for the entire mixed bag that covers the lunar surface. The word "soil" has been generally abridged to identifying the subcentimeter particles that actually make up the greater part of all regolith.

"Regolith" thus identifies the entire comprehensive composition from the largest boulders to the smallest microscopic grains, but "soil" refers to the grains that average 70μm which are the most abundant grains and form the bulk of the regolith. The

finest grains or what is considered "dust", in contrast to "soil", lies as the upper most layer of the regolith and has been identified with a grain size < 20μm and possibly contains grains as ultra-fine as <0.01μm (Park, J., et al., 2006a). Dust, soil and regolith will be used interchangeably as the context requires. (For μm see Note 1.)

Before we begin to work with the terms soil, dust and regolith, the reader needs understand that the weathering environment of the Moon's surface is very different from that on Earth. During the Moon's earlier history, great bombardments took place resulting in the dramatically cratered surface. Some of the catastrophic impacts resulted in volcanic activity that produced the dramatic surface changes of the basalt maria. The early heavy bombardments pulverized the greater percentage of the early Moon's surface, leaving behind a varying degree of near site melt and pulverization and an enormous amount of layered impact ejecta that was thrown in all directions and distances and in all shapes and sizes. This jumble of rubble covered the Moon's surface. However, while this rubbly concoction was the covering for the early Moon's surface, it is not the regolith that presently covers today's lunar landscape.

3. What Produced Today's Regolith?

Today's weathered surface, as reflected in the regolith, has been shaped from outside cosmic forces referred to as "space weathering," not the result of the Moon's atmospheric forces, but of a very different scenario from what happened on Earth.

The soil on Earth is composed of material that has been altered by chemical and environmental weathering produced by a thick, dynamic atmosphere. The Earth's atmosphere has left the soil rich in two major components, moisture and air. Moon soil is devoid in both moisture and air since the Moon does not have a gas and moisture laden atmosphere that could produce Earth-like soil.

The lunar weathering force is of cosmic origin. The dramatic lunar features left over from the great bombardment era, including the maria, have all succumbed in varying degrees to this relentless force.

The cosmic forces that produce the lunar surface are the same forces that significantly affect the surface of Mercury and that strike asteroids without any resistance. Mercury has a weak magnetosphere as a factor <1000th of Earth's and a tenuous non-collisional atmosphere. The Moon does not have a magnetosphere, but does have what is considered a non-collisional atmosphere (even thinner than Mercury's), where the molecules are so sparse that they do not collide with or have the ability to interact with outside forces. In perspective, the Moon virtually has no atmosphere. This opens the Moon to all cosmic forces. Knowing this, we need to set aside preconceived ideas about weathering from our Earth-bound perspective.

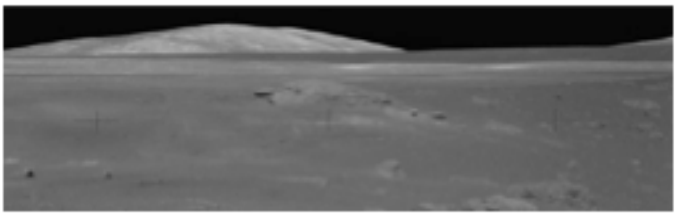


Figure 1. The Moon's Regolith Landscape. Credit: NASA

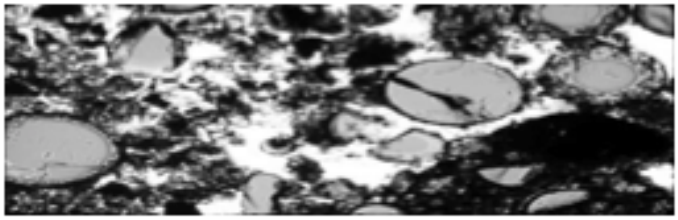


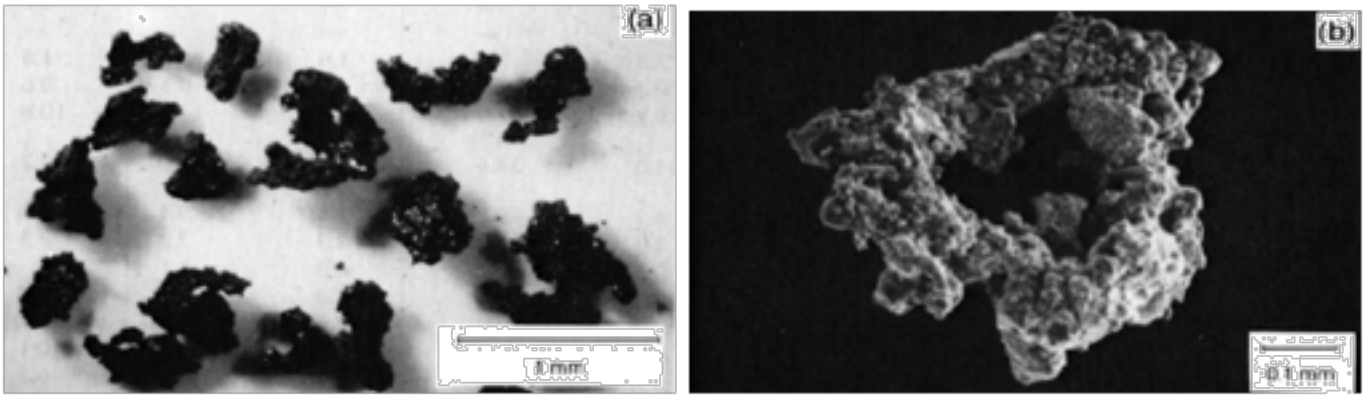
Figure 2. Cross-section: Lunar Pyroclastic Beads: NASA

4. Regolith Grain: Size and Appearance

On average, a bulk lunar regolith sampling taken downward to approximately a 20m depth would reflect ≈95% of the soil that is finer than 1.37μm by weight and ≈5% finer than ≈0.0033μm. The median particle size of such a sampling is approximately ~72μm (Carrie, 2005). Spudis also supports the idea that the regolith soil grains, on average, are composed of grains of ~70 μm (Spudis, 2006a). With the soil grain sizes stated above, the reader needs to realize that the average grain size is almost impossible to be seen by the unaided eye. If one viewed the grains under microscopic enlargement, the shapes would be highly variable. In general, the particles would be somewhat elongated and ranging from spherical to extremely angular (Carrier, et al., 1991). Because of the limited effects of space weathering, most of the granules remain abrasive with jagged sharp edges and tend to pack together.

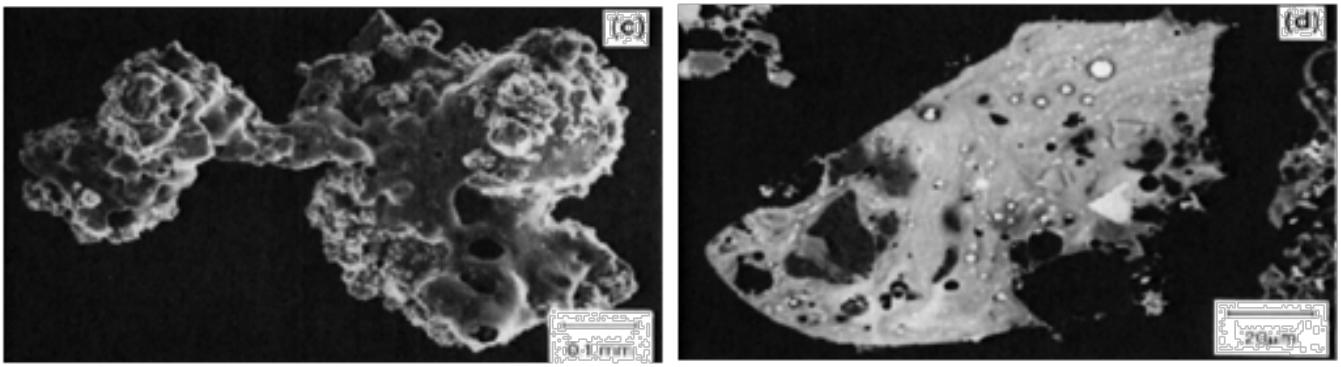
Below: examples of a very common lunar grain called agglutinates,good overall representations of lunar soil grains. But some grains will vary greatly from the examples given, e.g. the non-impact grains consisting of volcanic pyroclastic glassy spherical beads dispersed over the lunar surface. (See Fig. 2.) Compared to agglutinates, they are sporadic and do not contribute significantly to the bulk of the regolith.

Agglutinates grains are aggregates of smaller soil grains or particles. The average agglutinate grain is usually <1 mm. Agglutinates are formed by heat generated by meteoritic impacts striking the lunar regolith, producing the melting, mixing, and bonding of mineral grains, glasses, and even older agglutinates. The soil grains take an endless array of shapes. An individual grain can have multi-faceted coatings and appendages, barbed and extremely abrasive. Figure 3 (a to f) **below** show examples of typical lunar agglutinates with grains under extreme magnification



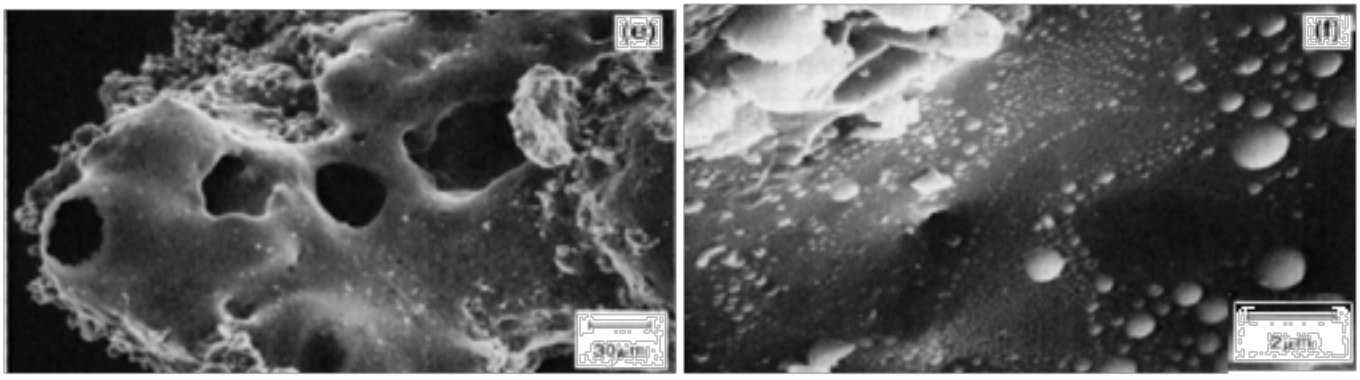
(a) Optical microscope photograph of a number of agglutinates from an Apollo 11 soil sample showing a variety of irregular agglutinate shapes.

(b) A doughnut-shaped agglutinate. This agglutinate shows a glassy surface extensively coated with small soil fragments and a few larger vesicles. Notice the extremely small size.



(c) Scanning electron photomicrograph of an irregular agglutinate soil showing some vesicular, glassy, fragment-free surfaces adjacent to fragment-laden surfaces. Some agglutinates are very delicate and display narrow bridges, necks, and dendrite-like arms

(d) Shown is a polished thin section of an agglutinate. The agglutinate particle contains a variety of vesicles with circular, elongate, and irregular shapes. Irregular mineral fragments in the glass include plagioclase (darker), pyroxene, and ilmenite (brighter). The bright circular features are metallic Fe (iron), which occurs as isolated droplets and trains and swirls of small droplets (<5 μm). Fe is not confined to surfaces, but is present throughout the volume of most agglutinates.



(e) Closer view of a glassy agglutinate surface, showing vesicular structure. Small mounds and trains of metallic Fe are visible as bright spots that occur over the entire glassy surface.

(f) Close-up view of a glassy agglutinate surface, with clusters of Fe mounds, with groups and trains of smaller Fe mounds (20-Å to 1-μm diameters).

5. Regolith Structure

As mentioned earlier, regolith in any one discrete area is a layered concoction of contiguous material and rock fragments and other impact debris possibly thrown in from adjacent and remote regions. After the large bombardment era and over time, in relative calm, this material tended to organized itself into a somewhat common structural pattern. Then again, even with these common structural dynamics in motion, any given pattern within varying radial distances will have its own unique variations.

Keeping in mind the structural idea of variation and replication above, Figure 4 (left) shows a possible representational structure of a vertical section of the stratified regolith layers, which might commonly be found on the Moon. Figure 4 starts at the uppermost surface downward to the lunar crust. The structure, for ease of interpretation, is divided into six zones representing structural layers and their depths. Measurements are averages of available information.

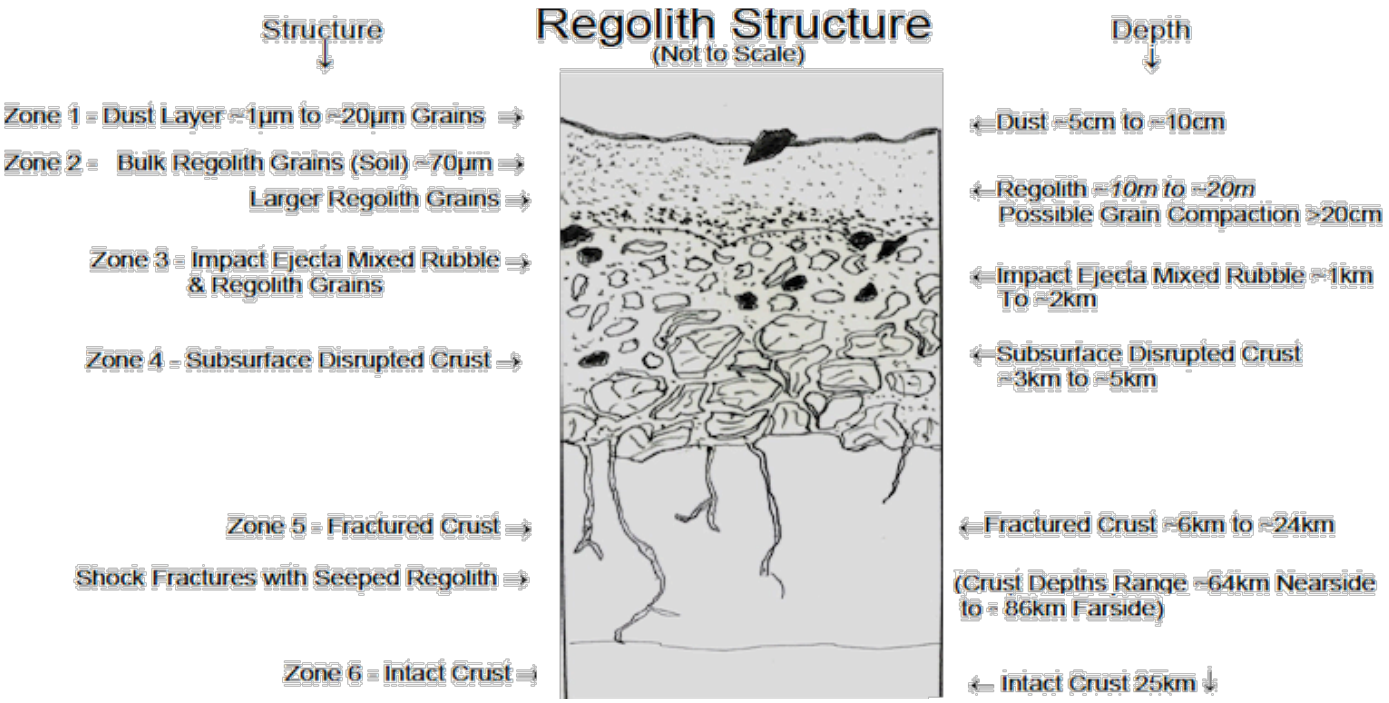


Figure 4 sketch by the author

Zone 1. (Dust layer) The dust layer is the finest of all regolith and consists of grains sized from ~ 1µm to ~20µm (ultra-fine to 0.01 µm µm) of covering the top 5 cm to 10 cm of the surface.

Zone 2. (Bulk layer) consists of regolith grains averaging ~70 µm (lunar "soil"). This upper surface varies widely across the lunar surface, but averages somewhere between ~10m to ~20m thick. Maria regolith can range from ~1m to ~5m, and highland regolith averages ~10m to ~20m or more.

Zone 3. (Mixed Rubble) Consists of a mixed bag of larger rubble from impact ejecta and intermixed regolith grains. This zone lies~1km to ~2km below the surface. This zone is generally protected from weathering.

The structure configuration such as in in Figure 4 may also not remain in a static condition in any one discrete location. A meteoritic impact of varying magnitude could bring about a fragmentation of any compaction, overturn or bury the existing regolith structure, and virtually destroy what was achieved over time. Nevertheless, as the aeons pass, cosmic weathering and soil mechanics would again most likely return the site to a similar structural pattern.

Zone 4. (Disrupted Crust - Megaregolith) A layer of disrupted (broken) blocks ~ > 1m in size with regolith grains dispersed throughout. The result of impacts that fractured and broke the crust into large size blocks that has not been exposed to weathering. This zone is referred to as the megaregolith and lies ~3km to ~5 km below the surface.

Zone 5. (Fractured Crust) Lunar crust that has been fractured but is firm. Most likely grains of regolith will have seeped into the fractures or cracks. The fractured crust averages ~6km to ~24km below the surface.

Zone 6. (Intact Crust) Part of the lunar crust not affected by impacts and is generally intact. The intact crust slabs lie at ~25km and below from the surface.

6. Regolith Compaction through Meteoritic Impact and Moon Quakes

Some additional points need to be made in regards to better understanding of the regolith structure. It is also interesting to note that, below the top 20cm, the grains are thought to be strongly compacted.. Taylor believes the compacting is brought about by shaking during impacts (1982). It does seem likely that large regional impacts could produce sufficient violent shock waves and shaking to jar the abrasive, jagged grains into an inter-particle linking, producing a strong compaction. However, it seems likely that in addition to impacts, Moon "quakes" would be a significant contributor to regolith compacting.

During the Apollo excursions, seismometers were placed on the lunar surface. The seismometers clearly detected Moon quakes of various magnitudes at varying durations. In his paper, "The Importance of Establishing a Global Lunar Seismic Network," C. R. Neal states that some "quakes" detected by the seismometers registered up to 5.5 on the Richter scale and lasted up to ten minutes. He also expresses that the quakes can make the moon "ring like a bell" (2005).

Three types of Moon quakes have been identified:

(1) Thermal quakes, which are caused by the extremes of lunar cooling and heating,
(2) Shallow moonquakes, which occur relatively near the moon's surface, and
(3) Deep moonquakes, which take place more than 600 miles under the surface. This is about halfway to the center of the Moon much deeper than any quakes on Earth. The vibration and shaking produced by stronger moonquakes would definitely seem to be a strong factor in compaction of the regolith lying on the surface above.

7. Cosmic Weathering of the Lunar Surface through Meteoritic Impact

The most visual and impressive weathering of the lunar surface is that by meteoritic impacts. "Meteoritic" is an inclusive generalization of the surface impacts made by asteroids and comets or fragments thereof. (For more information on meteorites, asteroids, and comets, see Note 2.) Impacts on the Moon's surface have formed structures ranging in size from .01μm (assigned the name of a "zap pit") to the multi-ringed basins that can measure over 1000km across, e.g., the South Pole Aitken (SPA) Basin.

However, what we are not considering here are the events that took place in the young solar system of three billion years ago in which heavy blankets of impact ejecta were produced by great bombardments and the lava emplacements of the maria. What we are considering is the meteoroid flux comprising mainly of dust-like particles that constantly strike the Moon. In our maturing solar system, larger objects, say, the size of a compact car, strike the Moon every century or so.

This small but constant hammering away at the Moon's surface by meteoroid flux produces three primary physical weathering mechanisms that have altered surface features. The impacts have produced rock and mineral fragments derived from what is called "comminution," or the breaking of rocks and minerals into smaller particles, and "agglutination," which is a fusing of mineral and rock fragments forming impact-produced glass particles and vaporization of grains.

With vaporization of grains, the lighter materials escape while the heavy materials usually condense on nearby grains. So what we have is a process of constant **pulverization, dissipation, and reassembly.** The ultimate outcome, however, is the diminution of the lunar surface material. The three mechanisms above are impact-based. However, space weathering also consists of almost imperceptible actions caused by solar wind, solar flares, and cosmic rays.

8. Lunar Surface Weathering through Ionizing Radiation from Solar Winds, Solar Flares, and Cosmic Rays

As mentioned earlier, the Moon has a tenuous atmosphere and no magnetosphere; it has no protection from outside forces. The weathering through solar wind, solar flares and galactic cosmic rays (Taylor, 1982 b) is very subtle and beyond sensory detection. However, the effects are real and need to be considered.

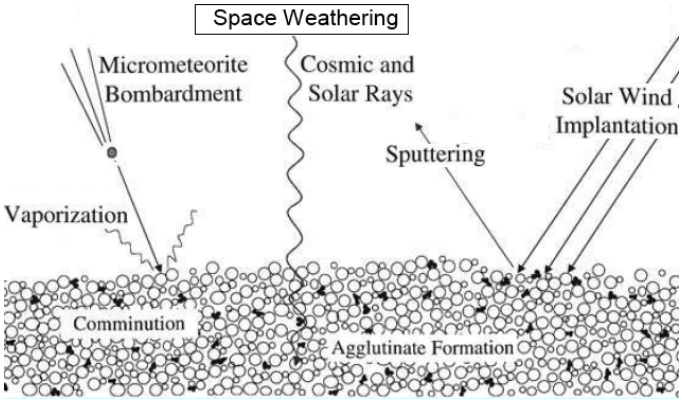


Figure 5 Wikipedia® (2011) Creative Commons Attribution-ShareAlike License

As the solar wind hits the unprotected lunar soil it causes an implantation of ions into the surface materials. (The solar wind is a steady stream of mostly protons and electrons that is constantly emitted from the Sun's upper atmosphere at about 400 km/s.) The solar wind also generates radiational surface damage that produces some fine-scale rounding (Taylor, 1982c). At the same time, the effect of solar wind produces an amorphous coating of ions at about 400Å (angstrom or nanometers) (Taylor, 1982d) on the adjoining grains of dielectric crystals (especially in grains of plagioclase) (McKay, et al., 1991c), producing granular changes.

Solar flares have even higher energy than the solar wind and produce three occurrences:

(1) the implanting of ions into the surface grains,

(2) the production of cosmogenic nuclides and

(3) radiational tracking (Taylor, 1982e; McKay, et al., 1991d). Solar flares, as with solar wind, implant ions into the surface grains. Solar flares also produce cosmogenic nuclides when high-energy cosmic rays from the solar flares interact or collide with the nucleus of an atom.

When the atom is struck, an erosional effect occurs through **spallation** [expulsion of nucleons (protons and neutrons)] from the nucleus of an atom] and **sputtering** (atoms are ejected from a surface particle) leaving behind **cosmogenic nuclides** (or cosmogenic isotopes), a rare form of isotopes.

The third effect of the flares is **radiational tracking,** which occurs within the mineral crystal structures in the lunar soil. The crystals are preferentially dissolved or tracked (i.e., an etched channel is generated) as the ion from a high-energy ray passes through the crystal (Krätsghmer & Gentner, 1977). The track lengths (or etching) of the crystal within the grains differ in differing minerals, usually in order of feldspars > pyroxenes > olivine (Taylor, 1982 f). The radiational tracking is considered "damage" in that it changes the structure of the crystal grain. The grains affected are usually found within the upper ~1mm of the lunar regolith.

Cosmic rays (Especially Galactic Cosmic Rays (GCRs) and Solar Energetic Particles SEPs) also produce radiational tracking and can generate rare isotopic species through spallation, as previously explained, with solar flares. They do not, however, implant ions into the surface grains due to their high energies.

The damage and changes made by the solar winds, solar flares and cosmic rays to the lunar soil grains may seem minor to the informal observer. However, it is a significant factor in lunar weathering and needs to be studied for a better understanding of the forces affecting our Moon's surface. It is a point of interest that the process of lunar weathering, such as sputtering, also contributes to the Moon's exosphere, but that is a story for another day.

A visible side-effect of continuing space weathering is the slow darkening and reddening of the regolith. As an impact strikes the lunar surface, the underlying lighter-colored regolith, which has not been darkened through weathering exposure, is ejected outward, forming the lighter ejecta rays overtop the weathered, darker regolith. Eventually, the impacts that produced the spectacular bright ejecta rays of the craters Kepler and Tycho will darken through weathering and blend into the surrounding regolith, as have the rays of older crater ejecta.

9. Regolith Mineral Composition

There have been about 100 minerals identified on the Moon, in comparison to Earth, where approximately 2,000 have been identified (Rickman & Street, 2008). In general, the major mineral composition of regolith is of plagioclase feldspar, clinopyroxene, orthopyroxene, and olivine (Schrader 2010). However, there are noteworthy additional minerals in most regolith samples. It appears that the major differences in mineral make-up lie within the two distinct lunar topographic forms, the highlands and the maria.

The major mineral composition of the lunar regolith generally holds throughout the surface. However, the regolith found in the highlands is additionally rich in aluminum and silica and poor in iron, as are the highland rocks. In contrast, the regolith covering the maria is rich in iron and magnesium and is silica-poor because of the basaltic rock (from lava flow) from which the regolith covering the maria was formed. The mineral differences between the highlands and maria seemed to have been maintained over billions of years with a relatively small amount of lateral mixing (mixing from one surface area to another). Spudis believes up to 95% of all material in the regolith is locally derived and that usually this percent is upheld within a few kilometers of any one sample (1996). McKay, et al., also concludes that the general mineral composition of any given distinct sample of regolith reflects the composition of the bedrock underneath (1991e; Taylor, 1982g).

There is some mutual mixing from the maria basalt layers and highland locations. This mixing is especially true within the sloping plains that lie between areas of the maria and highlands. Nevertheless, it is not enough to suppress the basic regolith differences between the two distinct topographies. The mixing that has taken place seems more contingent from highland impact ejecta being transported to the maria than the reverse (Li & Mustard, 2005).

Nonetheless, due to repeated meteoritic impacts and the possible contiguous traveling lateral spread of ejecta radii from one location to another, especially impacts such as Copernicus or Tycho, any given sample of regolith may reveal mixed-in material from anywhere on the Moon.

10. Regolith Depth

Regolith depth anywhere on the Moon has to do with the results of crater formation. The oldest surfaces in the solar system including that of our Moon are characterized by a topographical condition called maximal cratering density. This means that one cannot increase the density of craters because there are so many craters that, on average, any new crater is formed over the top of existing craters by obliterating all or part of older craters, leaving the total number visible for a realistic density count unchanged. Some regions of the Moon, especially the highland regions, exhibit nearly maximal cratering density.

In contrast, the original lunar crustal formations of the maria regions were struck with colossal impacts followed by extensive lava emplacement, which destroyed the original crustal formation and any accumulated regolith. The regolith blanket that covers the ancient highland regions, where maximal cratering density has been maintained, would logically be thicker than that covering the lava-emplaced maria.

However, the average depth or thickness of the regolith in both the highland and maria regions varies widely, as has been confirmed by research. The average measurements seem to range from approximately 1 to 5 meters thick over the maria to an average of 10 to 15, even up to 20 meters or more in some highland regions. This reflects the true inconsistencies in the regolith depths from one discrete location to another. It seems to have been difficult to determine exact measurements of regolith depth over a few or several kilometers in a given discrete area in both the highlands and maria.

However, regolith depths are continuously being confirmed by research. One such research technique is called equilibrium diameter depth measurements. A key to this type of regolith measurement is hypothesized from crater counts using the solar incidence angle of the crater image(s) with crater counts determined by sun angles, which helps reveal craters with diminutive features, as proposed by Young and most recently by Wilcox and Ostrach (Young, 1975; Wilcox, et al., 2005; Ostrach et al., 2011).

The equilibrium diameter is a measured dis-crete topographical area where the function of crater mechanics has created a steady state between the formation of new craters and the removal of old craters. The total number of craters visible for a realistic density count seems to remain unchanged, as with the function of maximal cratering density, keeping in mind that the presently visible craters are less than the total number of craters that existed in the given area at any one time.

Two major mechanics are in action to create this steady state. First, craters start as voids in the lunar surface, and as they age their protruding rims erode and their interiors slowly fill in with regolith, making them almost indistinguishable from the surrounding landscape. Second, a number of aging craters become even less visible when the lunar surface is impacted and a new crater is formed, obliterating all or most signs of the old crater(s) within the impact zone. Hence, the topographical area in which the total number of craters that can be identified on a discrete lunar surface area remains the same, but is less than the number that was actually there at any one time is the equilibrium diameter.

The result of such mechanics in turn has significant implications for inferred regolith depth. Measured regolith depths increase with the size of an equilibrium diameter. In other words, when new craters, which produce additional surface pulverization, are consistently formed over and near old craters in an increasing proportion, the regolith grows in depth. It would be obvious to the observer that the depth of the regolith, especially in the highlands, could not have been produced by the existing visible craters alone.

There are exceptions and extremes in regolith depths. In one lunar location, the Taurus -Littrow Valley on the southeastern edge of Mare Serenitatis, extreme depth variations have been detected ranging from 6.2 to 36.9 meters (Taylor, 1982h) In a few exceptional instances, regolith has not accumulated to any significant degree or not at all on some inclines along crater walls or on sheer rocky outcrops.

11. Regolith – When is it Soil? When is it Dust?

There is a difference between lunar "soil" and lunar "dust." This difference is promulgated on the size of the pulverized and weathered grains and impact melt fragments in a given sample. As reviewed above, the overall average lunar regolith grain (including melt fragments) size is ~70μm. There seems to be a general agreement that the uppermost regolith surface is also covered with nearly pure dust with a grain size >~20 μm (McKay, et al., 1991f). This extremely fine, dusty grain makes up about 10-20 wt% of the regolith (McKay, et al., 1991g).

The dust layer has varying reported depths or thickness, but probably averages somewhere between 5cm to 10cm thick. Heiken believes there is a relationship between the increased overall total regolith depth and the accumulation of finer (dust) grains on the surface (McKay et al., 1991h). The top layer of lunar dust could consist of grains as small as >1 μm and as small as grains considered as ultra-fine at <0.01μm (Park, J., et al., 2006b).

One needs to take into consideration that the larger regolith grains tend to sink into the lower stratum, a result of what is called soil mechanics, whereas the heavy-density soil grains sink downward to leave the very finest grains on the surface (Ostrach & Robinson, 2010a). Ostrach and Robinson worked with soil particle density in their well-known "Brazil Nut" experiments, which supported the idea of density sorting, which leads to having the finest particles on the surface (2010b).

12. Properties of Lunar Dust

The properties of lunar dust are best described as loose and fluffy and thus liken to talcum powder. However, that is where the comparison stops. Unlike the talcum we all know, this dust is hard and abrasive instead of soft (Spudis, 2009). While it may look soft and fluffy, you would not want to get this dust on your skin and definitely not into your lungs for any length of time.

If you have ever worked with Portland Mortar Mix and let it smoothly slip between your fingers, you know how the grains are silky and super fine. However, the mortar mix grains are much larger in size with an average of ~ 90μm, in comparison to lunar dust grains, which can be from ~20μm down to ~1μm or even 0.01μm in size.

This dusty lunar powder has been generated by billions of years of bombardment by micrometeorites of less than ~ 1mm and impacting at speeds estimated to be 10-30 km/s. Even with the very small size of the micrometeorites, enough energy is generated to melt the impacted regolith and produce glassy melt fragments of extremely small, hard, abrasive particles of 1 μm or less.

Dust, then, is defined as the finest component of the regolith. McKay and Halekas describe the dust as grains of <20 μm or less (McKay et al., 1991i; Halekas et al., 2006b). Spudis believes the uppermost few centimeters of regolith is a little greater than ~10μm and the uppermost surface layer of regolith could consist of dust of > 1 μm (2006b). Katzan and Edwards also found that the lunar regolith consists of significant amount of grains of 1μm or less (1991). Lunar dust grains seem to range from less than 1μm up to 20μm.

A curious finding about lunar dust was made during the Apollo flights. Lunar dust has a distinct smell. It is well known that the space suits of Apollo crews were covered with lunar dust, which was then transported into the lunar module. The dust was released into the module and breathed in by the astronauts. The crews reported the dust had a smell like gun powder (Halekas et al., 2006a). Fortunately, due to the small amount of dust and the short duration of exposure, the astronauts were not harmed.

13. Conclusion

As one studies the lunar regolith, one quickly finds it to be extraordinary in what it is and in the way it is produced. The lunar regolith comes in all shapes and sizes, including boulders, rocks, sandy grains, and dust, all with graduated layer depths and distributions. The concoction that covers the Moon's surface has resulted from billions of years of persistent meteoritic impacts and is part of a unique type of space weathering that also includes ionizing radiation from solar winds, solar flares, and cosmic rays. From the fear that a lunar module might sink into a parched quagmire of dust and rubble, to problems for astronauts and possible malfunctioning of their equipment and instruments, the lunar regolith has been a stimulating topic to those interested in the Moon for many years. Our knowledge of this subject has grown steadily from research leading to and following the Apollo landings and up to the present day.

Those interested in investigating the regolith in more detail should avail themselves of such books as Heiken's **Lunar Sourcebook: A Users Guide to the Moon**, Taylor's **Planetary Science: a Lunar Perspective**, and Paul Spudis' **The Once and Future Moon.** These volumes are excellently written and a treasure trove of information on the Moon's regolith and a myriad of other lunar topics. There are also numerous journal articles and presentations available for more in depth study.

Our Moon is indeed a captivating world that does not follow or need to follow our Earth-generated conceptions. It presents a true challenge and investigative adventure to those who have chosen to study it. Slowly, the mysteries are being revealed about our puzzling and fascinating companion world.

Acknowledgement

The author would like to thank Dr. Timothy Stubbs for his content review and supportive suggestions. His willingness to sure his knowledge was invaluable.

Note 1

Boulders are > 200mm (8 inches) in diameter – in turn, rocks are considered < 200mm in size.
≈ means approximate or the same.
~ means a poorer approximation but in the same order or size.
μm is a micron or 1 millionth of a meter
Å (angstrom) is a unit of length equal to 0.1 nanometer or 1×10^{-10}

Note 2

A meteoroid (classification) can range from a few microns in diameter to meters, perhaps up to 10m to 100m in size. All are of asteroid origin.

An asteroid (classification) can range from a few microns in diameter up to 1000 m or more in size.

Asteroids are most likely to be in an orbital path, mainly between Mars and Jupiter.

Meteoroids and asteroids are basically made from similar compositions with up to 75% being carbonaceous in nature.

Comets are an icy, small solar system body that, when close enough to the sun, display a visible coma and (sometimes) a tail. Comet nuclei are them-selves a loose collection of ice, dust, and small rocky particles. (According to NASA guidelines, a comet must be at least 85% ice.) Comet size ranges from a few hundred meters to tens of kilometers across. Comets travel in orbits that generally take them close the sun and then into the far reaches of the solar system. Comets that have had all their volatiles vaporized by the sun's radiation pressure and solar wind can appear as asteroids.

REFERENCES:

Bates, R.L. & Jackson, J.A., (1980). The glossary of geology. 2nd. Ed. American Geological Institute, 751.

Carrie, W., (2005). The four things you need to know about the geotechnical properties of lunar soil. Lunar Geotechnical Institute, 1. Retrieved from: http://www.lpi.usra.edu/lunar/surface/carrier_lunar_soils.pdf

Carrier, W., Olhoeft, G., & Mendell, W. (1991). Lunar sourcebook: A user's guide to the Moon, Chapter 9, Physical properties of the lunar surface. Cambridge University Press. 478.

McKay, D., Heiken, G., Basu, A., Blanford, G., Simon, S., Reedy, R., French, B., & Papike, J. (1991a). Lunar sourcebook: A user's guide to the Moon, Chapter 7, The lunar regolith, Cambridge University Press. 285.

McKay, et al., (1991b). 286. McKay, et al., (1991c). 315. McKay, et al., (1991d). 315.

McKay, et al., (1991e). 287. McKay, et al., (1991f). 478. McKay, et al., (1991g). 478.

McKay, et al., (1991h) 321. McKay, et al., (1991i). 478.

Halekas, J., Delory, G., Stubbs, T., Farrell, M., Vondrak, R., & Collier, M. (2006a). Lunar electric fields and dust: Implications for in situ resource utilization. Presentation: Space Resources Roundtable VII. October 31-November 2.

Slide12. Retrieved From: http://www.isruinfo.com/index.php?page=srr_8

Halekas, J., Delory, G., Stubbs, T., Farrell, M., Vondrak, R., & Collier, M. (2006b). Lunar electric fields and dust: Implications for in situ resource utilization. 2. Retrieved From: http://www.isruinfo.com/index.php?page=srr_8

(dust size)

Katzan, C. M. & Edwards, J. L. (1991). Lunar dust transport and potential interactions with power systems components. NASA Contractor Report 4404. 32.

Krätsghmer, W., & Gentner, W. (1977). A long term change in the cosmic ray composition: studies on fossil cosmic ray tracks in lunar samples, Philosophical Transactions of the Royal Society. Vol. 285, No. 1327, 593.

Li, L. & Mustard J. F. (2005). On lateral mixing efficiency of lunar regolith, Journal of Geophysical Research., Vol. 110.11.

Neal, C. R., (2005). The importance of establishing a global lunar seismic network. Presentation Paper. Meeting of NASA's Lunar Exploration Analysis Group (LEAG).

Ostrach, L. R. & Robinson, M. S. (2010a). Effects of seismic shaking on grain size and density sorting with implications for constraining lunar regolith bulk composition. 1-2. Retrieved From: http://www.lpi.usra.edu/meetings/1psc2010/pdf/2521.pdf Ostrach, L. R. & Robinson, M. S. (2010b). 1-2.

Ostrach, L.R., Robinson, M. S., Denver, B. W., Thomas, P. C. (2011). Effects of incidence angle on crater counting observations. 1-2. Retrieved From: http://www1pi.usra.edu/meetings/1psc2011/pdf1202.pdf

Park, J., Liu, Y., Kihm, K., Taylor, L., Micro-morphology and toxicological effects of lunar dust. (2006a). Lunar and Planetary Science XXXVII. 1. Retrieved from:
http://www.lpi.usra.edu/meetings/lpsc2006/pdf/2193.pdf Park, J., et al., (2006b) 1.

Rickman, D. & Street, K.W., (2008). Expected mechanical characteristics of lunar dust: A geological view, Proceedings of the Space Technology and Techno-logy Center. 3. Retrieved from http://isru.msfc.nasa.gov/lib/Documents/PDF Files/ NASA_TM-2010-216781.pdf

Schrader, C. M. (2010). Lunar regolith simulant guide.7 Retrieved from: http://isru.msfc.nasa.gov/lib/.../ NASA_TM_2010_216446_SimUserG.pdf

Spudis, P., (1996). The once and future Moon. Smithsonian Institution Press. 89.

Spudis P., (2009). The Deadly Dust of the Moon - The Once and Future Moon

Retrieved From: http://blogs.airspacemag.com/moon/2009/04/the-deadly-dust-of

Spudis P., (2006a). The lunar environment: Asset or liability? Slide 21. Retrieved From: http://www.spudislunarresources.com/ Papers/Spudis%20Lunar%20

Spudis P., (2006b) Slide 21.

Stubbs, T., Vondrak, R, & Farrell, W. (2005) Impact of dust on lunar exploration. Solar System Exploration Division, NASA Goddard Space Flight Center. 239. Retrieved From: http://www.scribd.com/doc/19748917/Impact-of-Dust-on-Lunar-Exploration

Stubbs, T., Vondrak, R, & Farrell, W. (2006). A dynamic fountain model for lunar dust. Advances in Space Research. vol. 37, 59-66.

Taylor, L. A. (2008a). Formation and evolution of lunar regolith. Planetary Geosciences Institute, Department of Earth and Planetary Sciences, The University of Tennessee. 1. Retrieved From: http://www.lpi.usra.edu/meetings/lpsc2008/pdf/1346.pdf

Taylor, L. A. (1982a). Planetary science: A lunar perspective. Lunar and Planetary Institute. 119.

Taylor, L. A. (1982b). 155-157. Taylor, L. A. (1982c). 155. Taylor, L. A. (1982d). 155.

Taylor, L. A. (1982e). 155. Taylor, L. A. (1982f). 158. Taylor, L. A. (1982g). 116.

Taylor, L. A. (1982h). 119.

Wikipedia (2011). Figure 4 Space Weathering. Retrieved From: http://en.wikipedia.org/wiki/Space_weathering Under the Creative Commons Attribution-ShareAlike License

Wilcox, B. B., Robinson, M. S. P. C. Thomas, P. C., & Hawke, B R. (2005).

Constraints on the depth and variability of the lunar regolith. Meteoritics & Planetary Science 40, Nr 5, 695–710.

Young R. A. (1975). Mare crater size-frequency distributions: Implications for relative surface ages and regolith development. Proceedings, 6th Lunar Science Conference. Vol.3. 2645–2662.

Editor's comments: Many thanks to **Ron Brooks** for this in depth article. We cannot deal with moondust if we don't know what it is and how it behaves. For Lunar Pioneers, that will be job #1. **RB**

• **Ron Brooks** is a new Director of the Moon Society, and brings with him 39 years of experience as an educator. This is his 2nd major article in MMM. In the May MMM #245, he contributed a very informative article about lunar "**Mascons."**

==========

Learn more about "moondust" / "regolith"

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

http://www.space.com/6598-moon-dust-worse-apollo-missions.html

"What a little moon dust can do" - http://www.wired.com/science/space/news/2005/04/67110

The curious smell of moondust - http://www.nasa.gov/exploration/home/30jan_smellofmoondust.html

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

http://www.merriam-webster.com/dictionary/regolith

http://www.thefreedictionary.com/regolith

http://www.moonminer.com/Lunar_regolith.html - Dave Dietzler's page

http://curator.jsc.nasa.gov/lunar/letss/Regolith.pdf

http://www.universetoday.com/59106/regolith/

http://www.spacegrant.hawaii.edu/class_acts/RegolithTe.html

RB

SPACE DEBRIS and its Mitigation

By **Sourabh Kaushal*** and **Nishant Arora*** -
*III Year, B. Tech, Department of Electronics & Communication Engineering
*Institute of Science & Technology, Klawad, Haryana, Email: ers.arora.kaushal@gmail.com

***Abstract* -**: Space debris has become a growing concern in recent years, since collisions at orbital velocities can be highly damaging to functioning satellites and can also result into more space debris. Some spacecraft, like the Inter-national Space Station, are now armored to deal with this hazard. Armor and mitigation measures make satellites or human spaceflight vehicles like the shuttles very expensive and heavy. This paper is a semi-technical survey of the expanding literature of the subject. The paper explores the different sources and mitigation methods of Space Debris. We have proposed some methods to deal with this problem of space debris. We have also highlighted the shortcomings of some of the proposed methods found in the literature and we have further proposed some modifications in some of those methods. We feel some of them can be very effective in the process of mitigation of space debris; few of them may need some modifications.

The paper proposes the use of **nanobot** and **nano-tube mesh technique**, the use of **decayable material** for manufacturing of space machines and we suggest the **proper segregation and decomposition of the space debris** and use of some it for **energy generation** and **space structure** also.

Keywords: Space debris mitigation, orbit, nano mesh, nanobots and fuel cell.

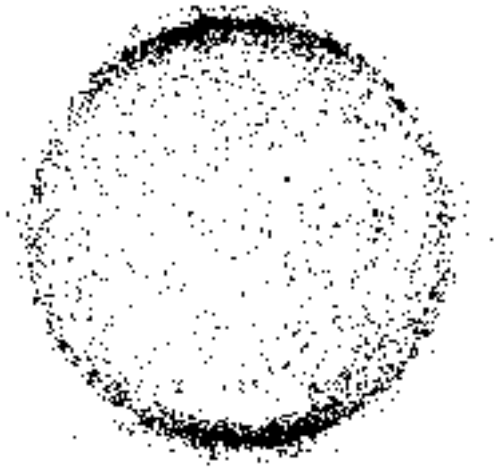
I. INTRODUTION

With the space travel gaining importance, space debris mitigation has assumed a lot of significance. Wikipedia [1] defines “Space Debris” as the collection of objects in orbit around Earth that were created by humans but no longer serve any useful purpose.

Space debris is basically all space objects nonfunctional and human made, that include fragmentation debris (42%)- break ups of satellite, unused fuel, dead batteries, rocket bodies (17%), mission-related debris (19%), non-functional spacecrafts (22%) [2]. These objects consist of everything from spent rocket stages and defunct satellites to explosion and collision fragments. The debris can include slag and dust from solid rocket motors, surface degradation products such as paint flakes, clusters of small needles, and objects released due to the impact of micrometeoroids or fairly small debris onto spacecraft. As the orbits of these objects may overlie the trajectory of spacecraft, debris is a potential collision risk [2].

This space debris is very hazardous if it impacts a spacecraft or even a space-walking astronaut. No one with a venture in the future of outer space would dispute the fact that near-Earth orbit has become increasingly populated with man-made junk and hence, the probability of accident due to this has grown to very high level.

There are approximately 15,000 pieces of space debris in Earth’s orbit that are larger than three inches and can be currently detected. And there are probably millions or even billions of smaller pieces of space debris, which can not be detected. Despite the size of these objects, they all have the potential to be mortal because of the speed that they are traveling, especially since most space debris are traveling hundreds or thousands of kilometers per hour [3].



(d) Damage to other exposed shuttle surfaces [10].

C. Effects of space debris on human space operations

In order to protect crews from debris during flight, operational procedures have been adopted. In the case of the Space Shuttle, the orbiter is often oriented during flight, with the tail pointed in the direction of the velocity vector. This flight orientation was adopted to protect the crew and sensitive orbiter systems from damage caused by collisions with small debris [10].

VI. SPACE DEBRIS MITIGATION MEASURE Avoidance of debris generated under normal operation

A. Mission-related objects

Approximately 12 per cent of the present catalogued space debris population consists of objects discarded during normal satellite deployment and operation. It is normally relatively easy, both technically and economically, to take mitigation measures against these objects.

Solution Clamp bands and sensor covers should be retained by parent bodies, and all fragments of explosive bolts should be captured [10]. This kind of debris can be minimized by adoption of proper construction or manufacturing techniques.

B. Solid rocket motor effluents, paint and other exterior materials

Other mission-related particles may be generated unintentionally, as in the release of slag during and after the burn of solid rocket motors. The precise nature of the amount and distribution of these slag ejecta are unclear, and the improvement of solid propellant and motor insulation to minimize the released solids is difficult.

Solution The application of more long-lasting paint and protective covering could be an effective remedial measure.

C. On-orbit explosions

Thirty-six per cent of all resident space object breakups are upper stages or their components that operated successfully but were abandoned after the spacecraft delivery mission was completed. Accidental explosions can also be caused by malfunctioning propulsion systems, overcharged batteries, or explosive charges. Intentional break-ups have also been conducted.

Solution Avoidance is the best solution for this problem and again proper manufacturing techniques should be adopted.

D. Reentry

Old satellites are now starting to be returned to Earth where they will hopefully completely burned up in the atmosphere or crash into unpopulated areas. However, some satellites, such as the Hubble Telescope, have no such plans for removing them from orbit. Another piece of space debris could hit these satellites, cause an explosion, and create millions of more pieces of space junk. These pieces of space debris could literally become dangerous and lethal shrapnel

Limitation Since it is not economically feasible for a spacecraft to pick up all the pieces of space junk, then we recommend a laser that could vaporize or redirect space debris back to Earth. This laser would probably be most easily installed on the International Space Station, since it will need a huge supply of power that we think the space station could be upgraded to provide. Since only large objects can be detected and redirected by the laser, this solution would be limited.

E. JUNKYARDS

Instead of tossing trash away in space, like what was recently done onboard the International Space Station, use waste to create huge orbit junkyards surrounding the space station for additional shielding. These junkyards would additionally be storage locations for resources that future space missions could use if needed.

Limitation Junkyards can prove beneficial only in the case of larger space debris. This method can't be used to serve the storage purpose for small space debris.

VII. PROPOSED METHODS

A Use of Decayable material in manufacturing of space machines

As we know that man- made space debris is mainly due to the defunct satellites and other space machines. The satellites and other space machines remain as it is in the space and serve no purpose after they become defunct. So they are just a kind of waste in space. we propose that the satellites and other space machines should be manufactured with some decayable material instead of non-decayable material like metal, plastic etc. We mean to say that the satellites and other space machines should decay themselves in space after they become defunct. We know this is a difficult method but it can really solve the problem of space debris.

B The Use of Nano Tubes by creating a mesh:-

In this technique we will use the nano tubes. We will create a mesh that will act as a touch panel of the touch screen cell phone. When any small or tiny particle will come on this mesh and touch it then the mesh will act as a touch panel and so that the corresponding processor or sensor will come to know the co-ordinates of it then further by using Destructive laser beam we can destroy that particle.

For this type of mesh we are going to use the bunch of the Nano tubes(as per need) for creating the single thread of the Nano mesh. In this we planned to implement the technique of the RESISTIVE TOUCH PANNEL. The working of this panel is just similar to the working of the resistive touch panel that presently we are working in the Touch Screen Cell phones.

Whenever the particles dashed the panels the place where the particle dashed there resistance reduce from infinity to some vale. And current will flow from the point of touch between the two meshes. This is how the processor will get its co-ordinate and further action will be taken.

For making the meshes we use the CNT because of its properties. CNT have been constructed from lengthto- diameter ratio 132,000,000:1 as compared to other materials. CNT is the strongest material yet discovered in the terms of strength. Mainly we have to use the multiple nanotubes as MNT consist of multilayer rolled of graphite. Having good strength as compared to other material. Moreover CNT is better than stainless steel, good electrical property, which help us in the process.

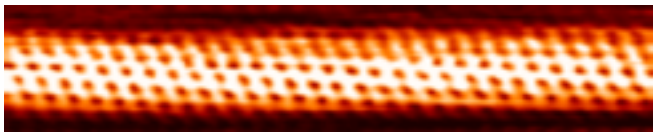


Fig. 3 Single walled CNT

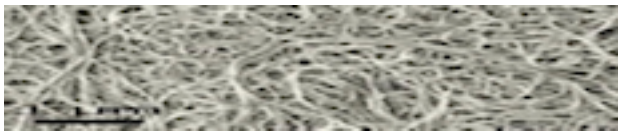


Fig.4 CNT bundles (explains the upper process)

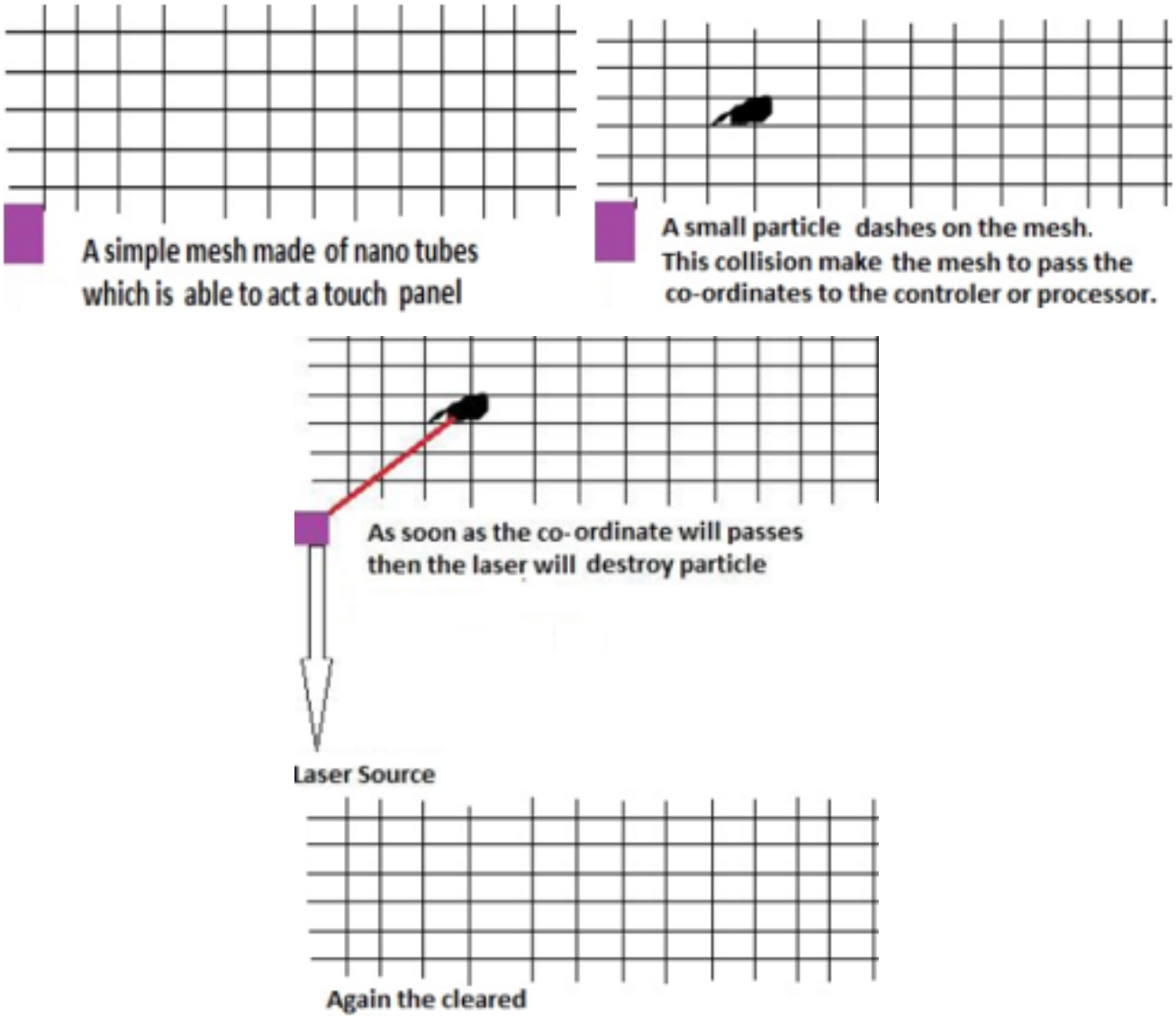


Fig. 5 explains the upper process

C Use of the Nano tubes and Nano Bots for the collection of the Space Debris:- In this method also we will use a nano mesh, which is made up of the nano tubes and the corresponding arrangement will be done so that that mesh will act as a touch panel same as that of the touch screen phones. So when tiny particles will dash on the nano mesh then the Nano Bots, which will be at the specific co-ordinates, collect the particles and store them into the garbadge storage. Today the Nano robots are used for

various medical treatments. But here we will use the Nano robots as a carrier. When the tiny particles from the space will get entangled into the mesh and corresponding will be sent to the processor then the nano robots will go to the specific location. These nano robots will be programmed to collect the particles and placed it into the storage. One point here we have to notice that the size of these Nano Robots wont be at nano level it must be greater normally visible to our eyes at least because we want these robots to picked up the particles and move them to the storage. But the accuracy of these robots must be that much sufficient so these robots wont leave any particle behind.

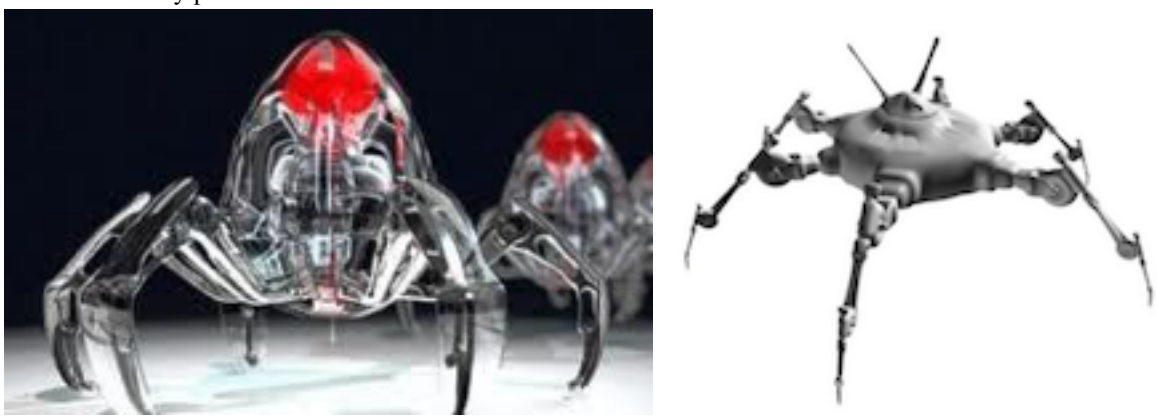


Fig. 6 Nanobots

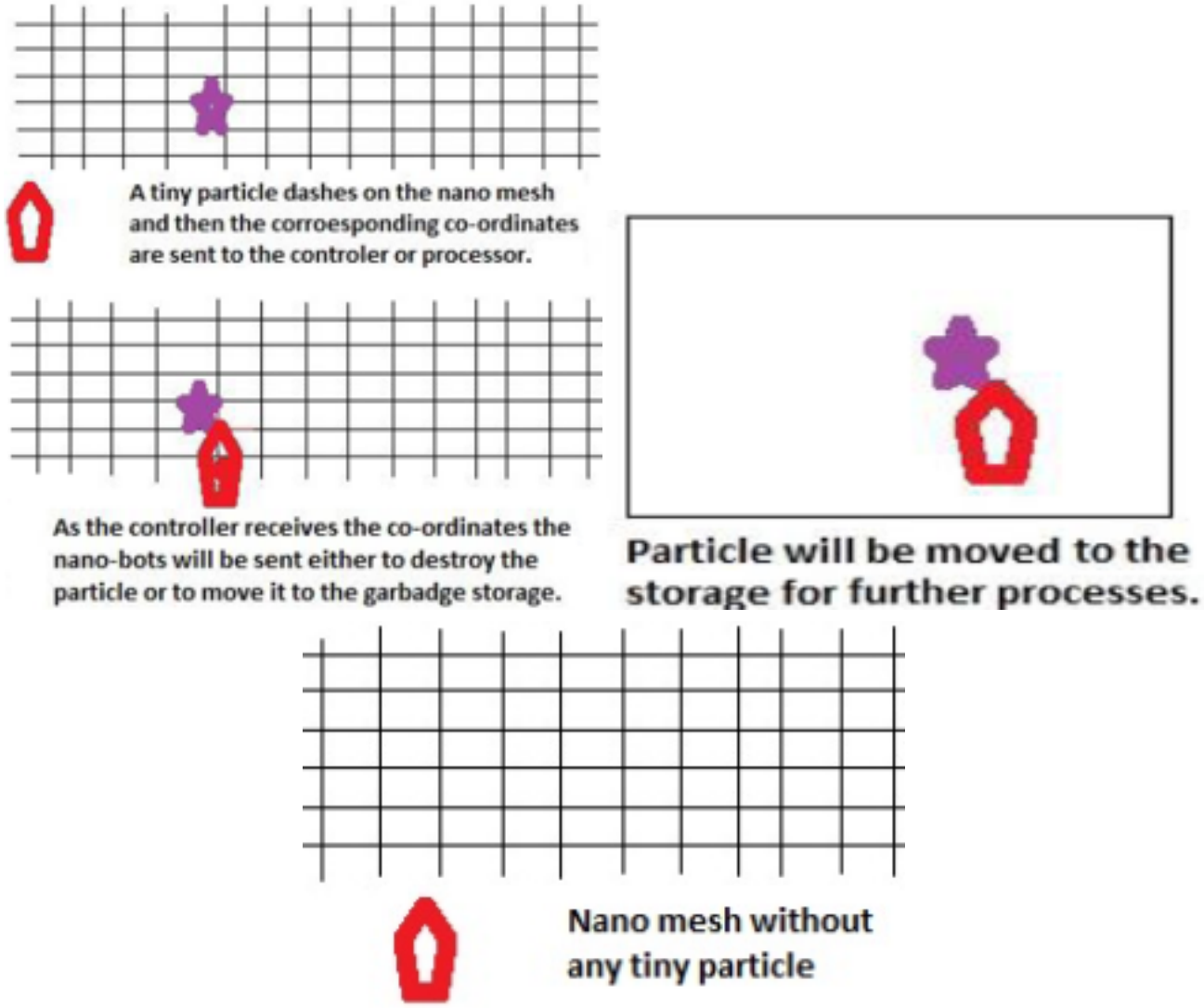


Fig.7 Explains the process

D. Further the space Debris can be use for the other purposes too:- As we know that the space debris can be any tiny particle in the space. So instead of decomposing that particles or destroying it we can use those particles for the purpose of energy production by using the fuel cells, but for this the one condition is that the particle material should be capable of forming the ionize liquid or solution, which can be successfully use in the fuel cell for energy production. But this is useful for only the big projects where in smallest amount of energy has also the great demand or value.

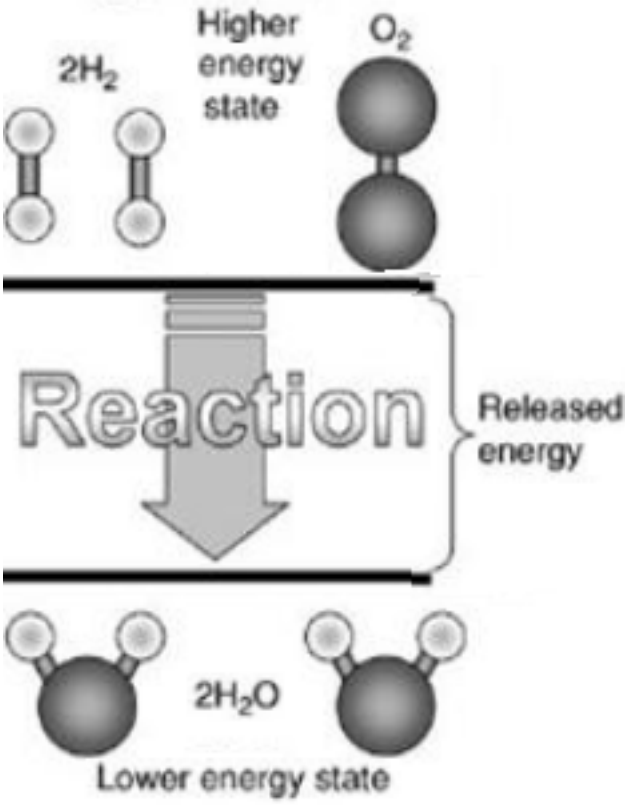


Fig. 8 working of fuel cell

E. RECYCLING OF SPACE DEBRIS

The general idea of making space structures by recycling space debris is to capture the aluminum of the upper stages, melt it, and form it into new aluminum structures, perhaps by coat

ing the inside of inflatable balloons, to make very large structures of thin aluminum shells.

VIII. CONCLUSION

Space debris has become the topic of great concern in recent years. Space debris creation can't be stopped completely but it can be minimized by adopting various measures. Many methods of space debris mitigation have been proposed earlier by many space experts, but some of them have limitations. After some modification those measures can proved beneficial in the process of space debris mitigation.

We have proposed some new methods of space debris mitigation in this paper, which include use of decayable material, and a nanobot and nanotube mesh technique. Moreover we have to use it for energy purpose or the making of space structures. We end this paper by appealing that "We have already polluted our own planet earth; we should now ensure that the space is kept least polluted for our own safe exploration of the outer space and also for the safety of aliens from other planets if they happen to exist."

References:

[1]Oswald, Mube S. Stabroth, C. Wiedemann, P. Wegener and C. Martin: "Upgrade of the MASTER Model", Final Report of ESA Contract No. 18014/03/D/HK(SC), Braunschweig, 2006.

[2] http://en.wikipedia.org/wiki/Space_debris

[3] http://www.philforhumanity.com

[4]Fred Whipple, "The Theory of Micro- Meteorites, Part I: In an Isothermal Atmosphere", *Proceedings of the National Academy of Sciences*, Volume 36 Number 12 (15 December 1950), pg. 667-695

[5]Whipple, Fred. "The Theory of Micrometeorites."*Popular Astronomy*, Volume 57, 1949, p. 517.

[6]Kessler, Donald. "Upper Limit on the Spatial Density of Asteroidal Debris." *AIAA Journal*, Volume 6 Number 12, December 1968, p. 2450.

[7]Hoots, Felix, Paul Schumacher Jr. and Robert Glover. "History of Analytical Orbit Modeling in the U. S. Space Surveillance System." *Journal of Guidance Control and Dynamics*, Volume 27, Issue 2, pp. 174–185.

[8] http://orbitaldebris.jsc.nasa.gov/newsletter/pdf s/ODQNv13i2.pdf

[9] http://www.iafastro.net/index.php?id=558

[10]Technical report on space debris (PDF). United Nations (1999). Retrieved on 2006-04-05. ISBN 92-1-100813-1

[11]April 2010 "IEEE SPECTRUM"-SPACE INVADERS VOLUME-7 PP35-39

[12] http://orbitaldebris.jsc.nasa.gov/protect/shiel ding.html

[13] http://orbitaldebris.jsc.nasa.gov/protect/prote ction.html

Editor: We thank Sourabh Kaushal and Nishant Arora, 3rd year Bachelor of Technology students from Haryana State for this fine paper. Space Debris has been a major concern of ours for over two decades and this paper gives it the attention it deserves and avoids the trap of believing that one simple solution can tackle the problem. As the authors point out, we need both strict preventative measures as well as a variety of debris remediation techniques. **PK**

Desolate, Lifeless, Unforgiving: Is the Moon too Forbidding a Challenge?

By Peter Kokh

Why many space enthusiasts are more interested in Mars

Many space enthusiasts see Mars as a more attractive goal than the Moon, despite Mars' much greater distance, and the much harder to reach at very limited travel opportunities.

- **Mars has color:** its pallet is not one of unrelieved light to dark gray tones.
- **Mars sky is bright, not black**, and even though it is not blue that brightness surely helps one's mood.
- **Mars' day is the same length as ours**, almost – just 37 minutes longer and that may be easy to get used to (especially for late sleepers)
- **Mars may be cold, but it is never life-squelching hot.** Mars has an atmosphere, not the kind one can breath, but thick enough to provide shielding from the meteorite rain that is a constant "weather" condition on the Moon
- **Mars air can be mined** for nitrogen, oxygen, methane and other basic organic feed stocks. While the air pressure is very low, less than 1% Earth normal, there is much more CO2, the major ingredient of Mars air, locked up in the polar caps, and it appears to be a feasible goal to use various methods to thaw those ices to raise the pressure significantly.
- **Mars also has a large ocean-like basin**, suggesting possibilities for terraforming Mars into a more Earthlike place. No matter that these possibilities are far-off options.

The Moon, in contrast, has no atmosphere to speak of, and if we were to create one, we'd have a "dustbowl from hell" for millennia. The Moon may be nearby, but it seems to unforgiving, too unattractive.

Getting past appearances: Any "disadvantage" should be approached as "an opportunity in disguise"

This maxim was a lesson learned from my mother in my early teens. I was helping her redo a room in our home and commented, "If that radiator were not where it is!" To which she replied, "Well, keep looking at it until you figure out how we can turn its position into an opportunity!" And soon we did so. This experience transformed my life, and still gives soul to everything I write as well as to how I am able to turn every crisis in my life into something unexpectedly good.

Optimism (Latin "best") is useless.

Pessimism (Latin "worst") is useless.

Meliorism (Latin "better") is the only attitude that works. Whatever the situation, whatever the facts, we can take the situation and make things better!

Once you try this tack a few times, it takes over your life. Why? Because it works every time. Because it is the only "attitude" that has the power to produces better results. This applies not only to how we see the physical world, but how we fare in the human world that we all have to share.

Is the Moon a wasteland?

"There is no such thing as waste, there are only resources we are too stupid know how to use."

Arthur C. Clarke – to Walter Cronkite during launch of Apollo 13

The Moon: Just the "facts" - one by one

• Challenge: The airless surface is exposed to constant pulverization

√ micro-meteorite bombardment,

√ cosmic rays, and periodic solar flares.

√ Temperatures vary from very very hot to very very cold because the Moon is airless, and the day night cycle is so long (28.53 Earth days long).

√ The surface has been pulverized into a moon dust blanket 2-10 meters thick.

(See Ron Brooks very informative 3-part article in MMM #250, #251, with part 3 in this issue above.)

> **Opportunity: We can tuck our habitat structures under that blanket** (2 meters is enough for short tours of duty, 5 meters best for lifetime stays) and be fully protected not only from micrometeorites, radiation and solar flares, but also from the extreme dayspan heat and nightspan cold. Being underground, we can use heat pumps to store excess dayspan surface heat to use for nightspan heating, and conversely, to store surface nightspan cold for dayspan cooling. See link below:

http://www.moonsociety.org/home-page/center-column/changing-images/showimage.php?image=89

• Challenge: The Moon's day-night ("dayspan/nightspan") cycle is too long 29 1/2 Earth days, the Sun being over the horizon for 14 3/4 Earth days, and below the horizon for an equal amount of time. One result is that solar power if available for just half a lunar month (since it is defined by the period of sunrise to sunset, not the Lunar month, perhaps we should call it the "sunth")

> **Opportunity: as the pole is not significantly inclined** to the orbit around the sun, there are no "seasons" so to speak, to provide variety of weather and break monotony. For the welcome biweekly change of pace see below.

 # Helpful Reading: "Dayspan" - "Nightspan" - "Sunth" pages 10-13 in

http://www.moonsociety.org/publications/mmm_classics/mmmc5_Jul2005.pdf

• Challenge: The Moon's long nightspans make industrial operations impractical

> **Opportunity: as the Moon's dayspans are equally long,** there is ample opportunity to store up power. It is absurd to think that having to store up power in one form or another is a handicap. Power storage has been the backbone of industrialization for thousands of years.

 # Helpful Reading: "Multiple Energy Sources" pp. 7-10 http://www.moonsociety.org/publications/mmm_classics/mmmc4_Jan2005.pdf

"OVERNIGHTING: Consummating the Marriage of Moon & Base" pp. 52-55
http://www.moonsociety.org/publications/mmm_classics/mmmc9_Jan2006.pdf
"Potentiation" pp 31-35
http://www.moonsociety.org/publications/mmm_classics/mmmc13_July2006.pdf

• Challenge: The Moon has been geological dead for billions of years and did not go through active geology and tectonic processes in the presence of water that created ore-rich lodes on Earth, helpful to mining.

> **Opportunity: the same bombardment which produced the meters-thick regolith moon dust blanket means that the Moon is essentially pre-mined:** no deep shaft mining, no landscape-scarring strip mining, Everything we want is in this handy pre-pulverized surface blanket

Helpful Reading: "**Moon Mining & Common Eco-Sense**" p. 60 and "**Moon Mining and Engineering Realities**" pp. 61-61 in **www.moonsociety.org/publications/mmm_classics/mmmc4_Jan2005.pdf**

• Challenge: The moon's vacuum means that we have to wear space suits or travel in pressurized vehicles outside our cozy underground complexes.

> **Opportunity:** our habitat areas can all be actually or virtually interlinked so that one can go almost anywhere without donning a spacesuit

 # Helpful Reading "Middoors" and "Matchport" pp. 14-15 in

http://www.moonsociety.org/publications/mmm_classics/mmmc1_Jul2004.pdf

Making do without the "outdoors" page 39 in

http://www.moonsociety.org/publications/mmm_classics/mmmc10_Jan2006.pdf

• Challenge: the lunar "sky" is black all the time. That will be hard on the eye, leading to black sky blues

> **Opportunity:** Both inside and "out-vac" there are ways to create a pleasant and comforting atmosphere

 # Helpful Reading: "M is for mole" http://www.moonsociety.org/chapters/milwaukee/mmm/mmm_1.html

"Black Sky Blues" (1) pp 57-59 http://www.moonsociety.org/publications/mmm_classics/mmmc14_July2006.pdf

"Black Sky Blues" (2) p 37, (3) p 56 http://www.moonsociety.org/publications/mmm_classics/mmmc18_Jan2008.pdf

also www.moonsociety.org/home-page/center-column/changing-images/showimage.php?image=12

Challenge: the Moon's gravity is too light

√ The human body will deteriorate physiologically during stays on the order of a year or more, and may not stabilize at an acceptable level; Infants born on the Moon may not develop or mature properly.

> **Opportunity: First,** one cannot legitimately argue from the physiological degradation that is experienced by many months in a space station at"zero G" that the same degradation will occur at 1/6th lunar gravity or at 3/8ths Mars gravity. No one has been on the Moon for more than a few days. We can do long term experiments with small animals in a rotating environment at or near the Space Station to learn more.

Second, it is precisely the Moon's lower gravity that makes the Moon economically vital as a supply of building materials for structures elsewhere in space (Low Earth Orbit, Geosynchronous Earth Orbit, Earth-Moon Lagrange points, even Mars - because it takes only 1/22nd as much fuel to reach such destinations from the Moon as it does from Earth's surface. The Moon's reduced gravity level is the foundation of its economic and industrial potential. **Mars in contrast**, (1) is at greatly variable distance from the Earth-Moon "system", (2) is handicapped by the infrequent travel windows to and from Earth, and (3) its greater gravity and deeper gravity well, also handicaps Mars in any economic rivalry with the Moon.

Third pioneers will develop sports - and even dance and skating forms that are unique and which may be very entertaining to watch by Earthbound fans.

 # Helpful Reading:

"Native Born" pp 34-36 www.moonsociety.org/publications/mmm_classics/mmmc5_Jul2005.pdf

"Hexapotency Toning Centers" pp 13-15

http://www.moonsociety.org/publications/mmm_classics/mmmc13_July2006.pdf

http://www.moonsociety.org/home-page/center-column/changing-images/showimage.php?image=45

• Challenge: The Moon is too poor in the volatiles needed both for life support (food, agriculture, biosphere) and serious industrialization

> **Opportunity: While is true that the Moon is impoverished in volatiles in comparison to Earth and even in comparison to Mars, it is not true that the Moon lacks an endowment large enough to both support human settlements and to industrialize.**

√ The solar wind buffeting the powdery regolith blanket of the Moon for billions of years has enriched the surface layer with hydrogen nuclei (protons), carbon, nitrogen, and with the noble gasses such as helium, argon, etc. These can easily be harvested while constructing roads, settlement sites, etc.

√ Previous **probes such as Clementine and Lunar Prospector** gave strong indications of water-ice and other cometary volatiles in "harvestable" abundance within permanently shaded north and south polar craters - confirmed by **Chandrayaan-1, Lunar Reconnaissance Orbiter and** its **LCROSS impactor**

 # Helpful Reading: Byproducts of Helium-3 and Hydrogen Solar Wind endowment harvesting

http://www.moonsociety.org/home-page/center-column/changing-images/showimage.php?image=45

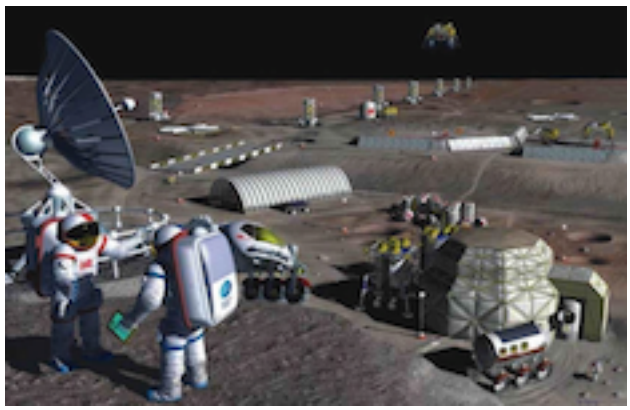
http://www.moonsociety.org/home-page/center-column/changing-images/showimage.php?image=59

'Gas scavenger" - pp 15-17 - http://www.moonsociety.org/publications/mmm_classics/mmmc3_Jan2005.pdf

"Primage" - pp 49-51 - http://www.moonsociety.org/publications/mmm_classics/mmmc4_Jan2005.pdf

PK

International Lunar Research Park Takes First Steps to Becoming Real



And this is just the beginning! **PK**

Phase 1 Earth-side Analog Prototype set to take shape on Hawaii Island

By Peter Kokh

"International Lunar Research Park" M3IQ #2 Feb 2009

www.moonsociety.org/india/mmm-india/m3india2_Winter09.pdf http://www.moonsociety.org/reports/beyond_nasa.html

The ILRP project has been adopted by **PISCES**, an international research and education center dedicated to the development of new technologies needed to sustain life on the Moon and beyond. - **http://pisces.uhh.hawaii.edu/**

PISCES stands for **Pacific International Space Center for Exploration Systems.** It was created in March 2007 as an official Center at the University of Hawaii at Hilo and was first funded by the Hawaii State Legislature in June 2007. The Center is being built on partnerships between industry, academia and the governments of space-faring nations around the world, but particularly those on the Pacific Rim,, which is geographically centered in Hawaii.

Background: PISCES

PISCES was conceived by the Japan-U.S. Science, Technology & Space Applications Program (JUSTSAP) under the auspices of the Hawaii's State Dept/ of Business, Economic Development & Tourism. Currently involved in this international venture are the State of Hawaii, Japan (JAXA), two NASA centers, Canada (CSA), and Germany (DLR). The collaboration is open to additional major international partners, such as India.

PISCES is being designed as **an international center** for aerospace education, astronaut training, and research and development of innovative space exploration systems to support future robotic and human missions to our moon, Mars and beyond. A major goal is to provide remote ground-based analog capabilities to assist in development, integration and testing of space exploration technologies.

The PISCES Vision: *A simulated Lunar Outpost on the Big Island with support programs/facilities statewide*

- Located on lunar-like terrain on volcanic soils.
- Supporting research and development, pilot-scale testing, technology demonstrations, astronaut training, human and robotic capabilities, visitor experiences and public education for space exploration and settlement.
- Hosting Japan-U.S. collaborative projects sponsored by public and private sectors in both countries.
- Learning to live off the land in a hostile environment.

PISCES will include:

- Research Laboratories, Solar Power Systems (grid-independent), Rover Terrain, ISRU Pilot Plants, Life Support Systems, Habitats, Communications Networks, Classrooms, International Visitor Center.
- Staff for Operations, Support, Research and Instruction, with Visiting Scientists.
- Machine Shops, Electronics Shop, Rapid Prototyping, Spare Parts, Living Quarters.
- Accessible to Users and the General Public.

Why Hawaii?

- Mid-Pacific location
- Unparalleled analog environment for lunar and Martian surface simulation

- International culture; ties with Asia-Pacific communities
- Strong and growing science and engineering at University of Hawaii at Manoa and Hilo
- Rapidly developing aerospace industry
- Credible simulations will provide opportunities to **develop/ test/evaluate new technologies, standardize space sub-systems and interfaces, and promote greater reliability and safety** in systems and operations (critical, given the remoteness/isolation of space exploration environments).

The selected location is on the slopes of Mauna Kea offers varied physical environments:

• Craters • Deep deposits of volcanic ash • Underground lava tube systems
• Long distance traverses • "Moon-like" and "Mars-like" terrain

Mauna Kea is also the site of a world-class collection of major astronomical telescopes including the Keck.
http://www.ifa.hawaii.edu/mko/telescope_table.htm - http://www.ifa.hawaii.edu/mko/
http://en.wikipedia.org/wiki/Mauna_Kea_Observatories

PISCES Votes to adopt the International Lunar Research Park Phase I (Analog Station) as its centerpiece

https://sites.google.com/site/internationallunarresearchpark/ - ***We encourage readers to visit the above page!***

The ILRP Vision: ***Been there but haven't done this!***

Overview - What?

- A revolutionary concept that could change the way we explore, develop and utilize space.
- Many nations coming together to pursue innovative space science, applications, commerce, and education toward establishing the first sustainable human presence beyond low-Earth orbit.
- The largest peaceful cooperative venture in space since ISS, but with much broader participation across all sectors of society.

Where?

- Beginning with a terrestrial prototype developed at PISCES1 in Hawaii.
- Migrating to the Moon via planned and future public and private robotic missions.
- Terrestrial Prototype replicated on the lunar surface.
- Beginning with a robotic village tele-operated from Earth, and leading to development of human-rated infrastructure supporting commercial, NASA, international tenants.

When?

- Terrestrial prototype development, 2012-2015.
- Robotic lunar migration, 2014-2018.
- Human occupation begins, 2019-2022.
- Timeframe aligns with 50th anniversaries of the first and last Apollo landings.

Why?

- The most cost-effective way to implement the "flexible path" to space.
- Meets overarching goals of U.S. National Space Policy: International/Commercial.
- Promotes STEM Education and massive public participation.
- Enables sustainable robotic and human space settlements beyond low-Earth orbit.

How?

• Developed through public-private partnerships/multi-national alliances.
• Terrestrial prototype funded by State of Hawaii, private consortium, NASA, other space agencies, non-profits, philanthropists.
• Lunar Park funded by many nations, companies and institutions.

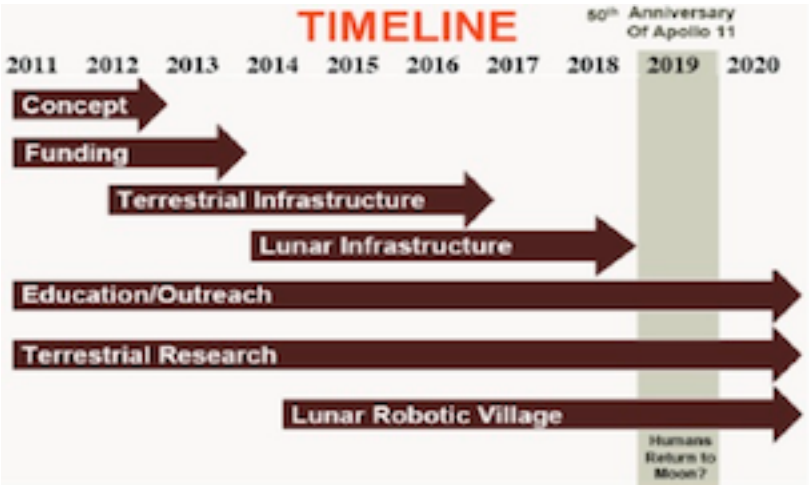
3 Phase Buildout - 1 Terrestrial Prototype in Hawaii - 2 Lunar Robotic Village - 3 ILRP on Moon

[The following is taken from AD Astra magazine (National Space Society) Fall 2011 issue, pp. 37-39]

"Going back to the Moon is a matter of harnessing existing technologies in innovative ways; breakthrough technology isn't necessary. This effort can be divided into three phases.

"**The first phase** uses terrestrial analogs like the one on the Big Island of Hawaii to demonstrate and validate the required technologies and concepts. The proposed ILRP would begin with the development of a terrestrial prototype for a multinational lunar base,

"**The second phase** leverages the investments from the Google Lunar X PRIZE teams and the capabilities of the traditional and emerging commercial space companies to go back to the Moon robotically, eventually setting up a "robotic village." These robots would prepare the site and develop the infrastructure to enable the third phase — a permanent human presence on the Moon."



Comments:

We (Peter Kokh and Dave Dietzler of the Moon Society had developed the "ILRP" concept *(same name)* a year and a half earlier. But whether PISCES got the idea from us, directly or indirectly, or independently, does not matter, and it is not important to us that any credit or mention is made.

We are absolutely delighted that an organization *that has access to resources* to make ILRP Phase I real is proceeding to "make it so." That is all that is important.

Meanwhile, Dave Heck of Moon Society St. Louis and of Boeing St. Louis, who gave a presentation on this concept at the 2009 International Space Development Conference (National Space Society) in Orlando, Florida, is actively participating with the working group endeavoring to set up ILRP Phase I in Hawaii. The Moon Society has been invited to participate in the process, and Dave Dunlop has accepted the role of keeping in touch with what the PISCES team is doing, and giving Moon Society input.

ILRP Partners: What about India and ISRO?

The PISCES team has asked the Moon Society to promote participation both in PISCES itself and in its Phase I ILRP Analog station project **by India and ISRO**. To us, this seems like "a marriage made in heaven." India has no lunar analog research program – *not yet!* Rather than starting a limited program from scratch, India's participa-tion in PISCES and its ILRP Phase I program could lead to India's participation in a real International Lunar Research Park proposed for the Moon. Individual national lunar outposts are far less likely to see the light of day, or to accomplish research that leads to the opening of a Lunar Frontier with pioneer's utilizing lunar resources in ways that benefit Earth, providing alternate energy resources and helping to preserve Earth's fragile and threatened environ-ment. India's considerable progress in recent decades is testimony to its talents, achievements and ambitions.

Go-it-alone national lunar outposts will be much more likely to fail for budgetary reasons and for lack of public support. The history of the International Space Station shows that endeavors founded on international partnerships are ***much less likely to fail*** or to be cancelled.

Whether India chooses to participate in ISS or not, we can see many ways that India's space program can benefit and thrive by participation in the PISCES ILRP Phase I project on the slopes of Mauna Kea on Hawaii Island, joining Japan-JAXA, Canada-CSA, Germany-DLR, the State of Hawaii, and US-NASA in a project that has the best chance of leading to an **International Lunar Robotic Village** on the Moon itself, that in turn has the best chance of morphing into *a permanently crewed International Lunar Research Park* - on the Moon!

Creating a Foundation in Hawaii for "The Next Giant Leap" PISA*, PISCES, and ILRP

* Pacific International Space Alliance

Pacific International Space Center for Exploration Systems - International Lunar Research Park

By David Dunlop - January 2, 2012

Background:

"The State of Hawaii, host of the Japan-US Science, Technology & Space Applications Program (JUSTSAP) Conference, recently launched the Pacific International Space Alliance (PISA) – a public-private partnership to facilitate multinational collaboration on both robotic and human missions to space. Designed to reduce the costs and enhance the benefits of future space exploration, this dynamic coalition is now collaborating with NASA and the Pacific International Space Center for Exploration Systems (PISCES – also headquartered in Hawaii). A principal goal of PISCES is to advance robotic space exploration and enable a sustainable human presence beyond low-Earth orbit through development of an **International Lunar Research Park (ILRP)** that will provide multiple scientific, educational and commercial benefits to the US and nations worldwide"

https://sites.google.com/site/ilrpexploratoryworkshop2011/invitation-letter

A Changing Situation:

For the present the US is buffeted by economic difficulties and that has created a financial retreat for NASA and its budget for exploration. Budget reductions of perhaps 10% at NASA may hobble many programs and diminish forward momentum.

But hold the fort! The dreams and plans for returning to the Moon do not begin and end only with NASA. The **Japan-US Science Technology and Space Applications Program** (JUSTSAP) is a 21- year initiative of the U.S.-Japan Leadership Council and has lead to the **Pacific International Center for the Exploration of Space (PISCES)** (1).

In 2010 the Steering committee decided to broaden the organization beyond it founders, Japan and the US to include other space faring nations around the world. A partner support organization was created and named the "**Pacific International Space Alliance" (PISA).**

Their 3-phase program is to initiate **a Terrestrial Prototype International Lunar Research Park as Phase I** with the participation of many identified stakeholders: (2)

1 Pacific International Space Alliance: PISA
2 University of Hawaii and Other Universities through Universities Space Research Association: USRA
3 Hawaii Legislature and Administration through the Office of Aerospace Development
4 Other States and Science Related Agencies
5 National Aeronautics and Space Administration: NASA
6 National Science foundation: NSF
7 Department of Energy: DOE
8 Department of Education: Do Ed
9 Japanese Space Agency: JAXA
10 Canadian Space Agency: CSA
11 German Space Agency: DLR
12 European Space Agency: ESA
13 Other International Space Agencies
14 Space Industry Prime Contractors
15 Other key partners (Caterpillar, Battelle)

International Trends

The International Space Exploration Coordinating Group also represents the major space faring and economically powerful nations of the G-20 countries. The involvement of this broad spectrum of organizations reflects the vision of an international, governmental, university, and commercial industrial collaboration which will be required to achieve Phase II A Lunar Robotic Village, and Phase III Long Term Human Occupation of the Moon. A Program of Permanent Human occupation will serve a diverse number of purposes. These range from further scientific exploration, industrial & commercial development and utilization, tourism, and other activities reflecting the full extension of human culture to the Earth's satellite and a sustaining Human Settlement. The Moon is also seen as a staging ground for deep space destinations such as Mars, the asteroids.

This diversity of stakeholders is the key to sustaining a lunar initiative that will require decades of effort and geopolitical cooperation on a global scale. That this initiative is forming at a time of economic turmoil in the Japan, Europe, and the US is a sign of both economic necessity and political realism.

This vision is also in broad alignment with the Global Exploration Roadmap recently announced at the International Astronautical Congress in South Africa by 12 space faring nations although it is a product of the International Space Exploration Coordinating Group which is composed of 14 nations which include Australia and China (3). Together they can better face the formidable challenges of developing the infrastructure that will enable a permanent returning to the Moon, clean energy production in space, economic and industrial development, human settlement, and the significant extension of both robotic and human presence and communication systems to Mars, the Minor planets and asteroids. It should be noted that this Exploration Roadmap creates a much leaner infrastructure than would be otherwise required for significant industrial development but it nevertheless plants the seed of more robust development.

It should be noted that while South America is unrepresented by these agreements that the strong and growing movement of South American integration may well lead to another significant space faring agency in time building on the space development interests in Argentina, Brazil, and Chile. Similarly the African Union is studying an integrated approach to space development and some countries such as Algeria, Kenya, Tunisia, Nigeria, and South Africa feel that it just a matter of time before an African Space Agency is initiated. Such developments for the time being are not economically or technologically significant for lunar exploration but in the long run are very significant for the development of a market infrastructure that utilizes space based resources and space technologies. It is the developing world that stands to move strongly ahead in the pace of development with large supplies of space based energy and the communications and data infra-structure that commercial space can offer. These countries can contribute through the development of their educational infrastructure in science, engineering, and space technologies. They can also benefit from participation of the PISA so their educational institutions can participate in the cutting edge of lunar analog research and development.

Administrative Structure

The 2011 November Conference was the 21st meeting of the Japan-US Science Technology and Space Applications Program. This conference is sponsored by the US- Japan leadership Council. It's secretariat is located in the Office of Aerospace Development at the Hawaii State Department of Business, Economic Development and Tourism. The Tokyo Institute of Technology is also a collaborative partner.

Expanding The Network of Lunar Partnerships

To this auspicious beginning it would seem desirable that other space faring nations with announced plans for lunar exploration might form working relationships with the Pacific International Space Alliance. China, Russia, and Indian are all nations with a lunar mission heritage and with more lunar missions announced and in active planning and PISA might therefore become “the poster child” for terrestrial planning for the concept of the lunar robotic village which has been promoted in prior meeting of the International Lunar Exploration Working Group. ESA, Roscosmos, and JAXA have all developed some conceptual versions of the lunar robotic village and further coordinating work may yield specific mission proposals. (4) (5) (6).

Especially because of the economic difficulties of the European Union, Japan, and the United States bold new national initiatives are less likely but this may in fact favor (and force) more collaboration and integration in the use of their limited resources. China is planning a series of Chang'e-3 lunar rovers with the first planned for 2013 and Indian's Chandrayaan II mission also includes a lunar rover. Russia is also planning it lunar Grunt mission.

The growing economies of these countries with lunar ambitions also is a positive prospect for lunar exploration and development advocates and this makes the work of groups such as ILEWG and ISECC extremely important in maintaining forward momentum both in technology development, mission planning, and collaborative legal and organizational development. ISECC is a very loose non-binding planning group but the presence of all the major space faring powers in this process is very encouraging for the future.

PISA, PISCES, and ILRP as a symbols of Lunar Exploration & Development

NASA has in the opinion of this M3IQ editor mistakenly changed its central focus from a return to the Moon (and industrial development and settlement) to one which talks more about human missions the Near Earth Asteroids and Mars and articulates program effectiveness in terms of how this affects ambitions to go to Mars. NASA however has not abandoned the Moon entirely. NASA is pursuing a Flexible Path development strategy, which encompasses both the Moon, NEO, and Mars. It still has technology development initiatives such as RATS (Desert Research and Technology Studies) and SCaN (Space Communication and Navigation) program, and the which are developing important elements of lunar technology for human-robotic exploration and essential communications infrastructure.

The Lunar Science Institute located at NASA Ames is another important international collaborative piece of NASA's program with international nodes in Canada, Germany, Israel, Saudi Arabia, and the United Kingdom. NASA has however virtually gutted it Lunar Quest budget and its previous efforts to develop an International Lunar Network. Its recent rejection of strong lunar surface mission proposals in its Space Mission Directorate was a sharp rejection of recent lunar mission planning momentum. Its retreat in planning for lunar surface missions has created a vacuum which PISA is helping to fill with its model of international participation with Canada, Germany and Japan. The other nations that have have not lost their lunar visions such as China, India, and Russia can also not only maintain but accelerate this process.

PISCES is an tangible expression of the internal US constituency (which includes both academic (7), advocacy (8) and commercial interest (9), state governments (10) and component of NASA centers (11) as well as the international constituency for lunar exploration and development as expressed. Its location in the middle of the vast Pacific Ocean is also central to the enormous Pacific Rim and perhaps also symbolic nature of the central role the Moon's development has to play in saving the Earth's environment and economy.

Forging New Models

The growth of the PISA supported PISCES program hopefully can become a tangible template for collaboration, and cooperation on the lunar surface. It can be a terrestrial model for organizational relationships that are broader than the old ISS model of participating space national agencies because it includes commercial interests and participants, as well as academic, and even state government participation.

The NSS affiliate United Societies in Space has recently chartered a new corporation in Colorado, the International Space Development Authority for example which is intended to provide a legal model for international space governance and industrial development.

THE STRATEGIC FIVE PILLARS OF GROWTH OF EARTH/MOON SPACE DEVELOPMENT

The old monopoly on human presence on the Moon held by the US is getting increasingly stale and inappropriate to the times. Multinational lunar initiatives represents a logical demand for effective use of scarce resources and the interest in rapid progress in spite of limited national and commercial resources. The prospects for a breakout of space development rests in the opinion of this editor on several pillars:

I . Of accelerating national scientific lunar exploration,

II. A new drive to use lunar in situ (from on the Moon) ice reserves for fueling cislunar transportation infrastructure,

III. The prospects of building on the model of 5 decades of growth in the commercial satellite industry to reach the potential of solar power satellite proving clean energy and a multi-$-Trillion market fueling continued economic growth and limiting the environmental destruction caused by fossil fuels and ending this dependence on fossils fuels for global and Cislunar civilization.

IV. Space Tourism

V. Space manufacturing of in situ (on location) resources predominantly from the lunar surface due to proximity to Earth but over time including asteroid resources. This pillar is strongly linked to construction of facilities such as the solar power satellites where cost per kilogram to GEO from Earth might compete with cost per kilogram to GEO from the Moon.

The program of scientific space exploration has along with military space program created a global space infrastructure that has accomplished many achievements in the exploration of the solar systems, the avoidance of nuclear war, and a comprehensive program of Earth observation that has lead to increased consciousness of human environmental threats of the Earths environment. It is however the steady growth of commercial space satellites that provides the best model for projecting the growth of the Earth Moon economy. This is where the PISA model also plows new ground.

Use of lunar materials for fuel and other materials as well as space tourism promise new directions of growth and rationales for lunar surface economic activity, not the stagnation of the last 40 years since the end of the Apollo missions. NASA's Constellation Program suffered from any true grasp of why we must return to the Moon with its anemic 4-person base and 2 missions per year scenario. That in my opinion is why it was a good thing that it was canceled. The world needs both a lunar destination as well as new understanding of the purposes of returning. PISA, PISCES, and the International Lunar Research Park phase 1 project shows that this vibrant new vision of a robust international lunar return to the Moon is alive and part of the growing foundation for its realization.

Notes:

(1)https://sites.google.com/site/internationallunarresearchpark/overview

(2)https://sites.google.com/site/internationallunarresearchpark/justsap-2010-report

(3) International Space Exploration Coordination Group +

(4) G-20 nations*
http://en.wikipedia.org/wiki/G-20_major_economies

Postscript: ***We hope India will consider*** that this plan of international cooperation, may be a “best match” for its own space ambitions. We can all do so much more together than either alone, all parties finding strengths that complement their weaknesses, in a global endeavor. **DD**

Visit these sites:

http://astroday.net/MKrovers.html testing lunar rovers on Hawaii Island

http://www.astronautforhire.com/2010_11_01_archive.html towards establishing a lunar research park

http://www.frc.ri.cmu.edu/project/lri/scarab/fieldnotes_MK.html Field notes from Mauna Kea

http://bladt2010.blogspot.com/ BLADT - Bronco Lunar Agricultural Team

http://www.spaceagepub.com/calendar/SCarchive/SC-20081110.html

The Terrestrial Environmental, Economic and Strategic Requirements of Space Settlement and Industrialization

(Space Based Solar Power Systems, In Situ Resources/Development and G)

By Dave Dunlop - December 26, 2011

Background

Nuclear Bombs

At the end of WWII the world was faced with the then novel strategic issues of atomic warfare and the lopsided military advantage possessed by the United States. This was quickly changed by the symmetric possession of the Soviet Union of these same technologies. With the proliferation of nuclear technologies the nuclear powers faced the conundrum of Mutual Assured Destruction (MAD)(1). A nuclear arms race of epic proportions followed resulting in the production of some estimated 50 thousand nuclear weapons. Later Carl Sagan's climate model showed that a large scale nuclear exchange might well result in environmental results that he described as a global "nuclear winter."(2) Thus in a span of just 50 years or so the human species demonstrated its capacity to produce harmful global environmental change in a breathtakingly brief time, and in a way likely to produce self-extinction

It is not as if this capacity for environmental destruction in the name of progress had not been demonstrated before by homo sapiens. Earlier we had been responsible for the extinction of mega fauna over much of the Earth's surface. Domestication of animals has lead to local over grazing and desertification of grasslands. Agricultural use of irrigation has lead to the destruction of soils and many forests have been destroyed by their conversion into agricultural lands. The destruction of most ocean fisheries has occurred since WWII. (3)

"The Population Bomb"

Author Paul Ehrlich warned of the "Population Bomb" by a book of that title in the 1970's and of the consequences of global over population (4). This warning was only the most recent popular pronouncement of Malthusian prophecies warning of over-population. As many of the prophetic timetables expounded by Dr. Ehrlich did not come to pass, its warnings were discounted, and its critics assumed an intellectual hubris in regard to the power of technology and industrial production to fend off the consequences of expanding population.

Some four decades later however, the environmental impact of global civilization have increased and this is consistent with the consumption of resources by those heritage countries of the G-7 and the rapid growth of newly emerging BRIC economic powers and other members of the G-20. The inclusion of a great percentage of the global population into the modern global economy has increased demand, and pressure on the environment. Many advocates of social and economic "progress" now have weakened faith in an economic model that too willingly ignores environmental constraints and the Earth's carrying capacity in it pricing structure. Our model focuses on short term growth and profits, rather than a longer term perspective that looks at lifetime costs, sustainability, and the potential of unintended consequences of economic decision making.

The Challenge of Contemporary Mutual Assured Destruction: a Species Intelligence Test

The level of economic activity and the prospects of additional population and economic growth are presenting a new form of Mutual Assured Destruction, one that is all the more insidious because it is endemic in the growth of modern economies in every advancing country. While the threat of environmental damage is external to every country (from its economic competitors) it is also a function of internal economics, that prized goal of internal economic growth and the rise in "the standard of living." We are facing a species intelligence test and the fact is we have met the global "enemy and it is us! What is perhaps unique in this historical conundrum is that the problems and challenges facing the great global economic powers (and all of those that are space faring nations) are parallel in this regard. Common problems call for cooperation and commonly embraced solutions. Unregulated growth in human tissue is called "cancer" and this term is also a metaphor for human economic activities writ large at present. Yet, there are many prospects for solutions to these problems of growth and many opportunities to create a hopeful scenario for the human species and its home planet.

Space Settlement and Space Industrialization as "Articles of Faith"

Perhaps one branch of those critics of Dr. Ehrlich are those who foresee space settlement and space industrialization as answers to the problems of "over population." For space advocates, this argument is an "article of faith." Public support for the space program grew out of an American culture of optimism that resulted from scientific and engineering campaigns to produce first the atomic bomb (The Manhattan Project) and then the voyages to the Moon (The Apollo Program). Science fiction set the stage for these later visions. Jules Verne wrote about "A Voyage to the Moon" (5) in the 1890s but this was regarded as amusing but also "progressive" science fiction. A greater popular impact was made by radio dramatist Orson Wells of the more sinister vision of creatures from Mars invading the Earth originally presented by H.G. Wells in his book War of the Worlds." (6) (7)

The transformative changes wrought by WWII with ballistics missiles and atomic weapons set the stage for a less innocent vision of the future of homo sapiens in space. A progressive development of the feasibility of this prospect has been extended in the last 50 years or so and especially in the aftermath of the Apollo Program. This Utopian vision however has struggled to realize its visions in the face of the high costs of launching materials and people into low Earth orbit and beyond.

The visions of the early space pioneers are still inspiring and motivate those in the space advocacy community in organizations such as the National Space Society, Space Studies Institute, The Space Frontier Foundation, Mars Society, Moon Society, Space Foundation, United Societies in Space, and several others. The challenges of economic implementation however remain daunting.

The Growth of Commercial Space.

Over the period from the early 1960s to 2012 the world space economy has grown to an annual level of approximately $250B as reported by the Space Foundation. Some $175B of this is associated with commercial space industries and the robust growth of commercial satellite for telecommunications and geospatial information. *This foundation of commercial space activities is the best hope of realization of the potential growth of an expanded Earth-Moon econosphere.* The sale of weightless electromagnetic waves is the only truly profitably activity that has emerged thus far from the space age. The expansion of this market by the development of space solar power satellites is both logical as well as challenging. It is logical because experience and success tend to breed success. There is a huge potential demand for additional "clean" energy from developing nations. There is also a demand from those who wish to replace their fossil fuel economies with energy that does not accelerate the concentration of greenhouse gases and environmental changes associated with global warming. In a global energy market already valued in the trillions, the Solar Power Satellite industry might grow the commercial space industry an order of magnitude. It is challenging because the costs of launches remain formidably high, although some progress is being made on that front by Space-X, whose Falcon Heavy appears to be "relatively inexpensive."

The Development of a Literature of Human Space Settlement and Industrialization

Prior to the Apollo program in "*The Case for Going to the Moon*", Chicago author and magazine editor Neil Rudzic wrote about the development of a space based industrial economy and the use of space based resources in this little noticed book in 1963. (8) The book presaged the Apollo flights and looked forward to the industrialization of space via activities such as mining in situ resources on the Moon and asteroids for the production of fuels, utilizing the characteristics of LEO such a vacuum and 0-G conditions for manufacturing activities and advanced materials, and anticipating space tourism.

In the late 1960's Dr. Peter Glaser first wrote about the potential of Space Solar Satellites to produce large volumes of electrical power (9). Several generations of studies of this have not shown this scenario to be cost feasible ar present, but progress toward that objective has been formidable. (10)

Dr. David Criswell wrote about the potential of a Lunar Power System to use the Moon and its in situ material resources to produce a global power supply in the 1980s and 1990s and to date. (11) Dr. Gerhard O Neil's book *The High Frontier* also inspired many in the global space movement about the potential to produce extra-terrestrial city scale Human Habitats systems in Earth Orbit and elsewhere in the inner solar system. (12) In the post Apollo days NASA also promoted a vision of space settlement following the work of Dr. O'Neil. (13)

In the 1990's Dr. Bob Zubrin wrote a popular critique of NASA's plans to go Mars and fashioned his own counter-proposal in "The Case for Mars and Why we Must Go There." (14) Zubrin argued for a more cost effective strategy based on using indigenous resources to both explore and establish human settlements on Mars. This strategy has been amplified more recently by John Strickland in a modified mission architecture used for both the exploration and settlement of Mars. (29) This would involve less of a dead end "Flags and Foot Prints" model of exploration and a more robust strategy of using a Mars supply chain to create orbital assets first and then an associated Mars Ferry System to enable both simultaneous human exploration and settlement activities.

Industrialist Mark Grieson has more recently argued for a strategy of human exploration and settlement which is based on the ability for fuel production from indigenous resources at the ISDC Conference in 2011. (15) In the same forum Planetary scientist Dr. Paul Spudis and Aerospace Engineer Tony Lavoie more specifically argued for the potential of mining the (recently confirmed) frozen volatiles on the Moon in order to produce supplies of rocket fuel first on the lunar surface, and then extending to their use in Low Lunar orbit Lagrange points, and ultimately to LEO. (16)

Another thread of this optimistic scenario is that associated with the prospect of obtaining clean energy from commercial fusion reactor technology and of the prospect of using Helium 3 found and mined on the Moon as a source of fusion fuel. (17) (18)

NASA itself created the Augustine Commission, which presented space policy strategies to the Obama Administration, which in turn followed the recommendations of "a flexible path" for advancing the space infrastructure. This would permit a variety of activities including continued use of the International Space Station, development of vehicles and infrastructure that would enable a variety of destinations beyond LEO including, the Moon, Lagrange Points, Near Earth Asteroids, and Mars. (19)

Another recent landmark study is that conducted by the International Academy of Astronautics on Space Based Solar Power, which reaffirmed the lack of a contemporary business model supporting solar power satellites, but which indicated that a 15 to 20 year effort could bring that technology within both technological and economic reach. (20) This report also lays out a roadmap of research and development challenges which will require investment in the coming decades. There is also a growing international interest in collaborative research and development activities in the Canada, China, India, Japan, and the US. There is a consensus that these challenges are beyond the economic grasp of any single nation but within the capabilities of collection investments. (21)

Building a Genuine Model of Space Development and Settlement

Interlocking Requirements

It is clear is that there is an interlocking of challenging issues: over population and associated demands for energy, minerals, clean water, creation of a sustainable civilization, an economic model for a planet of finite resources and carrying capacity, and a technological model of continuing growth of resources via an expanded Earth-Moon econosphere. *It is increasingly clear that these global problems are intractable without this expansion.* To paraphrase Carl Sagan, the extraordinary problems of the terrestrial survival of modern civilization demand extraordinary solutions.

This realization has not been symmetrical, however. The environmental movement has been informed by the growth of space based capabilities of Earth Observation satellites and the increasingly sophistication of global data sets and global climate models developed by NASA and NOAA and DOD scientists in the US and their international counterparts. *This awareness of the Earth's environmental damage and problems of human environmental impact has not translated into the support of space based solutions by the environmental movement.* Perhaps this is based on the perception of economic unfeasibility for proposed solutions, but in any event there is a large disconnect between the environmental movement and those advocating space industrial development and settlement. Making these connections is the larger purpose of this article.

The space movement, those advocating space industrialization and development, has remained much smaller and less politically influential than the global environmental movement. That picture is changing as a fresh generation of engineers, designers, scientists, and entrepreneurs work on the challenges of the Earth/Moon economy.

These big picture solutions include the further commercialization of cislunar space:

a. Further expansion of telecommunications and geospatial satellite services

b. New services to include new functions of global education, medical services

c. Commercial production of energy

d. Mining resources on the Moon and from asteroidal resources to enable further exploration and development

f. The expansion of human presence via production of habitats in space which expand the biosphere to include not only homo sapiens but other species on which we are codependent

g. The creation of an economic and political model of a scale sufficient to meet both terrestrial demands for resources within the context of the limitations of Earth's ecosystems, and sustain economic growth including a much expanded extraterrestrial economy

h. The definition of a needed research and development i roadmap and for additional international cooperative investments.

Big Picture Space Connected Solutions to Big Picture Global Problems

The Built Environment Connections

The unmet demands of the human population on Earth and of the requirements for sustainable economics are drivers of change in both the economic and geopolitical arenas. The demands of a sustainable habits in space can push the design standards which are applied to the conservation of resources and sustainability of our habitats on Earth. The built environment on Earth consumes some 40% of the resources of the economy and design standards such as LEEDS are the beginning of such heightened standards for continued development. This intellectual path is in its early stages. For decades there have been examples of 100 story skyscrapers which are marvels of engineering design. As of yet there are no 100 story “arcologies” that might significantly reduce the human footprint on the natural landscape and also reduce the energy and time demands of urban transportation.

Global Food Production and Designer Closed Bio-remediation Systems

Cities might also be designed with incorporation of urban agricultural production as Dixon Despommier has proposed. (22) Dr. Bill Wolverton (23) (24) and Dr. John Todd have long advocated architectural design that incorporates bioremediation technologies. (25) The commercial development of Controlled Environment Agricultural systems has opened the door to this aspect of urban design and economic growth and pushing this technology into both extreme terrestrial and space environments as is being done by Dr. Gene Giacomelli at the CEAC [Closed Environment Agricultural Center] of the University of Arizona in Tucson. (26)

The Clean Energy Connection & the Phase Out of Fossil Fuels

The connections between potential space based energy solutions and the environmental and political problems of the Earth’s fossil fuel dominated economy are also gaining more global traction. Doom and gloom scenarios proliferate in the absence of ground based solutions. Only thus far unrealized commercial fusion power plants might compete with space based solar power on. Both solutions could provide the scale of clean energy production the scale of clean energy production envisioned for this century supplying the needs of 10 billion people. Nobel Laureate, Dr. Sergio Trindad presented a projection of the mix of energy supply technologies out to the year 2100 at the 2011 China Energy and Environment Summit in Beijing. (27) In his scenario about 50% of the energy supply in 2100 would come from solar energy (both Earth based and Space based) and 20% from new biofuels.

The Clean Water and Energy Supply Connections

The supply of clean water is inequitably distributed. These shortages are a growing source of political, economic and military contention. That this should be so on a planet with a surface that is 75% ocean is largely related to the lack of sufficient energy to desalinate sea water, and create a pipeline infrastructure to pump it to where it is needed. The ability to import clean space based energy in virtually unlimited quantities (within the constraints of the Earth's heat engine) is another big picture solution to the problem of fresh water scarcity.

Terraforming Connections of Clean Water

Science fiction descriptions of a terra-formed Mars (28) are far from being economically practical at present. Yet the Earth is presently being inadvertently terra-formed by human economic activities and their impact on the climate and environment. This “inadvertent” terra-forming is related to destruction of grasslands, deforestations, advancing desertification, the destruction of ocean reefs and habitats, and the rapid loss of arctic and Antarctic ice sheets and the retreats of mountain glaciers due to climatic warming.

The creation of a global space based energy supply system (SBSP) is a development that could permit large scale utilization of ocean water to solve problems ranging from fresh water for huge urban conurbations, to increased agricultural production, to the restoration of grasslands, and reforestation to reduce the concentration of atmospheric C02. A global fresh water production and distribution system is another big picture solution enabled by SBSP.

The Development of Human Potential

Compact mobile devices and global communication networks are also changing opportunities for education and other personal services. Truly global access to educational and medical services are additional aspects of a transformational global economic, political, and cultural model. The launch of dedicated satellites by India in this regard is a beginning trend in new growth opportunities for global human services.

Big Picture Space Based Economics

I have presented a picture of interlocking global problems and space based solutions that presuppose a great growth potential for an Earth-Moon econosphere. I believe the dimensions of this potential growth are much greater than those the world experienced during the 2Oth century. Both the economics and the geopolitical organizational requirements of this growth are not well defined at present but an ambitious start has been made in the development of a space industrialization and space settlement literature over the last forty years. This can lead to a peaceful global transformation and is a central arena for additional work in the decades ahead.

Summary

The global challenges of over population, and of demands for energy, food, water, habitat, education and health services can be addressed with big picture solutions resulting from a great expansion of the Earth's econosphere into an Earth-Moon economy. This features the development of space based energy supplies and the development of extraterrestrial resources and infrastructure. It also includes equally ambitious terrestrial growth in urban habitats, energy distribution, water production and distribution, food production, bio-remediation services, human education, and health.

The realization that space-based resources ay be the only available solution to the most pressing strategic problems of humanity, constitutes a species intelligence geopolitical survival test.

The growth of both a scientific and technical and economic literature over the last 40 years offers the prospects of a hopeful future for humanity and for the fragile biosphere of the Earth. The development of economic and technical models which can be realized during the balance of this century is the “next big thing” in facing the formidable global human, geopolitical, economic, and environmental challenges of the 21st century.

Notes (1) Mutual Assured Destruction Herman Kahn? The Hudson Institute?

(2) Dr. Carl Sagan “Nuclear Winter” reference
(3) reference for destruction f ocean fisheries
(4) Paul Ehrlich, The Population Bomb
(5) Jules Verne “A Voyage to the Moon”
(6) Orson Well broadcast of War of the Worlds”
(7) H.G. Well “War of the Worlds
(8) (9) Neil Rudzic”The Case for the Moon.”
(9) (10) Dr. Peter Glaser, Space Solar Satellites 1960's reference
(10)(11) IAA 2011 report Dr. John Mankins et al.
(11)(12) Dr. David Criswell, The Lunar Power System
(12) Dr. Gerhard O'Neil, The High Frontier.
(13) NASA volume Space Based Settlements reference study
(14) Dr. Robert Zubrin
(15) Mark Grieson speech ISDC 2011 May 2011 U-Tube
(16) Paul Spudis and Tony Lavoie
(17) ITER Program references
(18) Jerry Kulcinski UW Institute for Fusion Research
(19) Augustine Commission Report
(20) IAA Report on SPSB Editor John Mankins
(21) Ad Astra, Winter 2011 Dunlop.
(22) Dixon Despommier .....
(23) Dr Bill Wolverton, Growing Clean Air
(24)Dr, Bill Wolverton Growing Clean Water
(25)Dr. John Todd Living Machines
(26) CEAC U of Arizona Dr. Gene Giacomelli
(27) Dr. Sergio Trindad, CEES 2011, Bejing, University of International Business and Economics
(28) Red Mars, Blue Mars Green Mars Trilogy
(29) "Access to Mars" paper by John Strickland, Presented at ISDC 2011, at Huntsville Alabama. http://www.nss.org/settlement/mars/AccessToMars.pdf

Human Space Activity: Catalyst for 21st Century Global Development

By Madhu Thangavelu

www.usc.edu/ur/federal_relations/experts/bios/1073.html

Human Aspirations

Human space activity epitomizes the noblest aspirations of humanity, exploring the unknown, extending civilization outward into our universe, settling new worlds, and promoting peaceful collaboration among nations in the process. Human space activity hopes to bring out the best in our species and has done so in those daring missions of the past. Every nation and administration prides in the achievements of these daring men and women who go out into the unknown and every president and prime minister touts human space activity such as landing on the moon to inspire their citizenry.

And yet, without vision, lacking direction, and in an apparent state of ennui, human space programs are withering around the world. Astronaut corps of Russia and the US have dwindled to an all time low, and the global economic downturn is not helping.

Goals of National Space Agencies

Nested firmly in science and high technology, the space agencies of the world have focused on human space activity efforts primarily as a vehicle for promoting national prestige, and more recently as an important venue for international collaboration in the sciences and engineering, albeit among select partner nations. Education in the various branches of math and science and technology has also been stressed.

And so, it seems natural that human spaceflight activities have been narrowly confined to scientific discovery mainly relating to human survivability and advances in life support and human factors through the building of space stations. A few missions have also been dedicated to deploying and servicing satellites, observatories and for conducting experiments in basic physical and life sciences as well.

Transition to an Era of Collaboration

It is also clear that human space programs, shaped by cold war policies of the 1950s and 1960s, replaced by international partnerships among certain economically developed nations in the 1980-2000 timeframe, now needs to be reassessed, reconfigured and transitioned to a new era employing the flat world model, one in which the entire globe of nations might participate actively.

Such collaboration also resonates with global needs in the vital areas of climate change and global resource management, all natural phenomena, some with human developmental activity components to it, that transcend all national, economic and geographical boundaries.

In this context it is worthy to note that human space technologies perhaps offer the best alternatives to adapting to climate change by providing highly reliable, advanced technologies and methods that can be put to good use both for sustainable shelters for both populations as well as livestock and agriculture, ameliorating the effects caused by extreme changes in climate and weather patterns across the globe. These very technologies are finding their way into FEMA projects that provide temporary shelters for populations following natural disasters or during emergencies. In the words of Dr. James Lovelock “adaptation is the most serious thing we can do” in the face of these seemingly accelerating changes occurring all over the globe. While the science behind climate change is nascent at best, we can deftly start to employ macro engineering principles to undertake projects that facilitate this “Adaptation Strategy” without causing irreversible damage to Earth’s highly intertwined, dynamic systems and those complex processes that have evolved over billions of years that we are just beginning to understand.

Cold War Policies as a Retardant

However, it has not been easy for the space community to shed the cold war policies of yore and regulations like ITAR[1], MTCR[2] and a variety of other weapons proliferation hurdles in order to become a more peaceful, transparent, and self sustaining, commercially viable industry. In fact, these regulations have long been a drag on the nascent industry, often suppressing creativity and innovation that thrive in small and agile organizations.

The free flow of information, vastly accelerated by advances in information technology, computation and especially the advent of powerful handheld devices have even antiquated the Freedom of Information Act of our own democracy and is reshaping nations and governments around the world. We must seize this opportunity to use human space activity, the ultimate metaphor for the freedom of humanity, as a catalyst to promote the unalienable rights and values for all freedom loving people around the globe.

While nations tackle these global issues including restructuring the global economy that is underway, a vast array of commercial projects lie waiting in the wing, and now is the time to start thinking about large complex building projects in space that require on-site human supervision.

International Space Station

The International Space Station is the only platform for human space activity today. A select partnership of a few nations has been brought together to build, operate and evolve the ISS. Currently, the scope of projects on this platform is narrow.

Human space activity is a much, much larger endeavor than just scientific human space exploration.

Projects like space-based solar power, orbital fuel depots, orbital recovery of high value assets and debris management, not to mention suborbital point-to-point commercial cargo and passenger transport, are all potentially large revenue generating projects for the profit minded private investor in a flat-world, multi-nexus global economy. Orbital and cis-lunar space tourism could also be a vital revenue stream. ISS could be the springboard for many of these activities that have little in common with scientific human space exploration.

Maintenance and Decommission

Maintenance and decommission architectures, the way we hope to keep the many proposed missions flying and how we intend to establish reliable systems to communicate with them through all phases of mission life including anomalies that are sure to arise in complex systems, is also a very important role. Sometimes, in our excitement to field missions, we tend to forget this most important attribute of flight systems. ISS operations is now in a steep learning curve in her operations phase as we seek how to support her many logistics needs.

Artifact Preservation

And so is the importance to preserve artifacts after their useful life. Great civilizations hold dear to their past achievements and yet the space community is notorious for abandoning priceless objects of historic importance to re-enter and burn up in our atmosphere. All the more ironic that the Smithsonian Air and Space Museum is the most visited building on the mall, and yet more ironic that we have remnants of our first habitats on the Moon and space-craft on Mars and a few even roaming outside or solar system where we cannot visit them, at least not yet.

The baton has been passed to a new generation of space activity and space commerce professionals, rooted in tried and tested economic and entrepreneurship models, and private sector must be empowered by governments to take on these projects quickly, and find alternatives to protect National security infrastructure while encouraging entrepreneurship, as we did with the space communications sector in http://www.spaceagepub.com/calendar/SCarchive/SC-20081110.html 1960s.

It is darkest before dawn, they say, and perhaps that is the case with human space activity today. **MT**

Acronyms

[1] ITAR - International Traffic in Arms Regulations
http://www.pmddtc.state.gov/regulations_laws/itar.html
http://en.wikipedia.org/wiki/International_Traffic_in_Arms_Regulations
http://www.flightglobal.com/news/articles/in-focus-space-industry-unites-in-criticism-of-itar-restrictions-364544/
http://www.transterrestrial.com/?p=38746

[2] MTCR – Missile Technology Control Regime
http://en.wikipedia.org/wiki/Missile_Technology_Control_Regime

==========

Editor's Comments on "Artifact Preservation"

Sadly, it is too late for one of the most significant man-made creations placed in space: The Russian Space Station MIR
Space Frontier Foundation Calls Mir's De-Orbit Historic Tragedy - http://www.spaceref.com/news/viewpr.html?pid=4204

There is now considerable discussion of how we can protect the 6 Apollo Landing Sites from future tourists who will surely want to visit them. A number of proposals have been put forward to provide for both preservation and for visitation.

For a paper by the Editor that attempts to address some of these needs, see: pp. 34-25 in MMM Classics #19
http://www.moonsociety.org/publications/mmm_classics/mmmc18_Jan2008.pdf

GREAT BROWSING LINKS

INTERNATIONAL SPACE STATION + COMMERCIAL SPACE

http://www.space.com/72-**iss-module-russian-mrm-1-rassvet.html**

http://news.cnet.com/8301-13772_3-57342415-52/**paul-allens-stratolaunch-grand-plan-for-next-gen-space-travel/**

http://www.**bigelowaerospace**.com/i**n-the-news**.php

(Commercial) Human Achievements Beyond LEO soon - http://www.thespacereview.com/article/1985/1

ASTRONAUTS + SPACE TECHNOLOGY

http://www.space.com/73-**orion-capsule-emergency-escape-system-test.html**

http://mis-asia.com/resource/industries/**nasa-declares-solarsail-d-mission-complete/**

http://io9.com/5863422/**10-mega**%20**construction-projects-that-could-save-the-environment--and-the-economy**

EARTH

Paleoclimate Record/Potential Rapid Climate Changes http://www.spaceref.com/news/viewpr.html?pid=35499

Early Earth may have experienced extreme glaciation - http://www.spaceref.com/news/viewpr.html?pid=35497

http://www.universetoday.com/92022/**earths-other-moons/**

MOON

http://astrobotic.net/2011/11/29/**astrobotic-wins-nasa-contract-for-robot-teams-to-explore-martian-and-lunar-caves/**

http://www.universetoday.com/92022/**earths-other-moons/**

http://www.indiavision.com/news/article/scitech/264139/**nasas-twin-grail-probes-may-find-remnants-of-moons-lost-sibling/**

Solar Power ring around Moon's equator - http://www.shimz.co.jp/english/theme/dream/lunaring.html

http://old.news.yahoo.com/s/space/20120105/sc_space/**moonmineralfoundinancientaustralianrock**

Shackleton Energy Co: Humans to the Moon by 2019 http://www.spaceref.com/news/viewpr.html?pid=35264

ANALOG STATION RESEARCH

International Lunar Research Park proposed for PISCES Analog Research effort on Hawaii Island

https://sites.google.com/site/internationallunarresearchpark/the-international-lunar-research-park-concept

https://sites.google.com/site/internationallunarresearchpark/

ASTEROIDS

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

www.signonsandiego.com/news/2011/dec/21/**dawn-spacecraft-beams-back-new-images-of-asteroid/**

New NASA Dawn Visuals Show Vesta's 'Color Palette' - http://www.spaceref.com/news/viewpr.html?pid=35448

NASA Developing Comet Harpoon for Sample Return - http://www.spaceref.com/news/viewpr.html?pid=35541

OTHER PLANETS + MOONS

www.engadget.com/2011/12/12/**nasa-looks-to-send-landers-to-europa-in-2020-**wants-to-break-the/

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

Very Large shallow Lake within Europa's ice crust

http://astrobio.net/index.php?option=com_retrospection&task=detail&id=4423

http://timesofindia.indiatimes.com/home/science/**On-Pluto-hints-of-building-blocks-of-life/**articleshow/11227377.cms

http://astrobio.net/pressrelease/**4434/the-lakes-and-storms-of-titan**

Titan plane http://story.albuquerqueexpress.com/index.php/ct/9/cid/89d96798a39564bd/id/202361705/cs/1

SPACE SETTLEMENTS

NSS Space Settlement Journal - http://blog.nss.org/?p=3175 - www.nss.org/**settlement/journal/index.**html

ASTRONOMY + ASTROBIOTICS

http://www.foxnews.com/scitech/2011/12/21/**hubble-telescope-spots-complex-organic-molecules-on-surface-pluto/**

www.indiavision.com/news/article/scitech/263379/**soon-seti-to-search-the-moon-for-alien-artifacts/**

http://old.news.yahoo.com/s/space/20120105/sc_space/**thehuntisonforhabitablemoonsaroundalienplanets**

Assessing odds of life on other worlds - http://www.spaceref.com/news/viewpr.html?pid=35310

EDUCATION + OUTREACH + MEDIA

http://lightyears.blogs.cnn.com/2011/12/27/**space-idea-factory-brainstorming-school/FICTION**

http://lightyears.blogs.cnn.com/201

GREAT INDIAN SPACE VIDEOS

Chandrayaan-1 video
http://www.youtube.com/watch?v=-f5qLMPIfe4&feature=related

Chandrayaan-2 video
http://www.youtube.com/watch?v=ZDKtTQubIEI&feature=related

Chandrayaan-3 Video
http://www.youtube.com/watch?v=Q1NX3EVGdLw

Chandrayaan-1 discovers water on the Moon
http://www.youtube.com/watch?v=Y0p3HKv0wNU&feature=relmfu

Water found on the Moon
http://www.youtube.com/watch?v=gq_ftKu1jCU&feature=fvwrel

Indian Space Shuttle program
http://www.youtube.com/watch?v=4EObgnrMY_w&feature=related

GREAT "ROBONAUT" VIDEOS

Avatars, Robots, and Robonauts - Introduction - What is a Robonaut?

A Robonaut is a dexterous humanoid robot built and designed at NASA Johnson Space Center in Houston, Texas. Our challenge is to build machines that can help humans work and explore in space. Working side by side with humans, or going where the risks are too great for people, Robonauts will expand our ability for construction and discovery. Central to that effort is a capability we call dexterous manipulation, embodied by an ability to use one's hand to do work, and our challenge has been to build machines with dexterity that exceeds that of a suited astronaut.

There are currently four Robonauts, with others currently in development. This allows us to study various types of mobility, control methods, and task applications. The value of a humanoid over otherdesigns is the ability to use the same workspace and tools - not only does this improve efficiency in the types of tools, but also removes the need for specialized robotic connectors. Robonauts are essential to NASA's future as we go beyond low earth orbit and continue to explore the vast wonder that is space.

The making of Ronaut 2 - http://www.guardian.co.uk/science/video/2010/nov/02/nasa-robonaut
Team 118 Robonauts 2010 - http://www.youtube.com/watch?v=yqVVCRmXdiE
Team 118 Robonauts 2011 - http://www.youtube.com/watch?v=8lRtC8wBUa0
NASA Robonaut Humanoid Space Robot - http://www.youtube.com/watch?v=jOnp2M5qibs

Robonaut TELEPRESENCE (key) - http://robonaut.jsc.nasa.gov/R1/media/videos/video/telep2.avi

Robonaut head - http://robonaut.jsc.nasa.gov/R1/media/videos/video/head2.avi

Robonaut hand - http://robonaut.jsc.nasa.gov/R1/media/videos/video/hand2.avi

Robonaut arm - http://robonaut.jsc.nasa.gov/R1/media/videos/video/arms2.avi

Robonaut grasping motion - http://robonaut.jsc.nasa.gov/R1/media/videos/video/grasp2.avi

Robonaut flexing - http://robonaut.jsc.nasa.gov/R1/media/videos/video/flex.avi

Robonaut soldering - http://robonaut.jsc.nasa.gov/R1/media/videos/video/solder.avi

Robonaut grasping truss - http://robonaut.jsc.nasa.gov/R1/media/videos/video/truss.avi

PROJECT M - robonauts on the Moon - http://www.nasawatch.com/archives/2010/02/video-jscs-proj.html

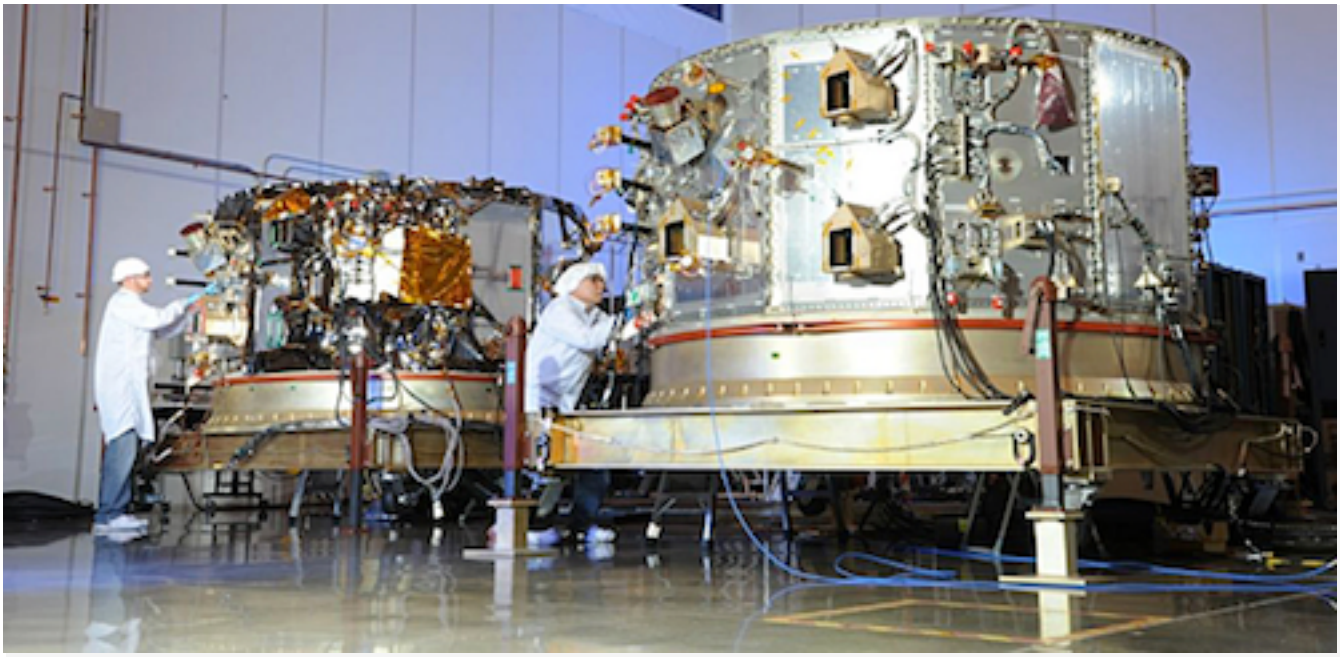
PROJECT M VIDEO - http://www.youtube.com/watch?v=kFPNcWN7QnM - awesome!

Cisco Telepresence Video Library - http://www.cisco.com/en/US/solutions/ns669/tpml_index.html

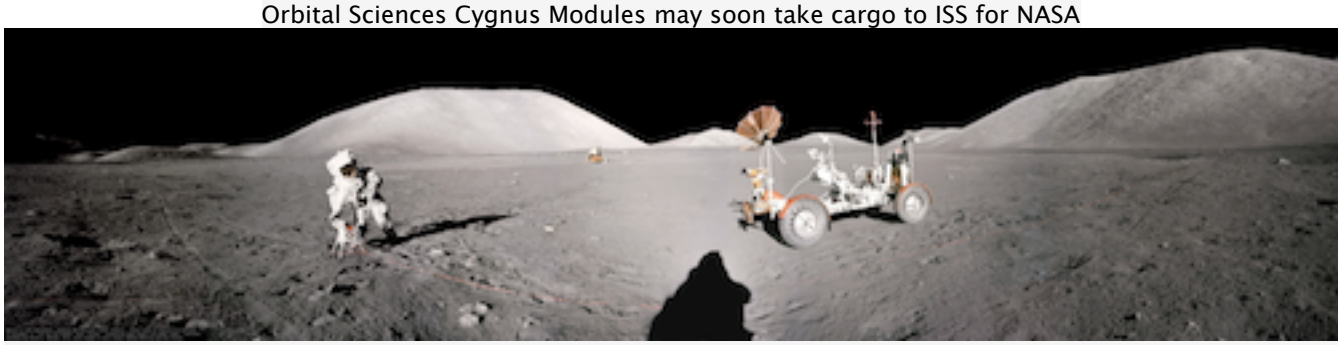
VGo telepresence robot gets Verizon LTE, we go eyes-on (video) - http://www.engadget.com/2012/01/11/vgo-telepresence-robot-lte-ces/
Science of the Impossible: VR Space Robot - http://videos.howstuffworks.com/discovery/31793-science-of-the-impossible-vr-space-robot-video.htm
And for "fun" some video "Robbie" clips from "Lost in Space" - http://www.youtube.com/watch?v=l7tU4OelFeU

MMQ PHOTO GALLERY

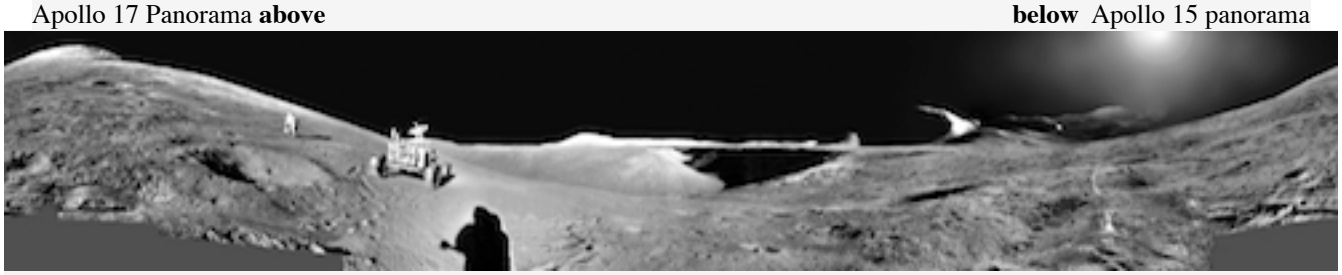
Bigelow Aerospace is learning how to arrange B330 interiors through the exercise of modeling



Orbital Sciences Cygnus Modules may soon take cargo to ISS for NASA



Apollo 17 Panorama **above** **below** Apollo 15 panorama



Moon Miners' Manifesto Resources

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

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

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

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

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

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

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

www.moonsocietyorg/publications/mmm_classics/

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

www.moonsociety.org/publications/mmm_themes/

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

www.moonsociety.org/publications/m3glossary.html

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

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

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

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

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

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

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

Help Circulate *MMM-India Quarterly*

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

MMM-India Quarterly will remain a free publication.

Upcoming Conferences & Events - http://www.spacecalendar.com/downrange/

INDIA **------2012 -----**

NET March 2012 — **ISRO, Launch PSLV / RISAT 1**, ***India*** PSLV set to launch the RISAT 1 Earth observation satellite.

NET Mar 15 — ISRO PSLV / RISAT-1, *Sriharikota, **India**:* A Chinese Long March 3A rocket set to launch the Fengyun 2F geostationary weather satellite.

July14-22 — Committee on Space Research, ISRO, Mysore, ***India:*** 39th Scientific Assembly of Committee on Space Research (COSPAR).

ELSEWHERE – a selection by the editor **--- 2012 ----**

Jan 9 – Feb 11 — Intern'l Space Univ., U. of South Australia, Adelaide: 'Southern Hemisphere Summer Program'

Feb 1-3 — Lunar and Planetary Inst., Houston TX, USA : '**Workshop on the Early Solar System Bombardment**'

Feb 13-15 — Lunar and Planetary Institute, Universities Space Research Association, San Diego CA, USA: **Conference on Life Detection in Extraterrestrial Samples'**

Mar 19-23 — Lunar and Planetary Institute The Woodlands TX: '43rd **Lunar and Planetary Science Conference**'

Mar 21-23 — Nuclear Science & Technology & Technology Aerospace, Lunar & Planetary Institute, The Woodlands TX, USA **'Nuclear and Emerging Technologies for Space 2012'**

May 24-28 – International Space Development Conference, Washington, DC, USA (National Space Soc., Moon Soc.)

Apr 12-14 — Space Access Society, *Phoenix AZ:* '2012 Space Access Society Conference.'

Apr 16-19 — The Space Foundation, *Colorado Springs CO:* '28th National Space Symposium.'

Apr 16-20 — NASA, *Atlanta GA:* 'Astrobiology Science Conference 2012: Exploring Life – Past and Present, Near and Far.'

Apr 19-20 — NASA Lunar Science Institute, *Berlin, Germany:* 'European Lunar Symposium.'

NET Apr 28 — Orbital Sciences Corp, **Launch Antares / Cygnus 1,** *Wallops Island VA:* OSC Antares rocket set to launch the 1st Cygnus cargo freighter on a test flight to the International Space Station.

May 2 — The SETI Institute, *Mountain View CA*: Colloquium Series Lecture: 'Companions to Solar-Type Stars: Analysis of a Wide Variety of Planets, Brown Dwarfs, and Small Stars,' Tristan Guillot.

May 7-10 — Aeronautics and Astronautics Association of France, ESA, et al, *Bordeaux, France:* 'Space Propulsion 2012.'

May 21-22 — Wien University – Dept. of Astronomy, *Vienna, Austria:* 'Workshop on Extraterrestrial Life: Beyond Our Expectations?.'

May 21-25 — Lunar and Planetary Institute, NASA Mars Program Office, et al, *Lake Tahoe NV:* '3rd International Conference on Early Mars: Geologic and Hydrologic Evolution, Physical and Chemical Environments, and Implications for Life.'

May 24-28 — National Space Society, *Washington DC:* '31st International Space Development Conference 2012.'

Jun 3-6 — Institute for Astronomy Maui Maikalani/ATRC, *Maui, Hawai`i:* 'Transiting Planets in the House of the Sun A Workshop on M Dwarf Stars and Their Planets.'

Jul 2-15 — Nordic Network of Astrobiology, NASA Astrobiology Network, *Reykjavic, Iceland:* 'Nordic – NASA Summer School: Water, Ice and the Origin of Life in the Universe.'

Jul 16-22 — Association of Aeronautics and Astronautics France, ESA, et al, *Bordeaux, France:* '3rd Space Propulsion Conference,' event to promote exchange and discussion on spacecrafts and spacecraft transportation.

Aug 3-5 — The Mars Society, *Pasadena CA:* '15th Annual International Mars Society Convention.'

Oct 25-27 — ESA, International Association of Sedimentologists, et al, *Marrakech, Morocco:* '3rd Conference on Terrestrial Mars Analogues.'

Nov 8-11 — Students for the Exploration & Development of Space (SEDS), *Buffalo NY:* 'SEDS SpaceVision 2012 Conference: Crossroads – How Our Generation Will Take Us To The Space Frontier.'

Note: ***If you know of a scheduled space event in India that is not listed at the address above, please inform us of this in advance –*** email mmm-india@moonsociety.org

Trivia hint for non-Indian Readers

Just as in the United States, **NASA** is not pronounced letter by letter "N-A-S-A" (4 syllables) but **Na**-Sa (2 syllables), likewise in India, **ISRO** is not pronounced letter by letter "I-S-R-O" (4 syllables) but **iS**-Ro (2 syllables)

The Editor (among others) stands corrected!

Student Space Organizations in India

http://india.seds.org/ -

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

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

EXECUTIVE COMMITTEE Pranay Puchakayala, President pranayp53@gmail.com
Lakshmanaperumal K, Vice-President 0lakshmanaperumal@hotmail.com
Soumya Batra, Secretary - batra_soumya@hotmail.com
Deepak Namdev, Joint Secretary (Events and Projects - tia747@gmail.com

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

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

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

VITSAT - 1 - series of small satellites to demonsrate miniaturization of technology and implementation of a varity of payloads
SEDS VIT UAV - automatically controlled aircraft,different sensors, servos, communication equipment, GPS, Microcontroler
CanSat - a satellite in a Tin Can - to conduct basic atmospheric studies at cloud base, provide a test for amateur communication protocols, provide basic knowledge of a Satellite to the students

Help Wanted !

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

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

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

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

Guidelines for Submissions

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.

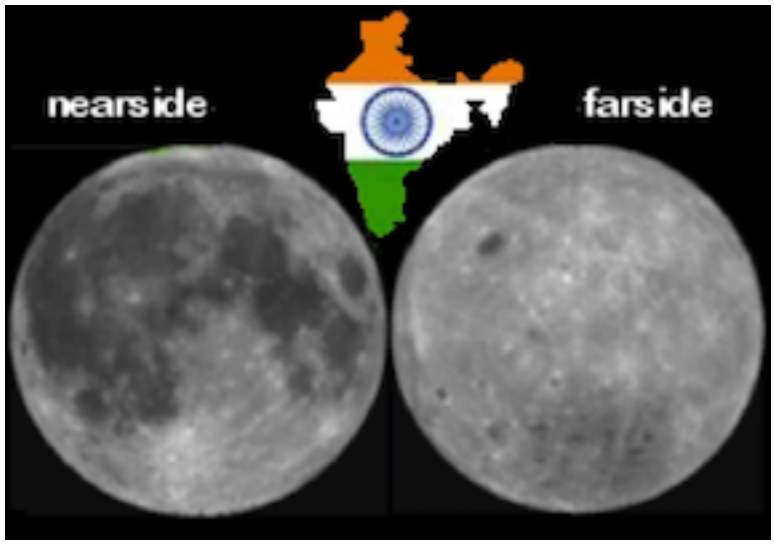
If anyone in India wishes to become a Moon Society agent and publish and mail hardcopies of MMM-India Quarterly to addresses on a paid-subscription basis, please contact us at **mmm-india@moonsociety.org**

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

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

MMM-India Quarterly #13: January 2012 Index - Table of Contents

---



Moon Miners' Manifesto - India Quarterly #13

Engage! And Enjoy!