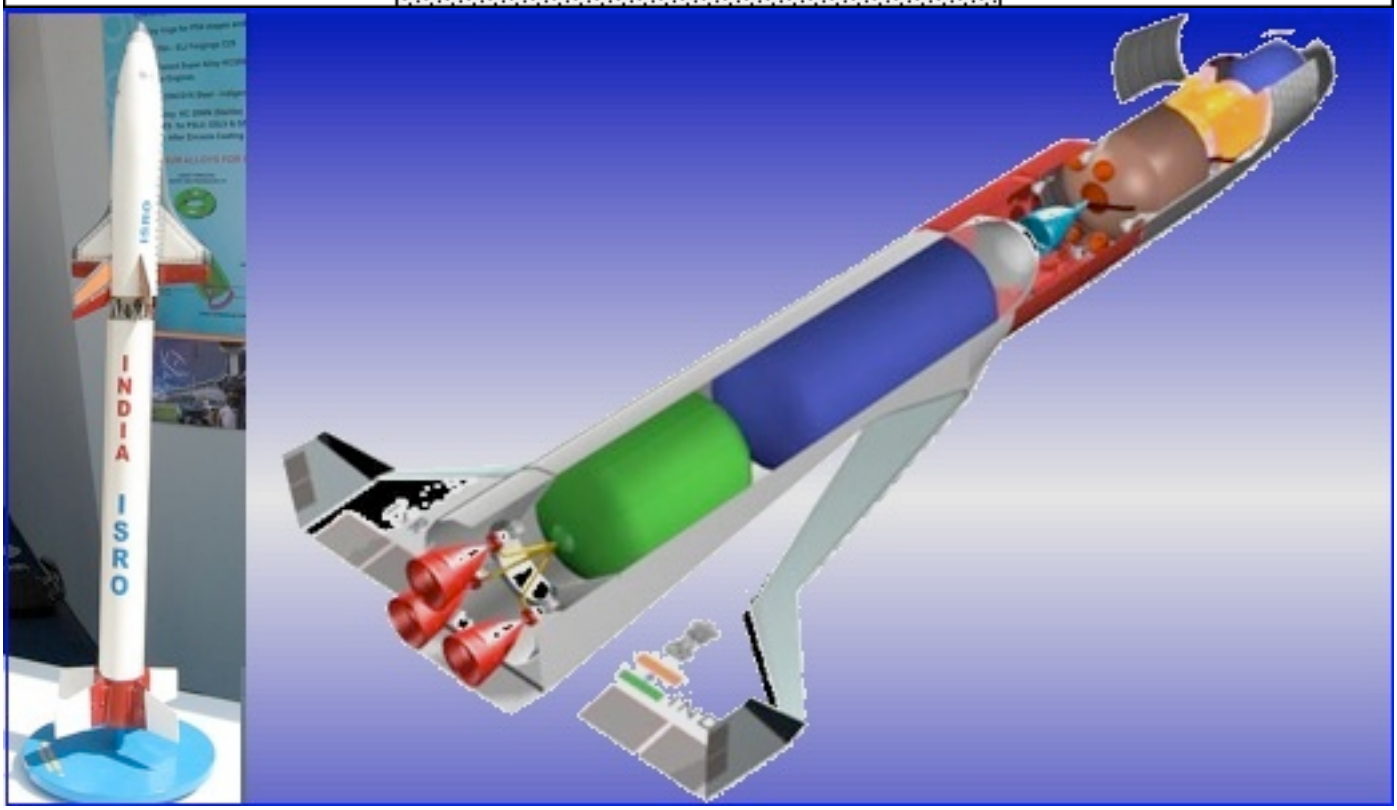
"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

Moon Miners' Manifesto

India Quarterly Edition

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

#12 OCT-DEC 2011



ISRO's new reusable cargo shuttle could give India an edge in the highly competitive space launch market – story page 3.

Feature Articles This Issue

Articles and Letters Wanted

Issue #12! Three years! Time flies when you are having fun! That said, if this publication effort is to be long-lived, we will need your help.

a) We need to grow the circulation considerably, and if each reader sends us just one friend's or colleague's email address, that will be a start in the right direction.

b) We need more contributions: articles, essays, reports, book reviews, not to forget photos with captions, feedback and comments on past articles, and requests for articles about specific topics. Submissions should be aimed at a general educated adult audience. Writers from anywhere are welcome, but more contributors from India would be especially welcome.

With your help, publication of MMM-India Quarterly can continue indefinitely, though our dream is that this publication be taken over by an Indian team and given a fresh look and identity, even a new name! **PK**

About The Moon Society

http://www.moonsociety.org

Our Vision says Who We Are

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

Moon Society Mission

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

Moon Society Strategy

We seek to address these goals through education, outreach to 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 (except January and July. The December 2009 issue began its 24th year of continuous publication.

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

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

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

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

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

www.moonsocietyorg/publications/mmm_classics/

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About MMM-India Quarterly

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

This publication was launched with the Fall 2008 issue. This issue completes our 2nd year. The Moon Society was founded as an International organization, but in fact has few members outside the United States, and these are for the most part solitary and unorganized.

Background

The Moon Society and The Planetary Society of Youth (TPSY) in India, http://www.youthplanetary.org/ in December 2003, put together a "Design a Mission to the Moon" category in TPSY's student design contest -- "A Mission to the Moon and Beyond."

The contest was designed to help students learn about various objects in the solar system as they compete in the design of a mission.

www.youthplanetary.org/moon_mission_contest.html

Why an MMM-India Quarterly?

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

And – *India has now gone to the Moon!*

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

This vision was well-expressed by the former President of India, Dr. A. P. J. Abdul Kalam in a speech at The Symposium on "The Future of Space Exploration: Solutions to Earthly Problems" to mark the occasion of the 50th Anniversary of the dawn of Space Age, Boston University, Boston, MA, April 12, 2007.

In this speech, Dr. Kalam made the point that to fully industrialize and become an equal partner in the future of our planet, India needs to access the unlimited clean undiluted solar energy available in space. We agree with his assertions and want to share that bold vision with the forward-looking people of India.

Free Access:

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

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

We encourage readers to share these files with others freely, and to use this publication to grow and cultivate wide-spread interest in the open-ended possibilities of space among the people of India, and to encourage the rise of additional citizen support space organizations within the country.

Indian Space News

ISRO's new Reusable Cargo Shuttle

See artwork on Cover of this issue

http://www.ndtv.com/article/india/**soon-india-to-have-its-own-space-shuttle**-123239?pfrom=home-India

In its ongoing effort to win India a greater share of the highly competitive world launch market, ISRO has been working on something unique, a reusable cargo shuttle. Unlike NASA's now retired fleet of the three remaining Space Shuttles, Discovery, Atlantis, and Endeavor (both Challenger and Columbia having met tragic ends) India's shuttle would not be man-rated, nor have space dedicated for crew or passengers. But if it is both reusable and fuel-efficient, that will be something new to the cargo launch business, which is growing internationally.

An engineering model of what scientists at ISRO call the "re-usable launch vehicle" is currently housed at a secure and secret facility in Kerala. While it won't carry astronauts to orbit, like the US Shuttle, it will be covered with special heat resistant tiles, to protect those parts of the craft that will be especially exposed to the heat of re-entry into the Earth's atmosphere. Like the NASA shuttle and rockets in general, it will be launched vertically. But unlike "the Shuttle" it will at first come down at sea. Airport landings will come next.

Why not design and build it to carry passengers? It is now generally agreed that combining cargo and people involves shared risks and costs that could be better managed separately. Cargo should not pay the price for "man-rating." By having separate vehicles, cargo and people can both fly vehicles sized and designed especially for each.

Comments by Editor Peter Kokh

No other space agency is known to be working on a reusable unmanned launch vehicle. As an observer, we have a caveat. One reason the US Space Shuttle was so very expensive to "turn around" – to get ready for the next flight, is that its tile protection system required a significant number of man-hours for repair and replacement of tiles, each different in size and shape. It might be a wiser choice to pick a different angle of attack in reentering the atmosphere so that a simpler, easier to repair or replace heat-protection system were devised. A one-piece (or few-piece) ablative shield that was designed to be snap-on, snap-off when replacement was warranted would greatly cut both costs and "turn-around time." NASA is much admired, but other agencies should think twice about copying NASA's mistakes.

Another thing that made the US Shuttle more expensive than it needed to be was the Congressional insistance that it be designed to meet US Air Force requirements if needed. Only one of over a 135 space shuttle flights was for an Air Force mission. ◘

Galaxy Forum India

Courtesy Space Age Publishing, and the International Lunar Observatory Association.

Hawaii, USA

Recently, The International Lunar Observatory Association of Hawaii and The JW Nehru Planetarium of Bangalore presented

Galaxy Forum India 2011:
Astronomy Education in the 21st Century
"Our Place in the Milky Way and Beyond"
The JW Nehru Planetarium, **Bangalore**
September 8th and 9th
http://www.iloa.org/galaxyforum.html
http://galaxyforum.org/

This national event was organized for India science educators with the collaboration of the **Bangalore Association of Science Education** (BASE) and the Government of **Karnataka's Department of Science and Technology.**

Astronomy experts, India space leaders and teachers from across the country gathered to present on the Galaxy, stars, the Moon, cutting edge research, discoveries and astronautical missions, as well as 21st Century Education developments.

Former India President 'Rocket Man' **APJ Abdul Kalam** inaugurated the 2-day event as India maintains trajectory towards a leadership role in international space exploration and research. Indigenous space technology and orbital launch system development has for many years been a growing national focus and source of inspiration for the next generation of India pioneers. ◘

Assembly Hub to be Built at Sriharikota

http://zeenews.india.com/news/sci-tech/assembling-hub-to-be-developed-at-sriharikota_731171.html

September 12, 2011 - **Hyderabad:** ISRO is planning to develop the Satish Dhawan Space Centre at Sriharikota in Andhra Pradesh into a Centre for assembling the satellites and rockets to be launched there.

"Our vision is a quantum jump in satellites and launch vehicles to be dealt with in future years. The space port Sriharikota should further develop into an area where the industries in India working for space would come together, assemble satellites and rockets there and move to the launch pad," ISRO chairman K Radhakrishnan said.

ISRO would work with the Andhra Pradesh government to develop the plans and turn them into reality.

The Ministry of Earth Sciences would benefit from this collaboration with ISRO. Radhakrishnan said it exemplified how a user ministry could internalise inputs from space. There should be similar collaboration with other departments that deal with agriculture, water, and minerals.

ISRO and the Indian National Centre for Ocean Information Services (Incois) are working together in the area of environment and climate monitoring on two new sagtellites. The Megha-Tropiques satellite to study the Tropical Climate set for an October 12th and satellite Saral to be launched later will provide ocean hieght data,.

Andrah Pradesh would be donating land adjacent to the Space Center for this purpose. ◘

India to have Another Satellite Launch Site

http://zeenews.india.com/news/sci-tech/india-to-have-one-more-satellite-launch-site_730988.html

New Delhi: Given the increase in requests from several countries for satellite launch services, India will develop another launch site to expand its current capacity. A feasibility study will be conducted for a new site that could be developed within two years. Both of ISRO's two satellite launch pads located at Sriharikota High Altitude Range (SHAR) can be adversely affected by cyclones, so ***a site less dependent on weather would be desirable.*** The report gave no further clues to where a new site might be located.

ISRO seeks 230 more scientists

http://zeenews.india.com/news/sci-tech/isro-short-of-230-scientists_725466.html

August 10, 2011 **New Delhi:** The Indian Space Research Organisation (ISRO) is short 230 scientists and engineers, the Lok Sabha was told Wednesday. The number of scientists and engineers in ISRO as on June 30 was 6,782, against a sanctioned strength of 7,012.

These vacancies will be filled through induction of the first batch of graduates from the **Indian Institute of Space Science and Technology**, Thiruvananthapuram, and ISRO's centralised recruitment process. ◘

New Satellite to Study Tropical Climate

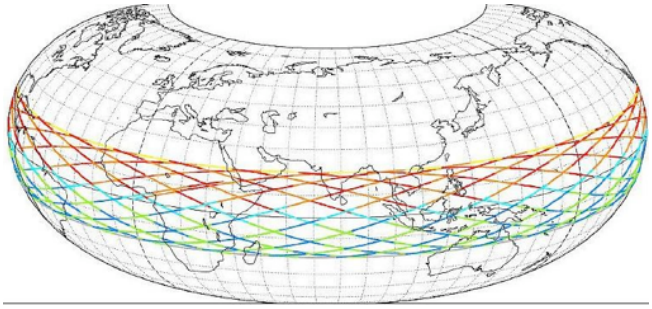
http://events.eoportal.org/presentations/7336/14846.html

http://www.youtube.com/watch?v=_Mdpt4AByo4 - 15m

http://zeenews.india.com/news/sci-tech/india-launching-satellite-to-study-climate_730888.html

http://timesofindia.indiatimes.com/city/ahmedabad/ISRO-promises-reliable-weather-forecasts/articleshow/10371525.cms

October 12, 2010 **Bangalore:** India has launched a new dedicated satellite to study climatic and atmospheric changes in the tropical regions in collaboration with the French space agency CNES.



"Megha-Tropiques" was launched into an orbit of 870 km above the surface with an inclination of 20 degrees **covering the equatorial region to study the life cycle of convective systems and their role in the energy and moisture budget of the atmosphere in tropical regionse**.

The 1,000-kg satellite was launched on a 230-tonne PSLV (polar satellite launch vehicle) from Sriharikota.

Megha-Tropique carries an imaging radiometer Microwave Analysis and Detection of Rain and Atmospheric Structures (MADRAS) to gather data **to estimate rainfall, atmospheric water parameters and ocean surface winds in the equatorial belt**, a six channel humidity sounder (SAPHIR), a four channel scanner for radiation budget measurement (SCARAB) and GPS radio occultation system (GPS-ROS). ISRO contributed Rs.90 crore and the French space agency - Centre National d'Études Spatiales (CNES) has contributed Rs.300 crore. Of the three instruments on board, MADRAS was built jointly by ISRO and CNES, while other two were built by CNES. A key instrument is the 5-frequency conical scanning passive micowave radiometer. See Video link above.

"Until now the weather forecasting was based on the satellite images of the clouds and a few other parameters like temperature and wind measured from the land. Through

Megha-Tropiques we will be able to study the inside of the clouds to gather other important details like the amount of water vapor contained in the cloud and such other parameters," says Pradep Pal.

The satellite is undergoing a 3-month-long period of characterization and validation before becoming operational. Riding along into orbit were three nano-satellites - a 3kg remote sensing satellite 'Jugnu' of the Indian Institute of Technology (IIT-Kanpur), a 10kg SRMSAT of the SRM Univ. in Chennai, and a 30kg VesselSat of Luxumbourg.

The design and construction of the Sattelite was task of the **Space Application Center (SAC) at ISRO in Ahmedabad** which will also analyze data from the satellite received in Bangalore**.** ◘

Chandrayaan-1 data proves that the Lunar Highlands were formed by Magma

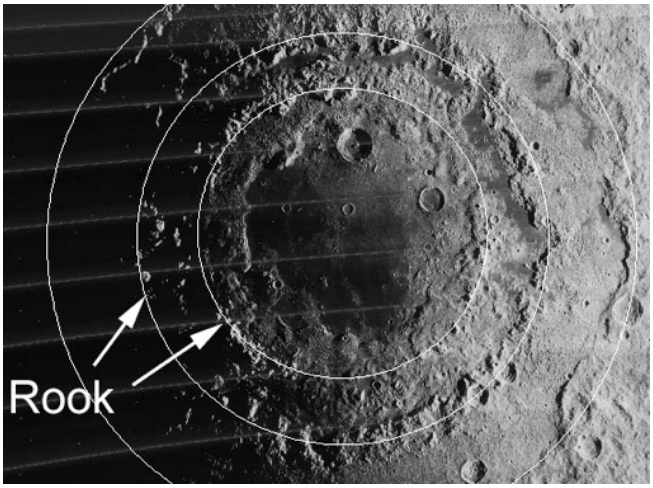
http://lunarscience.nasa.gov/articles/chandrayaan-proves-lunar-highlands-were-formed-by-magma

September 16, 2011 – Ever since the orbital and surface-based observations during the Apollo program 40 years ago, the hypothesis that planetary bodies got their first, or primary, crust from the cooling of the surface of a primeval magma ocean has gained wide support. Now, new data from NASA's Moon Mineralogy Mapper on ISRO's Chandrayaan-1 lunar orbiter proves that the Moon's highlands were formed by the eruption of a hot magma from below the Moon's surface, and not just the mare plains.

. "The hot liquid, magma, seems to have flowed on to the surface and taken the form of lava. The rocky remains that floated to the top appear to have transformed into the Moon's highlands or mountains," said an ISRO investigator.

Experts from Brown University, where the Moon Mineralogy Mapper was designed and built, have said new images show the Moon's surface in fine detail "so clear that even the colors of the surface can be seen separately to indicate the formation of the highlands or the crust.

The entire Inner Rook Mountain range that frames the great Mare Orientale basin was formed by upwelling magma triggered by the impact that created this basin. Japan's Kaguya mission reported similar findings. ◘



The Moon's **Rook Mountains** are a spectacular feature

Google Lunar X-Prize Contender Team Indus Progress Report

http://www.googlelunarxprize.org/teams/team-indus

Unnamed lunar rover under development by Team Indus

Team Indus: That's us!

The Google Lunar X-Prize Mission Steps

The Google Lunar X Prize challenge requires team to safely land a robot on the surface of the Moon and have that robot travel 500 meters over the lunar surface and send images and data back to the Earth

» **Stage 1: Launch:** Rideshare launch vehicle to near Earth orbit

» **Stage 2: Raise orbit:** Burn first set of boosters to raise orbit

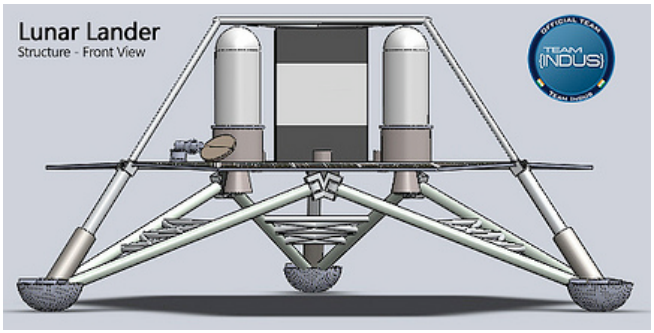
» **Stage 3: Lunar Orbit injection:** Burn third set of boosters to slingshot towards the Lunar orbit

» **Stage 4: Lunar Orbit:** Achieve stable Lunar orbit

» **Stage 5: Deorbit:** Final set of retro rockets to assist with descent to Lunar surface

» **Stage 6:** Soft land Rover on the surface, roam to complete GLXP requirements - sleep and wake up the next day to roam some more

Our Logo/Emblem >>



Team Indus Lunar Lander that delivers the Rover

More about Our Team and our Mission

- Team Leader: Rahul Narayan
- Graphi8cs Design Dilip Chabria
- Our Team consists of people from India, and it will continue to be for, of and by the people of India
- Seeks to represent the aspirations of one of the world's oldest civilizations and youngest population Head quartered in New Delhi
- Part of the mission of Team Indus and Google Lunar X PRIZE as a whole is to get kids excited about math and science, and spark their imaginations:
- A team of professionals from Technology, Science, Finance and Media background
- A habit of pushing boundaries
- Non-profit
- Hope to establish a Global Innovation brand
- Commercial aspects
- Setting up a separate non-profit education foundation that will work towards enhancing awareness of higher education, encourage youth to create, innovate growth campaign in India.
- A few out-of-the-box theories on each phase of the mission, going radical on technology was the obvious choice given the late entry
- Goal the Endurance and Distance bonus prizes.
- Potential launch sometime in 2014 on ISRO's PSLV

Team Indus Videos

http://www.googlelunarxprize.org/teams/team-indus/videos/team-indus-rover-ideas-i

http://www.googlelunarxprize.org/teams/team-indus/videos/team-indus-rover-ideas-ii

Team Indus Presentation @GLXP Summit2011

http://www.googlelunarxprize.org/teams/team-indus/videos/team-indus-presentation-glxp-summit2011

"It is a privilege to be part of GLXP's exclusive group of teams, we are excited by the possibilities and eagerly look forward to putting up a good show!"

"We are a team of professionals from Technology, Science, Finance and Media background all of whom have made a habit of pushing boundaries. At a personal level we are individuals driven towards disruptive technologies, looking beyond the "box", yearning to break new ground at all time"

TI

Elsewhere in Asia

Chinese National Space Agency

Chinese Scientists Develop Methodologies for Mapping the Moon

http://www.deccanchronicle.com/channels/sci-tech/space/chinese-scientists-develop-methodologies-mapping-moon

Chinese scientists have found a way to make precise maps of the Moon, including creating "an accurate 3D models of lunar surface". Hong Kong Polytechnic University reports that its surveying experts had developed methodss for precise mapping of the Moon, after doing intensive analysis of the data from China's lunar orbiter ChangE-1 and from Japan's Kaguya-Selene orbiter.

The result of their work is "the most updated parameters of the lunar figure (shape of the moon). This is essential to making a map of the Moon from the 17.5 million laser altimetry measurements from the ChangE-1and the Kaguya missions.

Poly-U scientists used these new topographic and gravity models "to calculate improved crustal thickness and mass distribution of the Moon." This enabled them to determine that the average thickness of the Moon's crust is about 40 km on the nearside and 50 km on the far side. (It had previously been thought to be 60 km on the farside.)

According to Professor Chen Yong-qi who led the team, the lunar mapping project started in 2006. The techniques needed to map the Moon surface are much more challenging than those needed to map the surface of Earth as there have been very few surveyed control points essential for accurate map making - only fourteen lunar laser ranging retro reflectors (LRRR) and Apollo lunar surface experiment package (ALSEP) transmitter sites with accurately known coordinates exist on the, all installed by US Apollo and Soviet Union Luna missions in the 1960s.

The highly reflective lunar surface creats signify-cant problems for the automatic processing of images for 3D models using the technique of photogramemtry, a widely used and highly reliable technique for the creation of maps and 3D models on Earth.

NASA's new GRAIL mission should yield signify-cant refinements in our gravitational map of the Moon. ◘

China's Orbital Lab Testbed Tiangong 1, launched September 29th

Artist depiction of unmanned **Shenzhou 8** capsule (right) with new **Tiangong-1** lab (left) planned for November

http://spaceflightnow.com/news/n1109/29tiangonglaunch/

www.youtube.com/watch?v=yMAFpDEuwKA&feature=related

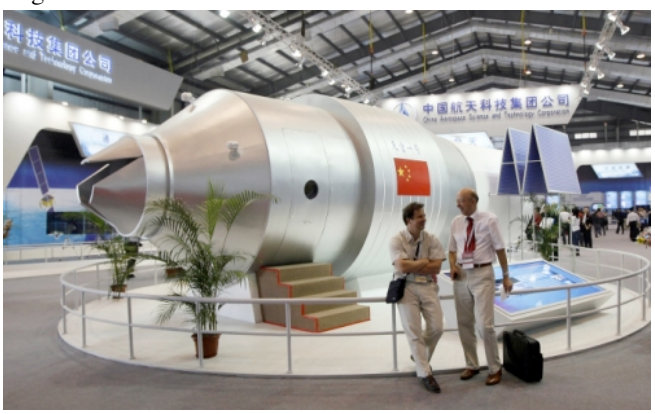
The launch of Tiangong 1, which means "Heavenly Palace" in Chinese, is a major milestone in China's space launch program for this year.

Due to the launch failure of the experimental orbiter SJ-11-04, the Chinese unmanned space module Tiangong 1, the prototype of the Chinese space experiment station, which had been scheduled to launch in late August, was delayed pending the investigation into the failed rocket.

The 8,600 kg Tiangong 1 module lifted off at 1316 GMT (9:16 a.m. EDT) aboard a Long March 2F T1 rocket. Chinese engineers has modified the 170-foot-tall rocket for the launch of Tiangong 1, which is heavier and larger than China's manned Shenzhou capsules that previously flew on the rocket seven times, having a larger nose shroud and longer liquid-fueled boosters than previous missions.

This November an unmanned Shenzhou-8 capsule will attempt the first remotely controlled cocking with Tiangong-1, to be followed within two years by dockings with the Shenzhou 9 and Shenzhou 10 crew modules. China is expected to complete the assembly of its space station in 2020 with all new and improved larger modules..

As an independently developed "space experiment station", Tiangong 1 is to be the test-bed prototype of the larger station to follow.



Museum model of Tiangong-1 shows size ◘

China Pursues Space Solar Power

http://spacejournal.ohio.edu/issue16/ji.html

"Fossil energy reserves in China, such as oil, coal and natural gas, will be exhausted in the next 15 years, 82 years and 46 years" per Chinese Academy of Engineering. Low-carbon energy options have become a national priority.

"The advantages of SPS for China can be grouped into three relevant directions:

- sustainable economic and social development
- disaster prevention and mitigation
- retain qualified personnel & cultivate innovative talents."

"A sustainable development strategy" must include "renewable energy sources from outside Earth"

This "Apollo-like project" will require development of fundamental new aerospace technologies"

- revolutionary launch approaches
- ultra-thin solar arrays
- on- orbit manufacture/assembly/integration (MAI)
- precise attitude control
- in-situ resource utilization (ISRU) (materials produced on the Moon)

In addition to reducing demand for fossil fuel energy sources, there may be other environmental benefits. "From preliminary research, it appears that microwave wireless power transmission may heat the top of the clouds, thereby reducing the force of typhoons and hurricanes."

Realization of Space Solar Power will take some time. These milestones are forecast:

- 2010, CAST finishes the concept design
- 2020, finish industrial level testing of in-orbit construction and wireless transmissions
- 2025, complete first 100**kW** SPS demonstration at LEO
- 2035, 100**mW** SPS to be generating electricity
- 2050, 1st commercial level SPS unit operational in GEO

Chinese Scientist promotes Solar Power Satellites

http://www.wantchinatimes.com/news-subclass-cnt.aspx?id=20110902000023&cid=1105

China's Space-Based Solar Power Strategy

http://bigthink.com/ideas/40504

China and the UU-India Space Solar Power Dream

www.orfonline.org/cms/sites/orfonline/modules/analysis/AnalysisDetail.html?cmaid=25917&mmacmaid=25918

"In the India-US context, space has remained a potential area of cooperation for the last decade or so whereas **China, which has studied the Indo-US joint communications carefully, has made fast progress on space-based solar power (SBSP), in terms of devoting financial and human resources into the project.** The need of the hour is for democracies like India, US and may be even Japan to come together, structure large collaborations around space and capture the political space in this regard. The political leadership in both India and the US should recognise the importance of it and act accordingly before it is too late."

"The Chinese plan drawn by one of its space pioneers Wang Xiji is an ambitious one and aims to look at various aspects of space-based solar power applications, designs and key technologies that would make the option economically feasible … and sustainable by 2020." ◘

Japan Aerospace Exploration Agency

Akatsuki to make 2nd attempt to Orbit Venus

http://www.space.com/12900-japan-venus-spacecraft-akatsuki-

Japan's Akatsuki Venus Climate Orbiter probe fired its main engine on September 7th for the first time since overshooting the planet in December, preparing for a possible second try four years from now, in 2015.

The craft was to have entered orbit around Venus on last December 6th. But an engine failure during the orbit-insertion burn sent the probe sailing past the planet.

JAXA officials are convinced they can give the probe a second chance during its next Venus encounter in 2015. They started testing the probe's "orbit maneuver engine" and got a successful burn, just enough to give the agency confidence that it is "a go" for a second attempt at getting into a usable orbit around Earth's sister planet. But a second test was planned for September 14th

If the 2nd test is also successful, Akatsuki will attempt an "operational burn" in November, to put the craft on the right path for second attempt at Venus in four years. If all goes well, Akatsuki will spend two years studying Venus' clouds, atmosphere and weather.

Scientists hope to determine how Venus - "similar in so many ways to Earth - veered off on such an extreme path, becoming an inhospitable world with thick sulfuric-acid clouds and surface temperatures hot enough to melt lead," according to JAXA officials. ◘

Japan passes Germany to take 3rd place in total number of "astronaut days" in space

http://seattletimes.nwsource.com/html/nationworld/2015720605_japanspace25.html?syndication=rss

Here are the latest statistics:

#1 Russia (including former Soviet Union) 20,760 days
between 104 cosmonauts

#2 United States !4,786 days
between 334 astronauts

#3 Japan 494 days
between 9 astronauts: Satoshi Furukawa, 47, is now on a long-term mission to ISS so that total # grow.

#4 Germany 493 days
between 10 astronauts

5, 6, 7, 8, 9, 10, 11 not stated

#12 China 20 days

These figures include days spent in small capsules (Vostok, Mercury, Gemini, Apollo, Soyuz, Shenzhou, Space Shuttles, etc., and on the Moon, as well as in other smaller stations (Skylab, Salyut, Mir) as well as on ISS.

Indian astronauts: Rakesh Sharma served 182 days on Salyut-7, **Kalpana Chawla** 15 days on Columbia, **Sunita Williams** 195 days on ISS: total **= 393 days.**

Russian Space Agency

Soyuz Flights to ISS set to Resume

http://www.upi.com/Science_News/2011/09/14/Russia-to-resume-manned-Soyuz-flights/UPI-44291316046190/?spt=hs&or=sn

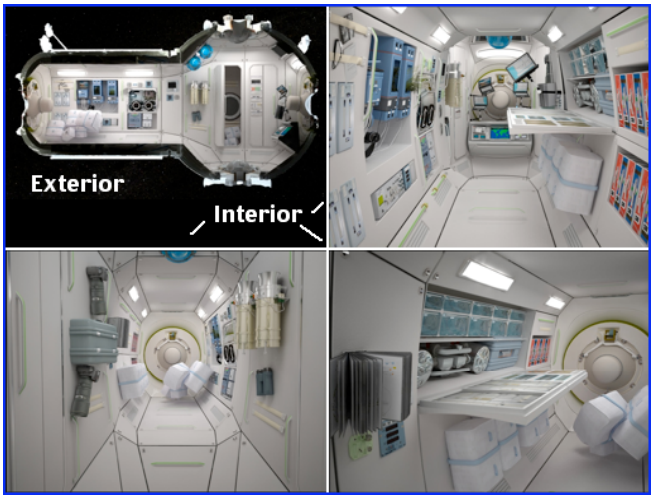
September 14, 2011 - After a recent rocket failure led to a Progress freighter, bound for the International Space Station to crash in Siberia, Roscosmos announced a halt on all Soyuz flights pending an investigation. There were rumors that the ISS might have to be abandoned, now that with the retirement of NASA's space shuttle fleet, Soyuz was the only available spacecraft able to carry crew to and from the station. But tests quickly determined the defect.

The investigation determined that the third stage of the Soyuz rocket carrying the Progress freighter had failed because of a blockage in a fuel line. Roscosmos has concluded that this was an isolated event caused by a production flaw that has now been identified and corrected.

Manned Soyuz flights could resume as early as the end of October. However, it is more likely that to gain the confidence of all involved in ISS, another Progress freighter will make the trip first. ◘

Russian Commercial Space Station Interior Outfitting Preview

http://orbitaltechnologies.ru/



See our illustrated report in M3IQ #9 page 8-9

"**Excalibur Almaz acquires Russian Space Station Modules for Future Commercial Space Stations**"

The first of at least two stations could ge flying by 2016. ◘

Elsewhere in the Commonwealth

UNITED KINGDOM

British Small Satellite Companies eye Collaboration with state-owned Space Florida

http://www.spacenews.com/commentaries/110405-fromwires-fla-officials-partnership.html

CANADA

Canadian pushes Merits of Developing Country's Own Launch Facility

http://www.ctv.ca/CTVNews/SciTech/20110730/should-canada-have-its-own-space-launch-facility-110730/

The scientific and business communities in Canada have been debating the merits of having their own launch facility with little progress towards a consensus. But now astrophysicist and honourary professor of theoretical physics at the U. of British Columbia Redouane Fakir has developed a proposal to build a rocket launch site on Canada's west coast on Vancouver Island as a future hub for space science and exploration, The hurdles are finding the money, and securing both local co-operation and Canadian and British Columbia provincial government approval.

He cites a promising site at Estevan Point, halfway down the island's west coast. There he envisions a "parking-lot-sized" launch pad that would send Canadian space probes into a polar orbit. From there, one can launch over the Pacific in a SW direction, Scientific balloons could also be launched there, The pad would not be busy all the time.

"In the beginning, we'll be lucky if we have one launch a year and then maybe two or three a year," said the director of Space Launch Canada. The hardest part is convincing others, including both businessmen, key corporations, and government officials at various levels.

Canadian "Space Handyman" Dextre, completes its first task aboard ISS

www.forbes.com/sites/alexknapp/2011/09/01/canadian-space-robot-makes-repairs-on-international-space-station/

Dextre has successfully replaced a faulty circuit-breaker box on the orbiting lab, swappong the failed component for a fresh one, to restorepart of the International Space Station's backup electrical systems. This is the first time Dextre has replaced defective equipment on the ISS without having an astronaut go outside on an EVA exercise. For a crew member, such an operation had become routine, but not without significant risk. No ISS crew members were involved as Dextre was operated by controllers in Houston.

In the event that the space station were to be temporarily abandoned, Dexter may be able to do some maintenance duties until a human crew returned. ◘

AUSTRALIA

NASA conducts Mars Research in Pilbara Region of NW Western Australia

http://spacewardbound.nasa.gov/australia2011/index.html

http://pilbara.mq.edu.au/wiki/Main_Page

Persuant to a NASA Space Act Agreement with the Australian Centre for Astrobiology at Macquarie University in Sydney and in collaboration with several other institutions, a remote area of the outback in Western Australia is being used as a training ground for Astrobiologists who might one day look for traces of archaic life forms on Mars.

The NASA expedition has been studying a landscape filled with fossil fragments scientists believe contain evidence of primitive microbial life forms that existed 3.5

billion years ago. Chris McKay of NASA's Spaceward Bound Program, which has done research also at the Mars Society's Mars Desert Research Station in Utah, says "What we see here in the Pilbara is macroscopic evidence of microscopic life from the very dawn of life itself and the structures are large enough that we could recognize them if we found them on Mars and drove up to them on a rover."

Australia Launches Citizen Science "theSkyNet" Astronomy Data Project

www.zdnet.co.uk/news/after-hours/2011/09/13/australia-launches-theskynet-space-project-40093919/

http://www.zdnet.com.au/theskynet-launched-set-to-spread-online-339322240.htm

TheSkyNet will pool computing power from home PCs to analyse radio signals from space, gathered by radio observatories such as the CSIRO Parkes and the planned SKA – Square Kilometer Array, which could well be awarded to Australia. Another southern hemisphere commonwealth nation, South Africa, is the only other contender. That is a story in itself.

theSkyNet

theSkyNet.org

TheSkyNet;s purpose is to use the combined computing power of personal computers to help analyse and interpret radio signals received from space. The first such project to tap the combined computing power of millions of private computers was the SETI@home project.

http://en.wikipedia.org/wiki/SETI@home

Related Australian Astronomy Stories:

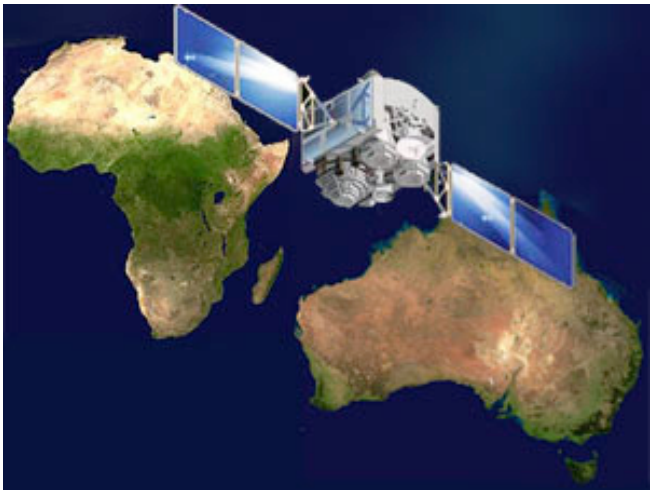
http://spaceinfo.com.au/2011/07/07/new-spirit-for-student-astronomy/ - The Internet Telescope Project

http://spaceinfo.com.au/2011/07/07/milestone-as-radio-dishes-linked/

http://spaceinfo.com.au/2011/07/25/radio-astronomy-protected-in-western-australia/

http://spaceinfo.com.au/2011/07/07/dishes-take-shape-in-the-desert/

http://spaceinfo.com.au/2011/07/14/aussie-scope-to-be-upgraded/



Australia & South Africa vie for Astronomy's biggest prize to date: SKA = The Square Kilometer Array

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

[from Wikipedia;] "The **Square Kilometre Array** (SKA) is a radio telescope in development which will have a total collecting area of about one square kilometre. (about 3/8ths of a square mile or 250 acres)

It will operate over a wide range of frequencies and its size will make it **50 times more sensitive than any other radio instrument.** It will require very high performance central computing engines and long-haul links with **a capacity greater than the current global Internet traffic**.

It will be **able to survey the sky more than ten thousand times faster than ever before**. With receiving stations extending out to distance of 3,000 km from a concentrated central core, **it will continue radio astronomy's tradition of providing the highest resolution images in all astronomy.**

The SKA will be built in the southern hemisphere, either in South Africa or Australia/New Zealand **where the view of our own galaxy, the Milky Way, is best and radio interference least**. With a budget of €1.5 billion, **construction of the SKA is scheduled to begin in 2016** for initial observations by 2019 and **full operation by 2024**.

SKA is a global **collaboration of 20 countries** which aims to provide answers to fundamental questions about the origin and evolution of the Universe.

Jodrell Bank Observatory (of the University of Manchester) in Cheshire, England will be the location of the **headquarters office** for the project. "

anzska

SKA AFRICA
SQUARE KILOMETRE ARRAY

The Australia - New Zealand Plan

The hub cluster will be in Western Australia with outlying scopes throughout Australia and in New Zealand

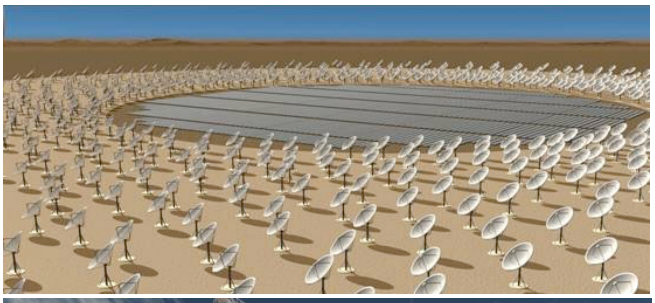
The South African Plan

South Africa plans a tighter concentration of telescopes in the Great Karoo Desert of Northern Cape Province.

Advantages and disadvantages of the two rival plans

The Australia-New Zealand plan for a more dispersed network might provide superior mapping resolution. The South African plan could be built significantly sooner and at less cost. Both sites are among the most radio-quiet areas in the world. Both entries have received very high marks. There is enormous enthusiasm for the project in both countries. And a winner may be announced next year. Both sites are in the Commonwealth.

SKA Photo Gallery



Elsewhere in the World

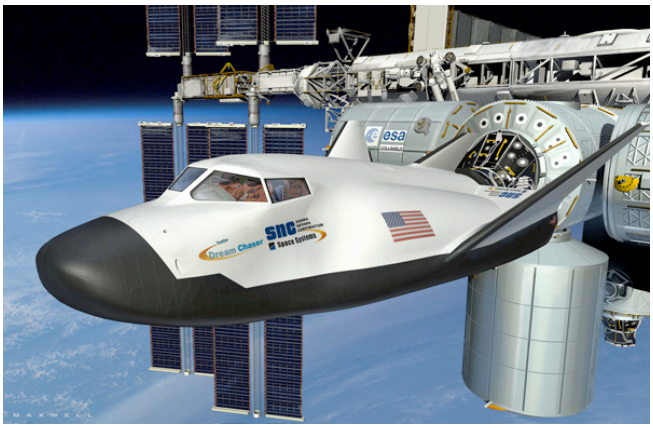
UNITED STATES

Space-X Dragon Cargo Capsule set for 1st Commercial Docking Mission to ISS

http://www.newlaunches.com/archives/spacex_dragon_will_dock_with_iss_on_november_30.php

If successful, this docking will be a watershed in space history which has been tiotally dominated by the various national space agencies, Commercial companies have been limited to contractor roles to date. Space-X Dragon capsule has already approved its ability to enter orbit and safely land back on Earth. Given that NASA, now that the Space Shuttle Fleet has been retired after some 30 years of service, is now otherwise totally dependent on Russia's Roscsomos Soyuz spacecraft to deliver crew personnel to ISS, and for cargo deliveries to Roscosmos' Progress freighter, and Japan's Kounotori 2 H-2 Transfer Vehicle (HTV-2), and ESA's Automated Transfer Vehicle (ATV), NASA will be glad to see Dragon enter service.

And this is only the beginning. Several other US commercial firms are not far behind when it comes to cargo delivery capacity, and Sierra Nevada's Dream Chaser space plane for crew deliveries.



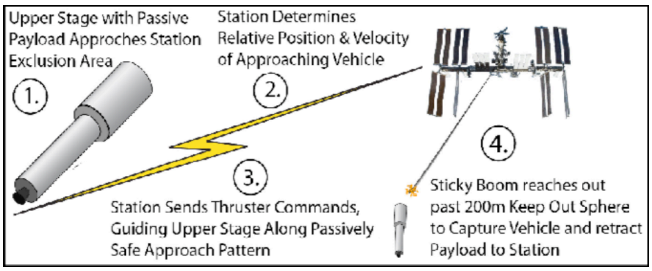
These encouraging commercial developments flow from NASA's COTS program (Commercial Orbital Transportation Services) which included phased grants to jumpstart development.

Historically, commercial providers can deliver services at a significantly lower cost than government agencies for which cost savings are often not a goal. Thus a successful docking by the Dragon cargo craft could issue in an era of unprecedented growth in space activities.

Space-X is also developing a 7-person crew version of the vehicle, comparable to the capacity of the Space Shuttle, to be ready in 2014. With Sierra Nevada, Boeing, and Lockheed Martin working on commercial crew carriers as well, access to new commercial space stations should be comparatively affordable. ◘

New Commercial Company invents Cheaper, Faster way to boost small payloads to orbit

http://blog.altius-space.com/2011/08/direct-to-station-d2s-deliveries-system/

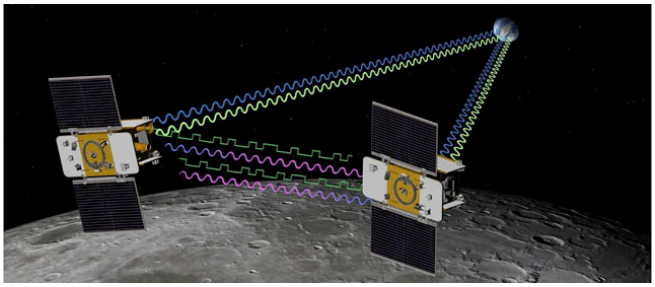


Jonathan Goff, a co-founder of Masten Space Systems, at which he was lead propulsion engineer, and a recognized expert in the area of cis-lunar architecture and low cost space flight systems has now started his own company, Altius, to develop a solution that enables nanosat launch vehicles to deliver small, just-in-time packages directly to the station. "This opens a huge new market for nanosat launch developers, and enables Altius to achieve $20-70M in annual commercial revenue once scaled-up to full commercial operations, and more importantly enable us to change the way space deliveries are made forever."

Watch a video of his winning presentation at:
http://blog.altius-space.com/2011/08/biz-plan-pitch-video/ ◘

NASA Launches GRAIL Gravity-Mapping Orbiter Pair to the Moon

http://www.nasa.gov/mission_pages/grail/main/index.html
http://solarsystem.nasa.gov/grail/home.cfm

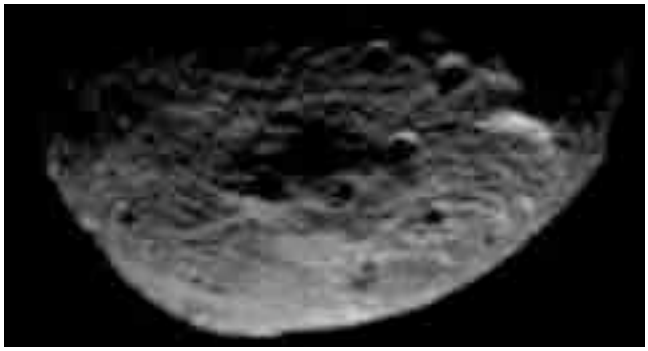


"The Gravity Recovery And Interior Laboratory (GRAIL) mission will create the most accurate gravitational map of the Moon to date, improving our knowledge of near-side gravity by 100 times and of far-side gravity by 1000 times. The high-resolution gravitational field, especially when combined with a comparable-resolution topographical field, will enable scientists to deduce the Moon's interior structure and composition, and to gain insights into its thermal evolution--that is, the history of the Moon's heating and cooling, which opens the door to understanding its origin and development. Accurate knowledge of the gravity will also be an invaluable navigational aid to future lunar spacecraft. Ultimately, the information contributed by the GRAIL mission will increase our knowledge of how Earth and its rocky neighbors in the inner solar system developed into the diverse worlds we see today."

"This will be the first time any space agency has attempted the complex set of maneuvers required to place two robotic spacecraft into the same precise orbit around a planetary body other than Earth so that they can fly in formation." The science mission will extend from March to May in 2012. ◘

Dawn Spacecraft continues year-long Study of 2nd largest asteroid, Vesta

http://dawn.jpl.nasa.gov/mission/journal_09_01_11.asp
http://lunarscience.nasa.gov/articles/nasas-dawn-spacecraft-orbits-vesta - full rotation video



Dawn entered orbit around Vesta on July 15, and entered its final orbit August 11, at an altitude of nearly 1,700 miles (2,700 kilometers) and began its "in-depth analysis." Vesta is the brightest object in the asteroid belt, as seen from Earth and easiest to see with the naked eye. Scientists believe Vesta is the source of a large number of meteorites that fall to Earth.

After a year in orbit, the probe's engine will fire, putting it on a trajectory for another orbital study, this time around the dwarf planet **Ceres**, the largest body in the Asteroid belt, in 2015. ◘

EUROPE-ESA

. European Space Agency (ESA) Approves Resumption of Work on Exo-Mars

http://www.spacenews.com/civil/110527-esa-cleared-restart-work-mars.html

This joint mission with NASA is a double mission, with a 1916 Mars Orbiter and a 1918 joint rover. ◘

SOUTH AMERICA

Argentine and Brazilian defense officials suggest creation of a "South American" Space Agency

http://en.mercopress.com/2011/09/01/argentina-with-brazilian-support-proposes-a-south-american-space-agency

This proposal would seem to be in very early stages of discussion as it involves military defense officials only, not higher-level government officials, or space scientists from either nation, and it does not appear to ber an attempt to set up an organization such as the very successful and productive European Space Agency – ESA. Meanwhile, Chile is also moving aggressively to set up its onw Space Agency and program, not to be left behind. "Stay tuned!"

There are two major launch cites on the continent, the one in Kourou, Guyana, operated by the European Space Agency, and recently with involvement by RosCosmos, being the more important. Brazil's north coast site at Alcantara, the closest launch site to the equator, is growing.

http://www.esa.int/esaMI/Launchers_Europe_s_Spaceport/

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

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

Not to be left behind, Argentina is developing its own launch center at Puerto Belgrano near Bahia Blanca.

http://www.upi.com/Business_News/Security-Industry/2010/08/16/Argentina-plans-to-join-Space-Age/UPI-15291281976235/

Given that the proposal involves the 1st and 3rd most populous South American nations (Columbia is 2nd), this is an encouraging sign, which in time could make South America a major player in another decade.. ◘

AFRICA

Progress in Space Cooperation by Several African Nations

By David Dunlop - October 18, 2011

African Leadership Roundtable

The International Astronautical Congress was held in South Africa in October and this was the first time the IAC had been held in the African Continent. An interesting session was the African Leadership Roundtable of Space Agency Heads from **Algeria**, **Kenya**, **Nigeria**, **Tunisia**, and **South Africa**.

The common thread of cooperation between African Space Agencies concerns practical application of space technology to the many problems of development that these countries are facing. A principal thrust is cooperation on the development of an **African Resource Management Constellation of Earth Observation Satellites**. Applications involve **remote sensing, agriculture, communications, health services and tele-educations.**

Another area of coordination involves **Disaster Management Planning**. An additional priority is the development of human resources and the improvement of **space science and engineering programs in which African Universities train African professionals**.

Agency leaders spoke of a **20-year Vision for Africa** in which *Africa develops its human capital so that it can build its own satellites without the dependence of other more technologically advanced spacefaring nations*. These countries are also encouraging the development of private sector companies to provide an aerospace service sector.

South Africa

The head of South Africa's Space Agency is Sandile Malinga. South Africa has the status of having space assets such as the Tracking Facility at Stellenbosch University. It also has a program developing the Square Kilometer Array and a National Astronomy and Space Science Program. It is using its satellites for precision farming and the monitoring of migration across its borders. South Africa has also developed small satellites.

There is a wide understanding that satellite services are an essential element of national infrastructure for all the African countries.

Many additional African nations will establish space programs to further economic development. Some of the leaders in the Roundtable said that bilateral agreements between African countries are a first step toward more ambitious goals. They expressed the opinion that it is not a question of "if" but "when an African Space Agency will be established." A working team is conducting a study on this possibility for the African Union. **DD**

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BUILDING INTEREST & ENTHUSIASM FOR SPACE IN YOUR COMMUNITY

By Peter Kokh

We launched MMM-India Quarterly three years ago (already!) with the purpose of supporting, and helping to build, enthusiasm for space and for India's space program among the people. With that public support, Indian legislators are more likely to fund ISRO programs and projects. India's space feats and abilities continue to grow and have achieved a remarkable record with much promise, earning India deep respect worldwide.

I have personally been involved in "public outreach" about space in my own community (Milwaukee, Wisconsin, USA) for the past 25 years, and this is an activity I personally love and feel passionate about.

In this column, each issue, we will share some ideas and lessons that have worked for us, and which you, as a space enthusiast in India or elsewhere, may be able to adapt to your own local conditions.

Many readers may have to start on thier own, as there may be no type of club or chapter or group in your community that is focused on space exploration and development. We will keep that in mind!

Leveraging the Sky

By Peter Kokh

It's a fact: in any country, there will be far more local astronomy clubs than space-interest chapters. While astronomy buffs and space enthusiasts may have differing goals and interests, there is clearly some overlap, and it makes sense to leverage that. Doing so makes sense even for established chapters in large urban areas. But it could be especially helpful for those with small chapters, and especially so for lone individuals who would like to start a local Moon/space chapter, but who are still at the "Outpost stage" (one or more persons looking for others to start a full chapter, and now serving as local contact.)

The splendors of the nighttime sky include Mercury, Venus, Mars, Jupiter, and Saturn, not to forget the brightest asteroid Vesta and an occasional comet – ***but above all, the Moon!*** And for the Moon, a pair of binoculars will be enough to provide stunning views. While many amateur astronomers are focused on stars, double stars, variable stars, star clusters and nebulae, and faint galaxies, most also are interested in the planets when they are in good observing position.

What can one Moon/space-enthusiast do, starting in a local astronomy club?

1 Give talks and presentations about the Moon, and its resources that could change our future; focus on areas of special interest such as sinuous rilles and the lava tube networks they imply. Divide your topic into a series of such talks for monthly meetings.

2 At observing nights open to the public, volunteer to be the one to show the planets that happen to be up, and the Moon, while other club members focus on showing visitors the stellar sights. Prepare to answer questions and to talk about past & future probes and what we have learned and hope to learn from each.

3. Download pamphlets and flyers about the Moon Society, its vision, mission, and goals, and how to join with a pitch about your chapter or outpost.

http://www.moonsociety.org/downloads/

4. Be knowledgeable about ISRO projects and programs and have brochures and other printed matter to hand out.

In time you may find others who would like to join you in starting a Moon/Space club or chapter. To do this you need others, and a local astronomy club is a good place to start. Have a notebook to take down names, addresses, email addresses, phone numbers and information about each person's interests and "buttons" (topics or issues of special interest to that person.) Also try to find out each person's special talents and expertise. This information will help you follow through when you meet people who share your enthusiasm, at least in part. Have a simple business card so that others can find you and share information with you and work with you.

5. Keep informed about upcoming rocket launches, whether they are of satellites or Moon orbiters and probes. Anniversaries of important space events like the first man in Space – Yuri's Night, or the first Moon landing, or the first ISRO rocket launch. You may be able to host a party for others interested in watching and following or commemorating the event as the case may be.

6. Try to find projects that suit the special interests and talents of those you find who want to help start a Moon/Space club. That way you will have better results.

7. Build a group library of books owned individually but which can be shared. Give reports or reviews on books you find informative and/or helpful.

8. Keep in contact with other local Moon/space groups that you learn about. You can learn from each other, even do joint projects or events with them, building a mutually supportive network.

9. Start a group Facebook Page on which you can share information and reports and projects.

10. Collect email addresses and send them to mmm-india@moonsociety.org so that we can send these persons notices when the next issue of MMM-India Quarterly is ready to download!

11. If at first you get no positive reaction, keep trying, and that by itself will get attention. Remember, "it isn't easy, but it is worth it!" ◘

"**Sidewalk Astronomy**" has become increasingly popular around the world. While many astronomy clubs engage in this form of outreach, it is also something a lone enthusiast can launch by oneself.

Here are some Sidewalk Astronomy websites and you can find more through a simple Google Search (never forget companion Google Image Searches@!)

www.flickr.com/photos/iyacalgary/4417678906/
www.sidewalkastronomy.com/ (New Orleans)
www.sidewalk-astronomy-club.com/chicago/

A Sidewalk Astronomy kit should include a small portable telescope, and a collapsible free-standing rack to hold literature about the Moon Society (and your local Chapter/Outpost, sample copies of M3IQ with sign-up forms, and so on. A 12" 20 cm globe of the Moon would be great.

What: select all equipment to fit in a car trunk or large shopping cart and be taken out in the field whenever clear skies, a volunteer, and the Moon are all available. *You do not want or need a high power telescope to view the Moon*. A good pair of binoculars will work. A small light-weight backpack-portable **Astroscan**™ would do quite well*!*

Where: busy urban places are fine as dark skies are not needed to see the Moon! A cinema parking lot (when a good sci-fi film is showing) might be promising. Choose safe, busy spots (not secluded parks!)

When: the eight day stretch, from four days before half moon (first quarter) to about four days after, offers the most satisfying views, showing craters and mountains in good relief and contrast in prime time evening hours. The dates will shift with each month.

Why: most people have never looked at the Moon through a telescope and are amazed to see craters and mountains so clearly. This drives home the realization that they are looking at more than a bright light in the sky, but at ***another world.*** ◘

The Moon: What's in it for Earth?

By Peter Kokh

[Expanded from Moon Miners' Manifesto #248 Sept. 2011]

, To most people, the Moon is a pretty sight, even romantic, but otherwise quite irrelevant. We need to show them how and why it isn't so, that opening the Moon is very relevant to us all.

To do this, we need to firm up our own understanding of "**What's in it for Earth?"** Below are some key "talking points."

• **Continuing our Frontier-opening saga:** Humanity's "home world" is Africa. *It is too late to "stay home where we belong!"* Over more than a hundred thousand years, we have expanded to one continent after another. This expansion has increased our cultural diversity, and, more importantly, our capacity to adapt to frontiers with differing climates, different sets of resources, different plant and animal species. This Epic has demonstrated the all but unlimited capacities of the human endowment to adapt. In many ways. In this respect **the Moon is just another continent across another kind of sea, and part of Greater Earth.**

Not to open the Moon would become humanity's first significant failure.

All past generations of youth have enjoyed the options offered by new frontiers. Do we have the right to close the frontier door for generations of youth to come?

• **Booster shot for World Economics:** The Moon is the ideal and most environmentally friendly source of raw materials with which to realize the maximum economic potential of GEO [Geosynchronous Earth Orbit] already a significant contributor, nearing $300 Billion a year, to the world economy, through various kinds of satellite operations. The capacity to expand the GEO sector of the World's economy is enormous, especially in these directions:

1. Construct giant platforms in GEO capable of hosting hundreds of satellites, providing station-keeping, power, telerobotic maintainance and repair, etc. To keep satellites in GEO from bumping into one another in this tight band, there is a world agreement to divide GEO into 180 "slots" with 2° spacing between them. GO is getting crowded. By placing individual satellites on "hosting platforms" the capacity of GEO could grow a hundredfold, even a thousandfold. And then we are talking about "real money."
2. Construct hundreds of giant solar power satellites to gather full-strength sunlight 24 hours a day, and beam the power to surface grids on Earth by microwaves or lasers. This is the dream of the "NSS-Kalam initiative."
3. A less ambitious alternative, or rather *a way to jump start the transition to space solar power* would be a world-wide orbital power grid, something we discussed in M3IQ #5 p. 19. Electric Power to India via Space.

It would take 1/23rd the rocket fuel to bring needed materials down the gravity well to Geosynchronous orbit as it would to bring them up the well a much shorter distance from Earth – and without the air pollution so many rockets might create.

• **Technologies for Healing our Environment:** Sadly, to many people, the ever-increasing degradation of our environment is not a pressing concern. Yes, we worry about passing on to our children a shattered economy, but not about passing on a shattered environment.

*There are several ways in which opening the Moon can help on both fronts. On the Moon, pioneers will live **"downwind and downstream of themselves."** There will be nobody else's "back yard" to dump in. The pioneers will have to learn to live in harmony with nature within their mini-biospheres under pain of death. We can learn from them what we would never bother to learn for ourselves simply because we do not feel the ill effects of our bad stewardship in the near term.*

• **Zero-G Exports from Lunar bases and settlements:** Some, many in fact, doubt the economic feasibility of developing usable construction materials from moon dust. Not only has most needed research into lunar on location materials languished in the early theoretical stage, but little homework has been done on a step-by-step process to "bootstrap" lunar industries, except by the Moon Society's St. Louis Chapter "Think Tank".

Be that as it may, there are some "Lunar Exports" that are not material but still of significant economic value. And we take this up in this issue.

The bottom line is that the answer to "the Moon, what's in it for Earth?" is "much more than one might expect!" **PK**

Note: These subtopics are addressed below, but not necessarily in the order stated above.

The Moon: What's in it for Earth?
I. Zero-G Export$ from Lunar Outposts & Settlements to Earth

By Peter Kokh

[Expanded from Moon Miners' Manifesto #248 Sept. 2011]

Many space enthusiasts are skeptical about the economic feasibility of producing anything on the Moon to send back to Earth. That's another article, but read pages 6-8 for clues. Here we want to cite those products that "ship free". Know-how processes and technologies that could be developed on Earth, but will not be, as the perceived need is less urgent.

• Environmental technologies developed first on the Moon where the urgency is immediate

Lunar Pioneers will learn to live in harmony with Nature within their mini-biospheres, and learn fast, because they have no choice. They will be "living downwind and downstream of themselves" and there is nobody's back yard to dump pollutants, especially organic compounds made of elements scarce on the Moon. The processes and technologies they develop, because they have no choice, can then be exported to Earth and as they are adopted on Earth, make a very critical and significant contribution to the preservation of Earth's fragile environment for future generations.

These technologies will include stale air and used water treatment, products and new production processes that make "total recycling" feasible and easy. They will also produce a mindset, beginning at a very young age, of ingrained personal responsibility to preserve their fragile mini-biospheres.

• Moon-appropriate building materials and variants that could find a market niche on Earth as well:

As so many of the materials that we use on Earth include chemical elements rare on the Moon, we must make do with substitutions. Glass-glass composites ("glax") is a promising area of research in which only minimal demonstrations have been done to date. We might make habitat modules, furniture, vehicle bodies, and many other useful products form this material, which could be pre-developed here on Earth as it has advantages such as a substitute for wood. Read:

http://www.moonsociety.org/publications/mmm_papers/glass_composites_paper.htm

New types of concrete types; new metal alloys that do not use alloy ingredients rare on the Moon such as copper, zinc, even carbon, are some options. Once developed on the Moon where the need is urgent, such materials may well find a market on Earth in nations less well endowed with mineral wealth.

• Technology options using elements *not rare* on the Moon (i.e. excluding elements *rare* on the Moon)

Even given confirmation of surprisingly large quantities of water-ice in permanently shaded craters at both lunar poles, and recent evidence of unsuspected quantities of water bound up in lunar materials in micro-drops, water will be harvested with much greater effort on the Moon than on our water-rich planet. New ways of conserving water and recycling it with ever-greater efficiency will be an effort that is pursued religiously as need grows with population.

As to mining, pioneers will treat the tailings with respect, as they are necessarily enriched in all elements not yet extracted. When no more elements can be affordably extracted, pioneers will find ways to turn these last-generation tailings into products that are useful. And some of the technologies and processes so developed will help reduce our "trash problems" here on Earth. The "**throughput**"***** footprint of the settlement is thus reduced, with the result that population for population, the lunar landscape will be far better preserved than Earth's has been. And perhaps some of these technologies applied on Earth could in time "recover and restore" significant portions of industry- and wastes-wrecked lands here on Earth.

****** *The percentage of raw materials mined that ends up in landfills as a negative indicator*

To conserve energy, lunar industrial parks may be arranged so that waste heat from those operations that require higher operating temperatures supplies those that need somewhat less, in a "**Thermal Energy Cascade**". It would make sense to design industrial parks on Earth to do likewise: reusing and reusing waste heat, which is potential energy.

• Education of youth in environmental responsibility.

The lunar settlement experiment will surely fail if living right, given the strictures of the lunar environ-ment does not quickly become "second nature," and anything but a resented burden. This means raising children and youth accordingly. **A "4th R"** ~ "**Recycling"** must be added to the original trio **"Reading,** w**Riting,** a**Rithmatic"**, in settlement educational curricula. Assigning recycling chores of increasing complexity to youth as they age. [Everything produced on the Moon should be designed for easy and correct recycling. Dissimilar materials need to be mechanically assembled for ease of separate sorting, doing away with the use of bonding adhesives which cross-contaminate dissimilar materials. Only recylcable plastics should be used, color-coded for ease of proper sortation.

For older youth, before they enter the workforce or going on to College or University. a year of "universal service" in the water/air treatment systems or in bio-waste recycling operations would make sense. The driving consideration here is that their survival is at stake. The instincts needed to insure that settlers succeed in maintaining their fragile frontier mini-biosphere ecosystems must become ingrained, "as if by "second nature." These lessons can then be exported to communities here on Earth with the result that more and ore people world-wide will become good citizens of "Mother Earth."

• Art Form Options that work on the Moon/Mars, will also work on Earth

Art forms that are totally inorganic will have their own unique beauty and could catch on here. There are a number of possibilities. For a report on our own personal experiments starting in 1994, check out:

http://www.moonsociety.org/chapters/milwaukee/painting_exp.html

• Social Experiments to maximize productivity of all

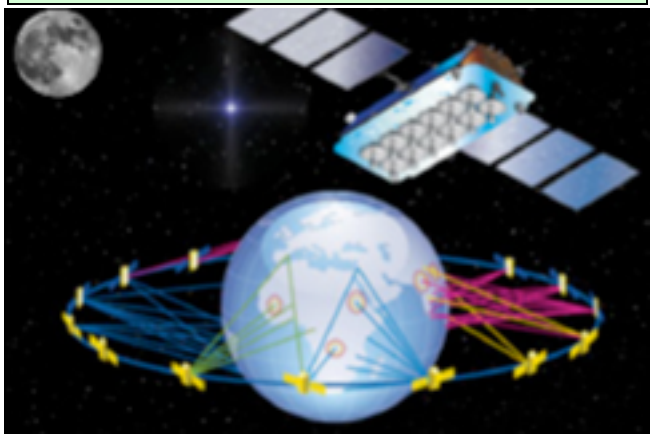
Making a frontier economy work will depend on everyone doing their part: no room for slackers and/or those who add to the burden. This means taking cradle-to-grave steps to minimize anti-social behavior. "Out-the airlock" solutions may seem severe, but chain-gang labor should not be dismissed for the stubbornly uncooperative. Handling the handicapped so that any burdens are offset with plusses will be a challenge. The lessons for Earth will be significant.

• Retirement must mean switching to more relaxed forms of *productivity*.

Better child-care options (such as pre-retirement part time grandparenting?) are needed to free adults in their prime for economically productive activities. Retirement should be a transition to other less demanding forms of productivity freely chosen by each individual. Teaching can certainly be one of these activities, whether in formal school or more relaxed environments. We must develop better systems to pass on generational wisdom. In the United States in many communities, children are raising one another with a consequent loss of values. The way we must do things on the space frontier to ensure the community's survival can help revitalize communities here on Earth.

The above is not meant to be an exhaustive list of "Zero-G Exports from the Moon to Earth. **PK**

The Moon: What's in it for Earth?
II. Lunar Materials to Grow Earth's Economy



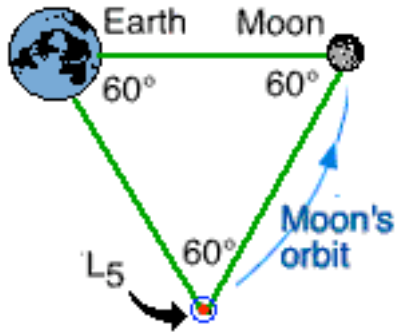
(Photo Credit: Briot/Thales Alenia Space), *Moon image added*

By Peter Kokh

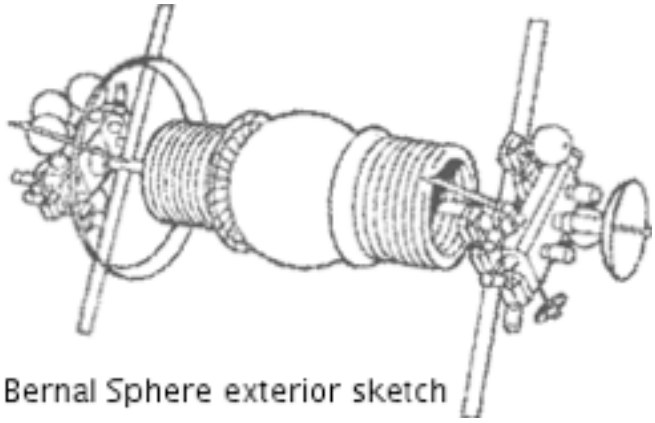
[Expanded from Moon Miners' Manifesto #249 Oct. 2011]

How the Dream began

Thus began **the L5 Society**, named after the stable L5 Earth-Moon Lagrange point 60° behind the Moon in the Moon's orbit around Earth, In the early 1970s, Princeton University physicist Dr. Gerard K. O'Neill publicized a scenario in which we would go to the Moon, mine lunar materials near the equator and sling them into space with an electomagnetic "mass driver." There they would be used to build space settlements to house workers in comfortable and pleasant surroundings, workers who would use more lunar materials to build hundreds or thousands of gigantic solar power satellites to feed our planet's ever more voracious appetite for clean energy as opposed to environment-destructive reliance on fossil fuel energy sources such as oil and coal.



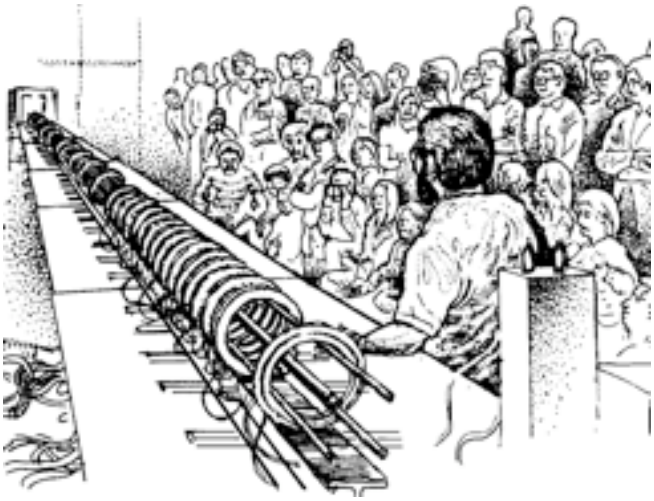
Thus began **the L5 Society**, named after the stable L5 Earth-Moon Lagrange point 60° behind the Moon in the Moon's orbit around Earth, as that was where at first it was proposed to build these giant space settlements.



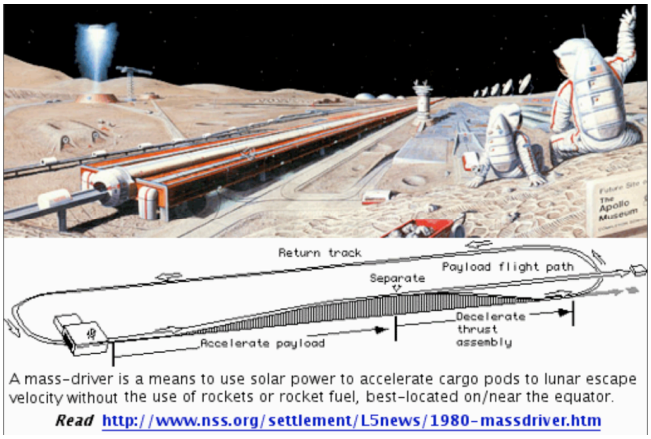
Artist conception of interior of an "Island 1" Bernal Sphere which would house a thousand persons in an Earthlike environment with artificial gravity. Two successively much larger space settlement designs were also proposed.

In response to U.S. Congressional requests, NASA even produced a comprehensive "**Space Resources and Space Settlement**" report in 1977 on the scenario and related ideas for Congress. It is still worth reading and belongs in every space enthusiast's library.

While the scheme was logical, too many of the needed technologies were still in the conceptual stage. To their credit, O'Neill's Princeton team produced three working model mass-drivers, each more powerful.



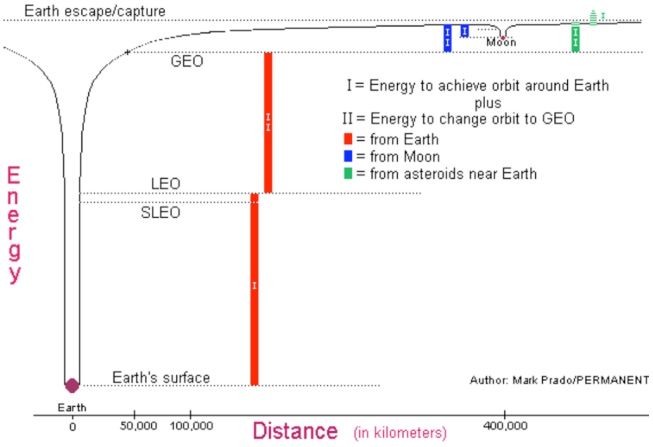
Don Davis sketch of mass-driver demonstration at Princeton



How they work: http://www.permanent.com/t-massdr.htm

The logic of using "lunar materials" to build giant structures in Geosynchronous Orbit is impeccable: it would take only 1/23rd the fuel to "downport" (down the Earth's gravity well) material's from the Moon up on the gravity well's shoulder down to Geo-synchronous Earth Obit as it would to "upport" them up that steep slope the much shorter distance from Earth's surface. And this could make solar power satellites much less prohibitively expensive.

It is the unique economic potential of Geosynchronous Orbit (Economic Gross Product as of 2010 c. $275 Billion) that makes the existence of potential construction materials on the shoulder of Earth's Gravity Well so significant. The Moon and GEO are a natural economic team literally "made in heaven." This is a 2-way economic case of **"Location, Location, Location."**



http://www.permanent.com/images/t-gravity-wells.gif

Enter The Giggle factor

Many of those old "L5ers" are still around, including this writer. But others, also convinced that Earth's future depends on Solar Power Satellites, but not spiritual descendents of O'Neill, are reluctant to back plans that call for lunar sourcing of materials. It will take too much of an effort, gobbling up too many years of lead time, to Industrialize the Moon to the point where lunar raw materials could make a significant and timely difference. And on the NSS Space Solar Power Committee, this division between O'Neillian believers and those never caught up in the L5 Space Settlement dream is quite obvious, with both sides talking past each other.

Long overdue critical distinctions

1. **Distinction between parts made on the Moon and those made here on Earth** – this part of the puzzle's solution is something I contributed way back in MMM #19, September 1988, pp. 3-4, "**A Strategy for Following up Lunar Soil Processing with Lunar "M.U.S./c.l.e."** – In this plan, we would seek to produce on the Moon everything needed there that was **M**assive, **U**nitary (we need many of the same), and **S**imple. We would produce on Earth for up-shipment, things that are **c**omplex, **l**ightweight, and **e**lectronic. Now there are sure to be many things that do not fall neatly into one of these two divisions. But if they can be divided into "MUS" and "cle" subassemblies, then we have the problem of sourcing neatly solved. Basic simple lunar industries will produce the lion's share of what is needed weight-wise while terrestrial industries will provide the rest. This article is online at:
http://www.moonsociety.org/publications/mmm_papers/muscle_paper.htm
2. **Lowering the expense of developing "in situ" lunar resources into usable building materials** – this is a challenge we addressed even earlier, in MMM #16, June 1988, pp. 3-5, "**Glass-Glass Composites**" in which we suggested that just the opposite of the "spin-off" process, "**spin-up**" would yield prototypes of technologies needed on the Moon or elsewhere in space at much less research and development cost. Here, instead of a high-cost NASA crash program, entrepreneurs would examine the list of needed technologies and brainstorm each for possibly profitable terrestrial applications, then pre-develop those technologies precisely for those terrestrial uses, putting them "on the shelf." This article is online at:
http://www.moonsociety.org/publications/mmm_papers/glass_composites_paper.htm
3. **Pairing the use of lunar materials with the construction space habitats for workers** - gigantic hollow structures with artificial gravity provided by rotation, makes the combined concept a gargantuan one: attractive, yes, affordable maybe not. We must keep in mind the enormous progress made in robotics and teleoperated systems in the past forty years. We will need people on the Moon and in space, but perhaps at least an order of magnitude (factor of 10) if not two (factor of 100) fewer. That changes the economics already. Dave Dietzler brought this up recently in **MMM #242**, February 2011, pp. 7-8 "**O'Neill's High Frontier Revisited**" – in short, many labor-intensive tasks in space will be performed by robot avatars, some fully automated and some tele-operated from elsewhere.
4. **Building up the needed Lunar Industries** - even given the above distinctions and novel approaches that greatly reduce the challenge of creating an industrial complex on the Moon capable of contributing the major fraction of the mass of Solar Power Satellite construction elements, the idea of lunar industrialization remains "science-fictional" to many. Well the Moon Society has addressed that as well, in our concept (Peter Kokh and Dave Dietzler) for an "**International Lunar Research Park**" – see MMM-India Quarterly [M3IQ] #2 February 2009 p. 20 and MMM pp. 5-6, #224 April 2009.
The M3iQ article is online at:
http://www.moonsociety.org/india/mmm-india/m3india2_Winter09.pdf
The ILRP would be fully international, and thus quite resistant to any one nation's budgetary pressures or waning of resolve, witness the International Space Station. The basic enabling parts (spaceport, warehouse, recycling operations, and more) would be constructed by a contractor consortium, so that individual national space agencies could ship up their outpost modules and plug in, free to concentrate on the science and research they came to do. Other corporations and enterprises would be welcome. This is the kind of "critter" that could in time morph into the first industrial lunar settlement.

5. **Identifying feasible lunar materials and how to produce them -** This is a task to which Dave Dietzler and his "ILRP Team" has dedicated itself. What alloys of iron, aluminum, titanium, and magnesium, the four "engineering metals" are feasible on the Moon, given the low abundance of the usual alloy ingredients for each? So far, the team has identified several feasible options and how we can go about isolating the needed components from the mish-mash of moondust in which minerals have not been concentrated into mine-worthy lodes, absent the geological processes that work on Earth in the presence of water.

6. **Switching to more efficient, cheaper space transportation systems –** We have written often over the years about the flawed philosophy of NASA space transportation architectures. First we do need orbital refueling. Second we need to design all components for salvageability and reuse, all the way up the line from Earth orbit to lunar landing. The Apollo and "Apollo on Steroids" approach of the Constellation Program, and now its disguised reappearance as "SLS" are economically and technologically insane. Getting into space has to be about getting into space, not about providing money for the constituencies of key U.S. Senators and Representatives, or catering to the current stable of industrial-military complex providers. The growing number of Commercial launch providers can only help lower prices and add opportunities. Their technology breakthroughs can be adopted by national space agencies such as ISRO.

But is anyone listening?

MMM's and M3IQ's circulations are worldwide but in very small numbers. We try to make our presence and work known at the annual International Space Development and other Conferences and have used our "University of Luna Awards" to persons doing research along the needed lines, to help call attention. (One was given to Doctor Kalam last year.)

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

It is an uphill struggle. But slowly, some of these concepts are being talked about. If we are not mentioned that does not matter, as it is the ideas that are important.

Determining "trade-offs"

There is more work to be done, especially in deciding *trade-offs between what can be most cheaply made and shipped from whence to where*. As the involved technologies mature, some parts we now think can best be made and shipped to GEO from the Moon may turn out to be best made and shipped from Earth, *and vice versa*. So the exact combination of Moon-sourcing and Earth-sourcing of components for Solar Power Satellites and GEO platforms may change as we get closer to the day when we can launch such endeavors. But it is already clear that we will need a combination of both, and that is our message. We do need the Moon to grow Earth's Exo-Economy!

We are convinced that we are on the right track.

PK/DDz

The Moon: What's in it for Earth?
III. Availability of Frontiers to Settle as a Cultural Stimulant and Safety Valve

Bacon's *Landing of the Pilgrims*

I can't think of anyone who has better illustrated and explained with due passion the importance of human frontiers beyond Earth than **Robert Zubrin**, since then the founder of the Mars Society. I encourage all to read "The Significance of the Martian Frontier", an article published in the September/October 1994 issue of ***Ad Astra*** **–** a publication of the National Space Society. This essay is online at:

http://www.nss.org/settlement/mars/zubrin-frontier.html

Zubrin begins by quoting Walter Prescott Webb from his book **The Great Frontier**, 1951:

"It would be very interesting to speculate on what the human imagination is going to do with a frontierless world where it must seek its inspiration in uniformity rather than variety, in sameness rather than contrast, in safety rather than peril, in probing the harmless nuances of the known rather than the thundering uncertainties of unknown seas or continents. The dreamers, the poets, and the philosophers are after all but instruments, which make vocal and articulate the hopes and aspirations and the fears of a people.

The people are going to miss the frontier more than words can express. For four centuries they heard its call, listened to its promises, and bet their lives and fortunes on its outcome.

It calls no more..."

Zubrin quotes Frederick Jackson Turner, a young professor of history at the then little known University of Wisconsin over a hundred years ago:

"To the frontier the American intellect owes its striking characteristics, that coarseness of strength combined with acuteness and inquisitiveness; that practical, inventive turn of mind, quick to find expedients; that masterful grasp of material things, lacking in the artistic but powerful to effect great ends; that restless, nervous energy; that dominant individualism, working for good and evil, and withal that buoyancy and exuberance that comes from freedom — these are the traits of the frontier, or traits called out elsewhere because of the existence of the frontier."

He frontier has been slipping into the past. If we do not open new frontiers, we risk our civilization and culture becoming stagnant, ossified, fossilized – beeoming an intellectual and spiritual prison.

Yet it is clear that the personal characteristics that lead some to pioneer are not at all universal in our species. It is only certain types of personalities, with certain types of talents, who are so driven. And I believe I have stumbled on the key to those traits some years ago.

Here is the gist of my "eureka moment."

Those familiar with the Christian faith will have heard of "the Beatitudes" (8 or 10 depending on the source)

http://www.searchthebible.com/beatitudes.html

To this list I propose to add another:

Blessed are the Second Best for they are the ones who pioneer new frontiers!

Let me explain. Those who were doing well in Boston and Baltimore in the mid-19th Century stayed in Boston and Baltimore. Those talented and motivated individuals who found all suitable positions taken, leaving them no way to climb the ladder, were the more motivated to resettle in the wide-open West where they had a better chance of getting in on the ground floor. Their lives might be hard and difficult, but they would be rewarding, something that cannot be bought.

It was the same with talented and motivated Europeans who found little room to climb where they were, but with enough ability to reestablish themselves in the Americas or Australia and elsewhere. Indeed the paradigm can be found much further back, beyond the beginnings of humankind. Among lions, for example, and in other species, those capable males who were unable to successfully challenge the pack leader but still had leadership traits to offer, were the ones who with their mates pioneered new territory and established new populations.

> ***It is not the best individuals**, the cream of the crop, who pioneer. **It is the second best!***

The availability of frontiers, however rough and wild and challenging, has served both animal species (plants as well) and humans as expansion space and as a safety valve from time immemorial. Population pressure is a factor as well, of course.

Meanwhile, new human frontiers soon develop fresh cultures and spirit, that through return visits to the homeland, revitalize stagnant cultures there. The opening of the Americas revitalized all sectors and aspects of European culture and civilization. Feedback from other national "Diasporas" has done likewise, including that from India's and China's extensive Diasporas, even though sometimes this positive feedback is delayed.

Humans are a frontier-blazing species

And this began with the spread of human populations first throughout Africa, then "Out of Africa" to Europe and Asia, Australia and the Americas. But now that this more than 100 millennia long "**Epic of Man**" has taken us "Out of Africa" into one continent after another, are we to stop? Will there be no more frontiers? Will the freshness of civilization grow stale and moribund?.

The Antarctic Exception

So far, Antarctica has been a frontier for explorers and scientists only, fisherman tolerated on the periphery. By international treaty, "settlement" and access to resources are excluded, out of fear that this pristine environment would be spoiled - as we have "spoiled" the other continents – fortunately not in their entirety!

> *While we have committed our share of environ-mental atrocities on other continents, the belief that we cannot establish protocols and regimes that would preserve the most environmentally sensitive areas of the Antarctic while opening less sensitive regions to controlled settlement and resource use is an assertion that desperately needs to be challenged.*

If we allow the Antarctic Treaty to go unmodified, it could become a model for off-Earth non-expansion. Yes, we have sinned! No, ***humans can learn and adapt to environment-respecting and cherishing lifestyles and resource-access***. And unless we are allowed to try new paradigms off-Earth, we will be doomed to cultural and intellectual stagnation. Then we can write the final judgment on the human experiment right now: "a brilliant start, an abominable failure to keep it alive."

Antarctica would be a great proving ground for prospective Martian settlers, as its climate has a nearly identical thermal range. Mars, with less fresh water, no breathable air, and no fish in surrounding seas, will be the harder frontier. If you can't handle Antarctica, don't apply.

"Of Dust," or "of Star Dust"

Those of us raised in the Judeo-Christian tradition, are very familiar with the line from the Book of Genesis "Of dust thou art, and to dust thou shalt return." *Yes, but that dust is star dust!* Every atom in our bodies with the exception of hydrogen, has been forged in the interior of stars that have since exploded, seeding the interstellar gas clouds with the dust from which everything else has come, including our Sun and its family of planets and we ourselves. In that light, a correction is in order.

"Of stardust thou art,
and to the stars thou shalt return"

To close the door to frontiers beyond Earth would be the ultimate perversion, *the ultimate slap in the face to our Creator* or whatever creative agencies have made us!

Intercontinental > Interplanetary > Interstellar

Further, the Moon is not a sibling planet with its own orbit around the sun. It *shares* Earth's orbit and is *bound* to Earth. It is part of Greater Earth, part of our "Econosphere" and in a very real sense:

"another continent beyond another kind of sea."

We arose as an African species, and have since become an Intercontinental one. Settling the Moon will be the consummate chapter of our *intercontinental* epic, establishing the Keystone piece that prepares us for phase II: *Interplanetary* expansion starting with Mars. *Then, on to the Stars!* It is at once a human legacy, our birthright, and our destiny. And those remaining on Earth will benefit enormously just as those who stayed in Europe benefited form the settling of the Americas.

Lessons learned on the Moon of use on Earth

` Yes, planetary scientists and geologists are learning a lot about the Moon that sheds light on the early Earth. But while intellectually interesting and illuminating, this new knowledge is unlikely to be of practical economic significance unless it indicated unsuspected resources in Earth's upper mantle that could somehow be tapped – an unlikely scenario.

But pioneers, forced to adapt to an unfamiliar and a seemingly hostile and life-threatening environment on the Moon, would be facing the biggest test since early Siberians pushed into the arctic and conquered the ice and cold and snow as Eskimos and Inuit. Think of the phenomenal difference between the jungle-skirted plains of East Africa and the Arctic coasts of Alaska and Canada and you have some idea of the challenge that will face lunar pioneers. History says that with the right attitudes, determination, inventiveness and resourcefulness, pioneers can meet the challenge, turning life on the Moon into something rewarding and worth the sacrifices of favorite things about life on the Earth that they leave behind.

They will have to develop new alloys of familiar metals, and new materials to substitute for wood and plastics and fossil fuels. In the process, they will come up with things we have never tried on Earth but which would make welcome additions to our current stuff-inventories. New art forms, new sports that play to the $1/6^{th}$ G but standard momentum that people on Earth might enjoy watching on TV, and yes, new dance forms too.

It is imperative that lunar pioneers learn environment-preserving processes and techniques without delay under sentence of system collapse; whereas as we on Earth will not spend money and time learning such things because the punishing consequences of our environmental sins are long delayed. "Pioneers will live immediately down-wind and down-stream of themselves." There will be no lunar global water and atmosphere sinks to disperse pollutants, only local mini-biospheres.

The pioneers will have to learn to live with mischievous moondust and black skies and 2-week long dayspans and equally long nightspans, unbelievable nightspan cold and torrid dayspan heat, cosmic rays and solar flares.. After some years on the Moon they may have to face the fact that they might not be able to readapt to life on Earth.

But they will not be alone. Pioneers will have brought along plants and animals, establishing little "gaiacules." We must reencradle ourselves in pocket offspring of "Mother Earth." Thus the pioneers will be spreading Earth Life ("Gaia"), abd not just humanity. To the extent that there is no other way for Earth-Life ecosystems to reproduce themselves beyond the atmosphere, humans are essential to any such reproduction. This gives settlements on the Moon a double mission, a mission with a significance that transcends human history. If we are children of Earth, we can and must return the honor in midwiving islands of Earth wherever we go.

The effects and benefits on the life and culture of those who stay behind will be enormous. **PK**

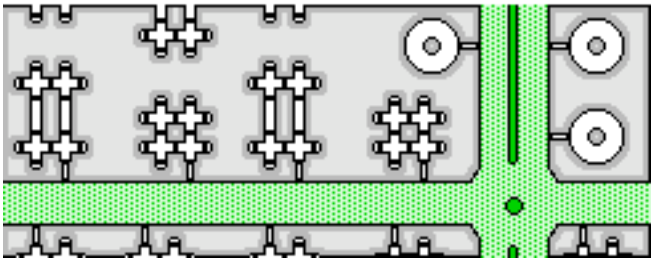
Challenges Facing Would-be Lunar Pioneers

By Peter Kokh

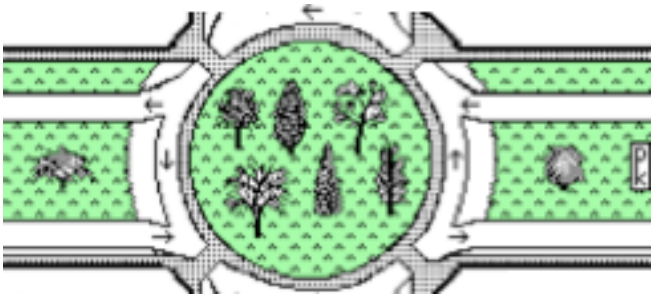
• **Life-quenching surface vs. tightly shielded habitats**. As the Moon is airless and thus exposed to temperature extremes, cosmic radiation, and solar flares, pioneers must live in small, tightly sealed modules either underground or tucked under a blanket of moon dust. The "gap" between the life-squelching exposed surface (what we have dubbed **the "out-vac"** (outside on the surface and exposed to vacuum) (rhymes with Australia's "outback") and the pressurized, temperature controlled, shielded living and work spaces is daunting and enormous. But we propose two intermediate environments:

1. The Middoors: pressurized common spaces such as hallways, 'streets', parks, and squares with abundant vegetation, where the temperatures are allowed to swing between warm in dayspan and cool during nightspan) – Middoor spaces, along with agricultural areas. would hold the bulk of the outpost or settlement mini-biosphere and, as a hosting complex, would expand as the outpost or settlements expand. In effect, what we enjoy as enjoyable "outdoors" would be realized on the Moon. Thus the pioneers would not be confined to tight residential and work modules. The Middoors could even make use of water in the process of treatment for ponds, streams, and waterfalls. Each settlement could pick the climate, etc.

Read the entry "**Middoors**" in the **MMM Glossary** http://www.moonsociety.org/publications/m3glossary.html



A settlement residential "block" showing pressurized roads with considerable vegetation and modular housing units

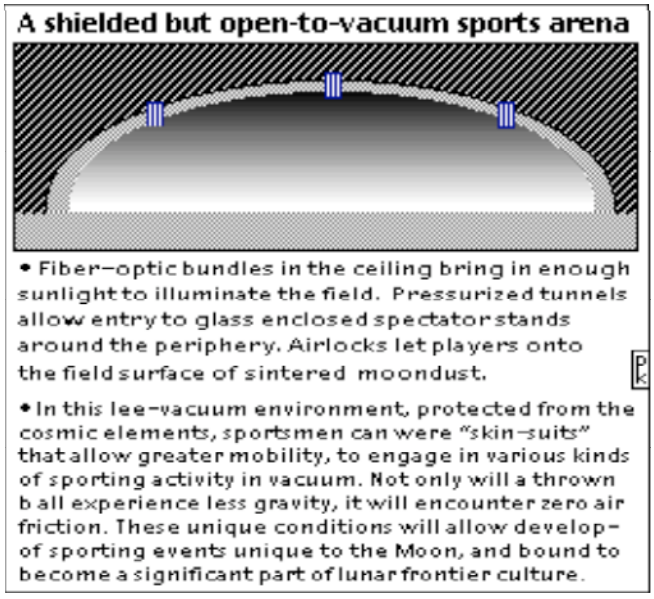


A vegetation-lush "round-about" intersection of the pressurized settlement road network

Read: Modular Biospherics II: "Middoor" Public Spaces
MMM Classics #21 pp 13-15
http://www.moonsociety.org/publications/mmm_classics/mmmc21_Jan2011.pdf

2. Lee-Vac or contained and shielded airless spaces protected from radiation and the micrometeorite rain that can be used for sports in vacuum with the need for mere pressure suits. Such spaces are also ideal for ware-housing and storing items that will be needed often.

Read the entries "**Lee-Vac**" and "**Lee-Vac Sports Arena**" in the **MMM Glossary**
http://www.moonsociety.org/publications/m3glossary.html

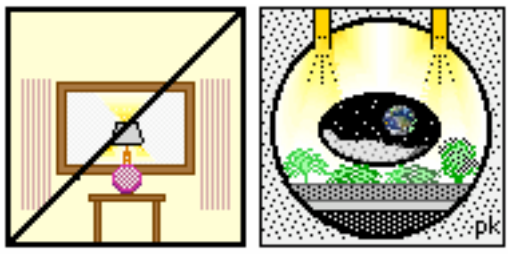


Nb. Robots and teleoperated devices will do a lot of the "routine" work out on the exposed surface, minimizing the amount of time humans need to be outside, at risk.

As to the hostile "Out-Vac", pioneers could humanize it with sculptures near air-locks and along paths and roadways. And they can import inside "Zen Gardens" of raked moondust and carefully placed moon rocks.

More, they could place living plants and flowers in front of windows to filter their view of the desolation outside.

Read "**Picture Window Clichés**" in the **MMM Glossary**
http://www.moonsociety.org/publications/m3glossary.html



• **1/6th G:** No one has been on the Moon long enough to determine whether deterioration of muscle tone and physiological processes will level off at some sustainable point, or sink to the level they do on the Space Station. We have no intellectual respect for those who argue that what happens in zero-G will happen in 1/6th G (or the 3/8ths G of Mars. There is an infinite difference between 1/6th and zero. But pioneers who wish to visit or return to Earth must surely exercise to maintain muscle tone etc. ***Read:***

"**Native Born**" MMM Classics #5, pp. 34-36
http://www.moonsociety.org/publications/mmm_classics/mmmc5_Jul2005.pdf

Hexapotency Toning Centers, MMM Classics #13 pp. 14-16
http://www.moonsociety.org/publications/mmm_classics/mmmc13_July2006.pdf

• **Tight mini biospheres** without "sinks" to dissipate by wind or water: Pioneers will live immediately downwind and downstream of themselves, and that will be a challenge that will drastically change our familiar careless lifestyles.

• **The need to create space module by module:** Large pressurized volumes, such as domed cities, would be at extreme risk of decompression – we need to disperse risk, not share it. The inclusion of biosphere-maintaining systems in all habitat and activity modules (each toilet with its own blackwater systems, living walls, etc.) pioneer biospheres will grow naturally as more units are added.

• **Long dayspan/nightspan periods** each 14.75 Earth days long: With well-chosen and designed interior lighting systems–this should not be a problem except for energy-consuming activities. We can schedule energy-intensive tasks during dayspan, saving energy-light tasks for night-span - welcome and maintainable rhythm. Even with good power storage systems, we will always have more power during dayspan with direct solar, than during nightspan.

Read "Dayspan", "Nightspan", "Sunth" pp. 10-13
MMM Classics #5
http://www.moonsociety.org/publications/mmm_classics/mmmc5_Jul2005.pdf

• **Extreme thermal swings.** As we must heavily shield our living/work spaces, indoor temperatures will vary little

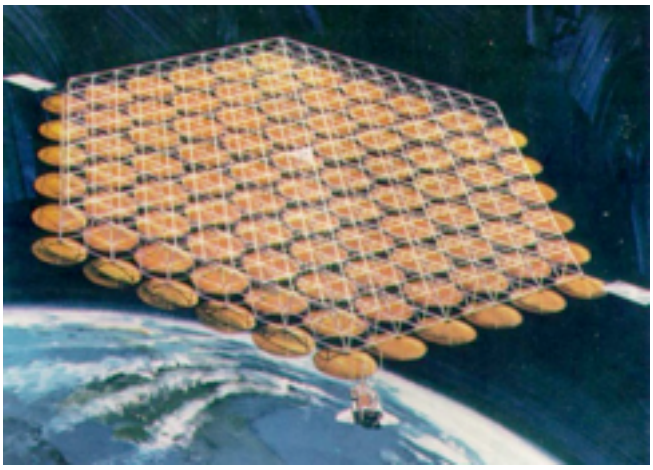
• **Water will be scarce** and must be recycled with care, keeping it all within our mini-biosphere.

• **The Moon is poorly blessed with carbon and nitrogen:** Organics (plastics, wood, paper): will be used sparingly and only in easily recyclable forms. Civilization reached a high state before plastics were available. We can do it again.

The Big Lesson

No matter what apparent obstacles, apparent show-stoppers, and apparent hardships the Lunar Frontier might throw at us, our epic expansion into an amazing diversity of differently challenging places, we have been able not just to adapt and survive, but to adapt, learn how to turn any perceived drawbacks into advantages.

Lunar pioneers, self-selected for willingness to adapt and prosper, will overcome all these challenges and to "make themselves at home" having learned to deal with all risks and drawbacks as springboards to a thriving, health culture. We have done it before, frontier after frontier. We will do it again! **PK**



Above: China's bold vision for Space Solar Power

NSS-Kalam Initiative Reaches out to China Alliance to Realize Space Solar Power is Goal

Report by David Dunlop

The NSS Kalam initiative took a great step forward with its participation in the 4th China Energy and Environment Summit, on August 28 at the International University of Business and Economics in Beijing, China, organized by Dr. Lin Zhiqin VP of IUBE, and Director International Energy and Environment Institute. This high level meeting focused on China's future energy requirements and their impact on China's environment.

L>R: Sang Baichuan, Dave Dunlop, Ge Chang-Chun, Sergio Trindade, Michelle, Mark Hopkins, Lin Zhinqin, Emily, Bao Ao, Yu Qing, Feng Hsu

Attending were some of China's leading academicians, technologists, and government officials:

Dr. Ge Chang-chun, member Chinese Academy of Science, Prof. Beijing Science and Technology University.
Dr. Hou Xingbin, Chinese Academy of Space Technology
Dr. Li Junfeng, Prof & Deputy Director of Energy Research Institute, National Development and Reform Commission.
Dr. Li Ming, Vice President of the Chinese Academy of Space Technology, who is responsible for the CAST research and development program. (The fifth branch)
Dr. Min Guirong - Member Chinese Academy of Science, Academy of Engineering, and International Academy of Astronautics.
Dr. Shi Lishan, Director of New Energy & Renewable Energy, National Energy Administration
Dr. Wang Li, Chinese Academy of Space Technology
Dr. Wong Xiji, Chinese Academy of Science, Consultant of Chinese Academy of Space Technology

Dr. Feng Hsu, (formerly of NASA of the DOE), and currently V.P. of Space Energy was instrumental in setting up the invitation from CEES to both Dr. A.P.J. Abdul Kalam, former President of India and to a National Space Society delegation led by NSS CEO Mark Hopkins.

Dr. Kalam's Address - Online at:

http://118.91.233.120/kalam/jsp/display_content_front.jsp?menuid=28&menuname=Speeches%20/%20Lectures&linkid=68&linkname=Recent&content=1898&columnno=0&starts=0&menu_image=-

Dr. A.P.J. Abdul Kalam was invited to give a keynote address. His talk was "**Harvesting Space Solar Power: A Global Vision."** He spoke to the meeting from New Delhi on Sunday morning at the opening session. He stressed the need to integrate international efforts to understand our own planet, to face challenges such as those relating to adequate supplies of clean energy and clean water, and to education the population and inspire young people.

As an internationally recognized scientist he proposed large-scale space missions that will benefit humanity. These include initiatives such as space based solar power, and project that comprehensive space security dealing with the problem of space debris. He also urged expanded efforts to explore targets of exploration such as the Moon and Mars.

Dr. Kalam said that present international space capabilities are not used to the optimum and proposed the formation of a World Space Council to advance these goals, lower the cost of access to space, capture the imagination of the young, and improve the utilization of resources.

He indicated the superiority of space based solar power over that of terrestrial solar due to the 24/7 access to the sun in GEO, no weather interference, and the ability to safely receive power from microwaves at the Earth's surface. He indicated that lasers might also be another transmission option but at "offshore "reception sites. He indicated that solar energy storage might occur in flexible "nano packets".

He further proposed a Global Space Solar Power Feasibility Study, which would occur in three phases:

- Phase I: A 2 to 3 year feasibility study.
- Phase II : A Research and Development Program Lasting 5 to7 years.
- Phase III: Industrialization.

In addition Dr. Kalam called for the development of a Not-for-Profit World Knowledge Platform to share research via a consortium of Universities to conduct these studies and research. The convergence of international thinking on methods of haring information and coordination of research and development efforts on energy and environmental issues was also demonstrated by Dr. Lin Zhiqin's book: The Path to A Global Think-Tank which summarizes the thinking of the first three CEES conferences and lays out the details. NSS has already established the largest open source of space solar power research with its SBSP Library on its web site.

National Space Society Delegation

Mark Hopkins spoke about the NSS as the premier member based non-profit advocate for space economic development and settlement in the United States and of its commitment, working with Dr. Kalam to create international support and collaboration for the research and development of clean energy from space based solar power. He welcomed Chinese participation in these challenges and welcomes their contributions to international space development as China continues to rapidly grow its economy. China's role in the development of space-based energy resources, as it grows into the world's largest economy, will be a key determinant in the future of humanity, as will that of India, the other rapidly growing economic giant.

Dave Dunlop spoke about the strategic convergence for clean energy options and the parallels between international support of a commercial fusion reactor and the argument for similar support for research and development of space solar power. He also indicated that a significant humanitarian purpose for a SBSP demo satellite might build on the example of the UN SPIDER (Space-base Platform for Information and Disaster Management and Emergency Response) program targeting power to areas struck by natural disasters including earthquakes, floods, hurricanes, drought, tsunamis, etc.

Perhaps the most dramatic presentation was made by Martin Hoeffer, who addressed the meeting electronically even as Hurricane Irene lashed New York City at 5AM where power had shortly been restored to his home. He presented some cost comparisons of laser transmission of photovoltaic electricity from space with ground based terrestrial photo voltaics with energy storage.

Private Sector Interest in SBSP

Steven Tennsel, CEO of Space Energy presented the corporation's plan to develop terrestrial energy services which would support the longer term initiation of space solar power development industrialization. Other Chinese investment groups demonstrated interest in this potential for space related economic development with their sponsorship of conference activities.

Dr. Sergio Trindade, SE2T, 2007 Nobel Laureate and energy expert, an MIT educated chemical engineer, presented a picture of the mix of energy utilization from the period 1860 projected through to 2100. He indicated that in the past, present, and future that a mix of various energy sources will characterize the global economy. He projected that solar power, including space solar power will account for some 50% of the global energy supply by 2100, and that "new biomass" sources such as bio-fuels will account for some 20% of the total in the same period. ("Old biomass" reflected the earlier dependence on wood for heating) The balance of supply in 2100 would be a mixture of hydropower, natural gas, petroleum, wind, and even coal. His projections underscored the serious consideration of solar power and space based solar power becoming the major component of the global energy economy.

The interest of the Tian Lue Holding Co LTD was reflected by their generous sponsorship of conference speakers and the support of Chairman Qui Zhen Liang and CEO Wan Jing Chun.

The 2011 CEES focus on space based solar power underscores the interest of the Chinese research community, the interest shown by Dr. Kalam and Indians research community, and the interest of the membership of the International Academy of Astronautics, and the interest of private sector organizations in this projected development.

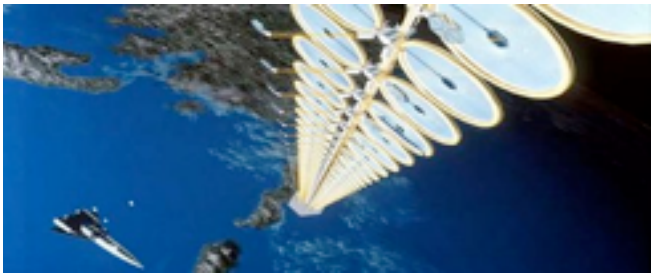
Future Steps for the NSS-Kalam Initiative

The National Space Society will pursue this agenda with a meeting later this fall in India with Dr. Kalam and members of the ISRO. A NSS team will be lead by Mark Hopkins, and include our Canadian collaborators from Space Canada, George Diterich.

The International Astronautical Academy report on Space Solar power development, which has been under the direction of Dr. John Mankins, will be released early this fall. Dr. M. Nair, the former ISRO Director is now the Chair of the IAA and the NSS delegation also anticipates meeting with him while they are in India. They will discuss further developing international interest and momentum with regard to space based solar power.

Of the G-20 nations, only Japan's government has made a strategic commitment to development of space based solar power. We hope that the NSS Kalam initiative will move additional countries towards a strategic commitment to SBSP research and development, including Canada, China, India, and the US. We are working toward more a more formal collaborative structure and hope that an International Think Tank/World Knowledge Platform mechanism can be developed.

The 2012I SDC [International Space Development Conference] May 24-28 in Washington DC will provide another focus and forum for the NSS-Kalam Initiative and we hope to expand both Indian and Chinese participation as events move forward. **DD**



Strategic Convergence on Space Based Energy

By David Dunlop

Presentation Given at the 4th China Energy and Environment Summit, on August 28, 2011 at the International University of Business and Economics in Beijing, China

Introduction

I am Dave Dunlop of the National Space Society of the United States and I am pleased to have the opportunity to be present at this important conference and have the chance to get to meet so many gifted and well informed people from China and elsewhere around the world. I think that we are here at this conference because there is a common recognition of the intertwined issues of energy use, energy supply, and environmental and social sustainability. Not only do we recognize these issues as linked but we share concerns at the trends and at fundamental problems associated with the way our global civilization is operating. That this perception is widely shared is a good thing because it creates a climate where a strategic convergence about options and solutions to these challenges can occur. Unless common concerns can be translated into practical proposals for common solutions, our problems will only increase and the ability to come up with shared solutions will be more difficult.

The Global Energy and Environment Challenges

Over the last 400 years or so human societies have accepted a certain exchange between the ability to obtain and use more energy and the willingness to accept some environmental destruction as part of that bargain.

- We employ efficient iron wood burning stoves but we cut down the forests to supply them.
- We find that we can alternatively burn coal but we must tear up the landscape to do so and we must accept the smoke and the dust.
- We can use oil to power car and trains and ships and planes, but we must accept oil spills, and polluted rivers and oceans.
- We can use cleaner burning natural gas but there is not enough over the long term and like all of the above sources of energy it produces more green house gases.

Even hydropower, which produces electrical power, enables irrigation, and moderates flooding changes the landscape and the natural ecosystems that previously existed along the course of the rivers.

We require more energy but now realize that we cannot accept the level of environmental damages of now 7 billion people and growing to 10 to 12 billion Consumers projected by the end of this century

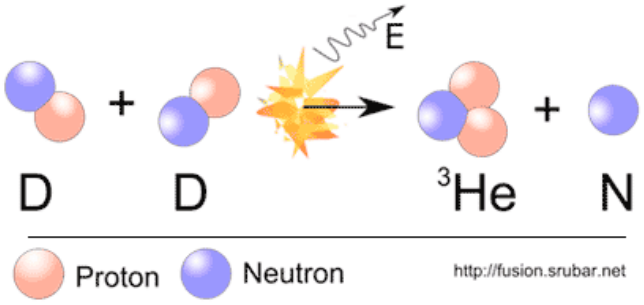
If our energy and environment challenges are well advanced now we also realize that they represent the activities and actions of the approximately 1 billion people who are part of the modern global energy intensive economy. Yet two billion people do not have access to electricity. Many of the rest of the world's population still utilize little electricity or transportation fuels in comparison the "First billion." We also realize that this situation is problematic from the standpoint of political and social equity. Others who are not in this energy privileged "first billion" aspire to the same standards of energy consumption, the same economic opportunities, the same educational opportunities, and the same life styles. These expectations are only natural and normal. Our economic model is biased in terms of growth and the requirements of the 6 billion represent a great business development opportunity, a great opportunity in education, and a great opportunity in health and medical services.

For our ambitions of global growth and development we need to multiple the existing levels of energy use. There are a variety of sources of alternative energy such as terrestrial solar power, wind, and geothermal energy and terrestrial solar but they are both expensive to implement and ultimately inadequate to meet the level of demand that we forecast. We now commonly and more fully understand "the devil's bargain" with the acceptance of environmental damage for energy consumption. Thus far, I think I have merely stated what is now widely understood around the world to be our common plight.

Clean Energy Options{ Pillars of the Future Economy - Nuclear Fusion

It seems clear to many that the world cannot solve its energy and environment problems by maintaining pasts practices. We need fundamental changes and new technologies to solve this predicament of "the devil's bargain" in energy use and environmental destruction.

One hopeful vision is that of the development of "clean nuclear fusion technology". This is a technology quest that has lasted more than 50 years. and it is also a collaborative endeavor involving the advanced technological nations. The ITER project to develop a prototype commercial fusion plants is currently a $17 billion dollar research initiative and it is also a collaborative endeavor involving the advanced technological nations sharing the costs. We have abundant resources of deuterium in the oceans as a potential fusion fuel for a deuterium tritium nuclear fusion reaction plant but this reaction produces some neutron by-products and therefore associated radiation damage. This neutron by-product damage is less than nuclear fission plants and so that would be a step forward.



Helium-3 Fusion Reaction

More appealing is a fusion reaction that uses a Helium-3 reaction, which does not produce radioactive particles. This fuel exists on Earth in small amounts (a few tones) only as a byproduct of nuclear weapons manufacture.

But we know from Apollo Mission lunar soil samples that it exists on the Moon's upper surface as deposits from the incessant solar wind. It is estimated that there is more potential energy supply in the Helium 3 supplies on the Moon than all the fossil fuels that exist on the Earth. So if we want a world powered by "clean energy" we must first master fusion technology and then go to the Moon to obtain our clean fuel supply: *a big challenge for a big reward*.

Space Based Solar Power

Since the 1960's the idea of building solar power satellites to supply electric power via microwaves or lasers to the surface of the Earth has received several generations of study. While requiring no fundamental technology challenges there is at present no competitive business case because of the high cost of doing business in space. The cost of launching materials and machines into Low Earth Orbit and getting them up to Geostationary Earth Orbit is just too expensive at present . The clean energy is there to be had in virtually unlimited quantities but the cost of building the supply system is very much more expensive than our well understood conventional energy supply systems such as coal, oil, natural gas, or even nuclear fission plants. *This is a potential solution only if we can learn how to lower the costs of doing business in space*.

IV The Prize of Global Growth

Without enough energy supplies we cannot win the "prize" of global growth and development. And what a prize that is! The present world economy of some $60 Trillion dollars of global domestic product is overwhelming the result of the activities of the "first billion" energy consumers. So if we had enough clean energy we can simply multiply by 6 to provide a very rough first order estimate of a global economy of $460 Trillion representing the potential of a more equitably expanded world economy.. That of course is a vast oversimplification and doesn't account for other essential and associated development requirements.

V The Prize of Clean Water

In addition to the pillar of clean energy to support this future economic edifice there is also a global scarcity of fresh water. If we can harness the power of sun in space and use that power on Earth, we also have the power to address the problem of providing fresh water on a planetary scale where it is needed. Much of the Earth's land surface is not suited to human occupancy and human agriculture due to a lack of fresh water. It is along the great rivers of the world on every continent that the great civilizations have developed and prospered, great cities have arisen. These rivers have also brought disasters where these human populations also suffered the ravages of floods.

VI The Prize of New Worlds

Can we imagine a world where there is enough power to make desalinated rivers from the ocean and pump them uphill to water the regions where inadequate rain and periodic drought prevail? Can we in the future have the power to make in essence the Yangtze, the Yellow, the Nile, and the Rio Grande run backward? Such power would in essence "create another useful planet" on Earth out of the deserts.

Some that advocate the human colonization of Mars have dreamed of the power of "terra-forming " the Red Planet and claiming another planet for our species. Yet the potential of fusion power and or solar power satellite would bring such power to bear on our home planet first. But the settlement of Mars, our closer neighbor the Moon, or even the distant minor planet Ceres, or building cities from materials on the Moon or asteroids are distant great prizes and great tests of or both our intelligence, wisdom, and will.

These goals even if achieved do not solve the present global difficulties but they do offer challenges that may help us to learn to manage better on Earth. Mars the Moon, and Ceres are extreme environments by the standards of anything we are used to on our home planet. To establish a permanent presence on the Moon or Mars we must design a habitat in which we live "down wind and down stream of ourselves."

We must conserve and reuse and recycle our resources with great skill and engineering solutions that provide for ongoing survival for both our own species and those on which we are co-dependent to a standard that is much higher than what we are used to on Earth. In order to live in space we must set an engineering standard in space that can also inform our practices on Earth and reduce the destructive impact on our own planet of our large population and the stress on the Earth's environmental systems.

VII The Power to Face a Challenging Planet

Our world displays its power to create dangerous and destructive events. Humanity is faced with a continuing onslaught of terrestrial drought, floods, hurricanes, tornadoes, earthquakes. At any given moment some 30 to 40 million people are refugees across international borders or internally displaced within their own country. The scope of these disasters often overwhelms the ability of the national governments and international programs to respond effectively due both to limited resources as well as the difficulties of responding to circumstances. The United Nations Space Based Platform Information for Disaster Management and Emergency Response (UNSPIDER) is a recent initiative to use space based resources to provide information to improve the emergency management and responses to disasters.

VIII A New Proposal & New Model

This model of the use of space based platforms might be expanded to include the use of a demonstration of a solar power satellite system that could beam power in response to terrestrial disasters where the conventional grid has been destroyed or seriously disrupted or in area where there is not a grid or generating source. As an international initiative such a demonstration could use the resources and supportive efforts of all the space bearing nations and those nations that are newly developing this capacity. The idea of the space faring nations providing a model of service to those most in need from disasters is also a symbol of determination to utilize space based resources more broadly to

address urgent global challenges and to demonstrate how this can become a practical reality.

This proposal is also a practical research and development program to build the capacity and understanding needed to build and operate significant facilities above Low Earth Orbit. Now to be clear this demonstration satellite would only address the power needs of populations struck by disasters for brief periods until more conventional power supplies could be arranged. The frequency of disaster situations around the globe would no doubt fully use the capacity of the demonstration satellite to generate emergency power. The experience gained in developing the first demonstration satellite would be a significant step towards the evolution of more cost efficient second generation commercial power generation satellites.

History is also a precedent for this model. Both the US and the USSR had constructed space stations before the beginning of the ISS. That project which included the efforts of 16 nations took twenty years and cost approximately $115B or about 15 times more than the beginning $8B estimates. (Z) Although expensive it demonstrated that these nations working together could build a large, sophisticated space laboratory system in low earth to advance our ability to live and work in space. It also supported the technological infrastructure of the partner countries. So that project is both a tribute to constructive political cooperation, international determination, as well as technological innovation, and operating capacity. Now the capacity exists to create a facility using inflatable modules of twice the volume of the ISS for a tenth of that cost.

Technological and Infrastructure Development

A space solar power satellite Disaster Response demonstration project could similarly advance our ability to utilize the power of the sun to provide clean energy to the earth and expand the economic sphere of the Earth further into space. We know at present that the costs of a SBSP Satellite are not competitive with terrestrial baseload electrical power. But learning to bring the costs down is one problem that can be addressed by this research. This project would also utilize advanced robotic telepresence technologies in construction, requires a supply chain based on multiple redundant launch capabilities, and utilize infrastructures such as space tugs, refueling depots, and even the potential of fuel production from ice deposits on the Moon, and advances in propulsion and launch technologies.

This project could also provide a framework for international cooperation in the development of space based energy resources. Beaming power down to Earth from space will also require transparent controls of the beaming facilities. and mechanisms of oversight and safeguards against malfunction or abuse of this technology so that there is international confidence in the safety of the operation.

Economic Rationale

Again we have historical precedents with the ITER fusion project. This international project is currently funded at $17B annually (Z) which is approximately the same budget level as NASA's budget and about half of the international civilian expenditures on space agencies. I would argue that a UN SPIDER Solar Power Demonstration Satellite Program, which could assist millions of people suffering from disasters, is equally deserving of a comparable level of research and development effort. This program could more fully utilize the launcher production capacities of all the spacefaring nations. These are significantly underutilized at present and increase in production would also increase employment,

The ComSat Corporation demonstrated the utility of Geostationary Earth Orbit Satellites and established a commercial industry now greater than $150B annually. The growing demand for communications services may also provide for both government and private investments in large GEO platforms with large solar power arrays, many transponders, and large reception dishes. So a GEO a solar power satellite might be both an evolution of commercial services as well as a pioneering effort in creating space solar power. Large communications platforms will need a large power supply so a solar power demonstration satel-lite might be its own first customer as it also functions as a large GEO communications platform. As the capability of the satellite grows it could expand its ability to beam down useful amounts power to the surface for humanitarian disaster relief. This development however is also signify-cant as the initiation of a new clean power industry in space.

The demand for space solar power could be orders of magnitude greater than the current commercial satellite industry, on the order of multiple trillions of dollars. It can become the driver of future global economic expansion now that utilization fossil fuels is pushing the limits of the Earth's environmental stability. It can provide the economic growth solutions for China, India, and the other rising powers, and also be a way to address both human and environmental requirements necessary for survival on this planet.

We might ask whether this proposal is economically feasible. Let us look again to history. During the cold war of the 1960's the US Moon program required about 5% of the US government budget when the US economy had just reached the 1Trillion dollar level. Apollo cost about $115 Billion dollars.

The ISS has cost a similar amount of money, but the partner nations have a combined GDP of over $ 30 Trillion dollars. and the NASA budget only represents about .05% of the US government budget. A project to initiate space solar power including **all the major space faring powers** would be supported by a combined economy of $50 Trillion. A level of effort no greater than the support of the ITER project is clearly a level of effort that is within the capability of the major space faring countries and might result in a budget about the size of NASA's current budget. This support of humanitarian efforts in support of disaster relief is a strong reason for beginning something that can both influence and benefit the world.

Some Steps Toward Space Solar Power

But even this proposal would best be served by a path of progressive development and study.

A. We might first suggest an international space based solar power working group like those that study and coordinate other areas of international scientific study such as the

Mars Working Group, or International Lunar Exploration Working Group.

B We might develop a consensus about a coordinated program of Research & Development with recommendations for development.

C We might develop a legal and organizational framework, perhaps based on the model of ComSat.

D We might develop a prototype demonstration solar power satellite(s) with a primary purpose of providing power in disasters and crisis situations. This project might be an extended project, which would be serve to prove engineering systems and the management of space beamed power technology with ground stations.

E We might encourage commercial investment in the spin-off of these technologies for the national power needs. This can model the transition from fossil fuel dependence to environmentally benign clean space-based energy supplies, clean water, and sustainable practices in our energy supply and management system.

Twelve Points In Support of A Space Solar Power R & D Demonstrator Project: Some Historical Precedents

1 International collaboration in R & D ~ ITER

2 Int'l collaboration in financing development ~ ISS

3 Int'l strategic convergence on new options ~ ITER

4 Int'l support of a LEO to GEO to LaGraange Points to Lunar Surface ~ ISS

5 Both public/private investment for development~ ComSat

6 Int'l collaboration shared risks management ~ ISS

7 Public education and outreach is global ~ ISS

8 Collaboration on addressing problems and remediation of space debris ~ iceberg patrol

9 Development of operational protocols and transparency power beaming ~ International Union

10 Provide commercial foundations for new commercial SSP industry ~ International Atomic Energy Agency.

11 A research and demonstration program would provide a stimulus to commercial space industry and employment using excess production capacity of each partner nation

12 Emerging space powers would participate in this economic and development project ~ Panama & Suez Canal development

An Unsustainable Conflict

Many wars throughout the course of human history have been fought over control of scarce resources: a fertile valley, mineral resources, or to secure a essential supply chain. Today it is estimated that we have created a global economy that is stripping away the fossil fuel energy heritage of this planet and using the fresh water resources at a level that is unsustainable. In one sense our species and the civilization it has constructed is in a terrible unsustainable plight. In many dimensions, we are living beyond the carrying capacity of this planet with the technology at our disposal. We might now say that we are at war with our own self interests. We are also compromising the survival of many of the other species on which we are co-dependent.

DD

Beginning Steps Toward Global Collaboration on Space Energy

By David Dunlop – October 17, 2011

The Challenge presented to the National Space Society by Dr. Abdul Kalam in his address to the ISDC in May 2010 to work together to influence the leading nations of the globe in a coordinated program of development for space based solar power is gaining momentum. The announcement of the "**NSS-Kalam Initiative**" in Washington D. C. last fall (2010) was the first step.

The second major step was the invitation to speak given to Dr. Kalam by Dr, Lin Zhiquin, of the 4th China Energy & Environment Summit, in Beijing this past August. This invitation was also extended to an NSS delegation from the United States.

A Global Partnership in Research Proposed

Dr. Kalam addressed the conference from New Delhi, providing a keynote speech about Space Based Solar Power. He proposed a Global Knowledge Platform as a mechanism to begin an international collaborative research and development efforts. – [http://www.abdulkalam.com]

At the same time Dr. Lin Zhiqin, of the University of International Business and Economics of Beijing proposed a Global Think Tank devoted to the R & D of Space based solar power at the conference and with a newly released book (1). Another keynote address to the CESS was by Dr. Wang Xiji, who at 90 is, like Dr. Kalam in India, a national hero in China because of his pioneering efforts in the development of China's atomic energy, and space program. He stated,

"The development of solar power stations(s) in space will fundamentally change the way in which people exploit and obtain power. Whoever takes the lead in the development and utilization of clean and renewable energy the space and aviation industry will be the world leader."

This parallelism of proposals represents independent thinking and analysis on the part of scientific leaders in each country of their own energy requirements, the technological challenges, and the financial and geopolitical necessities involved in the realization of SBSP. The two largest countries by population in the globe have come to very similar conclusions about their energy requirements, their energy options, and their economic future.

They join Japan in this respect which also has recognized the strategic necessity of space based solar power for Japan's energy needs though the strategic goals announced in 2009 by Kensuke Kanekiyo, Managing Director of the Institute of Energy Economics set for JAXA, the Economic and Trade Ministry, and commercial collaborators such as Mitsubishi Heavy Industries and IHI Corp. (2), (3). Koji Umehara, Deputy Director of Space Development and Utilization at the Science Ministry said:

"The project to generate electricity in space and transmit it to Earth may cost at least 2 Trillion yen" ($21Billion US). (4) (5)

Commercial Participation in SBSP Development

Stephan Tennsel, CEO of Space Energy, a company based in Switzerland, also represented a commercial perspective on the development of SBSP and his presentation of his business strategy for Space Energy to enable commercial participation. Dr. Feng Hsu, now VP of Space Energy, and formerly of NASA and the DOE had participated in prior CEES meetings, was instrumental in the invitations made by CEES to Dr. Kalam and the NSS. 1

NSS Delegation

Our NSS delegation was lead by Mark Hopkins who also presented a strategic view of the development of SBSP of the requirements of both governmental and private sectors investments. My own remarks at the conference were on the topic of international strategic convergence and I found it auspicious to see the convergence of strategic thinking on the part of the scientific leadership of both India and China. Their perspectives fit well with that of the National Space Society and other long term advocates and supporters of SBSP such as John Mankins, CEO of Artemis Innovation Management Services, Wael Almazeedi of the FATE Consortium, and George Dietrich of Space Canada an other organizationals members of the Space Power Coalition. Another NSS delagate, Eric Hoeffer, trapped by a hurricane nevertheless addressed the CEES from his apartment in New York by Skype about laser power transmission technologies.

The Green Energy From Space Solar Power IAA Report

A Third step is the release in October 2011 of the long anticipated study by the International Academy of Astronautics Green Energy from Space Based Solar power, edited by Dr. John Mankins. (6) This is the first comprehensive international study regarding the feasibility of development of solar power satellites. Several findings included:

A Solar Power Satellites are technically feasible.

B There are no fundamental technical barriers that would prevent the realization of large scale SPS platforms during the coming decades.

C *Questions remain however, as to the economic viability of SP*

D There are no fundamental show-stoppers" among the required supporting systems (i.e., no technological barriers that would prevent realization of large scale SPS platforms during the coming decades)

E *There are key challenges in achieving the very low cost operation needed to achieve economically viable SPS. The most critical was the essential requirement for very low cost ETO transport.*

F Solar Power Satellites appears to be technically feasible as soon as 10-20 years using technologies existing now in the laboratory (at low to moderate- TRL) that could be developed / demonstrated."

The "Green Energy Study" also provided a road map for further research and development of space solar power and solar power satellites.

"Finding 5A: Extremely lost cost ETO transportation systems appear to be technically feasible during the coming 20-30 years using technologies existing in the laboratory now (at low to moderate TRL) that could be developed and/or demonstrated (depending on the systems concept details. However, *the technologies required for tis future space capability are not sufficiently mature for system development to begin at present.*

Finding 5B: Acceptable ERO systems for future SPS must be "environmentally begin" - i.e., space transportation infrastructures to launch the satellites cannot result in harmful pollution of the atmosphere.

Finding 6: Systems studies are not enough. Technology Flight Experiments (TFEs) to test critical technology elements and Technology Flight Demonstrations (TFD) that validate SPS systems concepts to a high level of maturity (TRL 7) appear to be essential in order to build confidence among engineers, policy makers, and the public and allow space solar power technology maturation and SPS deployment to proceed.

Finding 6A: The International Space Station appears to represent a highly attractive potential platform at which various SSP and related technology flight experiments (TFEs) could be performed.

Finding 6: Free flying spacecraft appear to be an attractive option for selected SSP TFEs and systems level demonstrations.

Finding 7: Architectural approaches that most efficiently and seamlessly integrate energy delivered from SPS into existing terrestrial energy networks are likely to be the most successful. (The same is true for any transformational new energy technology.)

Finding 8: The SPS concept is sufficiently transformational and entails enough technical uncertainties such that major systems level in-space demonstrations will be necessary to establish technical feasibility, engineering characteristics and economical viability before any organization is likely to proceed with full-scale development.

Finding 8A: The likely investment in technology maturation, hardware development and system deployment for a very low-cost highly reusable space transportation (HRST) system will require some 10s of billions of dollars (US). If the SPS concept is the sole – or even a significant -markets justification for such a development, then it is likely that a large-scale, pilot plant type demonstration of the SPS to be launched will be required prior to a government and/ or commercial commitment to fielding HRST systems or supporting infrastructure.

Finding 8B: In-space systems and infrastructures that will support SPS deployment, assembly, servicing, etc will be intimately related to the detailed designs and characteristics of the SPS platform and to the design of supporting ETO systems (see Finding above). Such in-space systems will likely need to be developed and demonstrated in tandem with, if not prior to, the implementation of an SPS pilot plant demonstration."

The report reinforces earlier studies by NASA and the National Science Foundation and EPRI in 2002 in the US and conclusions reached in other countries such as China and India and Japan. It creates further impetus for

advocates for a more broad based international research a development initiative.

Planning is now underway for follow-up meetings:

A trip to India is now being planned by an NSS delegation including NSS CEO Mark Hopkins, Dr. Feng Hsu of Space Energy, Dr. John Mankins, the editor of the IAA Green Energy study, George Deiterich of Space Energy, Howard Bloom Chair of our Space Development Committee and perhaps one or two others with operational aerospace and diplomatic experience. The plan for this delegation is to meet with a number of Leaders including, former President Dr. Abdul Kalam in New Delhi. Former head of ISRO

Dr. Mahdavan Nair, is now head of the International Academy of Astronautics, the international organization which just released the Green Energy from Space Report and which has organized sessions on Space Solar Power at the International Astronautical Congress meetings the last several years. The IAA role in the international efforts to educate the world and to promote cooperation regarding space based solar power will be strategically important.

Another important leader is Dr. T.K. Alex, head of ISRO's satellite operations. NSS has also been working closely with Dr. Rajeswari Pillai Rajagopolan, a Senior Fellow of the Observer Research Foundation, New Delhi to further development the NSS Kalam initiative.

A Follow-up trip to China is also planned to meet with Chinese leadership including those engaged in the CEES summit in August.

Invitations for participation in NSS' International Space Development Conference in Washington D. C. in May 2012 will be made at the meetings in India and China.

Summary

The National Space Society is demonstrating its importance as a facilitator of international cooperation in space energy as well as an advocate for space solar power research and development. It is expanding its scope of activities to become an enabler of international efforts to fund this research and development on a global basis. NSS encourages NSS members in the US as well as in othwer countries to become more informed and more active as advocates.

Editors Note: The National Space Society and the Moon Society are part of a larger group of organizations The Space Solar Alliance for future Energy. (7)

www.moonsociety.org/reports/space_solar_alliance.html

Footnotes:

(1) Lin Zhiqin, The Path To A Gobal Think Tank, http://www.edpbook.com.cn/ ISBN 978-7-80257-265-2

(2) http://www.treehugger.com/files/2009/09/japan-space-based-solar-power-satellite-21-billions.php

(3) http://www.parabolicarc.com/2009/09/01/japanese-launch-21-billion-space-solar-power-project/

(4)http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aJ529lsdk9HI

(5) http://www.physorg.com/news176879161.html

(6) Green Energy from Space Solar Power, The First International Assessment of Space Solar Power: Opportunities, Issues, and Potential Pathways Forward, Editor John Mankins, National Academy of Astronautics, Copyright 2011, sponsored by Code ASBN/EAN National Academy of Astronautics, 6 rue Galiee, BP 1268-16, 75766 Paris Cedex 16, France

(7) http://www.nss.org/news/releases/pc20071010.html

A Global Exploration Roadmap
Announced by the 14 Agency International Space Exploration Coordinating Group (ISECG)

By David Dunlop – October 18, 2011

Report and Speculation

October 5, 2011 At the International Congress in South Africa the **International Space Exploration Coordinating Groups (ISECG)** announced its Global Exploration Roadmap. This group is comprised of 14 nations including: ASI (Italy), CNES (France), CNSA (China), CSA (Canada), CSIRO (Australia), DLR (Germany), ESA European Space Agency), ISRO (India), JAXA (Japan), KARI (Korea), NASA (USA), 1NSAU (Ukraine), Roscosmos (Russia), UKSA (United Kingdom).

The presentation was made by Yusioju Hosegawa of JAXA and William Gertenmaier of NASA. The full report is available on NASA website:

http://www.nasa.gov/pdf/591067main_GER_2011_small_single.pdf

This report build on the earlier international exploration agreement signed in 2007 in Houston and is the result of a year's consultations among the international space agencies working to align policies and plans.

This Roadmap is comprised of three sections:

1 Goals and Objectives
II Long Range Plans
III Near Plans

Section I. Common goals include the following:

1 The Search For Life
2 Extend Human Presence beyond LEO
3 Develop Exploration Technology Capability

4 Perform Science to Support Human Exploration
5 Stimulate Economic Expansion
6 Perform Space, Earth and Applied Science
7 Engage the Public in Exploration
8 Enhance the Earth's Safety

II. Long Range Scenarios share the common objective of Mars as the Ultimate Destination for Human presence. However two different roadmap paths were developed.

- *An asteroid is the next s*tep and then the Moon.
- *The Moon is the next step* and then the asteroids.

Apparently there was a lack of consensus about the sequence among the participating agencies and thus two differing roadmap paths were described.

III. Near Term Plans were divided into Three Phases:

Phase I involves starting with the International Space Station as a foundation for further advancement. and as the test bed for exploration technologies.

Phase II involves Cislunar activities. The development of robotic precursors will ermit both lunar and Martian objectives to advance. The development of advanced technologies will also enable the extension of human presence. Advancing technology development will also require Space systems and infrastructure.

Phase III involves Deep Space. Significant challenges involve dealing with severation risks associated with long duration flights to Mars, the development of deep space habitats,ß which can support human presence on the lunar and Martian surfaces, and work on analog activities both at the ISS and at terrestrial locations.

Interpretation: A Split About the Importance of Returning to the Moon as the First Priority

What I find interesting about this presentation is the admitted necessity for **two alternative paths** in this roadmap with reversed sequences of development:

1 NEOs (Near Earth Objects) then the Moon
2 Moon then NEOs

NASA's recent focus on NEO and the development of the Orion Capsule for long duration deep space flight including a flight to an asteroid, and the Congressional fights with NASA over it flexible path strategy are one context for interpreting this split among the ISECG countries.

I think that another perspective is that there is a strong consensus among space agencies and countries outside the US that the Moon is now the logical focus for international cooperation both for robotic precursor development, supporting infrastructure development, as a central human destination, and as extension of the human economic sphere. The Constellation Program really invited strong coordination from other countries with the US about a return to the Moon, but NASA sadly abandoned this objectives (in the near term at least) with the cancellation of the financial boondogle of Constellation program architecture as that was exposed by the Augustine Commission. 2

We have seen the discussion of the international lunar robotic village and coordination of precursor missions as part of international ILEWG conference and as the topics of Russian, Japanese, Chinese, and European, and Indian planning. This momentum continues even as the US grapples with plotting a coherent policy that can maintain bi-partisan Congressional support and excite the interest of the American public. The public is more concerned with jobs than space.

This editors opinion is that chasing a small asteroid (and exposing a crew to the high risks of deep space) will not excite the public or reassure Congress that NASA has the right priority. NASA's focus on the development of next step infrastructure to enable movement out to GEO for construction of space platforms and SBSP demonstrations, is the correct priority. The infrastructure development also enables a return to the Moon, an extension to Mars and NEOs, and the expansion of the space economy. This will produce US jobs and, at the same time, continuing a stable international partnership with the ISS nations.

The Launcher Development and Human Spaceflight Gap

China, India, Korea, Russia, and the US are all involved in launcher development programs: Long March 5, mkIII, Angara and Soyuz 2, and Falcon 9 Heavy/Dragon system and Taurus II/Cygnus systems respectively).

Much of this decade will pass before these launchers are demonstrated to be mature and reliable. ESA is also planning to gain independent human space flight capabilities with the evolution of it ATV to a manned status. India is also planning a manned program. The Spaxe-X Falcon/Dragon systems can also restore the US to a manned systems capability. When these launch systems and human rated systems are ready the mechanisms for international collaborative projects will accelerate.

This is also connected to the ISS. First, the ISS will be supported as a common project through 2020. India. Korea, and Ukraine in this Global Exploration Roadmap are added to the 16-nation ISS coalition. Second, with Indian and Korean launchers two more strands of a redundant logistic system for the ISS would be put into place.

China's Strategic Space Station Bid

Editor’s Speculation

A huge omission from this roadmap announcement is China, even though China is listed as a member of ISSCG. China is planning its own space station and has just launched its first crew lab module, Tiangong-1, with a near term test of rendezvous and docking followed by additional docking exercises in the next two years. A recent presentation by China at IAC indicated that they plan to construct a permanently manned space station from 20-ton modules by 2020. (3) (4) (5)

China has strategically positioned itself to build a new facility at the time the ISS will have completed more than 20 years of operation.

China's presentation of its plan for this space station was also a specifically open invitation to additional international participants. I see this clearly as an important assertion of Chinese leadership in space and a bid to also draw additional partner nations into the Chinese space station. What will be interesting is to see if some of the members of the ISS partners also discuss partnerships on the Chinese space station as their launcher and manned programs evolve. The Chinese may have a strategic advan-

tage of building a Next Generation Space Station. How they do this may be a largely indigenous effort, which will duplicate much of what has been done by the ISS. This isolation may perhaps be forced by ITAR restrictions. However, China may also take a much more international and entrepreneurial approach to attempt to leapfrog the ISS technology and to create a wider "China-centric" groups of partner nations, which likewise do not wish to be bound by US ITAR restrictions, as opportunities present themselves. 3

If China's economy maintains its growth rate over the next ten years it will likely surpass the US as the largest global economy. It will have much economic leverage as an ascending power in drawing new partners into its space activities, especially in the context of the Asia Pacific Space Cooperation Council countries with which it has strong economic connections and collaborative space activities. Conversely, the Chinese Space Station may represent a broadening of the international space agency partnerships. A new space station, with China as the main underwriting partner (in the manner of the US with the ISS) will also invite not only other nations, but also commercial partners.

This roadmap will also be the topic of a Conference in Washington D.C. Next May 22-24. Immediately preceding the ISDC Conference in Washington D.C May May 24-28. 2012.

Footnotes:

1. www.nasa.gov/pdf/591067main_GER_2011_small_single.pdf
2. ISS international partners: http://education.ssc.nasa.gov/pdf/mvw/MVW_ISS_Partners_Poster_and_Activity.pdf
3. http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=space&id=news/China101609.xml&headline=China%20Begins%20Lunar%20Landings%20Study
4. http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/china101909.xml&headline=null&next=10
5. http://strategicspacesolutions.com/Public-papers/**IAC**-10B38-E775.pdf

The Development of a New Economic Niche for Small Lunar Spacecraft

By David Dunlop - October 19, 2011

Background - The "CubeSat paradigm" has greatly reduced the cost of small satellites used principally in Low Earth orbit and developed by Universities, most often as student engineering and science projects. The projects can often be developed and launched for a cost in the low hundred of thousands of dollars as hitchhiker payloads on commercial satellite launches. These small spacecraft have gained a role LEO commercial and military applications as well.

This CubeSat paradigm is low cost because of the use of relatively inexpensive commercial off the shelf components, which do not undergo the expensive process of testing and space qualification and they avoid the high cost of fully qualified space hardware. These satellites are only planned for a short mission life in low Earth orbit before they fall into the Earth's atmosphere and burn up.

The CubeSat paradigm is now being extended to missions in cislunar and circumlunar space. These small spacecraft are in the nanosat class and are launched as hitchhikers on larger commercial satellite missions.

For lunar missions this low cost paradigm is being extended so that the price point of lunar missions can be much reduced. Lost cost components with a short useful lifetime in space may still be adequate for short duration lunar missions. Redundant internal systems are one approach and redundant small spacecraft are another approach to addressing mission risk-management in order to maintain low cost.

Alternatively expensive space qualified components may still provide a way to enable a spacecraft of very small mass and volume to undertake a longer duration missions and provide useful scientific or commercial services and communicate back to Earth.

Challenges in Extending The CubeSat Paradigm to the Moon

Microelectronic - Even the 10cm side (4 inches) scale of the CubeSat is a large volume of space when compared with the scale of microelectronic systems needed. Indeed an even smaller iteration, the pocketsat is only 5cm on a side but still adequate in relation ton the volume needed for microelectronic systems. As the capabilities of these microelectronic systems increase the size of the spacecraft needed is vastly reduced.

Power Supply - The surface area of these cubsats are covered with photo voltaic cells and though they do not have very much surface area they can provide a sufficient power supply for operations which can be in the range of 3 or 4 watts.

Low cost, Low Power, Low Frequency Communications - The low power available presents challenges to the communications capacity of cubesat-scale spacecraft at lunar distances especially in comparison to LEO operations. Low power signal detection requires large dish antennas. While low frequency bandwidth can be used; transmission volume is correspondingly low. The small spacecraft can operate on a communications power budget of as low a 500 milliwatts or up to 3 or 4 watts. Low frequency (UHF/VHF) and low power signals detection techniques used by amateur radio astronomers can address communication requirements at up to 8 to 10 Earth-Moon distances. They employ small antennas at a very modest cost. Ground stations may cost in the rage of $3K to $5K. A low cost global network relying on amateur radio is an approach to 24/7 communications requirements that can provide a very cost effective approach when such stations are linked through the Internet. This is an approach to communications that has been proposed by the GLXP Team Part-Time Scientists and independently by other amateur radio astronomers in the US at the Grand Rapids Radio Observatory.

Mechanical Structure - When the cubesats are put together, three in row are no more than a foot long. A "6 U" cubesat would weigh approximately 6 kg or 7.5 pounds. A 6 U "CubeSat stack" is still a very small mass and volume in relation to convention satellites and spacecraft. The use of

lightweight materials can further reduce mass so propulsion requirements are further reduced.

Propulsion systems - These small spacecraft can also employ electric propulsion systems, which have as much as 8 to 10 times the isp of chemical propulsion systems. Arcjet thrusters or pulsed plasma systems can provide the thrust needed in order to reach circumlunar space and meet its mission target if the "hitchhiker" is released from a larger lunar mission or from a commercial satellite placed into a high orbit. These small spacecraft are therefore largely "flying gas tanks" with "just enough" power, microelectronic instruments, and communication capacity to still perform useful science.

For longer duration missions, one propulsion approach that can be pioneered is that of solar sails. This approach trades the very low thrust provided by light pressure on a solar sail for long duration effects on acceleration and navigation against the damaging effects of the radiation in the space environment on the useful life and reliability of the microelectronics.

Instruments - The microelectronics MEMs systems can provide scientific instruments that are also low mass, low power, and low volume. If the total mass budget for instruments in these small spacecraft is limited to 1/2 kg. there are instrument payloads that can perform useful science weighing only a few grams.

A Low Price Point Lunar Mission Revolution

In combination, these design aspects of small lunar spacecraft can define a "sweet spot" price-point range that can be as low as the low single digit millions of dollars. *The cost per kg of such spacecraft remains quite high, but the price point of the mission is much reduced!* It is this reduction in mission price point that promises a low cost/ low mass revolution in lunar mission planning and development. Instead of lunar project mission costs of low hundreds of millions of dollars it is now within the realm of economic feasibility to think of missions in the low tens of millions and even the single digit millions of dollars.

The first example is the Team IL of the Google Lunar X-Prize. This team is planning a direct descent trajectory lunar landing with a small CubeSat-scale spacecraft after a launch as a hitchiker payload on a Falcon 9 rocket. They also have an $8 M budget, which they plan to use to obtain the $20M first prize by the end of 2012.

The second example is a team from the University of California Santa Cruz and UC Berkeley with support from NASA AMES. This $30M mission will dual nanosats with microelectronic magnetometers to impact the lunar surface and to measure more precisely the magnetic fields associated with lunar swirls. Small impact probes will be released from an orbiting "mother satellite bus" the size of a washing machine.

A third example of this hitchhiker system has been proposed by another Google Lunar X-Prize Team, Moon-X. The large lander provided by Moon-X would carry small CubeSat scale "hoppers" to investigate the region proximate to the large lander platform. These small hoppers could provide a larger exploration footprint for the primary lander mission.

This paradigm is spurring a range of lunar mission initiatives. For lunar science advocates and those interested in commercial space application, the extension into "deep space" of the CubeSat paradigm offers the prospect of a great increase in the number of lunar missions proposed and flown. The low price point also means that the province of the Moon will be open to a much broader cross section of space faring nations and their university programs. Of course the limitations of this new lunar paradigm means that such missions cannot address all the science questions that a heavier class of spacecraft could provide, but conversely there are questions that can be proposed and low mass low power instruments flown that might never have gotten to the moon on a larger more expensive lander.

Advocates of "pocket" satellites, only 2" on a side. which are spacious enough for many microelectronic systems and payloads, now look at the CubeSat itself as a larger, older 'dinosaur.' These questions of doing more with a lot less mass and volume will continue to offer price-point advantages for some types of lunar missions. We will revisit this topic as new information becomes available about the missions listed below and as new CubeSat scale lunar spacecraft and missions are announced.

A summary table of lunar missions I am aware of to show how this new low cost lunar niche is developing and included some other lunar missions by way of comparisons. Much of the information one would like is as yet incomplete as many of these project are both quite new and information about them is limited as of this writing some presented in recent sessions a the International Astronautical Congress in South Africa.

Current small lunar spacecraft projects

1. U California Santa Cruz / UC Berkeley / NASA AMES - $30M - 2014-2015- P.I. Ian Garrick-Bethel (1)
2. Vermont Technical College - Vermont - $295k – 2015 launch - NASA Goddard - NA - NA - (2) - Space Grant - U Vermont
3. Team Israel GLXP - Technion U - $8M - 2012 - (3) - Ben Gurion U - Weisman Science Institute
4. Politechnico de Milano - University La Sapienza - P.I. Dr. Michele Lavagna - Politechnico Torino - AMALIA (3) - U Frederico II - Thales Alenia Space - CGS SPA, Milan - Techno System Dev., Naples
5. Italian Space Agency - ASI - Italian Space Agency - MINAS ITHIL: Italian micro and nanosatellites mission to the Moon (4)
6. Surrey Satellite Technology - U of ESA - 2014 - ESMO European Student Moon Orbiter - Strathclyde (**not cube sat**)
7. Western Switzerland U - HEIG-VD - of Applied Sciences – P.I. Lorenzo Zago - **Jules Verne**: nano-spacecraft lunar orbiter (4)
8. Baylor University - P.I. Dr. Rene Laufer - ARMADILLO: A Demo Mission to Kordylewski Clouds (5)
9. Notre Dame - $250M - P.I. Clive Neal, JPL/NASA – Lunnette family of small lunar landers (**not cubesat scale**) (4)
10. University? - Eletro-Communications - P.I. Dr. Kiyohiko Hattori - "autonomous Buddy Lunar Rover image processing"(4)
11. PartTime Scientists - Texas Instruments $15 M (~~E~~) 2012

Footnotes:

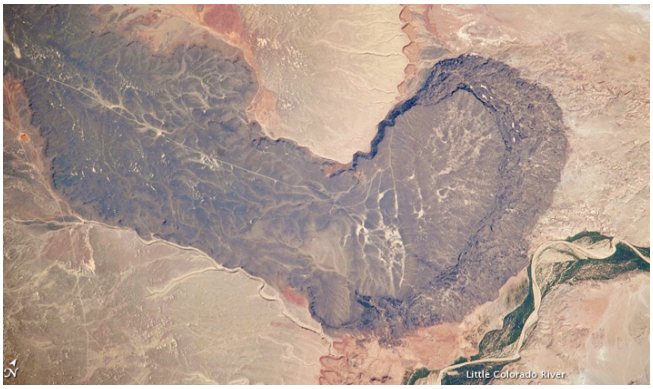
1. Lunar Science Institute Annual Science Forum, July 2011 and personal interview.
2. Vermont Space Grant website:
3. GLXP Team Pages website: for Team Israel, Team Italia,
4. International Astronautical Federation/IAC 2011 Technical Session: Hitchhiking to the Moon
5. Personal Interview with Dr. Rene Laufer **DD**

Lunar Analog Research News

M3IQ co-editor Madhu Thangavelu visits NASA's Desert RATS exercises in Arizona

www.nasa.gov/exploration/analogs/hdu_DRATS2011.html

Desert **R**esearch **A**nd **T**echnology **S**tudies (RATS) is a group of engineers and scientists from different NASA centers who collaborate with industry and academia to evaluate future mission architectures and capture real data. 2011 marks its 14th year of testing. Past Desert RATS field tests have been held in locations such as Moses Lake, Wash. and Black Point Lava Flow, Arizona (1910). The August 30-September 9 2011 Desert RATS field test was held in in the high desert near Flagstaff, Arizona.



The area has a rough, dusty terrain and extreme temperature swings that simulate conditions that may be encountered on other surfaces in space, such as the Moon and Mars. By keeping all hardware mobile, NASA's analog exercises are not tied to any one site, as are the Mars Society's Arctic (Devon Is., Canada) and Desert, UT research "stations." This is especially helpful in testing rovers, pressurized or unpressurized, and field equipment for various terrain types.

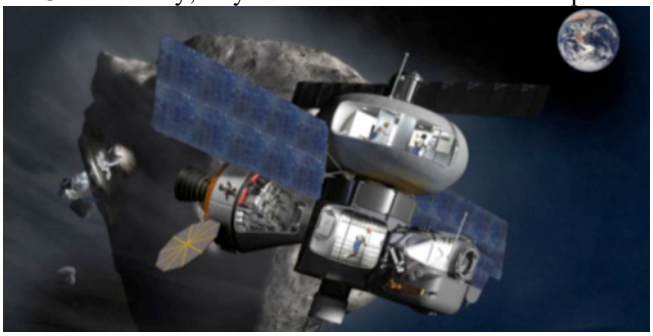
Habitat Development Unit (HDU) in Pressurized Excursion Module configuration is moved from JSC (Houston, TX) to the rockyard for integrated dry-runs prior to Arizona field tests. Note uninflated upper floor of the unit, designed by a competition winning U. Wisconsin (Madison) team.

http://www.flickr.com/photos/nasadesertrats/collections/72157627585042406/

Last day crew photo in front of HDU. upper floor inflated

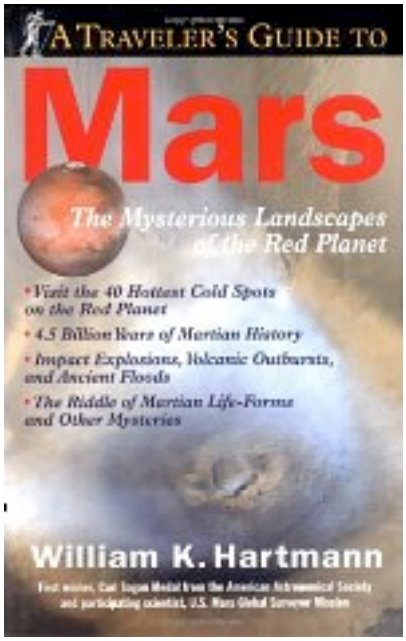
Posing with Robonaut friend, Madhu survived a fast moving hail storm, severe lightning and flash flooding to get here! Army shelters kept crew, VIPS, & equipment cozy & warm.

Madhu is proud of his new "off-road" pressurized all-terrain vehicle, designed by NASA for maximum visibility, and airlock-free access to the surface via "suit-locks." Unfortunately, they wouldn't let him take it for a spin.



The year's exercise theme was "How to explore an asteroid" NASA wants to be prepared, just in case! ◘

THE book WORM



A Traveler's Guide to Mars:

The Mysterious Landscapes of the Red Planet

- *Visit the 40 Hottest Cold Spots on the Red Planet*
- *4.5 Billion Years of Martian History*
- *Impact Explosions, Volcanic Outbursts, Ancient Floods*
- *The Riddle of Martian Life-Forms & Other Mysteries*

By William K. Hartmann

ISBN-10: 0761126066 - ISBN-13: 978-0761126065

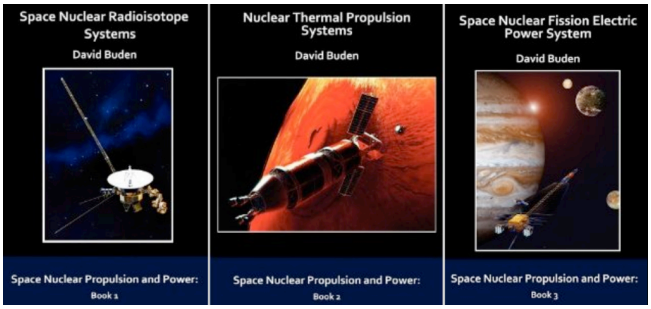
Workman Publishing, New York 2003

Maps and Dozens of Color High Resolution Photograph of various features of special interest

"prodigiously illustrated with photographs from Mariner 9, Viking, Pathfinder, the Hubble Space Telescope, and Mars Global Surveyor spacecraft"

Editor's Comments: most space enthusiasts, even those especially interested in Mars, have a geographic sense of Mars and its features that is skimpy at best. We all know of **Olympus Mons** and **Valles Marineris**. Some of us know the names of some of the other major volcanoes on Mars. Some of us are familiar with the largest and deepest impact basin on Mars, **Hellas Planitia**. By the time you finish reading this book you will be able to talk about Mars as if you had been there. And you will have a good sense of what feature is where relative to one another. It is important to know these things if you want to talk intelligently of where we might want to set up a first outpost, and about how we could tap the planet's resources. Martian landscapes are as varied as those on Earth.

- **I highly recommend this book.** It belongs in the library of anyone interested in opening a human frontier on Mars.
- **I hope that one as familiar with the Moon** will write such a book about its also very varied terrains, which tourists will get to visit far sooner



A three volume series on the history and engineering of space nuclear power and propulsion systems has just been published. Written by 50-year space nuclear program veteran **David Buden**, these books provide a comprehensive look into the space nuclear systems that may play a critical role in enabling human missions to the planet Mars.

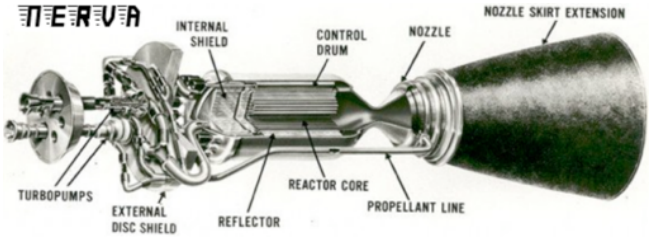
The first book, **Space Nuclear Radioisotope Systems**, describes the technical workings of radio-isotope systems, the requirements and safety design considerations of these systems, different systems with this technology that have been developed, and their operational history, including information on the two Viking pobes using radioisotope system technology.

The second book, **Nuclear Thermal Propulsion Systems**, explores the fundamentals of nuclear rockets, including the safety issues, mission requirements, developmental history of various concepts both in the U.S. and Russia, and a summary of the key develop-mental issues of this technology. This book also includes a comprehensive history of the Rover / NERVA rocket programs, which took NTP systems from the drawing board to the verge of flight tests as part of NASA's post-Apollo plans to achieve human missions to the Red Planet by the 1980s.

The third and final book of this series, **Space Nuclear Fission Electric Power Systems**, discusses the components that make up nuclear fission power systems, the principal requirements and safety issues involved, various development programs, status developments and development issues. Such systems are key for enabling the production of rocket propel-lants on the Martian surface, thereby making possible mission plans such as Mars Direct.

The author of this series, David Buden, is an engineer whose career spans five decades of space nuclear research and development and was involved in the development and management of various advanced nuclear power systems from the days of the nuclear airplane to the SP-100.

As a technical resource, these books are essential for anyone interested in the engineering of space nuclear power systems. Available at www.amazon.com.



GREAT BROWSING

SPACE TRANSPORTATION

NASA Selects Companies to Study Storing Cryogenic Propellants in Space
www.spaceref.com/news/viewpr.html?pid=34280

SPACE STATIONS, ISS

www.space-travel.com/reports/**New_uses_for_Space_Station**_999.html

COMMERCIAL SPACE

Dragon interview with Elon Musk on Dragon-ISS flight
http://nextbigfuture.com/2011/08/elon-musk-is-interviewed-by-npr-about.html#more

TECHNOLOGY

http://www.newscientist.com/article/dn20779-**nasa-bets-on-metal-hydrogen-and-cosmic-gas-stations**.html?DCMP=OTC-rss&nsref=tech

http://www.space.com/12818-**future-spacesuit-astronaut-gravity-rehabilitation**.html

Humans and Robots - ten-year old advice
http://www.spacedaily.com/news/oped-01k.html

Successful test of 3D Prining in Aero-G
www.spaceref.com/news/viewpr.html?pid=34249

SPACE SOLAR POWER

http://space.alglobus.net/papers/**TowardsAnEarlyProfitablePowerSatPartII.**pdf

NEAR EARTH SPACE

http://spaceinfo.com.au/2011/09/05/**space-junk-reaches-tipping-point/**

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/

ASTROBIOLOGY

http://spaceinfo.com.au/2011/08/11/**made-in-space-–-dna-building-blocks/**

Alien Life More Likely on 'Dune' Planets
www.spaceref.com/news/viewsr.html?pid=38216

Strange Life forms at Hypothermal Vents
www.spaceref.com/news/viewpr.html?pid=34548

THE MOON

Did the Moon have a smaller sibling that crashed into it to create two very different hemispheres?

http://www.space.com/12529-earth-2-moons-collision-moon-formation.html:

MARS

NASA-ESA 1st Joint Mars Mission picks Instruments
www.spaceref.com/news/viewpr.html?pid=31352

http://old.news.yahoo.com/s/ac/20110801/us_ac/8897299_spacex_red_dragon_proposal_for_nasa_mars_mission_could_revolutionize_space_exploration

Search for Life on Mars to get High-tech Instruments
www.spaceref.com/news/viewpr.html?pid=34516

http://www.dnaindia.com/world/**report_radar-for-mars-study-can-map-earth-s-freshwater-reserves-nasa**_1587806

OTHER PLANETS

http://www.newscientist.com/article/mg21128303.900-**plutos-icy-exterior-**

ASTRONOMY

http://machineslikeus.com/news/**kepler-reshaping-our-understanding-planets**

Funding Crisis for the James Webb Space Telescope
http://www.thespacereview.com/article/1926/1

Kepler Mission Discovers a World Orbiting Two Stars
www.nasa.gov/mission_pages/kepler/news/kepler-16b.html

How single stars (like the Sun) lost their companions
http://www.spaceref.com/news/viewpr.html?pid=34666

EARTH FROM SPACE

First global portrait of greenhouse gases emerges from pole-to-pole flights
www.spaceref.com/news/viewpr.html?pid=34547

India-Pakistan Borderlands at Night As Seen From ISS
http://earthobservatory.nasa.gov/IOTD/view.php?id=52008

GREAT VIDEOS

Mini Jumping & Gliding Robot
www.youtube.com/watch?v=A8X9ULBTPdA&feature=share

Near-Earth Asteroid - Mission Animation
http://www.nasa.gov/multimedia/videogallery/index.html?media_id=101500641#

http://www.space.com/12744-lumpy-gravity-moon-grail-learn-luna**.html**

How the Moon was formed and what it did for life
http://www.space.com/9926-moon-life.html

Two Sides Has the Moon & Here's What's On Then
http://www.space.com/9859-sides-moon.html

First Rover on the Moon **(Apollo 15, 40 years ago)**
http://www.youtube.com/watch?v=0_YhYBxjpQU&feature=player_embedded#at=30

Vesta full rotation movie
http://www.youtube.com/watch?v=FaUaoy33gHE

Inside the Space Station from one end to the other
www.youtube.com/watch_popup?v=H8rHarp1GEE

Musk on Mars in 10 years
http://online.wsj.com/video/elon-musk-ill-put-a-man-on-mars-in-10-years/CCF1FC62-BB0D-4561-938C-DF0DEFAD15BA.html

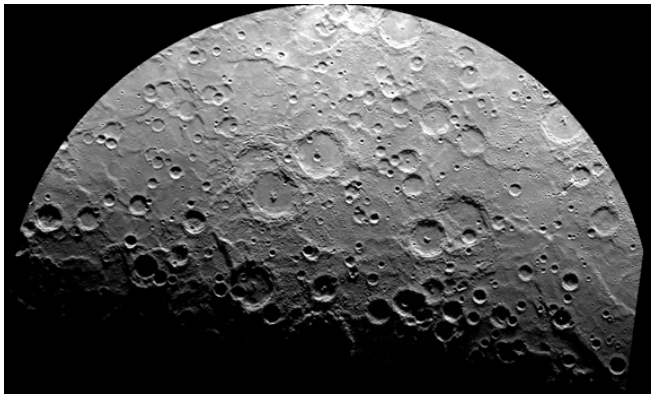
Russian Commercial Space Station Plans (3 videos)
http://orbitaltechnologies.ru/

Spaceport America Preview
http://www.youtube.com/watch?v=pHa8XatVUXA&feature=player_embedded

Preparing Russian Soyuz for launch at ESA's Kourou Spaceport in Guiana, South America
http://multimedia.esa.int/Videos/2011/09/Soyuz-dry-run-time-lap

Romancing the Cloud: The new **Indian**-French **Megha-Tropiques Satellite** will help forecast Tropical Weather
http://www.youtube.com/watch?v=_Mdpt4AByo4

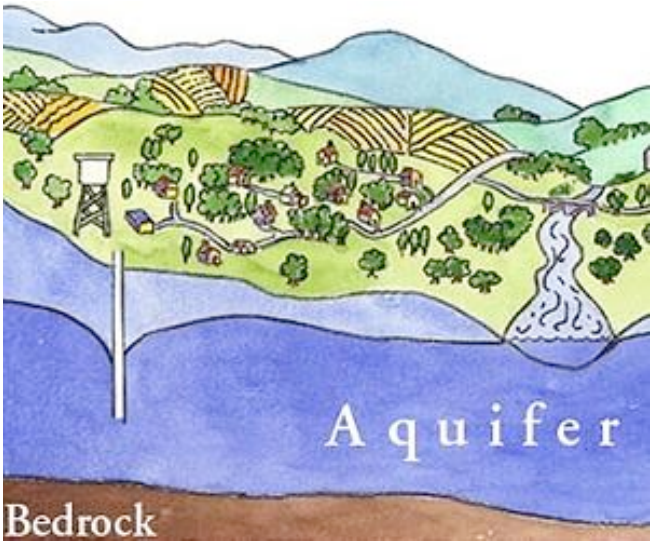
M3IQ PHOTO GALLERY



Messenger Photograph of Mercury's South Pole
http://www.spaceref.com/news/viewsr.html?pid=38423

This image from the original Star Wars film of **Tatooine**, a planet orbiting two suns, here seen near sunset, is validated by a recent discovery:
http://www.spaceref.com/news/viewpr.html?pid=34641

Mirrors completed for James Webb Space Telescope to succeed the Hubble Space Telescope in 2018.
http://www.space.com/12989-nasa-james-webb-space-telescope-mirrors.html
There is the real possibility that this awesome project may be killed by the US Congress for "budgetary reasons"



http://www.terradaily.com/reports/**NASA_Mars_Research_Helps_Find_Buried_Water_on_Earth**_999.html
Perhaps this method will discover yet unknown aquifers below India's deserts.

A peek inside a Tiangong-1 space lab mockup (China)

Research and Development areas for India's planned Manned Crew Capsule. with features modeled after Russia's venerable Soyuz capsule. ISRO

Moon Miners' Manifesto Resources

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

MMM is published 10 times a year (except January and July. The December 2010 issue will begin its 25th year of continuous publication.

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

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

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

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

MMM Classics: All the "non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of December 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 of MMM-India Quarterly

Upcoming Conferences & Events

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

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

NET 2012 — ISRO, Launch PSLV / Chandrayaan-2, India: 2nd India robotic Moon Mission expected to launch; lander/rover conducted in cooperation with Russia

Jul 14-22 — Committee on Space Research, ISRO, Mysore, India: '39th Scientific Assembly of Committee on Space Research (COSPAR).'

ELSEWHERE – a selection by the editor

Nov 1 — CNSA, Launch Long March 2F / Shenzhou 8, Jiuquan, China: A Chinese Long March 2F rocket set to launch Shenzhou 8 on an unmanned flight to conduct the 1st docking between 2 spacecraft in orbit. (Tiangong-1)

Nov 5 — RSA, Launch Zenit 3F / Phobos – Grunt, Baikonur Cosmodrome, Kazakhstan: A Zenit rocket set to launch the Phobos-Grunt mission to return samples from Mars moon, Phobos, and also carry small Mars-bound China spacecraft Yinghuo 1.

Nov 7-9 — Lunar Exploration Analysis Group (LEAG), Houston TX, USA: 'Annual Meeting of the LEAG.

Nov 9-10 — Explore Mars Inc, Washington DC, USA: **'Women and Mars Conference'**

Nov 13-17 — State of Hawai`i, Pacific International Space Center for Exploration Systems, **(PISCES)** Pacific International Space Alliance, et al, Waikoloa HI, USA: **'2011 Intern'l Lunar Research Park Leaders Summit'**

Nov 25 — ULA, Launch Atlas 5 / MSL, Cape Canaveral FL, USA: Atlas 5 rocket set **to launch NASA's Mars Science Laboratory (Curiosity) Mission**

Dec 10 —Moon Miners' Manifesto 25th Anniversary Celebration, Milwaukee, WI, USA

Dec 12-15 — Abu Dhabi Global Environmental Data Initiative, United Nations Environment Program, Abu Dhabi, United Arab Emirates: '1st Eye on Earth Summit'

Dec 14-16 — Earth Observatory of Singapore, Nanyang Technological U., **Singapore: '5th Asian Space Conf.**

---- 2012 -----

Jan 9 – Feb 11 — Intern'l Space Univ., U. of S. 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: **'Conf. on Life Detection in Extraterrestrial Samples'**

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

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

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

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

Student Space Organizations in India

SEDS India
Students for Exploration and Development of Space - India

http://india.seds.org/

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

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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 VEL TECH (Chennai) (419 members)
SEDS GGITM (Bhopal) (136 members)
SEDS NITW (Warangal) (100 members)
SEDS KCT (Coimbatore) (100 members)
SEDS NITT (Thiruchirapalli.) (17 members)
See map on last page of this issue

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 with different sensors, servos, communication equipment, GPS and 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

Triva 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!

Help Wanted !

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

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

If you think that you can add to the usefulness and vitality of this publication, in any of the ways listed above, or in fields we had not thought of, write us at:

mmm-india@moonsociety.org

[This email address goes to the whole editorial team]

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

Guidelines for Submissions

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

It is not intended to be a scholarly review or a technical journal for professional distribution.

Submissions should be short, no more than a few thousand words. Longer pieces may be serialized

Editorials and Commentary, reports on actual developments and proposals, glimpses of life on the future space frontier, etc.

Articles about launch vehicles, launch facilities, space destinations such as Earth Orbit, The Moon, Mars, the asteroids, and beyond, challenges such as dealing with moondust, radiation, reduced gravity, and more.

Help Circulate *MMM-India Quarterly*

If you know someone who might enjoy reading this publication, send us their email address(es) so that they receive notice when a new issue if published.

Readers are encouraged to share and to distribute these issues widely, either as email attachments, or via the direct download address (for all issues):
http://www.moonsociety.org/india/mmm-india/

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

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

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

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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.

"Destiny is not a matter of chance; but a matter of choice. It is not a thing to be waited for, it is a thing to be achieved." William Jennings Bryant

"Do not go where the path may lead. Go instead where there is no path, and leave a trail." – Mongolian proverb

Engage! And Enjoy!