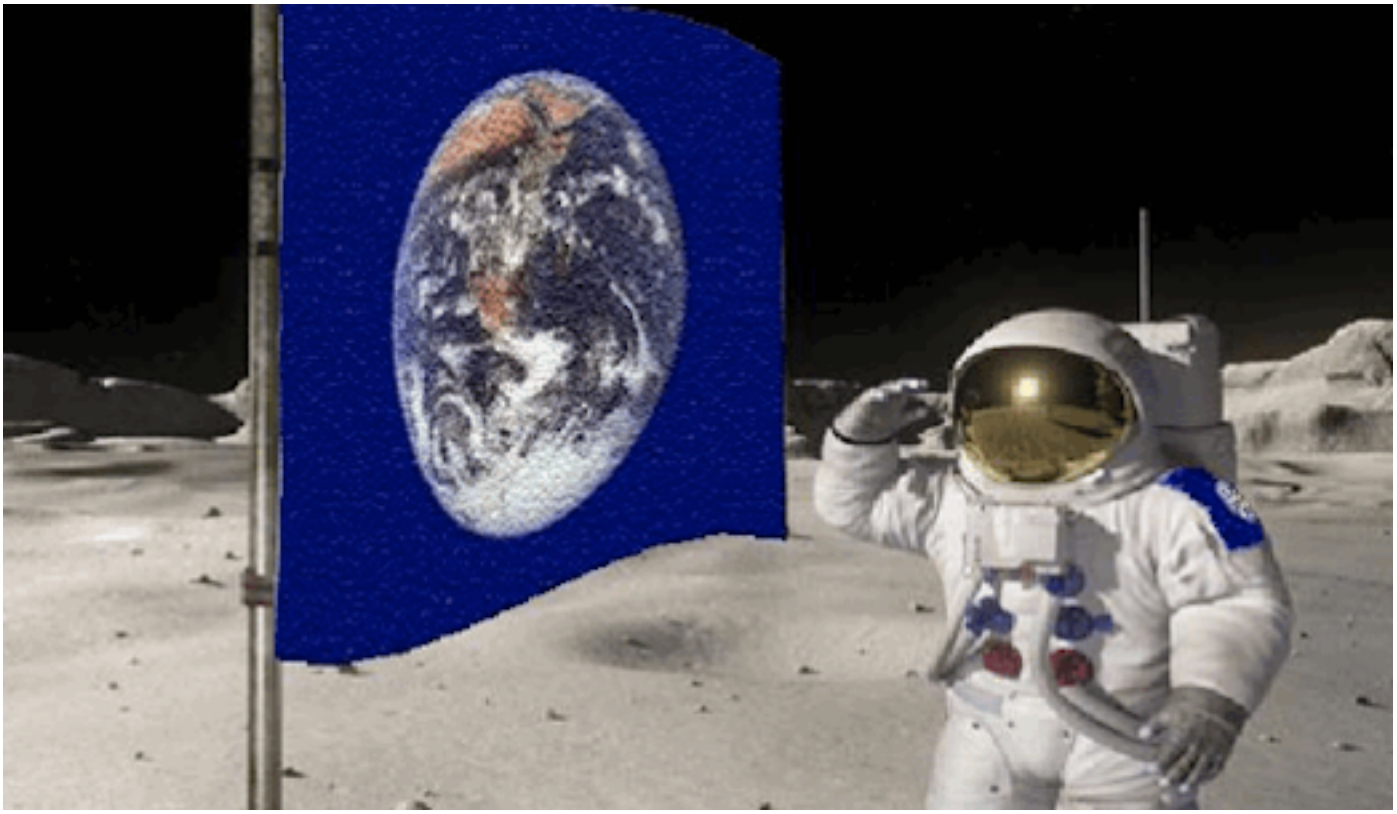
"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

Moon Miners' Manifesto

India Quarterly Edition

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



Will we return to the Moon under one flag? - That is the goal of the **International Lunar Research Park** Project

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

Innovation: L>R: Spanish Titan Lake Boat, a 3D Printer, Planetary Society's lightweight Mars Sample Return Probe

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

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

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

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

About Moon Miners' Manifesto http://www.moonsociety.org/chapters/milwaukee/mmm/

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

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

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

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

– join online at: http://www.moonsociety.org/register/

MMM Classics: All the "non-time-sensitive articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. These issues are freely accessible at: www.moonsocietyorg/publications/mmm_classics/

MMM Theme Issues: The same material has been reorganized in **14 Theme Issues**, also freely downloadable at: http://www.moonsociety.org/publications/mmm_themes/

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

This publication was launched with the August 2008 issue. This issue begins our 5th year. The Moon Society was founded as an International organization, but has few members outside the US, mostly solitary and unorganized.

Background – The Moon Society and The Planetary Society of Youth (TPSY) in India, 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. English-fluent Indians now outnumber English speakers in the United States. More books are published in English than in any other country. And – I**ndia has now gone to the Moon!**

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

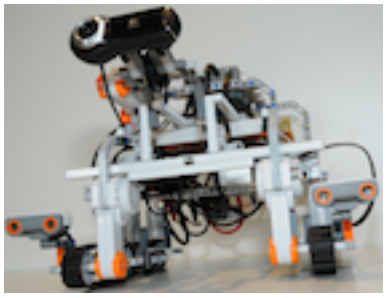
This vision was well-expressed by the former President of India, Dr. A. P. J. Abdul Kalam in a speech at The Symposium on "The Future of Space Exploration: Solutions to Earthly Problems" to mark the occasion of the 50th Anniversary of the dawn of Space Age, Boston University, Boston, MA, April 12, 2007.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

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

Indian Space Research Organization

Sunita Williams Drives Robot on Earth via Interplanetary Internet

http://www.space.com/18405-interplanetary-internet-robot-space-station.html




Sunita, hair floating in free fall – and the robot device on Earth that she "drove" via the internet

NASA and the European Space Agency have been testing a prototype system that may one day help enable Internet-like communications between Earth and robots on another planet.Astronaut Sunita Williams, International Space Station Commander of the current Expedition 33 mission, used the experimental **Disruption Tolerant Networking (DTN) protocol** to drive a small LEGO robot at ESA's Operations Center in Germany. The experiment simulated a scenario in which an astronaut orbiting another world controls a robotic rover on that planet's surface.

The DTN architecture is a new technology designed to enable standardized communications over long distances and through time delays. At its core is the Bundle Protocol (BP), similar to the Internet Protocol, or IP, that serves as the heart of the Internet on Earth. The experimental DTN tested from the station may one day be used by humans on a spacecraft in orbit around Mars to operate robots on the surface, or from Earth using orbiting satellites as relay stations. The big difference between \s that IP assumes a seamless end-to-end data path, while BP is built to account for errors and disconnections — glitches that commonly plague deep-space communications. Data move through the BP network in a series of short hops, waiting at one node until the next link becomes available, NASA officials said. **See the featured cover illustration on page one** of this issue. ##

Soyuz capsule lands at night with Space Station Crew including Sunita Williams

http://www.space.com/18537-**soyuz-spacecraft-rare-night-landing**.html


In the International Space Station's Unity node, NASA Indian-American astronaut Sunita Williams, Expedition 33 commander (right); along with Japan Aerospace Exploration Agency astronaut Aki Hoshide (center) and Russian cosmonaut Yuri Malenchenko (left), both flight engineers, **attired in their Russian Sokol launch and entry suits**, take a moment for a photo as they prepare to return to Earth on Nov. 18, 2012.

Besides the honor of being expedition commander, Sunita had waved the flag of India aboard the Space Station on India Independence Day on August 15th. And on November 14th, Children's Day in India, students from various schools in and around Ahmedabad spoke to her on the Space Station via radio, asking m any questions.

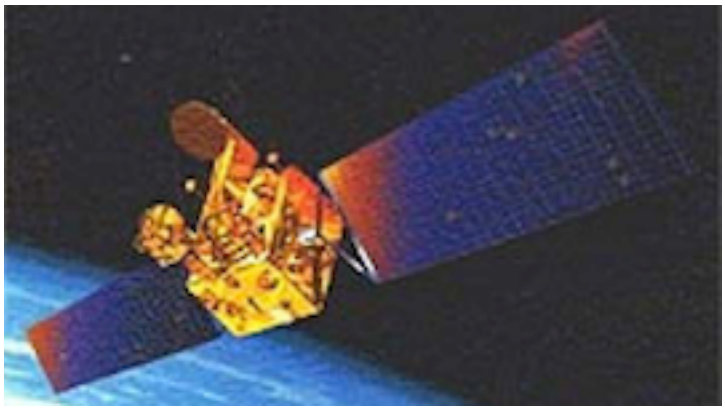
http://www.indianexpress.com/news/**city-kids-quiz-sunita-williams**/103226 6

Sunita's father was born in Gujarat. Her last trip to Ahmedabad in 2007 (after her first mission to ISS)

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

India's Oceansat-2 Satellite Helps NASA Track Hurricane Sandy

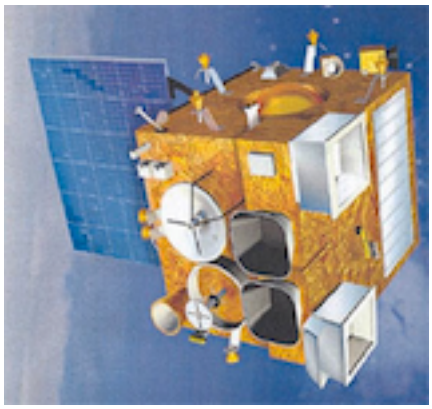
www.asianscientist.com/topnews/india-isro-oceansat-2-oscat-scatterometer-helps-track-hurricane-sandy-nasa-2012/




On October 29 when Hurricane Sandy was unleashing havoc on the eastern coast of the U.S., India's space organization teamed up with NASA and NOAA to monitor her path.
Read the **full report** by M3IQ co-editor **Srinivas Laxman** in **Asian Scientist** – link above.

Arianespace To Launch Two Indian Satellites In 2013

http://www.asianscientist.com/topnews/**arianespace-to-launch-gsat-7-and-insat-3d-isro-in-2013**/

The ISRO will launch two Indian communication satellites, the GSat-7 and Insat-3d, in 2013 with the help of Arianespace. Read the **full report** by M3IQ co-editor **Srinivas Laxman** in **Asian Scientist** – link above.

India Prepares To Go To Mars: ISRO Test-Fires Mars Orbiter Mission Engine

http://www.asianscientist.com/topnews/india-isro-test-fires-mars-orbiter-mission-engine-2012/

On Monday, the Indian Mars Orbiter Mission program crossed an important milestone with the successful test firing for the first time of the liquid apogee motor which has to restart after 300 days when the orbiter enters orbit around Mars. Read the **full report** by M3IQ co-editor **Srinivas Laxman** in **Asian Scientist** – link above.

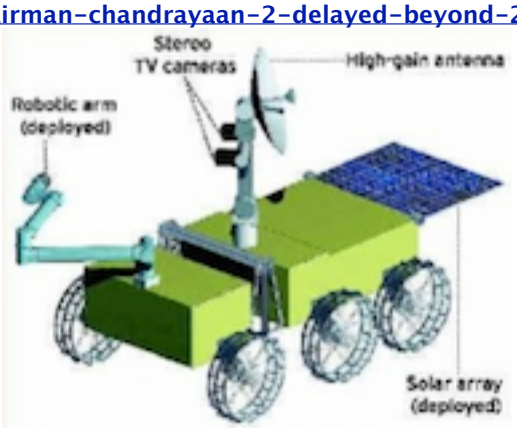
ISRO's Heaviest Satellite Launched, GSat-10 Placed In Orbit

http://www.asianscientist.com/topnews/isro-gsat-10-placed-in-orbit-2012/

Read the **full report** by M3IQ co-editor **Srinivas Laxman** in **Asian Scientist** – link above.

Chandrayaan-2 May Be Delayed, Says ISRO Chief

http://www.asianscientist.com/topnews/**isro-chairman-chandrayaan-2-delayed-beyond-2014/**



Left: Chandrayaan-2 lander **Right:** rover

Read the **full report** by M3IQ co-editor **Srinivas Laxman** in **Asian Scientist** – link above.

ISRO plans 58 space missions during 12th 5-year Plan

http://ibnlive.in.com/news/**isro-plans-58-space-missions-during-12th-plan**/298691-3.html

October 2012: According to the 12th Five Year Plan, approved by the Cabinet the 58 space missions include 33 satellite missions and 25 launch vehicle missions: specifically:

- **Spacecraft to Moon and Mars**,
- **A Geo-Imaging Satellite** or GISAT – to be stationed 36,000 km above to maintain round-the-clock vigil and assist state authorities to tackle natural disasters, floods and forest fires and keep a watch over the country's sensitive borders.
- **An additional 400 transponders** to the existing 187 to meet the growing demand from DTH operators, satellite mobile communications and new generation broadband VSAT systems.
- India;s own version of the **Global Positioning System** by putting into orbit a constellation of seven satellites which would form the Indian Regional Navigational Satellite System (IRNSS).

Not all of the missions called for in the 11th five year plan have been realized, but are still being pursued. These include

Chandrayaan 11– an ambitiou lander/rover mission (launch has been postponed from 2014 to an unspecified date)

Astrosat-1 India's first satellite dedicated to astronomy, which will scan the universe in x-ray, ultraviolet and visible light bands. and

Aditya-1 which will be dedicated to solar coronal studies and will contain Visible Emission Line Space Solar Coronagraph – the main payload to study the coronal dynamics.

India Unveils Ambitious Science Policy

http://news.sciencemag.org/scienceinsider/

3 January, 2013 – The Indian government has adopted a new science, technology, and innovation policy that calls for doubling the investment in science in the next 5 years and establishing India among the top five nations in output of scientific publications by the end of the decade.

The initiative differs from a similar announcement a decade ago in that it emphasizes innovation but does not specify bold new actions. Speaking at the annual Indian Science Congress in Kolkata, Prime Minister Manmohan Singh, pointed out that science-led innovation is the key to development. India must produce and nurture talent in science "to stimulate research in our universities, to develop young leaders in the field of science, and to reward performance." Singh added.

The goal is to raise the amount India invests about $12 billion annually on science and technology—about one-third of it from industry— to double that percentage by 2017.

"Complex issues, be they genetically modified food, or nuclear energy, or **exploration of outer space**, cannot be settled by faith, emotion, and fear but by structured debate, analysis, and enlightenment." ###

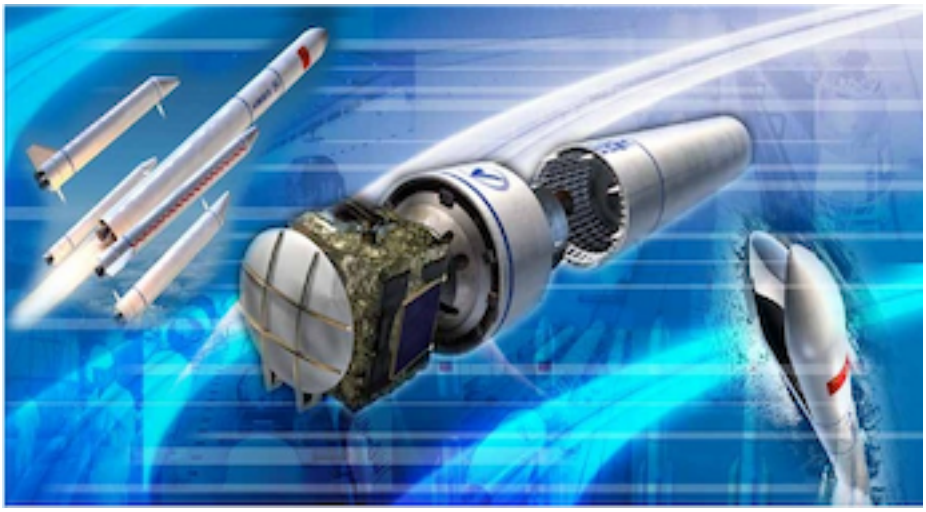
Elsewhere in Asia

Chinese National Space Agency

China eyes new "clean" rockets for Space Station, Moon Missions

http://www.space.com/18209-**china-new-rockets-long-march-5**.html

China is creating a new line of launchers for deploying its planned space station, as well as for landing robots — and humans — on the Moon. Earlier in 2012, the China Aerospace Science and Technology Corporation successfully conducted a 200-second test firing with the Long March 5 rocket's 120-ton-thrust liquid oxygen (LOX) and kerosene engine. The engine far more powerful than the 75-ton-thrust engines of the rockets used to launch China's piloted Shenzhou capsules.



The high-performance engine is the first kind of high-pressure staged combustion cycle engine for which China has proprietary intellectual property rights. Unlike many rockets used by other national space agencies, it is **non-toxic, pollution-free and highly reliable**. The engine makes China the second nation after Russia, to grasp the core technologies for a LOX/kerosene high-pressure staged combustion cycle rocket engine.

China's "repurposed" Change-2 successfully encounters Asteroid Toutatis

http://www.space.com/18933-**chinese-probe-asteroid-toutatis-flyby**.html

www.asianscientist.com/topnews/**change-2-space-probe-flies-by-asteroid-toutatis-2012**/

http://www.space.com/18914-**watch-asteroid-touatis-tumble-through-space-video**.html

China's "repurposed" second lunar orbiter, Chang'e-2, has flown by asteroid Toutatis. Launched on 1 October 2010, CSNA's second Moon probe was part of a three-phase lunar exploration effort. Its main mission was to scout for potential landing sites for China's first moon lander, the Chang'e-3 spacecraft, which is being readied for launch this year - 2013.

After the probe wrapped up its primary objective of orbiting the Moon in June 2011, it then departed lunar orbit for the Earth-Sun L2 Lagrangian point, where Earth's gravity and the sun's cancel out. Arriving at that location in August 2011, the spacecraft was used to evaluate China's deep-space tracking and control network.

[Earth-Sun L2 is the future home of the James Webb Space Telescope and is ideal for astronomy because a spacecraft is close enough to readily communicate with Earth, can keep Sun, Earth and Moon behind the spacecraft for solar power and (with appropriate shielding) provides a clear view of deep space for our telescopes. The L1 and L2 points are unstable on a time scale of approximately 23 days, which requires satellites orbiting these positions to undergo regular course and attitude corrections.]

http://map.gsfc.nasa.gov/mission/observatory_l2.html

In mid-April 2012, Chang'e-2 departed its L2 position and headed for what was to be a rendezvous with asteroid 4179 Toutatis, flying by, as close as 3.2 km, on 13 December 2012, taking pictures. The feat is a demonstration that China now has spacecraft capable of interplanetary flight. ###

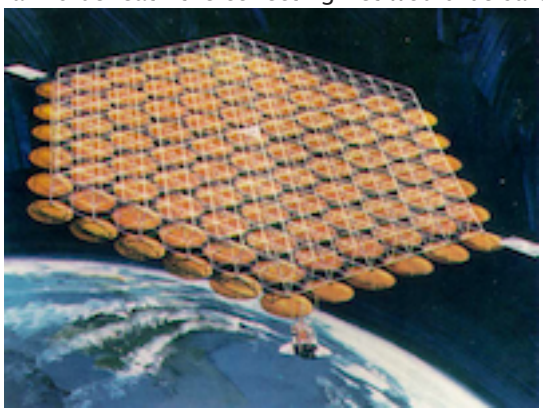
China proposes Space Solar Power collaboration with India

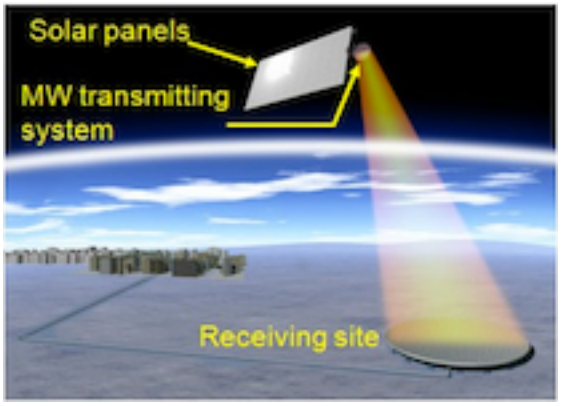
http://www.kurzweilai.net/**china-proposes-space-collaboration-with-india**

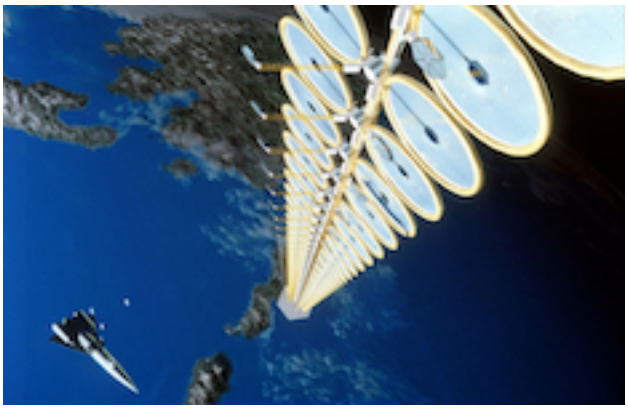
November 4, 2012 - The China Academy of Space Technology (CAST) proposed a joint collaboration for a space solar power mission with India and met with former Indian president APJ Abdul Kalam.

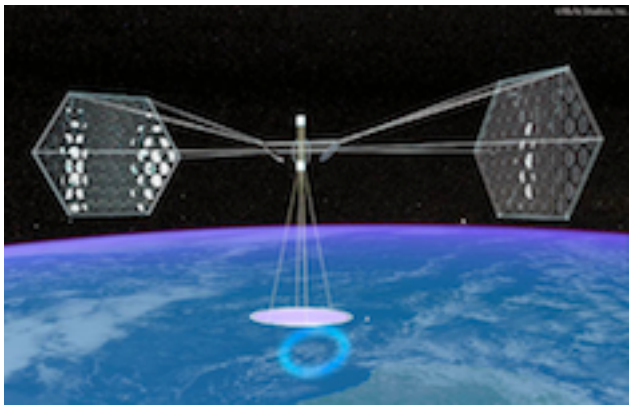
"Kalam assured that he will take this proposal to the Government of India and ISRO, so that a hard cooperation and collaboration between ISRO, DRDO [Defense Research & Development Organisation of India] and CAST is realised on ... Space-based Solar Power initiative so that both India and China can work for long term association with proper funding along with other willing space faring nations to bring space solar power to earth," the statement said.

Dr. Kalam is working with the National Space Society to spread the word about this environmentally clean way of producing abundant power, enough to bring prosperity to the whole world. It would make burning coal and other dirty power systems unnecessary. Giant, kilometers wide, "rectennas" on Earth would collect the beamed power. Agricultural farms beneath the collecting net would be safe









There are many design options: which is easier to build? Which is cheaper to build? Which can be built by robots?

To read more about Space Solar Power and Solar Power Satellites, check these links:

http://www.kurzweilai.net/a-limitless-power-source-for-the-indefinite-future
http://en.wikipedia.org/wiki/Space-based_solar_power
http://www.nss.org/settlement/ssp/
http://oilprice.com/Alternative-Energy/Solar-Energy/Solar-Power-In-Space-Power-Satellites.html
http://www.space.com/15189-solar-power-beaming-satellite.html
http://en.wikipedia.org/wiki/Rectenna

There are several proposed "architectures" – to see how they might look, enter "solar power satellites" in a Google Images Search (http://www.google.com/imghp?hl=en&tab=ii)

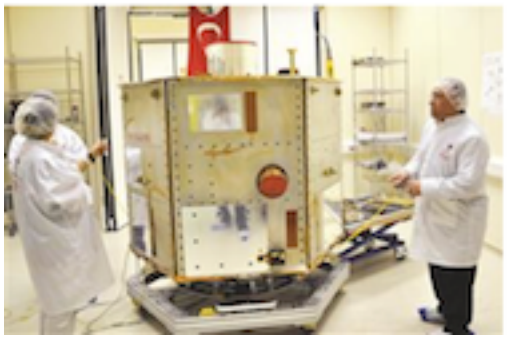
There are three ways such systems can be built

1. Components are manufactured on Earth and rocketed up to Geosynchronous Earth Orbit (GEO) where these satellites would be built in the orbit in which they will function
2. Components are manufactured on the Moon and brought down to GEO for 1/23rd the fuel cost
3. **Larger, simpler components are made on the Moon, while smaller, more complex components made on Earth, for the best overall economy.** (The Moon Society favors this option.)

Chinese Rocket Launches Turkish Satellite

http://www.space.com/18978-**chinese-rocket-launch-turkish-satellite**.html

Turkey's ambitions to become a force in satellite Earth observation took a step forward on Dec. 19 with the successful launch, aboard a Chinese rocket, of the Turkish Gokturk-2 medium-resolution optical surveillance satellite. Turkish officials said the 400-kilogram Gokturk-2, made mainly in Turkey but with an optical imager provided by South Korea, was safely in orbit at nearly 700 km in altitude and had sent signals to a ground station in Norway.



The satellite was launched aboard a Long March 2D vehicle operated from the Jiuquan Satellite Launch Center in Gansu Province. It was the 19th launch of a Chinese Long March rocket, for 2012.

Gokturk-2 is Turkey's second Earth observation satellite, following the small Rasat satellite launched in 2011 aboard a Russian-Ukrainian Dnepr rocket. Rasat, with a ground resolution c, 7.5 m, can detect objects of that diameter and larger. Gokturk-2 has a 2.5 m resolution and includes 15 gigabytes of image storage capacity.

Turkish Science, Industry and Technology Minister Nihat Ergun said before the launch that Gokturk-2 should be seen as an investment in high technology, and a signal of Turkey's determination to have its own, restrictions-free use of Earth observation imagery. Turkey's defense forces have purchased another Gokturk satellite from Telespazio of Rome and Thales Alenia Space of France and Italy. This 1,000-kg spacecraft will be similar to the two French Pleiades satellites now in orbit, with a 70-cm ground resolution in black and white and 2.8 meters in color.

The satellite's development has taken longer than expected, and it is not expected to be launched before late 2014. Telespazio's contract, valued at 250 million euros ($325 million) when signed in 2009, includes establishing a satellite integration and test facility in Turkey as well as a Gokturk ground station.

China launches 2nd satellite for Venezuela

http://www.cnn.com/2012/09/29/world/americas/china-venezuela-satellite/index.html

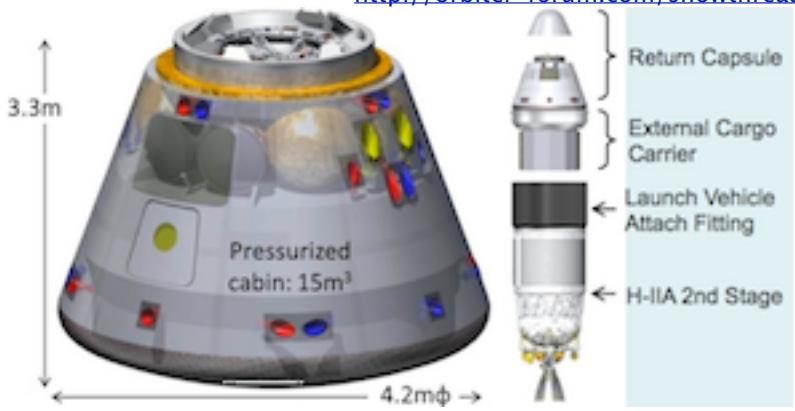
Left: Miranda satellite **RIGHT:** Venesat 1, also known as Simon Bolivar

19 September 2012: The observation satellite named **Miranda** was launched from the northwestern Chinese province of Gansu. It is Venezuela's second satellite in orbit, according to the Venezuela State News Agency, AVN. It will fly over Venezuela three times a day and take 350 high resolution images daily using four cameras, according to the news agency. The first one -- a telecommunications satellite -- was launched by China in 2008. It is named after Venezuelan independence hero, Simon Bolivar. Miranda will monitor the country, urban planning, military operations, and combat illegal mining and illegal crops.

Japan Aerospace Exploration Agency

Japan wants space capsule or space plane by 2022

http://www.space.com/18198-**japan-plans-manned-capsule-space-plane**.html
http://orbiter-forum.com/showthread.php?p=388919



Two different options: L capsule **R Space Plane**

"Japan hopes to be launching astronauts aboard a manned capsule or space plane by 2022, and the nation is also eyeing **point-to-point suborbital transportation over the longer haul**. The capsule or mini-shuttle — the latter option may resemble Sierra Nevada's Dream Chaser space plane [http://www.space.com/14446-photos-dream-chaser-space-plane.html]— would each accommodate a crew of three and carry up to 880 pounds (400 kilograms) "

"JAXA is considering two different versions of the capsule, which would have a similar internal volume to SpaceX's Dragon spacecraft. The 15,400-pound (6,985 kg) variant employs parachutes, while the 19,800-pound (8,981 kg) model uses a more maneuverable parafoil for greater landing accuracy to within a 1.9-mile (3 kilometers) radius. The heavier capsule would be able to land on solid ground, while the lighter model would only touch down at sea. JAXA also foresees further development of the capsule for missions beyond low-Earth orbit and ISS, officials said.

JAXA officials presented the human spaceflight concepts at the at the International Astronautical Federation's meeting in Naples, Italy, earlier this month."

Two Robots to join ISS Crew when Koichi Wakata takes command in 2013

http://www.space.com/18841-japanese-space-station-humanoid-robot.html

When Japanese astronaut Koichi Wakata arrives in space in 2013 to take command of the International Space Station, he'll have a little robotic helper ready to assist him. Being designed and built by a consortium of companies, the two robots that speak Japanese, and look like "dolls" will be able to recognize faces and perform simple experiment tasks. One will fly to the space station next year, while the other will stay on the ground as a backup, and for use in trouble-shooting, should problems arise aboard the station.

R: Kibo **L: Robonaut 2 and NASA astronaut**

The newcomer robot will live in the station's Japanese Kibo module. It doesn't even have a name yet, but the public is being asked for suggestions on a Japanese website. The project is capturing the imagination of designers and the public alike.

"Only a few people use phone voice recognition software in Japan because we are uncomfortable to talk to square gadgets. But we sometimes talk to our pets, even if they're a turtle or a fish," said Takahashi, a University of Tokyo researcher who founded the humanoid robot company Robo Garage.

"We talk to these animals because we can feel some kind of life to them that we cannot with the iPhone," Takahashi added. "So what we are doing for the Kibo robot is to encourage people to be willing to communicate with such things."

Scheduled for completion in February, the robot will be "a small humanoid," about 34 cm (13") tall and weigh i kilo (2.2 lbs), making it easy to ship up to the station in the summer, probably in a JAXA HTV.

The robot will do simulated, simple experiments that could involve tasks such as mixing liquids; It could also send information to scientists back on Earth. Future robot generations could work alongside astronauts and improve the humans' accuracy during routine experiments.

The robot was developed after JAXA requested ideas for "solving social issues" on the space station. As the humanoid improves, perhaps it could serve as a companion for lonely astronauts.

Future applications could include serving as a crew member during isolating deep-space missions, or on Earth, accompanying seniors living alone. "It's good at communicating with other machines ... we control so many things with remote controllers."

The robot's development should take more than 18 months. JAXA is providing no money for the concept, Instead, the funding is coming from the consortium of companies, including Toyota, that are working together on the project. The goal of this consortium is not to make money in the short term, but rather in the long term from likely spinoffs of the technology on Earth. -- Our concept of "spin-up!"

> "In "**spin-up**" a private enterprise, motivated by profit, examines a technology needed on the space frontier and endeavors to identify potentially profitable terrestrial applications. It then develops the technology, specifically for those terrestrial applications, with the **consumer** paying the bill. As a result, when the technology is needed on the space frontier, it is already "on-the-shelf," at least in an analogous form in need of relatively inexpensive adaptations only. Taxpayers and consumers are one and the same, but unwilling in the first instance, and willing in the second." www.moonsociety.org/publications/m3glossary.html

Japan to launch 2nd Asteroid Mission - Hayabusa 2 - in 2014

http://www.space.com/19064-japan-asteroid-sample-mission-hayabusa2.html by Leonard David (abridged below)

Japan's space agency JAXA is readying its second asteroid probe for launch in 2014. This follows a successful recovery of the Hayabusa 1 sample canister after a number of mishaps that nearly ended in disaster in its sample-return mission to astro chunch Itokawa - a complicated feat that earned JAXA considerable respect. "Hayabusa" is the Japanese word for "Falcon"

Target asteroid 1999 JU3 - http://en.wikipedia.org/wiki/(162173)_1999_JU3

> "a group of near-Earth asteroids named after 1862 Apollo, the first asteroid of this group to be discovered by Karl Wilhelm Reinmuth. They are Earth-crosser asteroids that have orbital semi-major axes greater than that of the Earth (> 1 AU) and a perihelion distance (q) < 1.017 AU. Some can get very close to the Earth, making them a potential threat to our planet (the closer their semi-major axis is to Earth's, the less eccentricity is needed for the orbits to cross)." "The largest known Apollo asteroid is 1866 Sisyphus, with a diameter of about 10 km." (there is list of "well-known" Apollo asteroids on this Wikipedia page)

Asteroid 1999 JU3 is of particular interest to researchers because it consists of 4.5 billion-year-old material that has been altered very little over time. Measurements taken from Earth suggest that the asteroid's rock may have come into contact with water. A C-type asteroid, the target is expected to contain organic and hydrated minerals, making it different from Itokawa, a rocky S-type asteroid.

Penciled in for launch in 2014, the mission will rely on NASA's Deep Space Network of ground stations to help track the spacecraft which will carry out some challenging firsts before departing the scene at the end of 2019. The craft's return capsule will land in Australia as did its predecessor.

New and novel hardware

JAXA has a reputation for raising pushing the envelope and setting precedents. The probe's configuration is similar to that of Hayabusa 1, but the second probe will carry new and novel asteroid-studying hardware. Instead of a single parabolic dish, Hayabusa2 will sport two flat high-gain antennas to support faster communication speeds than its predecessor. Also, it will have more propulsion power from its ion engines. Also new is a 2 kilograms "collision device" that will create an artificial crater on the asteroid. This "dent" is expected to be small, a few meters across. But it will allow the probe to acquire samples exposed by the crash, supplying fresh less weathered particles.

During the first Hayabusa mission, the probe's MIcro/Nano Experimental Robot Vehicle for Asteroid (MINERVA) failed to reach the asteroid's surface. This probe will carry a new version of the robot, **MINERVA2**."

The German Aerospace Center's (DLR) Institute of Space Systems in Bremen, in collaboration with the French space agency and JAXA. is contributing the Mobile Asteroid Surface Scout asteroid lander, or **MASCOT**. After the probe arrives at asteroid 1999 JU3 in 2018, Mascot will be released from the main spacecraft and "free fall" to the surface. A spring-loaded mechanism will push the 10 kg lander clear of from the probe. Mascot , packed with four separate instruments, will "hop around" across the asteroid's surface, a new feat! The purpose is it to take measurements at different sites. Meanwhile, a radiometer will measure surface temperatures as a camera images the fine surface structure. Controlled from DLR's Microgravity User Support Center in Cologne, Mascot will work on the asteroid for a total of 16 hours, the equivalent of two "days" on asteroid 1999 JU3.

Up close with an asteroid

Close-up photographs of the asteroid surface up to the centimeter-level resolution are expected, something that Hayabusa1 was unable to capture. Experience gained in surface collection and analysis techniques from the first has very useful.

JAXA'z**Long term strategy** "I expect Hayabusa2 to be a success. Then after that, I'd like us to proceed with an inquiry concerning where we came from and how life came about," Fujimura said. "It would be great to uncover the origins of the solar system, Earth, the other planets, and life itself by getting information that we can't obtain here on Earth. I'd like us to open up new lines of scientific inquiry that seek to discover these origins." ###

Is Russia's Space Industry becoming "non-competitive?"

http://www.msnbc.msn.com/id/49217472/ns/technology_and_science-space/#.UIQCZ1F5nzI

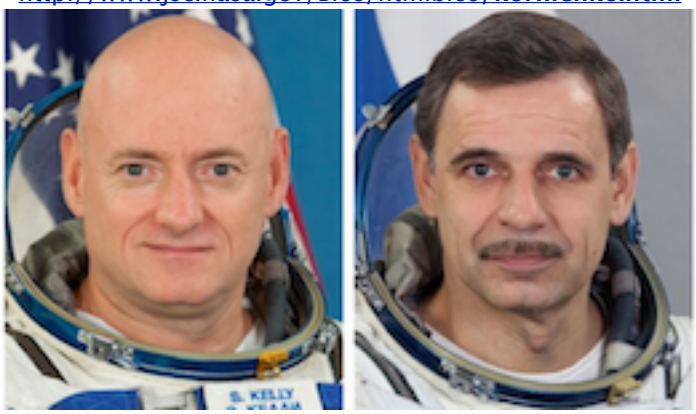
Veteran Russian Space expert James Oberg writes: "Perhaps telling the truth is catching on in Moscow, but perhaps it's already almost too late to save the Russian space industry. Over the past two years, program leadership has appeared powerless to stop a series of embarrassing failures in spacecraft launchings and flight operations that have cast the future of the entire program in doubt."

Such worries and complaints received major attention when "At the traditional Russian post-landing press conference on Sept. 21, cosmonaut Gennady Padalka complained about the 'spartan' conditions aboard the Russian side of the [International Space] station." The reaction has been a wave of similar complaints about many other parts of the Russian Space Program and the industries that support it. There has been a long wave of launch failures in recent years, of which the most embarrassing has been the Phobos-Grunt mission, in which not only the Russian Phobos probe was lost, but China's Mars orbiter, Yinghuo-1, as well. The launch failure in June 21, 2005 of the Planetary Society's Cosmos-1 Solar Sail was also quite embarrassing. This decline of the once great Soviet space program seems to mirror a general overall decline in Russian industry and economy. While communism may be gone, some of the old ways of doing business are not.

Perhaps, the embarrassing publicity will reach a point where real reforms are introduced top-to-bottom in all sectors of the Russian space economy. Perhaps if the Russian government allowed non-Russian firms to bid on space contracts, that would strongly motivate the across the board changes long overdue. Meanwhile, at stake is the planned **EXO-Mars** ESA-Roscosmos collaboration, as well as the ISRO-Roscosmos **Chandrayaan-2** mission. ##

US Astronaut, Russian Cosmonaut picked for one-year mission on ISS

http://www.space.com/18616-**astronauts-one-year-space-mission**.html
http://www.space.com/17924-**year-long-space-station-mission**-2015.html
http://www.nasa.gov/home/hqnews/2012/nov/HQ_12-406_**ISS_1-Year_Crew**.html
http://www.jsc.nasa.gov/Bios/htmlbios/**kornienko.html**



R: Scott Kelly **L:** Mikhail Kornienko

(Scott Kelley is the identical twin of retired astronaut Mark Kelley)

A veteran NASA space commander and Russian cosmonaut have signed on for the ultimate space voyage: a yearlong trip on the International Space Station.]

http://www.space.com/18959-**iss-yearlong-missions-health-challenges.html**
http://www.huffingtonpost.com/2012/10/07/**one-year-iss-mission-2015-deep-space**_n_1946198.html

"This mission will double the duration of a typical orbital stay. These long-term missions will be sending astronauts into largely uncharted territory, and some of the biggest unknowns are how the human mind and body will react to that much time in space."

Weightlessness wreaks havoc on the body, with astronauts losing muscle mass and bone density, and even suffering eyesight degredation, after spending time in space. This mission, double the usual length, will help define the problem, and may suggest remedies.

The 2015 space station flight by American Scott Kelly and Russian Mikhail Kornienko will be the longest mission at the International Space Station, but not the longest continuous spaceflight. That record is held by cosmonaut Valery Polyakov, who lived aboard Russia's Mir space station from January 1994 until March 1995, ultimately spending 438 consecutive days in orbit, two and a half months longer than a year.

The goal is better understanding of how the human body adapts to extremely long space missions, such as voyages to an asteroid or Mars.

Kelly and Kornienko will begin their stint in spring 2015 and return to Earth in spring 2016. They will begin their mission training in early 2013.

About Mikhail Kornienko: http://en.wikipedia.org/wiki/Mikhail_Korniyenko

About Scott Kelly: http://en.wikipedia.org/wiki/Scott_Kelly_(astronaut)

Russian Proton Rocket Launch Failure

http://www.space.com/18824-**russian-proton-rocket-launch-failur**e.html
http://www.space.com/18935-**russian-proton-rocket-failure-investigation**.html

9 December 2012 PARIS—The Breeze-M upper stage of Russia's Proton heavy-lift rocket on Dec. 9 failed for the third time in 16 months. The engine shut down some four minutes early during its fourth and final burn. Launch-service provider International Launch Services (ILS) and Russia's Roscosmos space agency said that the 4.5 tonne Gazprom Space Systems' Yamal 402 telecommunications satellite, built by Thales Alenia Space of France and Italy, reached a too-low orbit. The intended orbit is inclined 9 degrees relative to the equator, with an apogee of 35,696 km and a perigee of 7,470 km. Instead the satellite was left in an orbit inclined 26 degrees to the equator, with an apogee of 35,678 km and a perigee of 3,095 km.

As this failure bears little resemblance to the other two failures, it will reinforce a decision by Proton's manufacturer to perform a top-to-bottom assessment of Breeze-M, according to officials with International Launch Services (ILS), which markets Proton launch services. Yamal 402 was

Repercussions for upcoming launch of Mexican Satellite

On 14 December, ILS said that the **Satelites Mexicanos (Satmex)** C- and Ku-band Satmex 8 satellite launch is likely to be delayed due to the **ILS** Proton Breeze M glitch. The Satmex 8 satellite had arrived at Baikonur Cosmodrome in Kazakhstan, where Proton is launched, on 29 November to prepare for a 28 December launch.

Korea Aerospace Research Institute

South Korea postpones first satellite launch once again



South Korea's to take off on November 26th

South Korea aims to **join the ranks of spacefaring nations** by blasting a small test satellite atop its Korea Space Launch Vehicle-1 rocket, or KSLV-1, from the Naro Space Center – in Goheung County, South Jeolla operated by the state-run Korea Aerospace Research Institute. about 485 km (300 mi) south of Seoul

29 November 2012 – The launch of the Naro-1 rocket was suspended minutes before takeoff at a launch site on the country's southern coast. An inspection found problems with the electronic signal in part of the rocket's mechanism. Additional time is needed to find out the reason behind the problem.

KARI states that a successful launch of its own satellite into orbit would be a crucial step for the development of the country's civilian space program. The satellite carried by the launch vehicle is mainly intended for gathering climate data. – **KARI will try again, January 26th, 2013.**

North Korea succeeds in launching its first satellite

Meanwhile, on 12 November, 2012 North Korea successfully launched its first satellite.

http://www.guardian.co.uk/world/2012/dec/12/north-korea-launches-rocket

http://online.wsj.com/article/SB10001424127887324024004578174000078592218.html



The rocket appeared to travel the entire distance of a projected course and to put an object into orbit, making it the most successful of the country's five attempts at testing long-range missile technology. The rocket took off shortly before 10 a.m. local time, flew south over the Yellow Sea, East China Sea and the Philippines, according to Japanese military authorities.

There is some indication that Iran, which had purchased North Korean rocket technology, had sent observers to watch the launch. ###

Iran to unveil home-made satellite in February

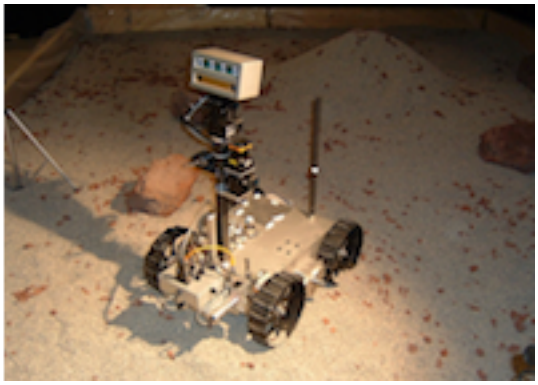
http://news.xinhuanet.com/english/world/2012-12/23/c_132058555.htm

A new domestically-manufactured satellite, named the **Nahid**, will be unveiled on Feb. 2, 2013, Iran's National Space Technology Day. Also the **Fajr** (Dawn) and **Sharifsat** satellites will be sent into space by March 20, end of Islamic year. On that day the **Iman Khomani Spaceport** will begin launching domestically made satellites into space.

Canada Unveils Lunar Exploration Robotic Rovers







VIDEOS: http://www.youtube.com/watch?v=SePPVZw7EC4&feature=player_embedded
http://www.cbc.ca/news/canada/montreal/story/2012/10/19/quebec-canada-space-agency-juno-rover.html
http://www.spacesafetymagazine.com/2012/10/22/canadian-space-agency-unveils-rover-fleet/

19 October, 2012 - Canadian Space Agency (CSA) Announces New Fleet Of Rovers Developed Under Exploration Science Mobility Project; Lunar Exploration Light Rover Mobile Lunar Lab With Sample Scoop Is Largest & Fastest / Upgradeable For Human Transport; Kapvik Micro-Rover Aids Humans By Doing Light Labor;

The rovers are the result of a 2009 $110 million 3 year project to advance robotics and space exploration technologies. NASA has expressed interest in the rovers, from small vehicles designed to work along side astronauts to large vehicles closer to the mini-Cooper sized Curiosity rover now on Mars. The one depicted at lower left is Juno, capable of traversing almost any kind of territory, even transforming its tank like treads into other shapes where appropriate. This effort continues Canada's tradition of excellence in robotics, as previously demonstrated by the Canadarm and Canadarm 2 "Dextre" semi robotic arms and grapplers attached to the International Space Station.


Canadian Chris Hadfield to Command International Space Station

http://www.jsc.nasa.gov/Bios/htmlbios/**hadfield**.html

Born August 29, 1959, in Sarnia, and raised on a corn farm in Milton, Ontario. Hadfield became interested in flying from a young age. As an Air Cadet, he won a glider pilot scholarship at age 15 and a powered pilot scholarship at age 16. He also taught skiing and ski racing, part and full time, for 10 years. For more, see the linked page above.

21 December 2012: Canadian Space Agency Astronaut Chris Hadfield, Roscosmos Cosmonaut Roman Romanenko and NASA Astronaut Tom Marshburn will begin their 5 month stay until they depart 14 May, 2013. The current ISS crew, Kevin Ford, Oleg Novitskiy and Evgeny Tarelkin are scheduled to depart March, 2013, marking the start of Expedition 35. One day prior to his trip back home, Commander Ford will formally welcome Hadfield as the 1st Canada Commander of the ISS. Hadfield is also the **1st Canadian to fly as a Mission Specialist, walk in space, operate Canadarm in orbit** and is the **only Canadian to board the Russian Space Station Mir.**

A related story: http://www.space.com/19212-**astronaut-hadfield-celebrity-canada**.html

South Africa progressing with MeerKat array core of SKA

Kat-7: http://www.ska.ac.za/meerkat/kat7.php
http://www.ska.ac.za/media/kat7.php

MeerKat-7 http://www.ska.ac.za/meerkat/index.php
http://www.ska.ac.za/media/meerkat.php

http://www.ska.ac.za/meerkat/specsci.php
http://www.ska.ac.za/learn/index.php

SKA http://www.ska.ac.za/about/project.php
http://www.ska.ac.za/media/africasite.php

http://www.ska.ac.za/about/bid.php
http://www.ska.ac.za/newsletter/index.php

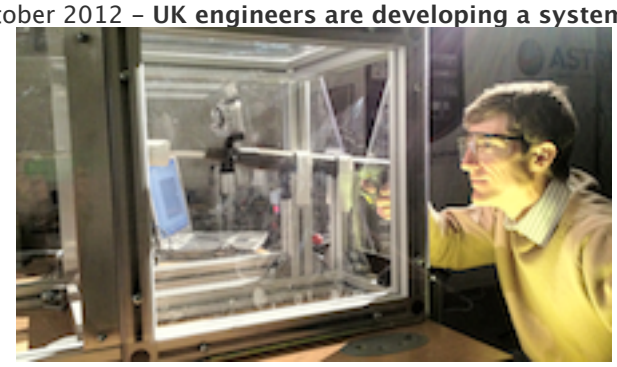
http://www.ska.ac.za/qa/index.php
http://www.ska.ac.za/education/index.php

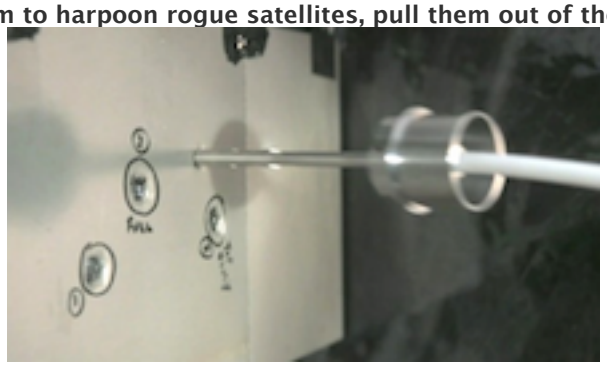
South African SKA extends northwards

UK engineers developing system to Harpoon Rogue Satellites

http://www.bbc.co.uk/news/science-environment-19803461

2 October 2012 – **UK engineers are developing a system to harpoon rogue satellites, pull them out of the sky.**



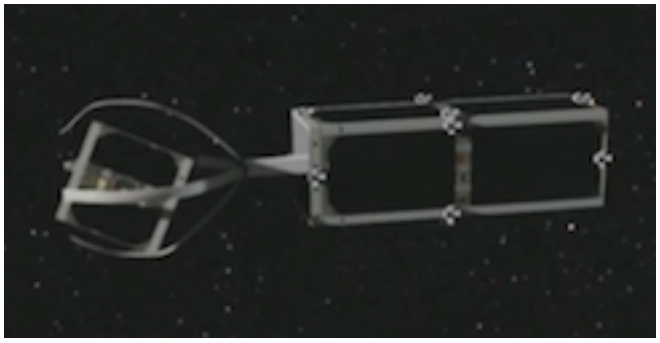


Editor: Space engineers everywhere are beginning to tackle the out-of-control growth of space debris – orbital junk, dead satellites, large chunks of satellites already involved in a collision – all of this endangering intact satellites, functional and out-of-service alike. Not to do so could lead to humans being locked on Earth, barred from access to space by a debris shield of our own careless making.

Story: "**The harpoon would be fired at the hapless satellite from close range.** A propulsion pack tethered to the projectile would then pull the junk downwards, to burn up in the atmosphere.

Space has become a critical part of our infrastructure – weather forecasting and Earth observation, to GPS and telecommunications" satellites have become a critical component of our civilization. The cascading debris problem threatens all this.

The harpoon system is one of several now being developed to make a dent in the problem. Its designer is Dr. Jaime Reed, from Astrium UK – http://www.astrium.eads.net



Left: Orbits of half a million pieces of debris **Right:** a Swiss designed "grappler"

Related articles:

http://www.space.com/15178-space-junk-removal-spade.html
http://www.space.com/9708-worst-space-debris-events-time.html
http://www.space.com/12860-photos-space-debris-images-cleanup-concepts.html
http://www.space.com/8334-junk-space.html

Related Videos:

Swiss "grappler" http://www.bbc.co.uk/news/science-environment-17068279
http://www.youtube.com/watch?v=4CJfEKoZKWc
http://www.youtube.com/watch?v=BxG0f2Z5eTc
http://www.youtube.com/watch?v=oM_J7nRjxi0
http://www.youtube.com/watch?v=fj4EB5u-omY

Editor's Comments:

Some of the "remediation" methods and devices being proposed, deserve an A for effort and a flunking grade for common sense. For example, the Swiss "grappler" would remove just one item, propelling it into a descent trajectory that will not only burn up the derelict satellite but the grappler too. Clearly we need devices that could remove one piece of junk at a time, but remain in service, removing dozens, hundreds, in its service life time.

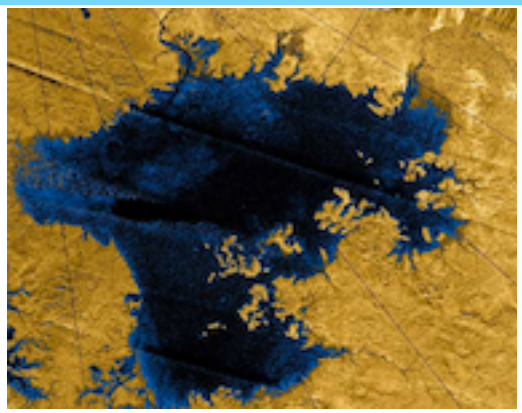
Strategy is essential here; Removing dead useless satellites is important. The priority is pretty much a matter of the odds that that piece of debris will sooner or latter be involved in a collision that will elevate the problem. The bigger the satellite, the more the risk of it being on a collision course with some other sizable item. The orbit it is in must also be considered in setting priorities. Some orbits are more crowded than others, or intersect with other crowded orbits. We need to design satellite "removers" which can "remove" one derelict object after another.

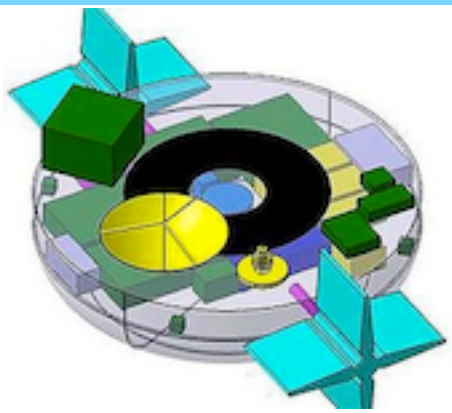
Making near space safe for transit through it for deep space missions is #1 priority, over Moon, over Mars, etc.

Elsewhere in the World

European Space Agency

Spanish partnership hopes ESA considers Titan Boat project that NASA declined





http://earthsky.org/space/if-i-had-a-boat-id-sail-it-on-titans-seas

Ligeia Mare, above (http://en.wikipedia.org/wiki/Ligeia_Mare) is a lake in the north polar region of Titan, Saturn's largest moon. Larger than Lake Superior on Earth, it is composed of liquid hydrocarbons (mainly methane and ethane). It is roughly 420 km by 350 km across, has a surface area of 126,000 km^2, and a shoreline over 2000 km (1240 mi) in length.[2] It is named after Ligeia, a siren in Greek mythology. The Lake is shallow, only a few meters deep.

Right: a design for the proposed shallow draft "boat" or floation device with a pair of paddlewheels for porpulsion and steering

Spanish Talise mission (proposal to ESA)

On September 27, 2012, Spanish engineers presenting to the European Planetary Science Congress in Madrid proposed to send a boat to Titan.

NASA Drops the ball.

"In August 2012, NASA passed over an idea to land a craft in the seas of Titan. Last week (27 September 2012), Spanish engineers announced their concept for a boat to sail Titan's seas."

"The Spanish company Grupo Sener – a private engineering and technology group founded in 1956 – and the Centro de Astrobiología in Madrid, Spain formed a partnership to study the **TALISE** concept. They presented their proposal last week at the European Planetary Science Congress in Madrid.

"They say the mission concept is the result of a Phase 0 study, meaning it's not very far past the concept phase at this time. Future phases include a feasibility study and the development of preliminary mission architecture. You have to start somewhere, and if NASA isn't going to Titan, someone should."

ESA's cluster quartet of satellites finds Solar Wind is "swirly"

http://www.esa.int/Our_Activities/Space_Science/**The_solar_wind_is_swirly**

18 December 2012 – **I**n a new study, two of ESA's four Cluster satellites have made extremely detailed observations of plasma turbulence in the solar wind. They were separated by just 20 km along the direction of the plasma flow and operated in 'burst mode' to take 450 measurements per second. By comparing the results with computer simulations, scientists confirmed the existence of sheets of electric current just 20 km across, on the borders of turbulent swirls, indicating that the solar wind plasma is extremely structured at this high resolution

Editor's question: How will this turbulence affect unmanned (and someday manned) spacecraft passing through the solar wind, on trajectories that take the craft closer to the Sun (bound for Venus, Mercury, or jus to observe the Sun or to gain a boost in velocity by a close pass by one of the inner planets?

ESA inaugurates 3rd 35m deep-space tracking antenna in Argentina

http://thewatchers.adorraeli.com/2012/12/19/**first-data-acquired-by-new-esas-deep-space-tracking-station**/

19 December 2012: The European SpaceAgency's new deep-space tracking station (DSA 3) in Malargüe, Argentina received its first image on December 18, 2012. The image of Mars above, was captured on December 15, 2012 by the Visual Monitoring Camera on the Mars orbiter and travelled 327 million kilometres in just over 18 minutes, and was selected as the symbolic 'first data' to be downloaded by DSA 3 and it marked its inauguration to service.

The station's 610-tonne, 35 m-diameter dish antenna was turne on by Cristina Fernández de Kirchner, President of the Republic of Argentina, via remote link from her office in the Casa Rosada presidential palace.

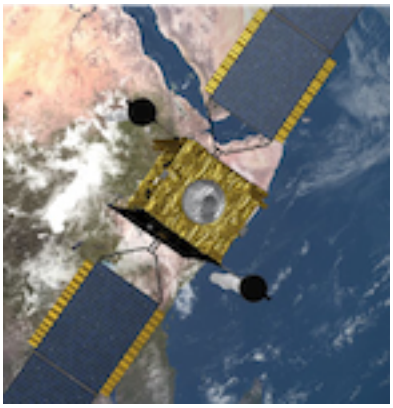
Once in regular service early in 2013, Malargüe station will support ESA science missions such as Mars Express, Venus Express, Rosetta and, in the future, Gaia, BepiColombo, ExoMars, Solar Orbiter, Euclid and Juice.

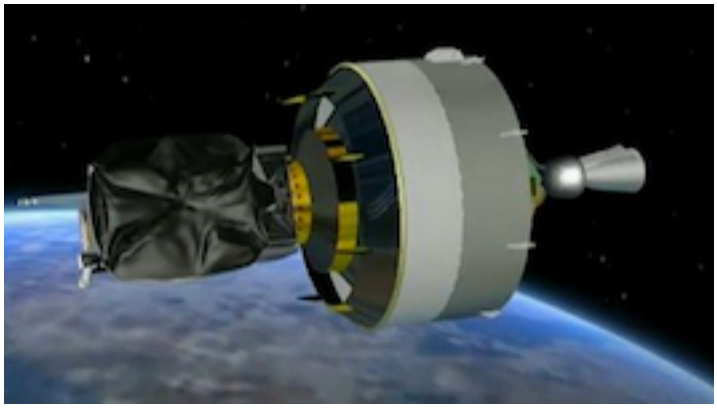
The agreement to build \the station was signed with Argentina on November 16, 2009. In exchange, ESA will make available to Argentina 10% of the antenna time for their national scientific projects in space. The inauguration of Malargüe marks the completion of the Agency's trio of deep-space antenna stations as part of the Estrack network.

ESA Ariane 5 launches British and Mexican Satellites

http://www.space.com/19014-**ariane-5-launch-british-mexican-satellites**.html

20 December 2012 PARIS — Europe's Ariane 5 ECA heavy-lift rocket successfully launched telecommunications satellites for use by the British (**Skynet 5D)** and Mexican (**Mexsat** Bicentenario**)** governments on the heavy-lift Ariane 5 launcher's 53 consecutive successful mission. Ariane 5 has now gone 10 years without a failure.





Left: Skynet 5D **Right:** Mexsat Bicentenario

The Skynet 5D, built by Astrium Satellites under a contract with sister company Astrium Services, will be tested in orbit at 25 degrees east before moving to its operating slot at 53 degrees east in geostationary orbit.

The 4,800-kilogram Skynet 5D is the fourth, and likely the last, Skynet 5 satellite ordered under a 20-year partnership between the British Defence Ministry and Astrium Services. The contract runs to 2022, after which the ownership of the Skynet satellites will transfer to the British government, which will then likely organize a fresh competition for satellite services.

Astrium Services provides Skynet bandwidth to NATO and individual NATO governments in addition to its guaranteed service to British defense forces

More on Skynet 5D http://en.wikipedia.org/wiki/Skynet_5D

More on Mexsat Bicentenario

http://finance.yahoo.com/news/boeing-orbital-sciences-corporation-mexsat-233401495.html

www.satellitetoday.com/st/headlines/Mexsat-Bicentenario-Satellite-Sends-First-Signals-from-Space_40301.html

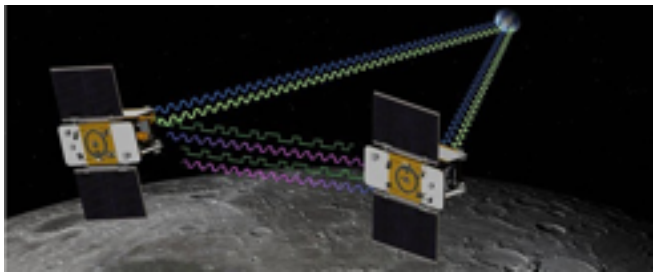
Peru working on New Satellite – Chasqui II

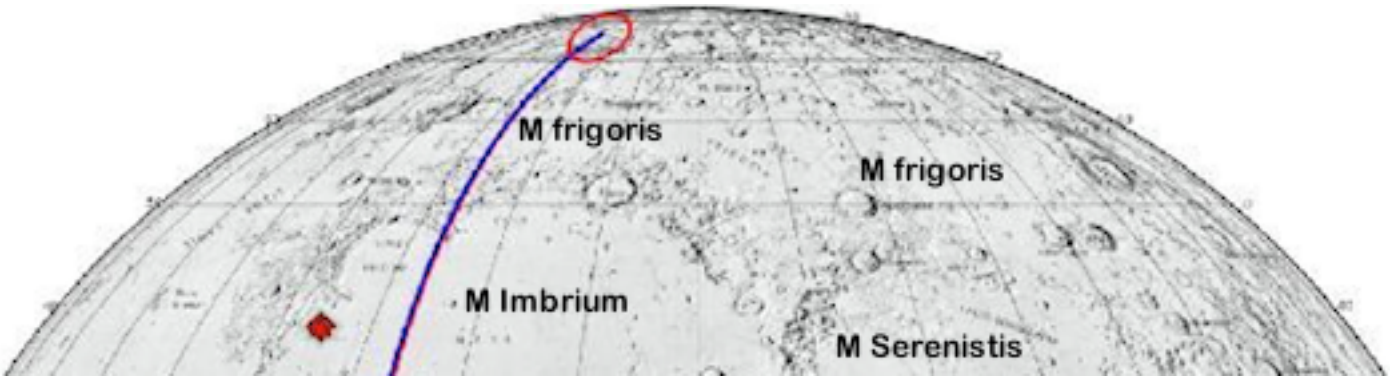
http://peru21.pe/2012/01/21/tecnologia/uni-prepara-nuevo-satelite-peruano-2008460

UNI · Universidad Nacional de Ingenieria (Spanish: National University of Engineering) is working on a new satellite, Chasqui II ("Messenger" or "Courier"). I A microsatellite, weighing between 25 and 30 kilos, it will be designed to monitor deforestation and natural disasters. It is scheduled to be launched into orbit in early 2014 with technical and scientific support of Russia (Roscosmos).

United States (America) NASA National Aeronautics and Space Administration

Grail Probe finishes Mapping Moon Interior, slams into surface Dec. 17





http://www.space.com/18928-nasa-grail-moon-crash-watch-live.html

Two NASA moon probes slammed into the rim of a lunar crater December 17, and the space agency gave viewers a behind-the-scenes look at the dramatic action. The twin Grail spacecraft, known as Ebb and Flow, were intentionally near the moon's north pole, bringing their gravity-mapping mission to a spectacular close. – Average crust thickness of Lunar crust appears to be 30km, half of previous estimate. – **http://rt.com/news/nasa-science-moon-crust-278/**

Video animation of last orbit – www.space.com/18896-**death-dive-for-twin-moon-craft-flight-path-video**.html

- We hope to have a eport on the science results of the Grail mission in next issue.

Breakthrough Demonstration of 3D Printing With Moon Rocks

Washington State University engineers have 3D-printed some simple-shaped objects using a simulant of lunar regolith, a mixture of loose dust, rock, and soil that covers solid bedrock.

http://www.3ders.org/articles/20121129-**wsu-researchers-3d-prints-parts-from-moon-rocks**.html

http://tinyurl.com/ceobzum - http://en.wikipedia.org/wiki/**Lunar_regolith_simulant**

VIDEO: http://www.youtube.com/watch?v=SFQFCeAas34&feature=player_embedded

http://en.wikipedia.org/wiki/**Rapid_prototyping**

http://www.msoe.edu/academics/research_centers/**rpc**/ - http://www.**rpc**.msoe.edu

Related Searches: "3D Printing" - "Rapid Prototyping" - "Additive Manufacturing"

Some NASA scientists envision astronauts making whatever they need out local materials on Mars or the Moon via 3D printing. While technology from organizations like Contour Crafting has made this theoretically possible, now, Washington State University engineers have actually used moon rocks to print some simple-shaped objects.

Real Moon rocks in storage here on Earth are too rare and precious to make available for experiments except in minute amounts, typically, much less than a thimbleful. Researchers are limited to imitation Moon rock called **lunar imulant**. Regolith (moon dust) is a mixture of loose dust, rock, and soil that covers solid bedrock on Earth, as well as other planets, the Moon, and some asteroids. The simulant is formulated to approximate the real lunar regolith's chemical and mineral properties.

The WSU team used 10 lb of one version containing silicon, aluminum, calcium, iron, and magnesium oxides.

Some NASA scientists envision astronauts making whatever they need out of local materials on Mars or the Moon via 3D printing. While technology from organizations like Contour Crafting has made this theoretically possible, now, Washington State University (WSU) engineers have actually used moon rocks to print some simple-shaped objects -- on Earth.

Lunar Simulant & parts made by 3D Printing

There are several versions of simulant: http://en.wikipedia.org/wiki/Lunar_regolith_simulant The very first was **MLS-1** (**Minnesota Lunar Simulant 1**): a lunar simulant that was developed at the University of Minnesota. The basaltic rock used in this simulant was mined from a quarry in Duluth, Minnesota. It contains plagioclase, olivine, pyroxene and ilmenite as some of its major minerals. The minerals and grain sizes resemble the chemistry of the Apollo 11 mare material (specifically soil sample 10084)

In the summer of 1987, in a visit to the University of Minnesota Lab where the simulant was produced from solid rock quarried from the rare Titanium rich basalt found in Duluth Minnesota, the editor acquired a few ounces of MSL-1 powder, as well as an 8 pound solid basalt rock sample, of which about half remains after chipping off samples to give to other National Space Society and Moon Society chapter leaders. **PK**

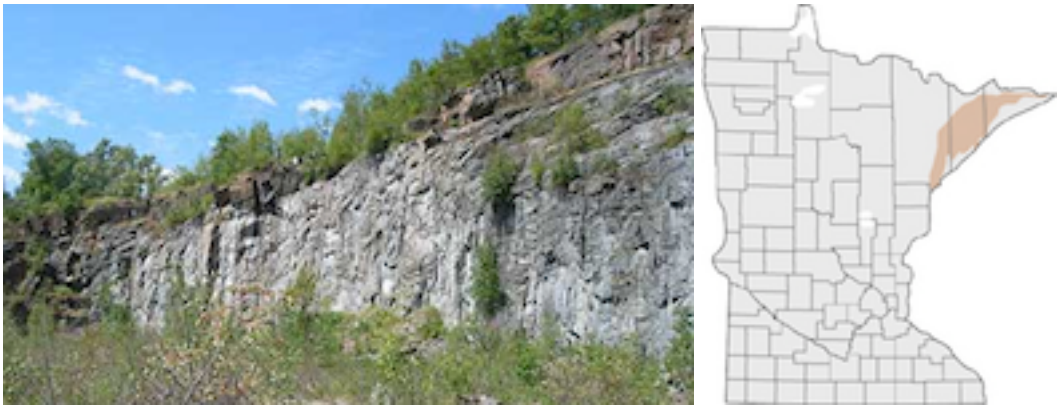


Photo of Quarry site above along with Map showing the extent of this basalt resource in NE Minnesota

Minnesota Lunar Simulant source: http://www.hutchk12.org/geo/mngeo/page21.html (page 2)

Nowadays, NASA tries to simulate moondust that is not Titanium enriched as is that from the Apollo 11 site.

These are exciting developments:

- 3D Printers are relatively lightweight, thus much cheaper to land on the Moon's surface than regular manufacturing equipment.
- Producing items needed in small quantities (or replacements of parts already shipped from Earth) by this means would be vastly cheaper than shipping replacements from Earth
- 3D Printing on the Moon would put people on the Moon in charge of making product design improvements

3D Printers will not always be the way to go:

- In the early period where the numbers of people on the Moon are relatively low, 3D printing of low wight (mass) parts needed in small numbers will be the cheapest way to go.
- But many items needed on the Moon may have parts too big to be produced by 3D printing
- As the number of people on the Moon and the number of items they need continue to grow, there will be a time when, depending on the individual item mass, it will be cheaper to have regular production equipment in place on the Moon

More on 3D Printing – Rapid Prototyping – Additive Manufacturing

Rapid Prototyping (RP) can be defined as a group of techniques used to quickly fabricate a scale model of a part or assembly using three-dimensional computer aided design (CAD) data. What is commonly considered to be the first RP technique, Stereolithography, was developed by 3D Systems of Valencia, CA, USA. The company was founded in 1986, and since then, a number of different RP techniques have become available.

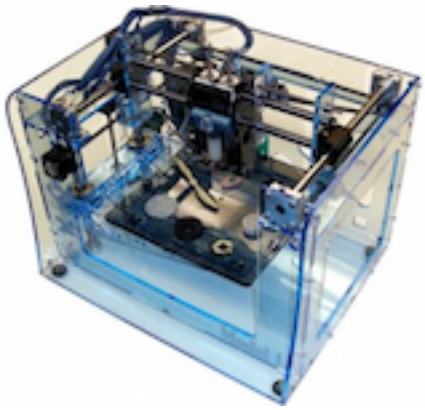
Rapid Prototyping has also been referred to as solid free-form manufacturing, computer automated manufacturing, and layered manufacturing. RP has obvious use as a vehicle for visualization. In addition, RP models can be used for testing, such as when an airfoil shape is put into a wind tunnel. RP models can be used to create male models for tooling, such as silicone rubber molds and investment casts. In some cases, the RP part can be the final part, but typically the RP material is not strong or accurate enough. When the RP material is suitable, highly convoluted shapes (including parts nested within parts) can be produced because of the nature of RP.

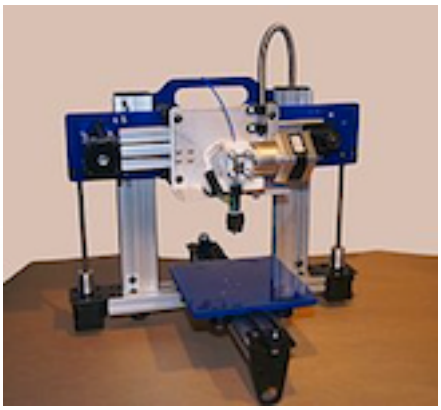
Rapid Prototyping decreases development time by allowing corrections to a product to be made early in the process. By giving engineering, manufacturing, marketing, and purchasing departments a look at the product early in the design process, mistakes can be corrected and changes can be made before commitment to mass production. The trends in manufacturing industries continue to emphasize increasing the number of variants of products and their complexity, while increasing product lifetime before obsolescence and decreasing delivery time.

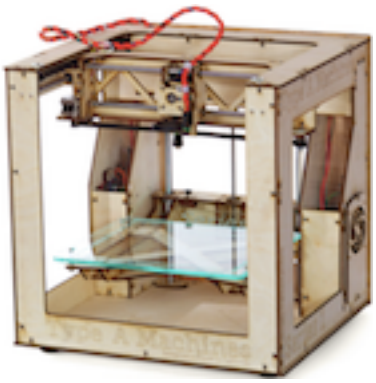
Additive Manufacturing – Laser Sintering Systems build complex parts directly from CAD data files using a variety of plastic or metal materials, fusing them into a solid part by melting it with a laser beam.

The number of people experimenting with 3D printing is increasing as the price of hobby 2D printers continues to go down. There are many "hobby" 3D Printer machines available. Equipment being used in university labs and in manufacturing company laboratories is likely to much larger and more elaborate and multi-featured.

Some Images of 3D Printers





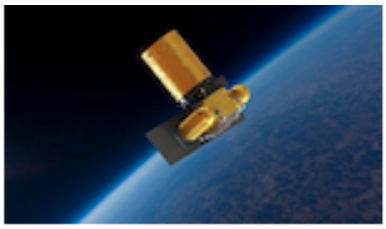


Editor's Action Item: We have put a visit to the Rapid Prototyping Labs at MSOE (Milwaukee School Of Engineering) and at UWM (University of Wisconsin Milwaukee) Rapid Prototyping Lab) here (in the editor's home town of Milwaukee, Wisconsin, US) high on our personal agenda, so that we can more intelligently report on the significance of this "industrial revolution" for the future of Lunar settlement and development. M3IQ co-editor David Dunlop will be accompanying me, as he has already visited the facility at MSOE. ###

P.S.The same scenarios apply to Mars; imagine if you will the first human crew arriving on Mars to find piles of equipment ready to use, of the parts to make them, all made in advance by 3D Printers!

US COMMERCIAL COMPANIES

Asteroid Mining Mission Revealed by Planetary Resources, Inc.



http://www.youtube.com/watch?v=zXXJtSZffVg - VIDEO WEB - http://www.planetaryresources.com

PRESS RELEASE http://www.youtube.com/watch?v=s15PeKzmcU4&list=PL96FC1A30D88E0638&feature=plpp_play_all

www.newspacejournal.com/2012/04/24/**planetary-resources-seeks-to-mine-asteroids-and-develop-propellant-depots**/

Seattle-based Planetary Resources plans to mine asteroids, eventually.

- First will come an incremental **series of robotic missions in Earth orbit and beyond** to get there.
- Once they're ready to start mining, **the first resources they're interested in are not precious metals but instead volatile compounds like water that can be used for propellant depots.** wt
- These depots will enable a wide range of commercial and government missions. In short, they're initially more oil drillers than ore miners.

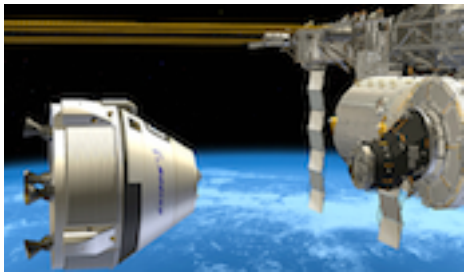
Sound too good to be true? This is an extremely bold plan, but has a lot of money behind it. We'll just have to wait and see what develops. Read the whole plan (last link above.)

NASA contracts awarded Space-X, Sierra Nevada, Boeing

Private Spaceship Builders Split $30 Million in NASA Funds

http://www.space.com/18842-**private-spaceships-nasa-certification-contracts**.html





Above: Space-X **Dragon,** Sierra Nevada **Dream Chaser**, Boeing **CST-100** at ISS

10 December 2012 NASA has awarded $30 million to help three private companies ensure that their astronaut taxis are safe and reliable, agency officials announced.

Boeing, SpaceX and Sierra Nevada Corp. will each receive about $10 million to begin certifying that their respective private spaceflight systems meet NASA requirements for ferrying crews to and from the International Space Station. A final contract in this process — the certification products contracts, or CPC — will be awarded in the future.

The effort will bring space system designs within NASA's safety and performance expectations for future flights to the International Space Station."

- Colorado-based Sierra Nevada got $10 million to continue work on its Dream Chaser space plane.
- Texas-based Boeing got $10 million for its CST-100 capsule
- SpaceX in Hawthorne, California, received $10 million to upgrade its unmanned Dragon capsule to carry crew.

NASA hopes at least one of these vehicles will be ready to carry astronauts to low-Earth orbit by 2017. The United States has lacked manned access to the station since NASA's space shuttle fleet retired in July 2011; it currently relies on Russian Soyuz spacecraft to do the job.

CPC Phase 1 runs from Jan. 22, 2013 through May 30, 2014, During this period, the three companies will work with the Commercial Crew Program on certification plans to implement NASA's safety and performance requirements across all aspects of the transportation system, from spacecraft to launch vehicle and ground operations.

CPC Phase 2,to begin in mid-2014, will include final development and verifications needed fo manned test flights to the space station. This second contract phase will involve a full and open competition.

This is the latest in a series of commercial crew awards granted by NASA. In 2010, the agency granted a total of $50 million to five companies. Sierra Nevada and SpaceX split $315 million in 2011 and $1.1 billion in another round of awards announced this past August. - Above report abridged. ###

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ARTICLES AND REPORTS OF INTEREST TO THE SPACE COMMUNITY IN INDIA AND ELSEWHERE

THE book WORM

Mars Beckons India: The Story Of India's Mission To Mars

Author: Srinivas Laxman – moonshotindia@gmail.com

Synopsis ---- as published in the book.

"India is slated to launch an unmanned mission to Mars provisionally between October-November 2013, and currently preparations are in full swing for this flight at various ISRO centres.

"The nearly Rs 425-crore project was approved by the Union Cabinet on 3 August 2012 and was announced by Prime Minister, Dr.Manmohan Singh, in his Independence day address.

"The book is basically an exercise in public outreach about the mission and attempts to explain to the reader the significance of the project. It contains interviews with some of the key personnel connected with this programme and highlights the excitement and enthusiasm among the scientists to launch the mission.

"It also touches upon the history of the Red Planet, though briefly, explains why space-faring nations like the US, Russia, China and Japan are vying with each other to launch missions to Mars and talks about some of them."

New Science Books in English or Hindi available through Vigyan Prasar Science Portal
"For anything and everything on science from India"
http://www.vigyanprasar.gov.in/Publication/new%20arrivals_n.asp

Summary of my Interview of Devi Prasad Karnik, Supervisor Publicity & Public Relations Dept., ISRO

By Paul Sudakhar

India is a fast growing and vibrant young nation. It is also one of the few major spacefaring nations of the world. Since its establishment in 1969, ISRO (Indian Space Research Organization) has come through several ups and downs and crossed several milestones in its course. With a powerful management and dedicated scientists' ever ceasing work, ISRO has helped India to keep up with the rest of the countries in the space race.

ISRO succeeded in developing its own range of indigenous launch vehicles like SLV, ASLV, PSLV, GSLV and GSLV III or MARK III*. Keeping this tremendous achievement aside, if we look at the structure of Indian space program once, we'll find that, unlike those of other developed nations, India's goals are simple and purposive. Till date, **ISRO mainly concentrated on developing space technology which can help the nation to improve the facilities for, and standards of its people.**

ISRO created some series of satellites like INSAT, GSAT, IRS and RISAT and successfully launched them into orbit(s). Almost all of them are serving the nation's advance in remote sensing, meteorology, telecommunications, healthcare, education etc.

With the changing world, Indian space program too is changing. While the emphasis on using space technology for National interests is still continued, ISRO is making its room bigger for more space projects with goals much bigger and momentous. The prestigious CHANDRAYAAN program demonstrated this change clearly. The Moon Mineralogy Mapper carried aboard in the Chandrayaan confirmed the existence of ice in the polar caps of moon and traces of water in the inner layers of lunar regolith. With projects of this kind, Indian Space Program is contributing for International collaboration in Space Exploration by sharing its research results with others.

Though ISRO is advancing in all technical, technological and scientific aspects, it's a bit less concentrated in education and outreach programmes. Less attention is paid about this issue so far. There are various reasons for not concentrating on this particular section;

- First is the budget allocation. India is a growing economy. It has many issues to cover up and hence is unable to give enough grants to additional aspects of the space program.
- Second comes the lack of amendments. At first when the indian space program started, it might not have been so **necessary** to include the Education and Outreach department. But in the course of time, many things changed. Education system in India has improved with global standards and is now competing with the rest of world. So, it is important that ISRO's education programs should be able to match with the current education system in Inida
- We should not forget that, youth and in particular students are the asset of any nation. India has a vast young power. It is ISRO's responsibility to inspire and encourage that youth towards space exploration.

I've discussed this issue with Devi Prasad Karnik, director - Publications and Public Relations Department, ISRO. He explained me the various educational programs taken up by ISRO.

ISRO has been conducting open days on special occasions when students from many schools visit ISRO's research facilities. That's a good way of attracting the attention of students towards space programs.

Apart from open days, ISRO is conducting regional campaigns and national level outreach programs. one example of such programs is the water rockets program conducted in various schools in Mumbai, Delhi etc. It's a really exciting event. A Team of scientists from ISRO goes to schools and conduct a 2 day camp.On the first day, They organize interactive sessions, in which students ask scientists, all their questions about space and other sciences. They even organize some sessions for teachers. And on the 2nd day of the camp, they teach the students how to prepare water rockets and then help students prepare their own water rockets. they'll test those water rockets built by students. This is a really interesting way of creating awareness among students.

Other educational activities of ISRO include encouraging students in academics by giving the top scores - awards and a chance to visit the regional research facilities. ISRO has also prepared some promotional stuff for students with inspiring and informative posters about the Indian space program and various satellites and launch vehicles.

I suggest that we rephrase this net paragraph. (First, ISRO's education and outreach profile could be more exciting in my opinion if it had an individual department working on Education and Outreach activities. Second ISRO educational activities are mostly confined to the urban centers. and this also could be addressed by an individual department with increased resources

Despite all these, ISRO's education and outreach profile is so dull. The main reason is lack of an individual department in ISRO for Education and Outreach activities. Secondly, uneven projection. Most of the ISRO's activities are confined to the urban regions. This can be overcome by setting up an individual department for Education and Outreach activities in ISRO.

I have handed over to Mr. Devi Prasad Karnik a proposal regarding this is a summary of my proposal:

- ISRO should set up an Individual department for Education and Outreach.
- Branches of this department should be started in major cities like Bangalore, Hyderabad and Chennai in south and Mumbai, Delhi in north and Calcutta in east.

- Main activities of these branches include:
- Conducting public meetings, seminars and webinars for students and general public in their limits.
- organizing outreach activities like the water rockets program.
- conducting various competitions and contests to students from grades 5 through 12, which provoke interest and enthusiasm towards space exploration.
- maintaining resource libraries for students and teachers separately. (schools can create account at the regional center and take tutoring materials, books, models etc., to schools to show students and use as teaching aids.)
- publishing books and promo stuff.
- conducting regional/state and national level space conferences.

Mr. Devi Prasad Karnik and said that they would consider my proposal and would forward it to the chairman. They also said that, they will see if they can conduct an outreach program in the near future in Vijayawada's surroundings, particularly rural regions. (Vijayawada belongs to costal region of Andhra Pradesh. I'm from that region. As a regard to my interest in space activities and the Education-Outreach Programs of ISRO, they said they will try to conduct a program for students in our region.)

Later I've inquired about ISRO's plans regarding a mission to Mars. Mr. Karnik said that Central Government Cabinet recently approved the Mars Mission, proposed by ISRO. With a successful mission to the Moon, ISRO marked its planetary research and exploration program. It will be taken a step further forward with this Mars mission. It is expected to be conducted in 2016.

ISRO also has plans for manned space missions. ISRO also prepared plans for a reusable technology. These projects are yet to be approved by the government. **PS**

Links:

ISRO Education Portal: http://www.isro.gov.in/education/

ISRO Publications: http://www.isro.gov.in/education/articles.aspx

ISRO Space Science Videos: http://www.isro.gov.in/education/videos.aspx

Playlist includes 4 Chandrayaan-1related videos: Chandrayaan-1 launch, Lunar Flyby of Chandrayaan-1, Lunar Fly through of Chandrayaan-1, and Chandrayaan-1 mission; Also one about the origins of India's space program and visionary Vikram Sarabhai.

A related side story

"**Life and Work on the Moon**" – a painting by **Pratham Karnik**, son of Devi Prasad Karnik. This was the cover image on M3IQ #4 Fall 2009, three years ago. http://www.moonsociety.org/india/mmm-india/m3india4_Fall2009.pdf Pratham had placed first with the best overall score in High School level in the NASA Lunar Art & design contest June 2009. At the time, Devi Prasad Karnik was Space Counselor at India's Embassy in Washington, DC, US.

At right: Pratham's New Years Day 2013 Card, his painting of Jog Falls, the 2nd highest waterfall in India. (http://en.wikipedia.org/wiki/Jog_Falls) Located near Sagara, Karnataka, these falls are a major tourist attraction. Our title for this beautiful painting? "**What you won't see on the Moon or Mars!**" But of course, there may well be "mini" waterfalls as water features inside pressurized Middoor spaces!

That is, there are no waterfalls on Moon or Mars, yet!

For some "mind-stretching" ideas of just how we could do this, read:

See http://www.moonsociety.org/images/changing/link-pages/hydroelectric-links.html and/or http://www.moonsociety.org/publications/mmm_papers/rille_paper5.htm

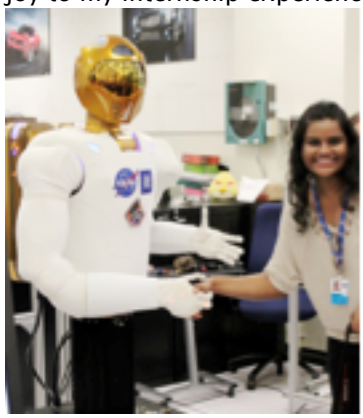
My Internship at NASA Johnson Space Center

By Jayashree Sridhar

My internship at NASA came as a surprise to me, it's definitely a dream come true. I had dreamed of working for NASA since I visited Johnson Space Center, Houston in 2009. The Lunar and Planetary Institute invites undergraduates with at least 50 semester hours of credit to experience cutting-edge research in the lunar and planetary sciences. As a Summer Intern, you will work one-on-one with a scientist at the LPI or at the NASA Johnson Space Center on a research project of current interest in lunar and planetary science. Furthermore, you will participate in peer-reviewed research, learn from top-notch planetary scientists, and preview various careers in science. It is a 10-week program runs from June to August.

I have a great passion for lunar science. Being an Aerospace Engineering major, I had no idea about geology and mapping but this internship was more about planetary science which created a fear for me. Never be afraid to push yourself to do things that are new to you, that is how you learn, by stepping out of your comfort zone so this helped me out to tackle the challenge. The greatest thing about experiencing NASA is that not only do I acquire technical knowledge, but I also enhance my character through experiencing some unexpected challenges, I have come to learn that patience, diligence, and versatility are imperative in this field of work- and those traits, simply cannot be taught in class. I also met people whom I had always looked up to but I am so glad that they exceeded all my expectations. I also made so many friends; we all had so much fun together. After 5 days of busy work schedule we planned our weekends and went on adventures.

I was interning at NASA's Johnson Space Center (JSC) in Houston, Texas in the astro-materials research and exploration science office. I worked on extraction of meteoritic metals from lunar regolith. This is a strategic research and involved strenuous work. The aim of this research is to develop and test ways to magnetically separate meteoritic metals from the lunar soil. To our knowledge, no other attempts have been made to accomplish this. The task would seem daunting because meteoritic metals are not the only magnetically-susceptible materials in lunar soil. It is known that pure metallic iron exists in the soil in the form of nanophase iron globules (npFe0) in the rims of soil grains, and that lunar soil as a whole seems to be magnetically susceptible. Moreover, while the amount of pure meteoritic metal increases with decreasing grain size, the amount of npFe0 also increases with decreasing grain size, making separation difficult. During my time at JSC, I had the opportunity to visit the lunar sample laboratory, star dust laboratory, meteorite lab, Robotics and Mock-ups facilities it was simply amazing. I just realized how lucky I got when I visited these facilities. The real surprise came to me when I got to know that I will be working with the lunar samples brought by the astronauts during the Apollo mission that is definitely the greatest achievement of mankind. The internship program strongly encourages learning outside of your assigned area. I have really enjoyed visiting different labs and going to talks on topics ranging from Mars rovers to supersonic engines. Landing of Curiosity in Gale added joy to my internship experience.



My experience at NASA has been fun, and I enjoy learning about new things, including all of the different projects and events going on at NASA that I never knew existed. I would like to include the thing I love about working at NASA is… that it's NASA! In my eyes, it is one of the major league of engineers, and only a few lucky ones make it here. I am so happy to work at an agency where I can read what is being done around and be amazed, and proud. The NASA capabilities are so vast and I am so happy to be a small part of something so revolutionary.

I hope sharing of this experience would inspire students to develop their interest and shape their career. In addition I also had the privilege to meet Astronaut Don Petit who was just back from ISS. He is a veteran of two long-duration stays aboard the International Space Station, one space shuttle mission and a six-week expedition to find meteorites in Antarctica. It was fun listening to his talk about his experience and fascinating things about space. I would also like to extend my gratitude to Lunar and planetary Institute for providing such a wonderful opportunity to me. **JS**

- **Jayashree Sridhar** is from Chennai (Madras), Tamil Nadu, India, and also reports to the new "To The Stars International Quarterly" - http://www.nss.org/**tothestars**/

NASA Ames Space Settlement Design Contest 2012 - RGUKT Nuzvid Students

RGUKT = **R**ajiv **G**andhi **U**niversity of **K**nowledge **T**echnologies

http://www.rgukt.in/extra/nasaexper.html (Full Text) Report below is abridged by TTSIQ editor

S. Krishna Bhavana, K. Akhil Raj Kumar and K. Kusuma Priya attended the **International Space Development Conference (ISDC), 2012** and presented their projects. These three students from Rajiv Gandhi University of Knowledge Technologies in achieved **Students Achievement Award**. And their experiences in the conference are expressed here. The Nuzvid campus is one of three in Andhra Pradesh State, and is located 316 km ESE of Hyderabad.

Lynne Zielinski, NSS ___, is second from left - Right: their entry in NSS Space Settlements Design Contest

The three students were excited to be at a major international conference, and beamed with pride when a tribute was paid to the three Indian astronauts that have been in space: **Rakesh Sharma, Kalpana Chawla** and **Sunitha Williams.**

"Mr. Al Globus, an eminent scientist and NSS member, has been the organizer of NASA Ames Space Settlement Design Contest for the past 19 years. And He accompanied us to the Gala party held in **Air & Space Museum** where Senator John Glenn and Commander Carpenter were felicitated with Space Pioneer Awards. [snip] We went around the Air & Space Museum and saw many space concern objects including the specimens of **Modules, Capsules** and **Spacecrafts** in which the astronauts Neil Armstrong and Buzz Aldrin explored the space." [snip] "There we were presented with **Student Achievement Award** certificates in the **Awards Presentation Ceremony** as we were bejeweled in the necklace of prize winners. We gave explanation about our projects to the visitors. We attended the **Lunar Track** where we shared our ideas about the settlement on Moon. "On Sunday we gave our presentation for which we were applauded and appreciated by the delegates and also answered their questions. We attended the **Mars Track** and we came to know about previous Mars explorations, future economic plans to send rovers to Mars."

"We spent a lot of time with **David** Dunlop, NSS Committee Member, discussing **Space Ventures** and **Planetary Defense**. We went around various stalls and came to know about various other international competitions. In the closing luncheon ceremony **Al Globus** gave us precious suggestions for future projects. He encouraged us to take part in real time professional projects. **Mr.John Strickland**, a great scientist, explained about economic rover launching plans and his attachment with Indian co scientist **Gopala Swamy.**

"Indian scientists and Astronauts were highly respected in the conference. In fact no speech was delivered without mentioning the name of our former president **Dr.A.P.J.Abdul Kalam** as he is going to play a key role in NASA's prestigious **Solar Cells Project**."

News Clips:

A memorable trip for IIIT Nuzvid students - http://www.rgukt.in/extra/hinduu.pdf

Nuzvid students' habitation in space plan wins laurels - http://www.rgukt.in/extra/hindu.pdf

IIIT students selected to attend global space meet - **http://www.rgukt.in/extra/Felicitation.pdf**

Dr.Kalam is at the center of the **NSS-Kalam Initiative** effort to promote Solar Power Satellites as a solution to the world's energy problems that can be adequate to the task as well as being environmentally benign.

http://blog.nss.org/?p=2214

http://www.nss.org/adastra/volume23/**kalamchina**.html

More RGUKT-Nuzvid student awards in Space Settlement Design Contest

http://www.rgukt.in/stu-nasa2012.html

Entry: The SAGA: The Journey Continues... Awarded Specialty First Prize


Ms. Krishna Bhavana Sivaraju


Mr. Harsha Katuri

Abstract the Project: Our SAGA, the journey continues, symbolises man's endless voyage to explore every nook and corner of the universe. So, this is man's first step towards unveiling the mysteries. It is a ray of hope for the existence of mankind in the future. "Man is an artifact designed for space travel. He is not designed to remain in his present biological state anymore than a tadpole is designed a tadpole" SAGA is a self sufficient environment far from the mother earth with all sophisticated technologies. It is a protective cocoon for mankind amidst the vast lifeless space. So, let us be prepared well with our special baggage to say 'Hello!' to those twinkling stars at the earliest.

==========

Entry: SANCTORUM: The Abode of Innocence: Awarded 11-12 Grade Third Prize


Mr. Akhil Raj Kumar Kalapala

Abstract the Project: **SANCTORUM**, a permanent space settlement, designed its existence in the vast space, where the high flying human survival stretches its arms for a new artificial world. **SANCTORUM**, the holy of holies, is the result of technical advancements which enlightens the new ray of bliss that provides earthly environment for man's existence in space included with all human necessities. **SANCTORUM**, the abode of alternative resources that minimises the pollution and burden of huge energy production on mother Earth.

==========

Entry: VEGA: The New Beginning: Awarded 11-12 Grade Third Prize


Mr. D.V.V.Avinash

Abstract the Project: Vega, the new beginning, is the name of a star in the constellation of Lyra. It is the human victory in science and nature. Mankind may face many problems on the earth in near future. So, the solution for the survival of human beings is a 'permanent space settlement'. Vega is the best example for the space settlement. Environment of Vega is an earth-like one. It is an alternative source for human beings to live in space.

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Entry: TRISHANKU SWARGA: The Replica of the Heaven: Award: 11-12 grade honorable mention


Ms. Subha Manisha Kadali

Abstract: 'Thrishanku Swarga' is the replica of the heaven which was the foster child of the great sage Vishwamithra for the King Thrishanku in Solar dynasty who wished to ascend to heaven with his mortal body. Necessity is the mother of invention, Curiosity is the father of creation. The blend of these two ideas is my Trishanku Swargam.....! In spite of the scientists' relentless efforts to unfold the mysteries, our enigmatic universe has been posing unending cluster of challenges imposing its supremacy over ever so confident, invincible attitude of human beings. The alternate for the survival of mankind is the space settlement. My Trishanku Swarga-The Replica of the Heaven is such a space settlement.

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Entry: GOOGLE: A WORLD OF BLISS: Award: 11-12 grade honorable mention


Ms. M.Hemalatha


Ms. A.Sri Vidya


Ms. S.Padma Sri


Ms. H.Divya

Abstract: Our settlement provides googolean amounts of bliss to its extra terrestrial humans (Residents of Google). It provides an opportunity to enhance the livelihood in the desired manner. Moreover, people can overcome most of the problems that they come across on the earth. Our settlement ensures them to live miraculous life. Our settlement is provided with necessary conditions like 1g, atmosphere and aggregate resources like water, food etc. We dedicate this project to all the teachers in this world.

Entry: ARENA, A Special Walk of Life.... Award: 11-12 grade honorable mention

Ms. K. Kusuma Priya

Abstract: **Arena** means "A Special Walk Of Life". This project details the creation of the new world with the conditions akin to Earth. This permanent space settlement will be the alternative step for the existence of humankind. The increasing pollution, radiation and global warming are the impending threats and disasters for the existence and survival of humankind. If we try to revert those conditions, it may be against the nature which is even more dangerous. The loss that happens may not be compensated forever. So it is not advisable to destroy the nature. Hence **Arena** is the alternative which reflects the Earth in its features and its conditions. **Arena** is a colony in a torus ring (with 1g environment) which is attached to the central cylinder by its spokes. Central cylinder is also attached with 6 cylinders on top and bottom of the ring. This colony provides and fulfills every need and requirement of the inhabitant. Station is provided with all basic requirements like food, water atmosphere, good security, real space experience and gives scope for more research in space sciences, and also helps for the increasing span of research in medical field. More over **Arena** is scope for future in every walk.

A Letter from Lynne Zielinski to Teachers and Students

To Those Teachers and Student Mentors that Accompanied Their Students
To the 2012 International Space Development Conference:

I very much appreciate your support of the students coming to the United States to participate in the Space Settlement Design Competition and to attend the International Space Development Conference of the National Space Society. I was delighted to be able to share the experience of the docking of the first commercial Dragon spacecraft with our guests while NASA administrator spoke at our plenary session and it was a pleasure to see and meet so many creative and enthusiastic students from around the world. NSS is happy to use this occasion to introduce to you the new electronic publication, To The Stars International Quarterly (TTSIQ) and to make some additional announcements.

The NSS Board of Directors has offered complimentary 1 year NSS memberships to those students, teachers, and mentors that came to our ISDC conference. We have provided a form for those of you who wish to take advantage of this membership offer to provide some personal membership information for our NSS membership database which will not be shared with other organizations. Persons submitting this information will have a 1 year membership from the date of submission and will also receive an electronic Ad Astra magazine link sent to your e-mail address.

We also want students and teachers that want to form a student chapter of the NSS to know that all it takes to start is three NSS members and the consent and participation of a teacher or other individual connected with the sponsoring school to start a chapter. A chapter starting kit is also provided in this issue of To the Stars International Quarterly. We will keep in touch through the TTSIQ and to share news about what is happening around the world in space and to give your students an opportunity to use this publication to report on what is happening in your chapter and in your country.

I hope to see many of you return to the 2013 ISDC and we will be sending you information about the program that is being developed for May 23-26 in San Diego.

Ad Astra
Lynne Zielinski
NSS Director & VP of Public Affairs, NSS Education & Outreach Chair

SPACE OUTREACH OPPORTUNITY IN INDIA – EARTH DAY – APRIL 22, 2013

http://www.icbse.com/events/earth-day
http://www.earthsite.org

"Mother Earth and Father Sky" **- Putting Yin & Yang Together**

Earth Day is a launch pad for course-changing, positive environmental action. Since 1970, Earth Day has activated individuals and organizations annually to strengthen the collective fight against man's exploitive relationship with the planet. The Earth Day campaign aims to combat climate change by driving substantive behavioral change and channel quantifiable action on behalf of the environment.

But what does **"Earth Day"** dedicated to protecting our precious environment, have to do with Space? Plenty:

- We are getting too much power either from dirty resources, and/or using it in dirty ways. One answer is to get power from solar power satellites (The NSS-Kalam Initiative)
- The cheapest and cleanest way to build such giant satellites may be to produce the bulk of the needed components on the Moon, shipping them "down to Geosynchronous Earth Orbit" for a 20th of the fuel needed to launch them up from Earth, polluting the atmosphere in the process
- People on the Moon involved with such manufacturing efforts will have to live in small mini-biospheres in which they will essentially "**live downwind and downstream of themselves**" – thus learning what we should be learning here on Earth under penalty of quick self-poisoning. The methods the pioneers learn and the technologies that they develop can be "exported" to Earth (knowledge has no transportation costs.) We won't try to learn those lessons, because we do not feel such an immediate need to do so.
- The same will hold true, further down the line, for lessons learned by pioneers on Mars
- Remote sensing satellites in space, including those put up by India, are helping us keep track of the accelerating deterioration of our precious environment: deforestation, desertification, water pollution, etc.
- Environmentalists and space enthusiasts commonly look on each other as enemies. We should be close allies.

Good reading:

http://www.moonsociety.org/projects/projectteams/**enviro-space**/index.html
http://www.moonsociety.org/projects/projectteams/**enviro-space/MotherEarthFatherSky.**html
http://www.moonsociety.org/publications/mmm_themes/mmmt**_EdenOnLuna.pdf**
http://www.earthsite.org/charta.htm
http://www.earthandspace.org

Videos:

http://www.youtube.com/watch?v=fmnYx2VUbqo
http://www.youtube.com/watch?v=nlZKZn_ZfJ8
http://www.youtube.com/watch?v=bMalcEubVn0
http://www.youtube.com/watch?v=VqeADZgjtpY (Michael Jackson)

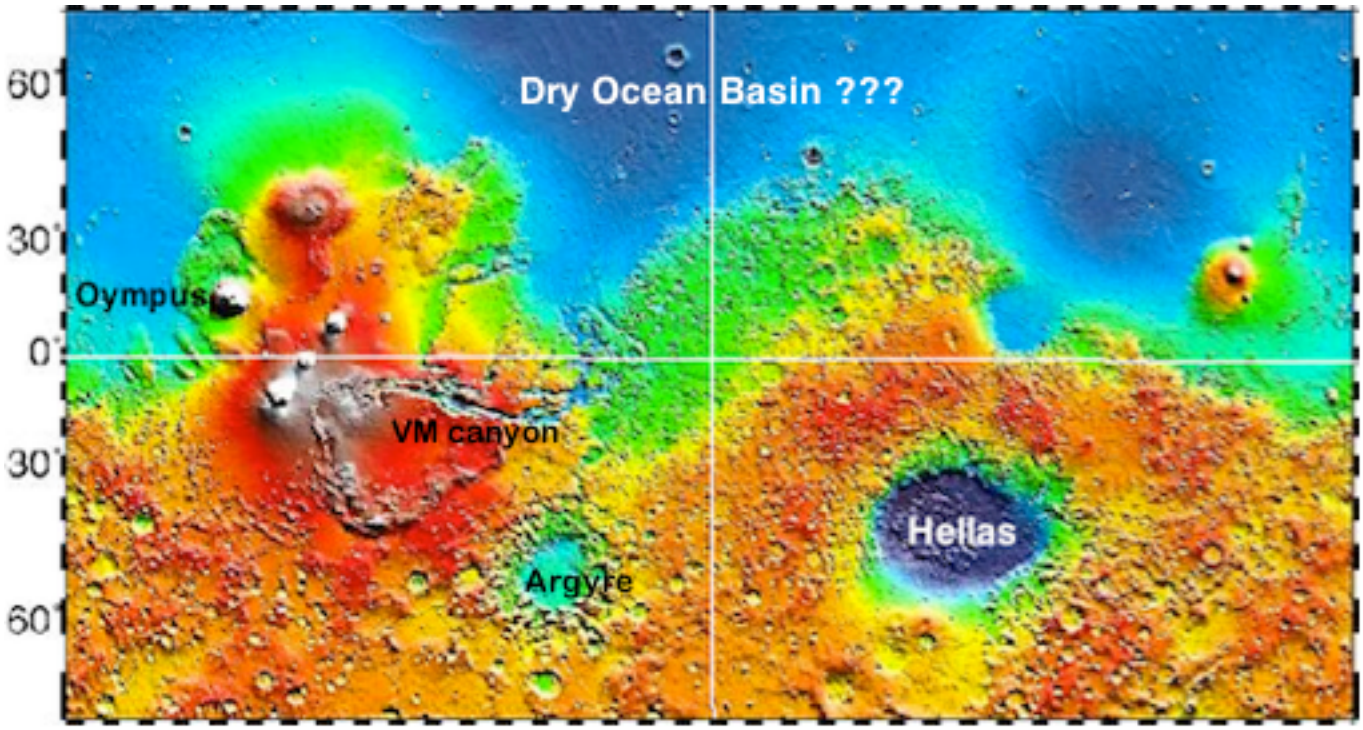
ARTICLES AND ESSAYS

Hellas: a glimpse of the past, a tease of Basoomian mythology, and the Future of Mars

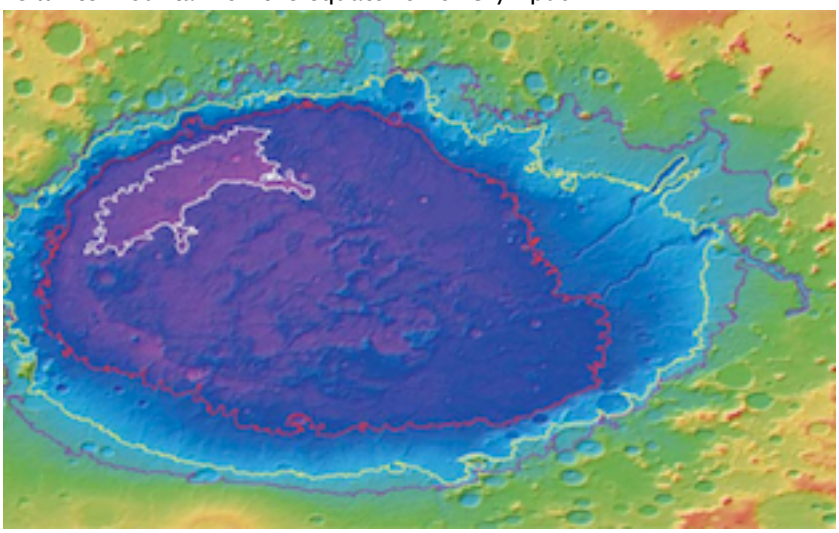
By Peter Kokh

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

The Hellas basin, more than 1,250 mi across and 26,000 feet deep, is the largest recognized impact structure on Mars, and once may have held a sea. "Fine-layered outcrops around the eastern rim of Hellas have been interpreted as a series of sedimentary deposits resulting from erosion and transport of highland rim materials into a basin-wide standing body of water." [see link above] The **circum-Hellas highlands** represent a significant percentage of the southern hemisphere of Mars and have served as a locus for volcanic and sedimentary activity throughout Martian geologic time. **Hellas Planitia** preserves the materials shed from these highlands and holds the key to further unraveling some of Mars' long held secrets.



Pavonis Mons is the white mountain on the equator SE of Olympus



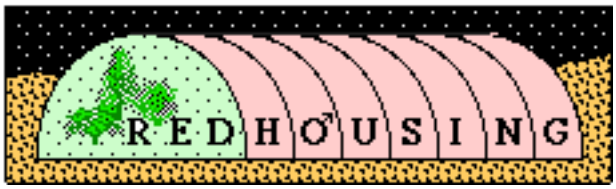
Right: The size of Hellas basin in comparison to the US Western States
Left: Circular basin distorted by the angle of image (to see this image in false colors denoting elevation differences, purple deepest. Image in color at http://news.bbcimg.co.uk/media/images/48020000/jpg/_48020986_hellas.jpg
"This mapping [snip] constrains the timing of these putative lakes to the early-middle Noachian period on Mars, between 4.5 and 3.5 billion years ago." Link above.

Even if Hellas Basin has always been dry, that does not diminish its capacity to hold water in the future. Surely in any Mars "terraforming" or "rejuvenation" program, Hellas will play a **starring role**. It is significantly lower in elevation than any other locale on Mars and as such will always be the area in which atmospheric pressure is the greatest. Hellas will be the first place on Mars able to hold liquid water. It will be the first place where watered land can support vegetation. And this is so whether this "plain" as "Hellas Planitia" has been so inaptly and unimaginatively named, ever held water and life in the past. Its depth is everything.

Hellas north shore will be the warmest part of the basin, being closest to Mars equator. Surely this shore or beach, as you like it, deserves to be picked as one of the earliest settlement sites. Pavonis Mons, smack on the equator (think launch track, think space elevator) and, being a "shield volcano" laced with many cubic miles of lava tubes, surely should be picked as a major settlement site as well.

In Edgar Rice Burroughs fictional map of Barsoom, as his fictional Mars inhabitants called their planet, it so happens on his map that roughly the same coordinates are those of the major Barsoomian cities of Greater and Lesser Helium. Helium and Hellas, what a coincidence. The word Helium is a derivative of the Greek word for the Sun, Helios, helium being an element first discovered in the Sun, long before it was found on Earth. Hellas is the Greek word for Greece. An interesting coincidence nonetheless. Also nearby was the Barsoomian seaport of **Aanthor** – an apt name for the first settlement along the north "shore" of Hellas basin.

[* For more colorful Edgar Rice Burroughs' Barsoomian tidbits, see John Flint Roy's 1976 **A Guide to Barsoom: The Mars of Edgar Rice Burroughs** – Ballantine, ISBN 0-345-24722-1-175]



"**Redhousing**" is a word we coined for developing "Mars-hardy plants" from high altitude desert and circumpolar Earth plants, in "redhouses" – greenhouses that contain lower pressure carbon dioxide atmosphere (with 3% nitrogen) gradually lowering the pressure as the plants become ever more tolerant of low pressure and Martian type atmosphere. See our article, "Redhousing" from MMM #93 in the MMM Mars Theme issue:

http://www.moonsociety.org/publications/mmm_themes/**mmmt_Mars.pdf** also in

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

Where "redhousing" meets a Mars in the process of rejuvenation or terraforming "halfway" may well be near or on the "North Shore" of Hellas Basin. That is where such evolved terrestrial plants will first take hold, beginning the process of "greening Mars."

Yes, this event, if it comes to pass, may be a long way off. But **while we are not in a position to start changing conditions on Mars, we are in a position to take the first steps with all kinds of candidate terrestrial plants**, in the redhousing project. If we wait until we get to Mars, and then wait until we have a permanent presence on Mars to begin redhousing experiments, we may have lost decades. **This is experimentation we can begin now.**

Redhousing experiments will take money and talent. This is best pursued at the university level. But it takes a P.I., a "principal investigator" to define and design the project and sell it to his academic institution, hopefully with backing from experimental agriculture firms. This is something that a self-made billionaire with a passion for Mars, like Elon Musk, could launch and nourish. **Designing and building such a greenhouse and providing the designated atmosphere is something we should be able to do in the very near term.**

The many faces of Mars

To too many Mars enthusiasts, Mars is Mars, and their image of the planet is far more uniform than this very diverse planet deserves. They want to go to Mars. Where on Mars? Anywhere will do, because they are not aware of the great diversity of Martian terrains. The false color map above showcases that topographic and geological diversity.

To learn more about Mars many faces, we recommend the book, **A Traveler's Guide to Mars** [Paperback] by William K. Hartmann. Aug 21, 2003 | ISBN-10: 0761126066 | ISBN-13: 978-0761126065 | First Printing.

> "In this extraordinary Baedeker—accessible, up-to-date, and prodigiously illustrated with photographs from Mariner 9, Viking, Pathfinder, the Hubble Space Telescope, and the ongoing mars Global Surveyor spacecraft—visitors will encounter: **Olympus Mons**, the largest volcano in the solar system, rising three times as high as Mount Everest and covering an area the size of Missouri; **Tharsis Planitia**, the "high plains of Mars," with plains rising 29,000 feet—wide enough to cover Europe; **Valles Marineris**, an equatorial canyon so vast that America's Grand Canyon would be a mere tributary." – **Amazon.com**

When you finish this book, you will far better appreciate the diversity, beauty, and desolation of this still empty planet. You will no longer be able to comprehend a mission to Mars that goes "just anywhere" on Mars. And Hellas will be one of the many very special places on "your" Mars, a Mars revealed. **PK**

The Planetary Society's Bold "PlanetVac" Mars Sample Return Project

By Peter Kokh

During the six Apollo surface excursions, 2,415 samples weighing 382 kg (842 lb) were collected, the majority by Apollo 15, 16, and 17. To date, 50 years later, not one tiny particle of Mars dust has been returned to labs on Earth. NASA designs for such a project would require a mission much more expensive than Curiosity.

It is time to go back to the drawing board with the order to make it **simple, elegant, effective, inexpensive, minimal size and weight.** With nothing but dreams on the drawing board, and the prospects for budgeting a very expensive mission unrealistic, the Planetary Society has adopted this assignment. Three Cheers!

http://www.planetary.org/**explore**/**projects**/**planetvac**/

http://www.planetary.org/blogs/bruce-betts/20121030_**PlanetVac-Intro-Blog.html**

http://www.planetary.org/multimedia/**video/20121026-honeybee_robotics_planetvac.html**

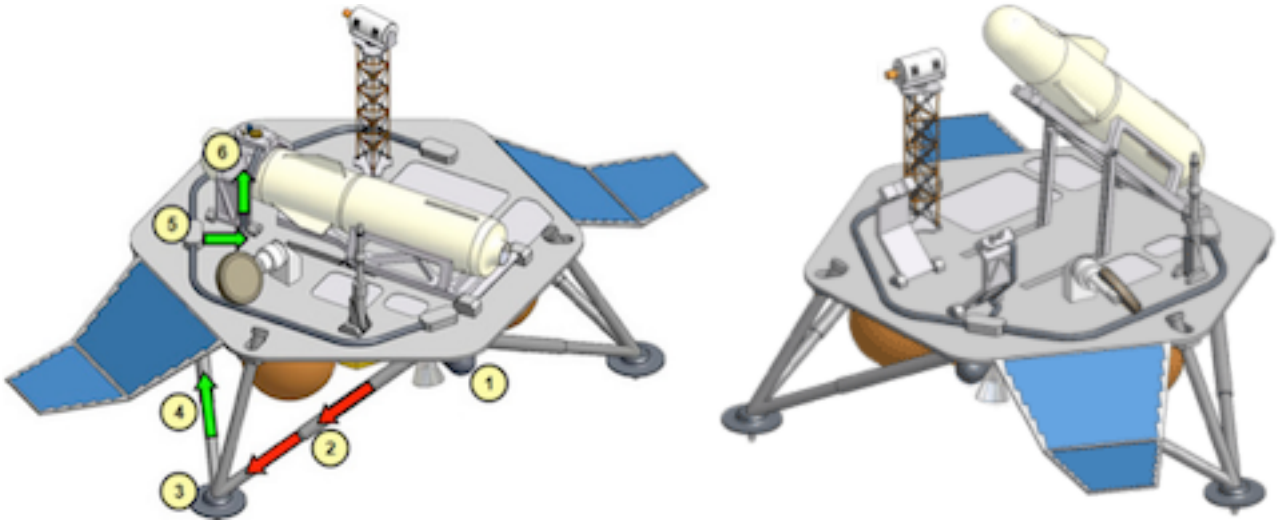
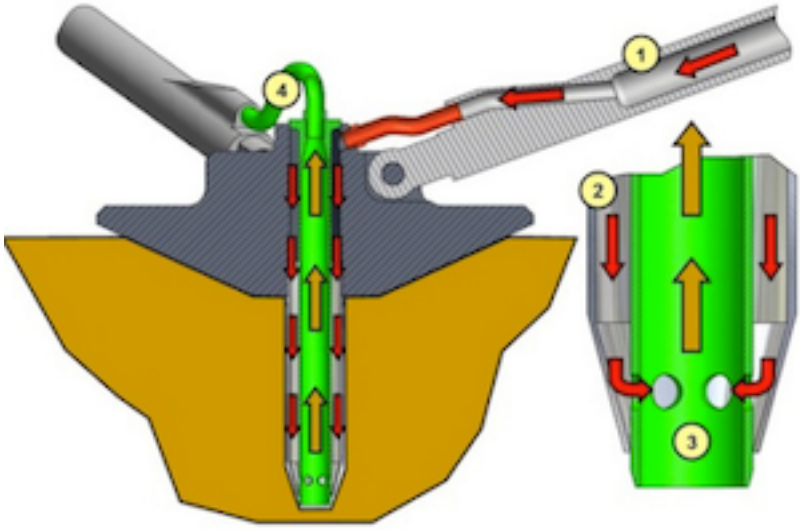


Diagram of how PlanetVac works showing a sample spacecraft: **(1)** Compressed gas cylinder releases a pulse of gas that **(2)** travels down lander leg strut and is **(3)** expelled through lander leg pad nozzle into regolith, **(4)** pushing regolith up a second leg strut to (5) sample intake manifold where it is then put into (**6**) sample return canister with other samples (or alternatively put into an in situ instrument).



(1) Gas flow down lander leg strut from gas cylinder, to **(2)** outer tube of collection nozzle, to **(3)** side holes in inner tube of collection nozzle, forcing regolith up the inner tube through the lander leg strut **(4)**, and up to a science instrument or to a sample return capsule container.

The Planetary Society is trying to raise funds to build and test the prototype. Then, hopefully, they can hitchhike a ride to Mars. Mars Scientists have wanted to do this for years. NASA would come up with something much more expensive, and, yes, it might do a better job – but many years later! To do it now, it has to be simple, workable, and lightweight. This is a very interesting project which deserves wide **s**upport. **MMM**

Moon & Mars – two Monochrome Worlds

By Peter Kokh

Our home planet is a world filled with color, blue skies with sometimes brilliant sunrises and sunsets, rainbows after a rain, green grass and trees, colorful flowers, birds, butterflies, blue lakes, rivers, seas, – and more.

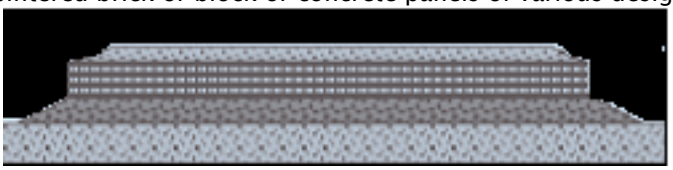
The Moon, in contrast, has forever black skies, and a surface in many shades of gray. Once in a while, Earth blocks out the sun, and the suns rays illuminate Earth's atmospheric ring while the Earth itself appears to become a black hole, with some lights coming from those of its many megacities not clouded over, and at brief times like this, the Moon's surface takes on the ruddy tones of Mars at twilight.

Mars is a symphony of ruddy tones from sand to rust, its skies also "salmon" colored.

We have speculated in past articles, that some settlers may want to have their habitat structures respectfully "blend in" with the host Moonscape or Marsscape. After all, on both worlds, we will need to cover our habitats with an overburden of surface material – moondust or marsdust – both to protect ourselves from cosmic radiation, and for thermal control: on the Moon to moderate between very hot dayspans and very cold nightspans, and on Mars, to keep heat in as the surface temperatures are in the same range as those of Antarctica, never "warm" by Earth standards.

In one article, "Moon Roofs" we speculated that some residents may want to adorn these mounds of regolith dust with rocks, tiles, or other means to catch the eye. (MMM #55 "Moon Roofs")

In another article, we speculated that these moondust or marsdust mounds could be contained with walls of sintered brick or block or concrete panels of various designs, to "stand proud," while still blending in, color wise.




(MMM # 137 "Taking Back the Surface: Above Surface Architectures for Moon Habitats") Both reprinted in the MMM Theme Issue "Under Construction" http://www.moonsociety.org/publications/mmm_themes/mmmt_construction.pdf

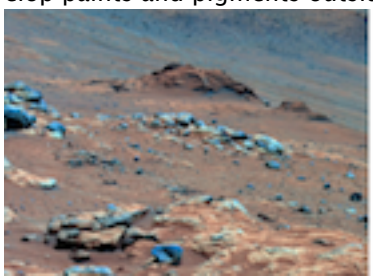
But will settlers of the lunar and Martian frontiers make such choices? Maybe not. Consider Greenland for example. Most of this large country is covered with an ice cap 3 km thick. Along the coasts there are ice free areas of gravel and sand – no trees – just mosses and lichens. The people choose to live in brightly colored homes.


Left: Nuuk (formerly Godthåb) the capital of Greenland --- **Right Qaanaak** (Thule)
http://en.wikipedia.org/wiki/File:**Nuuk**_city_below_Sermitsiaq.JPG
http://ivanterzic.files.wordpress.com/2012/03/greenland-**qaanaaq**.jpg?w=590&h=385

Now should some settlers want their homes to stand proud, not just in architecture but in color, this could be a challenge. Greenlanders can import colored house paint. For lunar and Martian pioneers, that would for the rich only.

Easy choices on the Moon: using lighter gray moondust from the highlands to cover homes in the dark maria and vice versa. The next easiest option is to steam moondust enriched in iron fines to bring out rusty tones.

Easy choices for Mars homesteaders? Collect the so-called "blue" rocks (left) and 'blueberries" (right) found here and there on the surface. Beyond these simple choices, pioneers on both worlds will have to wait for local chemical industries to develop paints and pigments outside the above color ranges. Stained glass?




For pioneers of both worlds, the real option is incorporation of individual homes within a settlement mini-biosphere, sharing a green "Middoors" environment – pressurized pedestrian and vehicle tubes with parks and all, where all the colors of life on Earth can be found. Green vegetation, colorful flowers and fruit, birds and butterflies, and using natural dyestuffs for coloring clothing etc. **PK**

Could we put an Outpost on Mercury? If so, why would we?

By Peter Kokh

For previous articles on Mercury, check out our Solar System Theme issue:
http://www.moonsociety.org/publications/mmm_themes/**mmmt_solarsystem.pdf**

Mercury is significantly closer to the Sun:

- As a result, its surface temperature range is much, much higher
- A trip from Earth's surface to Mercury's surface takes more energy than to reach any other planet surface

The Mercury Slingshot:

So why would we want to go there? By the same token – Mercury's orbit so much closer to the Sun – a solar power satellite of given size in orbit around Mercury would produce 4.6x as much power as it would in Earth orbit when Mercury was furthest from the Sun and 10.6 as much power when Mercury was closet to the sun. That power could be used to **decelerate arriving space ships and accelerate departing ships**, more than neutralizing the disadvantage of Mercury being deeper down the Sun's gravity well. Such assistance could make Mercury the Grand Central Station of the Solar System with the added benefit of the shortest interval between launch windows to and from anywhere in the Solar System. A ship bound from Earth to Callisto around Jupiter might get there faster and with less fuel by using this "**Mercury Slingshot**." Trips to Jupiter, Saturn, Uranus, and Neptune would be shorter.

Read "**Mercury Gateway: Grand Central to the Outer Solar System**" in MMM #78 Sept 1994 reprinted in
http://www.moonsociety.org/publications/mmm_themes/**mmmt_solarsystem.pdf** and in
http://www.moonsociety.org/publications/mmm_classics/**mmmc8_Jan2006.pdf**

These advantages provide ample economic incentives to establish a settlement on Mercury whose primary purpose would be to ramp up the volume and frequency of interplanetary travel and trade in the Solar System.

But isn't Mercury too hot to live on? (on the surface, yes, but ....)

Not only are the polar areas significantly cooler on the surface, but extensive thick lava flows (maria, like those on the Moon) ("enough to bury the state of Texas under 4 mi/6.4 km of once-molten rock" **have been found "at high northern latitudes"** i.e. near the North Pole – and that means that there must be lavatubes whose interior temperatures may be more than cool enough to support human activities in comfort. Human and industrial activities produce heat, so we do want those "tubes" to be on the cool side.

Mercury's axis is tilted even less than the Moon's. **Mercury could have double or more the total floor surface of permanently shaded craters**, and yes, **radar has detected water ice deposits in those craters**.

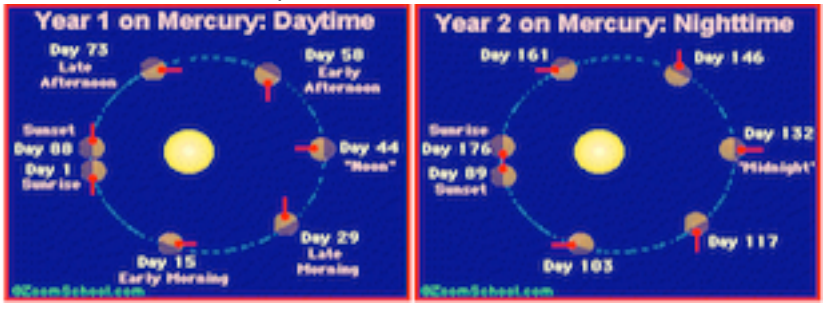
http://news.yahoo.com/blogs/sideshow/**nasa-says-enough-ice-mercury-encase-washington-dc**-194415297.html

So we have **a quadruple bonanza:**

1. **Water ice**
2. **Extensive and cool underground sheltered living spaces**, enough to house a considerable population
3. **Basalt**, a key industrial resource as it is on the Moon
4. **Iron and other key elements** in abundance

The Rhythm of life on Mercury:

- **Mercury's axis has the smallest tilt of any planet, but Mercury's orbital eccentricity is the largest.**
  - As a result the seasons on the planet's surface are caused by the variation of its distance from the Sun, rather than by the axial tilt, which is the main cause of seasons on Earth and other planets. At its closest to the Sun (perihelion) the intensity of sunlight on Mercury's surface is more than twice the intensity at than at its farthest distance (aphelion)
  - Because the seasons of the planet are produced by the orbital eccentricity instead of the axial tilt, the season does not differ between its two hemispheres.



Mercury's day-night/year follows a totally different paradigm:

- Radar observations in 1965 proved that the planet has a 3:2 spin-orbit resonance, rotating three times for every two revolutions around the Sun**. As a result, its dayspan/nightspan cycle is twice as long as its year,** 176 Earth days long vs. 88 Earth days. And Mercury's set of seasons coincides with the that cycle.
- Image Link: http://www.eso.org/public/outreach/eduoff/vt-2004/mt-2003/mt-**mercury-rotation**.html

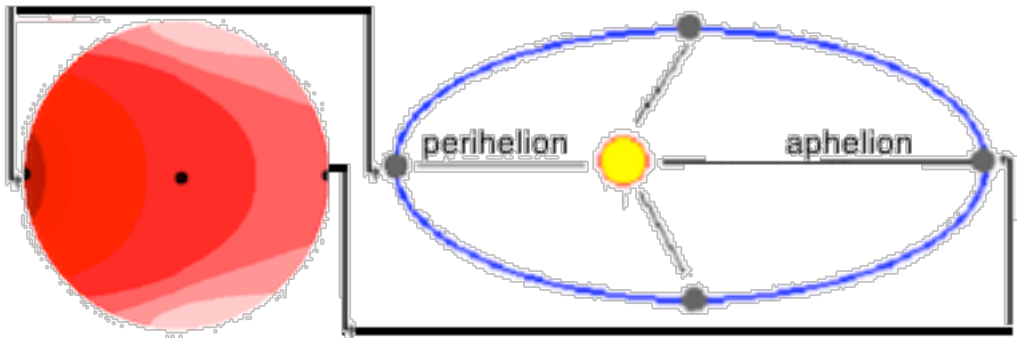
A "logical/practical" Mercury "Calendar" for settlers and temporary personnel should then be 176 Earth Days long, not 88. But, as 2 such cycles come very close to our year, **352 Earth days** (vs. our 365), settlers on Mercury may want to use a calendar that is two day/night = two season cycles long. Such a calendar would be similar in length to our Jewish and Muslim 12-Moon-cycle calendars (354 dates).

These 352 dates could be subdivided into 8 "seasons" of 44 dates each. As to weeks, a sequence of 2 seven day weeks, one 8 day week (x2=44 dates) with the 8th day being part of a 3-day weekend every 22 days, such a calendar might be very popular with the Mercury's settlers.

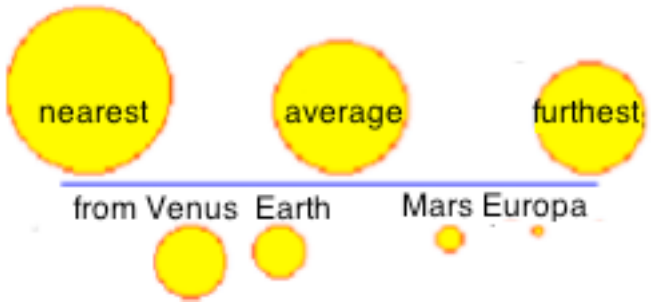
- Link: http://www.eso.org/public/outreach/eduoff/vt-2004/mt-2003/mt-**mercury-rotation**.html

Climate Zones on Mercury

As one face of Mars is always facing the Sun when Mercury's distance from the Sun is at its minimum, and the antipodal face is always facing the Sun when Mercury distance is at its greatest, the planets thermal climate zones are unique. I have tried to get the point across in the following illustration.



Above: The deeper the shade of red, the hotter the climate zone - Graphic by the author
Note that northern and southern climate zones are the same. The lightest pink areas are where we want to be.
Here **we have the four things needed** - "water, basalt, lavatubes, benign temperatures" - all in close proximity
Trips outside these areas would be practical only in most benign conditions (seasonal darkness)



Above: How big the Sun appears from Mercury in comparison to from other planets - Graphic by the author

How far in the future is any such development? The best way to answer such a question is to list **missions** and **technology developments** that must come first.

Missions: Currently, NASA's Messenger probe is in orbit around Mercury giving us an enormous amount of knowledge that we did not have previously. Messenger is photographing Mercury from various altitudes at various resolutions. What we need is **a Mercury Reconnaissance Orbiter** on a par with the Lunar and Mars Reconnaissance Orbiters, able to photograph the innermost planet at a resolution great enough to reveal any lavatube skylights in this "far northern latitude basalt sea." Finding one or more such skylights would help pin down candidate locations for a subterranean outpost.

Next, a "**skylight explorer**" on the model of JPL's Axel probe, able to winch itself down into the skylight and scan what it sees to give us an idea of the cross-section size of the lavatube in question, and a sense of what would be involved to set up an outpost within the tube.

Meanwhile, sampler missions could analyze on location samples of the surface regolith around the skylight area and at various distances from it.

Technology Development: We will have accumulated extensive experience in design and construction of modular outposts on the Moon, and maybe on Mars by this time. What else? We need to be already building upgrade versions of **Solar Power Satellites**, as they will be key not only to supplying power to the outpost, but for using to decelerate incoming craft and then accelerating them in a new direction. SPS units could also spot-illuminate areas of Mercury's surface currently in darkness for exploration of the rest of the planet under the best conditions.

Yes, these developments are a long time off. But we have taken step one: exposing the possibilities! **PK**

National Space Society's Road Map to Space, Part IV: To the Moon

http://www.nss.org/settlement/roadmap/RoadmapPart4.html

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The Moon, only a quarter of a million miles away, passing overhead every night, beckons as a visible and obvious destination for human settlement.

PARTICULAR BARRIERS:

Major Barriers specific to the Moon will have to be overcome to reach the Milestones en route to that settlement. Those Barriers include:

Psychological and Political

Scientific investigation of the Moon is currently being, and will continue to be, undertaken by or with the support of various governments, but only on a project by project basis. Until a firm, final, irreversible and financially supported commitment is made to create a permanent — and the operative word is "permanent" — settlement on the Moon, it will not happen. That commitment could occur early, in the event of a national political decision, or only after successive phases of lunar exploration and development have shown a likelihood of cost effectiveness and sustainability. Either way, obtaining that commitment might even be viewed as a Milestone in its own right.

Architecture Definition

Early Lunar bases run the risk of being abandoned if reusable transportation systems are not used from the beginning. This risk will be lessened to the extent that, from the start, mission architectures are designed as a sustainable, reusable, integrated system that pursues ISRU and self-sufficiency technologies as a very early goal.

Biological

There are two major potential barriers to a permanent human settlement on the Moon: radiation and gravity only one-sixth that of Earth.

(1) Lethal ionizing radiation comes from the sun and even more powerful cosmic rays originate from outside the solar system. Habitats will have to be shielded, probably by being covered with thick layers of local regolith or built underground. More difficult will be finding a way to shield humans while operating on the surface.

(2) Gravity is the true unknown. Humans (as well as other animals and plants) are the product of some 500 million years of terrestrial evolution, all that time being adapted to live in a one-gravity environment. We already know of problems from long duration space flight, such as bone loss and vision degradation. No one knows whether or not humans can live long-term in the low lunar gravity, nor whether offspring can be safely born and raised. This barrier will be tested either by the placement in orbit of a variable gravity centrifuge (something that was omitted from the International Space Station) or the hard way, by real-life experience by people living on the Moon.

Uniquely Lunar

Each body orbiting the Sun has its own characteristics. The Moon presents some unique challenges which will have to be overcome — e.g., its half-month days followed by half-month nights, its pervasive and abrasive dust, its cratered and mountainous terrains, its possible lack of usable water, and its most useful resources (including what water exists) not being conveniently located.

MILESTONE 10: Robotic Confirmation of Lunar Resources.

Satellites orbiting the Moon and possibly robotic landers determining the nature and extent of lunar ice and volatile deposits and providing the information necessary to guide the choice of the best sites for a lunar outpost.

The Apollo missions chose landing sites primarily on the basis of safety on landing and then on the basis of general scientific interest to learn about the history and composition of the Moon. Successor lunar missions have emphasized and will continue to emphasize discovering what lunar resources can best support future long-duration human operations there.

Water and Lunar Volatiles

Robotic probes from several countries have determined that water and other valuable volatile elements are present in significant percentages in lunar soil in certain areas near the lunar poles, notably in deep permanently shadowed craters. Knowing exactly what these volatiles are and how extensive are the deposits, and especially how much of them are water, will be crucial to understanding their availability to make rocket fuel and breathing oxygen and provide other support for human habitation.

Every kilogram of water that does not need to be imported from Earth represents a significant step toward self-sufficiency and immensely eases the logistical requirements for supporting humans on the Moon. Thus, this knowledge about lunar volatiles will provide the basis for designing all subsequent lunar habitats.

Sites for Lunar Outposts

While attention has been focused on volatiles at the lunar poles, as well as the possible advantages of a deep crater for lunar optical and radio astronomy, there are obvious difficulties of establishing the first habitats at those sites — e.g.,

- Fuel requirements greater than for landing closer to the lunar equator,
- Higher risks in landing inside a crater near a shadowed crater wall,

- Difficulties in communication with Earth when it is not in line of sight — establishing a network of lunar relay satellites will ease that problem but will add to the infrastructure cost and complexity,
- The lack of sunlight for solar power,
- Limitations on where ground vehicles can travel for further research.

These difficulties will motivate the continued search for sites that may lack volatiles but will have the advantages for a first outpost that a polar site lacks. Other advantages may include the existence of caves, or different soils that can be better utilized in the construction and maintenance of a habitat, or higher concentrations of particular metals.

When all the new data is evaluated, and all the variables balanced, including initial and ongoing costs, a choice will be made for where to site the first permanent outpost — i.e., where structures will be landed or built which will be the site for more than a single visit.

Further Reading:

- LCROSS Results Released: NASA Missions Uncover the Moon's Buried Treasures
- Resources of Near-Earth Space: Part II, The Moon

MILESTONE 11: A Lunar Research Facility.

A lunar research facility established to study human habitation, test various equipment and techniques, and conduct lunar investigations.

The first outpost will be designed to support successive missions, each building on the knowledge gained and infrastructure built by its predecessors. This facility may be government sponsored and funded, or could be established by private enterprises. The outpost may consist of a single module visited and used over and over or of multiple modules landed or constructed in later missions; the latter is likely to be the most cost-effective and productive. An early module could be a habitation module, allowing extended crew stays. Other deliveries, either before or after a habitation module, could be rovers, bulldozers and tractors, building cranes, mining equipment, kilns for metallurgy, telescopes for astronomy, medical labs and other scientific modules, and more habitation modules. This staging would allow for both short visits by scientific specialists and the gradual building of a larger facility at the initial site.

The outpost could be either vacated between missions or be continuously occupied. If the latter, the outpost will be exceptionally useful in determining the ability of Earth life to thrive for long periods in the one-sixth gravity environment, and in the case of plants and other animals, to reproduce successfully.

This first outpost will be mainly a research facility. Over time and as it grows, it will test, among other things,

- Life support and recycling systems,
- Health maintenance regimens (much as the International Space Station has tried various methods for keeping astronauts in good condition in zero gravity),
- Cooking in one-sixth gravity,
- Spacesuits,
- Lunar transportation vehicles,
- Alternate power sources (e.g., battery, solar, nuclear),
- If volatiles are nearby, techniques for extracting water and making rocket fuel,
- Construction techniques (such as digging, moving, shaping lunar regolith),
- Creating at a distance a storage site for rocket fuel,
- Various kinds of radiation shielding,
- Mining and smelting techniques,
- Manufacturing and fabrication techniques unique to one-sixth gravity and/or vacuum,
- Crew psychology in a new environment,
- Gardening and animal husbandry in that unique environment.

Surface explorations will also continue contributing to our scientific knowledge about the Moon generally. In addition, if the public relation possibilities are maximized, regular broadcasts from the Moon will serve to educate the public and increase support for further human space activities. Entertainment companies, in particular, may find a way to finance and profit from such activities.

The first outpost or outposts are likely to conform to current astronaut safety standards. That will mean (1) having always available in case of emergency a means to return to Earth, whether by a vehicle capable of returning directly to Earth or a vehicle capable of reaching a second vehicle in lunar orbit that can return them to Earth, and (2) having a crew refuge which can sustain the crew against sudden burst of solar or cosmic radiation for a specified length of time (and is also a crew habitat during normal operations). The exposure to sudden radiation bursts was an inherent risk accepted by the Apollo missions, but will probably not be accepted where long duration stays are involved.

Further Reading:

- Report of the In Situ Resources Utilization Workshop [PDF]

MILESTONE 12: A Government / Industry Lunar Base.

The initial research facility evolving into a permanently occupied, ever-expanding lunar base, or such a base created at another site using what has been learned from the initial facility, and increasingly performing commercial functions.

Once the initial lessons have been learned from the lunar research facility, a growing lunar base will turn its attention to maximizing its usefulness to other space operations and achieving some commercial profitability. The base will encourage early industry investment and involvement. Some separate modules could be privately financed, as could the visits by various researchers.

Noncommercial Functions

The lunar base will continue the basic scientific and technological research begun by the research facility, probably with government funding and direction. It will also be used to provide government services for use on Earth, such as environmental sensing, including "space weather," and tracking objects orbiting the Earth. The techniques learned during the Research Facility phase — e.g. utilization of lunar volatiles to produce rocket fuel — will increasingly be incorporated into the Base phase.

In addition, with the experience gained from operating in the lunar environment, the base very likely will be used as a test-bed for developing and checking out the many technologies and hardware that will be needed for Mars missions. While Mars has a slight atmosphere, different dust, seasons, and gravity twice that of the Moon (although still only one-third that of Earth) conditions on the Moon provide a much more rigorous environment for thorough testing. Even entire modules intended for Mars could be field-tested on the Moon.

Commercial Functions

Both by design and happenstance, commercial uses of the lunar base will increasingly arise. As the technology gets increasingly proved, so that the risk from innovation uncertainty is substantially reduced, private companies will be better able to evaluate the risks and potential profits of investment in the lunar infrastructure. At that point, they are likely to invest in (i.e., fund) lunar enterprises more substantially. Possible commercial opportunities include, e.g.,

- If the base is located near extractable volatiles, providing rocket propellant for cislunar operations which could be one of the base's primary and most commercially valuable uses,
- The gathering and sale of research data,
- The production and sale of lunar entertainment,
- Tourism, with a nearby bare-bones hotel module and lunar excursions.

Further Reading:

- The Second Conference on Lunar Bases and Space Activities of the 21st Century

MILESTONE 13: A True Lunar Settlement.

The lunar base evolving into a permanent settlement, increasingly self-sufficient and increasingly focused on commercial activities.

As the lunar base grows, in volume, in area, in the number of modules connected and nearby, and, especially, in population, at some point people will look back and realize that people are on the Moon for good. While it is hard to define a "permanent settlement," some aspects that might be present include:

- People moving to the Moon with no intention of ever returning to Earth,
- Residents other than government employees,
- Children being brought to the Moon, and, gravity permitting, being born there,
- Schools and chapel spaces,
- No requirement that enough vehicles be standing by to evacuate the entire population at once (though there would be provisions for evacuating people from individual modules in the event of emergency),
- Surgical facilities,
- Closed or Controlled Ecological Life Support Systems that recycle enough to minimize the need for imports for daily living,
- Ability to make repairs using local materials,
- Facilities for visitors, whether scientists, tourists, or others,
- Use as a staging point and support facility for the development of other lunar settlements.

While the settlement's facilities are reasonably predictable, the composition of its population is not. That will depend on what are the biological effects of living in the low lunar gravity for long periods, even a lifetime, and on fetal development and later growth. It may be that people and their families will be able to move to the Moon and live there for generations, or it may be that the permanent settlement is filled by a constantly changing population.

As the cost of space transportation drops and the cost of the settlement is amortized or written off, the commercial activities that were initiated and experimented within the base phase will be expanded, especially tourism and development of products and services for use on Earth. Lunar hotels may be among the structures most frequently added to the settlement. The low lunar gravity might even make the Moon a retirement destination of choice. An increasing proportion of lunar settlers will be involved in these commercial activities, rather than in routine maintenance.

One significant commercial activity that could be sustained by a growing permanent settlement would be the creation of a system of mass drivers. These would electromagnetically hurl mined lunar materials or lunar-derived rocket fuel into orbits where they could be used to construct orbital space habitats or to refuel outbound spacecraft substantially more economically than could be done if those resources needed to be brought up from the bottom of Earth's gravity well.

Another activity that could be supported by a growing settlement would the establishment and maintenance of permanent observatories at various locations, including on the far side of the Moon for astronomy, and on the near side of the Moon for continuous surveillance of cislunar space and the Earth.

Building Networks of Support for an International Lunar Geophysical Year

By Dave Dunlop – Chair, National Space Society International Committee

The case that has been made for a new phase of lunar surface scientific exploration is both compelling for basic scientific understanding of our solar system history and planetary formation processes. The case for lunar ISRU is to apply this understanding in order open cislunar space and the lunar surface for the economic utilization of the Earth's population. (1) (2) (3) Several fortuitous developments have combined to present unique opportunities to advance this agenda through the proposal for a declaration of an International Lunar Geophysical Year. (4)

International Interest in the Moon

International interest and momentum for lunar exploration is at its highest since the days of the cold war, and the race to the Moon between the US Apollo Program and that of the Soviet Union. In the last decade orbital spacecraft from China Europe, India, Japan, and the United States have been sent to the Moon and revolutionized prior understanding of the Moon with regard to the presence and abundance of frozen volatiles, the processes underlying their presence, and other fundamental characteristics including the fact that it contains the coldest known surfaces in the solar system. As of this writing the Lunar Reconnaissance Orbiter mission is active and in an extended mission until 2014. The Lunar GRAIL mission is just about to complete its approximately year long orbital gravity mapping mission in the first few days of 2013. The LADEE mission is scheduled for launch midsummer of 2013. Two heliophysics satellites Artemis I and II are in Earth Moon Lagrange point 1 and 2 respectively.

Several nations have committed to sending lunar surface mission during this second decade of the century. They include: China with a Chang'e III mission scheduled for midsummer 2013. Indian and Russia with a joint mission named Chandrayaan II and Lunar Resource in 2017, Russia with a mission called Lunar Grunt in 2015. Japan is also planning a Selene II mission in 2018. Unfortunately the European Council in October 2012 in the midst of financial crisis has just canceled the Moon Next mission which had been scheduled for 2018 as well. NASA had previously indicated that it would send four missions to the lunar surface in this decade as part of an International Lunar Network but also withdrew its budgetary support. NASA has recently presented a mission concept of an Earth-Moon Lagrange 2 Gateway project which would provide a range of opportunities to develop technologies advancing access to the Moon, Mars, and asteroids. A new private initiative The Golden Spike Company, has announced its goal of providing lunar surface expeditions to potential nation state customers as well as private industry using the capabilities of launchers from Space-X and United Launch Alliance. (5)

The New Paradigm of Lunar Cube Hitchhiker Missions

Parallel to this interest is the development of micro-engineering techniques and instrumentation which create the opportunities to create relatively low cost, low mass, low volume, space craft with unique operating capabilities in the extreme environments on the Moon including ultra low temperature and low power electronics systems. (6) Advances in solar electric propulsion, including further miniaturization, of propulsion can propel and orient these small space craft are. These are also being matched to lunar mission architectures and destinations. This new paradigm has been labeled Lunar Cube – Hitchhikers based on the cube satellite design paradigm.(7) These Lunar Cube craft rely on low cost secondary launch capabilities and opportunities to "hitchhike" on missions headed to Geostationary Earth Orbit or on to other destinations which provide trans lunar injection trajectories. (8) Several small lander projects are in development.(9) (10) (11)

Google Lunar-X-Prize

Another significant factor advancing this exploration agenda is the advent of the Google Lunar X-Prize competition for the first privately funded mission to the Moon. This competition was announced in 2006 and open to teams from any team where in the world that could land on the Moon, move 1500 meters, photograph its surroundings to prove its successful landing, and transmit these pictures to Earth fro a first prize of $20 Milton dollars. As of this writing in late 2012 over twenty teams are in competition and at least a few have developed agreements for launch before the 2015 deadline. Some of the leading contenders Astrobotics and Moon-X have landers that can bring at least 100 kg to the lunar surface. Astrobotics has a projected launch dates in October of 2015 while Moon-X has also indicated a 2015 launch. (12) (13).

Additional Opportunities to Lower Lunar Mission Price Points

At the Lunar Exploration Analysis Meeting in October 2012 at NASA Goddard, Russell Cox of Flexure Engineering proposed an International Lunar Geophysical Year during the two year period when the latest international landers were scheduled, (2017 and 2018) to advance both the scientific and commercial agendas. (14) To these currently approved international lunar landers landings might be added a number of other low cost missions which grow out of the Google Lunar X-Prize competition. First are missions such as those which hopefully will fly successfully to the lunar surface. Astrobotics and Moon-X for example can carry a number of small payloads and small craft. This capability will bring the price point for delivery to the lunar surface to approximately $1M per kilogram. Small payload of just a few kilograms could therefore cost in the single digit million dollar range.

Second are small lunar orbital and or surface lander mission costing in the low tens of $ millions. Such missions are within the reach of smaller countries in collaboration and similarly with many institutional budgets.

"Also-rans" Mission Adoption

Not all Google Lunar X-Prize teams are good at raising money and have no practical chance of winning the first or second Google Lunar X-Prize prize. Even if they are not the first this does not mean that they do not have interesting and worthwhile technological ideas and approaches. After the gold and glory of winning the Google Lunar X-Prize there is still the potential of many groups to advance their projects to the lunar surface if an extended objective can be developed and demonstrated.

These GXLP "also-rans" represent an opportunity for national space agencies and commercial companies to invest in their capabilities and missions. Many of these teams which will not win the GLXP have advanced to at least a Phase A of development and in some cases a "Phase B". Such teams
with national sponsorship might perform useful science missions during a International Lunar Geophysical Year. They might also further the commercial paradigm of exploration that was both the intention of the Google Corporation, the X-Prize Foundation NASA which has provided technical support in some cases like Moon-X and Astrobotics and Omega Envoy.(15) (16) (17). Team Space IL has also received approval to utilized data from the LOLA laser instrument now flying on the Lunar Reconnaissance Obiter.(18) The Google Lunar x-Prize has characterized itself as Moon 2.0 in contrast to the Moon 1.0 of the Apollo era. The ILGY could mark the beginning of a new Moon 3.0 architecture paradigm with a commercial government partnership in exploration.

Lunar In Situ Technology Testing and Demonstration

NASA for example has many technology programs which are intended to advance the state of the art with regard to operating in the extreme cold environment of the Moon and Outer Planets and moons. The Moon is the closest and cheapest place to test and demonstrate these technologies.
Their testing and qualification in cislunar space and on the Lunar surface is a matter of significant risk reduction for planning larger deep space missions to Mars and beyond by providing a flight heritage and record of reliability. The NASA 2013 budget and projected to outlying years from 2014 through 2017 contains a total of $3.2 billion for these technology development program. (19) These programs are in many cases in advanced development and both testing and demonstrations of their capabilities could be done in a well coordinated experimental program resulting in a program small lunar hitchhiker missions.(20)

NASA could support an ILGY initiative largely within its OCT budget by also engaging the next generation of scientists and engineering through a competitive program involving its network of Space Grant Funded Universities. Competitive Teams could propose such test missions working in partnership with existing NASA Centers and coordinating their efforts with both commercial and government secondary launch opportunities. This initiative would continue NASA's role as a cutting edge provider of both science and technology and education. NASA could not only demonstrate a new low cost high capability exploration program. It could and with its many international partners in the development of this program expand on the foundation of the International Space Station by pushing the frontier of international collaborative efforts out to the Moon.

A Corollary Lunar Cube Hitchhiker 50 Model

A flight program for the ILGY Lunar Cube 50 Hitchhikers could be modeled on the QB50 program of university developed Earth environmental monitoring satellites. The NASA Lunar Science Institute has a network of international teams which might be enlisted in this scientific campaign. (21) This would allow NASA to both share the risks, costs, and rewards while still leaning forward in pursuit of its science, exploration, technology development, and education objectives. This challenge is not so much a matter of new expenditures as it is the coordination and optimizing of existing NASA efforts by the NLSI, Space Grant Consortiums, the SMD, OCT, and HEOMD with coordination as well with DOD and commercial, and other international launch programs.

A Proposed ULA Partnership

The United Launch Alliance is active and interested in the use of it large vehicles for secondary payloads. They could be an obvious and immediate partner in this Lunar Cube 50 Hitchhiker as a matchmaker for both government and commercial customers that are purchasing the primary payloads. The trick here is to find ways to put these Lunar Cube hitchhiker mission within the envelope of risk that is acceptable for primary customers.

NASA has made the decision to cancel its satellite launch program program (22), but SWORDs might be a low cost vehicle which could provide low cost LEO tests of some of these instrument. (23) and the DARPA ALASA (24)program might also provide low cost LEO test opportunities in developing ILGY demonstration spacecraft and in demonstrating that such systems are of acceptable risk as secondary payloads on larger commercial or government launches.

Even within the constraints of reduced budget resources an ILGY program Lunar Cube 50 project can demonstrate the coordination of existing assets both domestic and with non-US partners. The matching of the talents of university teams with NASA Centers leadership can advance both science and commercial technology development goals that arise from the ILGY.

Notes:

(1) NRC "The Scientific Context for the Exploration of the Moon" 2007, LEAG web-site

(2) Strategic Knowledge Gaps in Scientific Exploration of the Moon – LEAG Meeting,October 2012, "Results of the Lunar Exploration Analysis Group GAT-SAT (Specific Actrion Team)

I and II examination of Strategic Knowledge Gaps for the Moon First Scenario for Human Exploration of the Solar System." Members of the GAP-SAT Teams I and II. Reported by C.K. Shearer, Institute of Meteoritics, Department of Earth and Planetary Science, University of New Mexico, Albuquerque, NM 98122 (LPI Contribution No. 1685

(3) Microsymposium 54, Lunar and Planetary Institute web-site, brown-MIT, Vernadsky Institute.

(4) Russell Cox flexure Engineering LEAG presentation October 2012.

(5) www.space.com/18800-golden-spike-private-moon-company.html

(6) David Dunlop & Dr. Rene Laufer, IAC-12,b4,8x16196

(7) Dr. Pamela Clark, LunarCube:Payload Development for Enhanced yet Low Cost Lunar Exploration; C"UA; R. MacDowall, NASA/GSFC; R.Cox, A Vasant, Flexure Engineering;

M.L. Rilee, RST; S. Schaire, NASA//WFF; B. Malphrus, Moorhead State University. LEAG

Meeting, October 2012, Goddard Space Flight Center.

(8) United Launch Alliance secondary Payloads program, www.ulalaunch.com

(9) mstl.atl.calpoly,.edu/-bklofas/Presentations/DevelopersWorkshop2011/36_Brandon_CubeSat_Moon.pdf

(10)Team Space IL web-site (GLXP)

(11) Team Barcelona web-site, (GLXP)

(12) Teams Astrobotic web-site, (GLXP)

(13) Team Moon-X web-site, (GLXP)

(14) Russell Cox LEAG Presentation October, 24, 2012 Goddard Space Flight Center.

(15) Astrobotic GLXP lander will potentially carry the "Resolve" Surface Drilling Payload.

(16) Moon-X has used NASA's common lunar bus (which will fly first on the LADEE Mission in 2013) as the core architecture for its lander.

(17) Omega Envoy has received an Innovative Lunar Data Demonstration contract.

(18) Team Space IL web:site (GLXP)

(19) NASA 2013 Budget

(20) NASA 2013 OCT budget

(21) NASA NLSI international teams

(22) The SpaceReview.com/article/2197/1

(23) USArmy Space & Missile Defense Command/ Army Forces Strategic Command Technical Public Affairs Office, P.O. Box 1500, Huntsville, AL 35407 Center SWORDpdf., www.army.mil/smdc

(24) To Keep a Steady Stream of Satellites Going Up- DARPA Wants to Launch Them from Airplanes, Pop Science 11- 07- 2011.

SPACEUP INDIA - http://spaceupindia.dhruvaspace.com/#spaceup-india

SpaceUp is an open attendance space exploration "**unconference**" http://en.wikipedia.org/wiki/Unconference at which participants decide the topics, schedule, and structure of the event - http://en.wikipedia.org/wiki/SpaceUp

The first **SpaceUp** in India was hosted in **Bangalore** this past year. It aimed to foster outreach for ideas, concepts within the enthusiastic community of students, teachers and amateurs to space professionals.

SpaceUp shall be coming soon to **Mumbai, Chennai, Delhi** and other major cities in India!

We encourage space enthusiasts in India to get familiar with this new unorganized but highly productive way of exchanging and developing ideas, finding collaborators and starting projects in motion. This revolutionary type of get together began in San Diego, California but is quickly spreading around the globe. It requires much less funding and organization, but is so far yielding amazing results.

And no, the editor(s) have yet to get their feet wet in this new medium.

Lori Garver – "NASA Has Not Abandoned the Moon"

By Dave Dunlop – 4 January 2012

Lunar Doom and Gloom

To advocates of a lunar program as a sensible next step out from LEO the shift in NASA's priorities under the Obama administration have seemed grim. The International Lunar Network program to establish an internationally coordinated network of perhaps 8 to 10 geophysical station of which NASA was to contribute 4 nodes was defunded. A Lunar Mission to the South Pole Aiken basin for a sample return was not selected in the last round of New Frontiers proposals. Similarly a Lunar mission to establish two lunar geophysical stations was not selected for the Discovery program. The Lunar Quest line item was eliminated from the Science Mission Directorate budget.

Current Successes

However, NASA has also under the Obama administration pursued and carried the previously planned Lunar precursors missions with spectacular success:

- The **Lunar Reconnaissance Orbiter (LRO),** now in an extended mission through 2014, has produced spectacular information from its WAC and NAC cameras, its Diviner temperature instrument, LOLA laser altimeters, Synthetic Aperture radar, and the Russian neutron spectrometer. **LCROSS** confirmed the existence of a variety of frozen volatiles in Cabeus crater with it's spectacular splash out of volatiles.
- The twin orbiters (Ebb and Flow) **GRAIL** mission had an extended mission which ended in late 2012 and is producing a gravity map of much greater resolution than its nominal mission requirements. The Lunar Atmosphere and Dust Environment Explorer is slated for launch in July of 2013.
- Another less publicized set of lunar missions are the **Artemis IV** and **V** satellites which are currently orbiting in L2 and L2 as heliophysics observatories. It is also only fair after mentioning this string of successful lunar mission launched during the Obama administration to mention NASA's successful collaboration with ISRO on **Chandrayann-I** in 2008 begun under the G.W. Bush Administration.

"NASA has not abandoned the MOON"

NASA's priorities and policy choices have been explained by, NASA Deputy Administrator Lori Garver at a September address to the American Institute of Aeronautics & Astronautics in Los Angeles where she pointedly made it explicit that while NASA's choices have been limited by budget constraints that NASA has not abandoned the Moon. (1)

While the recent evidence is that the Moon as a destination has not driven NASA's budget it would be unfair and inaccurate to entirely disagree with the Deputy Administrator. The Document '**The Scientific Context of the Exploration of the Moon**" published during the Bush administration laid the foundation of scientific justification of a return to the Moon. (2) NASA under the Obama administration has built significantly on that foundation.

First, the **NASA Lunar Science Institute (NLSI)** was established at NASA AMES and it has been funded and both spurred and reflected a revolution in the understanding of the Moon. Lead initially by its first Director David Morrison and subsequently by Dr. Yvonne Pendleton its three year report provides abundant evidence of groundbreaking advances and accomplishments in understanding the Moon. (3) The NSLI established a number of research teams in the US and also worked with a number of other nations to establish NLSI nodes in Canada, Israel, Korea, Germany, the Netherlands, the UK, and Saudi Arabia which represent networks of lunar research in each of these countries. (4) Two additional international partners may be announced in the near future. NASA's Lunar Science Institute is supported by both NASA's Science Mission Directorate and Human Exploration and Operations Missions Directorate. It 'successful model of establishing research teams has resulted in its being given an expanded responsibility for study Near Earth Object and the Moons of Mars Phobos and Deimos.

Second. the Lunar Exploration and Analysis Group (LEAG) has done yeoman work in creating a Lunar Exploration Roadmap and refining a set of Strategic Knowledge GAPS for defining exploration priorities (5) The LEAG Roadmap also advocates the establishment of a "**commercial on ramp" for lunar access**. NASA has worked effectively during this period to encourage and develop commercial initiatives.

Third, the Lunar and Planetary Institute has been the global pioneer in lunar research from the days of Apollo and also hosts perhaps the largest annual meeting of planetary scientists at it annual science conference in March and it lunar track alone draws audiences of hundreds of lunar scientists from around the world.

From the standpoint of an International Lunar Geophysical Year the NASA Lunar Science Institute, LEAG, and the Lunar and Planetary Institute are really the tip of the spear in the global scientific investigation of the MOON and in leading a coordinated international vision of more comprehensive exploration on its surface, and a vision of both permanent human presence and commercial utilization of the Moon's resources.

Fourth, NASA has developed a **Lunar Innovative Data Demonstration Program** with commercial providers to advance lunar science and technological capabilities and the commercial on-ramp.(6)

Fifth, smaller lunar and cislunar missions have been proposed and are under development and "under the radar" as small cost initiatives.

One is a **Lunar Swirls Mission,** which consists of a lunar orbiter mother ship and two 2U cubesat surface impactors that will carry small magnetometers to study anomalous regions of lunar surface magnetism associated with lunar swirls. This mission proposal is being developed at the University of California Santa Cruz by Professor Ian Garrick Bethel in association with the University of California Berkeley and Kyung Hee University in Korea, and the Max Planck Institute for Solar System Research in Germany, and Memorial University of Newfoundland, Canada, and the University of Maryland with some support at NASA AMES and from KARI. It estimated cost is $30M.

A second **LunarCube Lander mission** is being development by Professor Carl Brandon at Vermont Technical College in association with other Vermont Space Grant Institutions such as the University of Vermont. Starting with Space grant and EPCOR funding this mission anticipates with further funding support completion of a space craft in the 2016-2017 time frame. The spacecraft cost (excluding launch costs) is anticipated to be in the $1Million range.

The Google **Lunar X-Prize** has two US team missions with significant NASA connections. This third mission is being developed by Team **Moon-X lead by Bob McDonald** whose offices are located on the NASA AMES campus and which is using the standard lunar bus developed at AMES for its lander as well as AF propulsion system for it vehicle. It anticipated arrival on the lunar surface is estimated to be in 2014 and the Moon-/X team also has ambitions to be a commercial provider of lunar surface access. The NASA **LADEE mission,** in 2013, will use the same standard lunar bus and is that sense might be considered is a preliminary flight test. The cost of this mission is estimated to be in the $100M range.

The fourth mission is being developed by **Astrobotic Team** lead by Red Whittiger of Carnegie Mellon University. It will provide a variety of lunar cube scale payloads. NASA's HEOMD ISRU program is interested to fly a Resolve lunar surface drilling and sampling payload. This mission cost is estimated at a $150M cost and a launch date has been established in October of 2015. Astrobotics also has ambitions to be a commercial provider of lunar surface access.

Another new NASA proposal for an **Earth Moon Lagrange 2 Gateway** is another evidence that NASA has not abandoned the Moon in its programmatic plans. This facility would provide a facility that is part of the Flexible Path strategy recommended by the second Augustine Commission. It would provide a test bed facility to accomplish a number of deep space requirements while also enabling greater lunar surface activities. This project is also being tied to the SLS launch system but could very likely be accomplished alternatively by the Space-X Falcon 9 Heavy launch system which is scheduled for its first launch later in 2013.

NASA's Office of Chief Technologist also supports research and development on cryogenic fuel storage and transfer. A beginning initiative is already underway at the international Space Station.

This technology will lead to another element of the Flexible Path, fuel depots. These depots are another strategic step closer to the lunar surface. In combination with the Earth-Moon Lagrange station they will set the stage for routine lunar surface access by commercial providers such as those mentioned above in conjunction with the Google Lunar X-Prize but also by a newly announced company, Golden Spike, and companies such as Shackleton Energy which aim to produce lunar propellant among other things.

It seems highly likely that NASA will continue to experience a constrained fiscal environment. That is why an International Lunar Geophysical Year with a focus on international utilization of low cost Lunar Cube Hitchhiker Missions is so important. This determination to press forward in the face of a tough financial environment (that has discouraged many in the lunar community of interest) is a credit to NASA's leadership and has in fact been setting up the circumstances for a sea change in reduction of both space launch costs and commercial initiatives.

Footnotes:

1. Lori Garver speech AIAA September 2012
2. The Scientific Context for the Exploration of the Moon, NRC
3. NLSI: A Three Year Report
4. NLSI International partners: http://lunarscience.nasa.gov/international/
5. Strategic Knowledge GAPS, LEAG web-site
6. Innovative Lunar Data Demonstration Programl

About Lori Garver

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Getting Indian Astronauts on the Moon

By David Dunlop, M3IQ Editor's Opinion

Response to the article "Indian Aborts a human Moon Mission" in **The Space Review** by Dr. Ajey Lele who works at the Institute For Defense Studies and Analyses, (IDSA), a Delhi-based think-tank on security issues. Published Monday September 17, 2012. http://www.thespacereview.com/article/2157/1

D. Ajey Lele has provided a thoughtful detailed analysis of options for India's future development as a global leader and a spacefaring nation. There are many subtle and sometimes competing choices to be confronted with a large and sophisticated agency such as ISRO: Moon and Mars missions, propulsion systems development, manned systems development, commercial launches, tele-education, and telemedicine initiatives to name but a few.

1 India is participating in the /Global Exploration Roadmap, **sharing risks and leveraging limited national resources with other space powers** is a reasonable way for Indians to get to the Moon.

2 India should learn from the mistakes of the US as well as its successes. The Apollo program "footprints and flags" showed both its value and its limitations as a technological and political strategy. We got a brief period of satisfaction getting to the lunar surface with humans before the Russians, then quickly lost interest and squandered decades and fortunes by not building on the foundations laid by Apollo. The Russians beat us by demonstrating a robotic landing and sample return capability which the US never did. This lunar competition was followed by a conjoint Apollo-Soyuz orbital mission and this eventually led to a **collaboration** between the US, Russia and thirteen other nations in building the ISS. All of this took more than 30 years.

3 The objective of "Learning to live and work on another planet" facing the harsh environmental challenges and great distances remains a challenge to our species and to our global destiny. This is a much more formidable challenge than pulling of a few spectacular "stunt" missions even though they also raise the bar for national technological achievement.

4 Establishing a permanent human presence on the Moon is a goal that addresses that more formidable challenge. It is also a step forward to the goal of achieving a permanent human presence on Mars rather than another "Flags and footprints dead-end initiative.

5 If it is too expensive to think about a human presence on the nearby Moon then Mars is a planet too far, even though it has much more to favor it as a potential permanent home for the human species with higher gravity, more easily accessible water, and many advantages from its thin atmosphere, and a temperature range less extreme (though much lower) than the Moon.

6 There is no other sensible practical path to reach beyond the Earth with the goal of human settlement than to go together step by step **sharing the risks, the costs, and the rewards**.

7 Given the limitations of our small, beautiful and crowded planet, the real question is that

we cannot afford to not go beyond the Earth and obtain the resources that are needed for an advanced sustainable global civilization. This is our species intelligence test.

8 We support Dr. Abdul Kalam's strategy of international cooperation in the **development of clean energy resources from space based solar power** and his recent trip to China in that regard. We hope that further cooperation between India, China, Japan, the US and the other space faring powers is a "first priority". We must save our Earth's environment as well as grow our economy. If we do both using space based resources then we can be well positioned also to see humans living on the Moon, and Mars and beyond. Now that is indeed a grand vision put forth by Dr. Kalam and one returned with a positive response by his Chinese hosts.

9 The use of **lunar and/or asteroid resources may enable the construction of solar power satellites,** which can benefit the economic well being of all nations as well a provide solutions to the Earth's limited resources and damaged environment. So we have today more practical reasons than ever to go back to the Moon.

10 We also support a recent suggestion that an **International Lunar Geophysical Year** be organized to study the Moon's global geology and economic potential for advancing the use of lunar resources for a growing global economy. We have barely scratched the surface of lunar exploration. India has already showing its leadership with its support of the Chandrayaan II Mission in cooperation with Russia now projected for 2017. As a US citizen looking at India's progress I believe that ISRO is pursuing a thoughtful and balanced program of development and also being an international leader by example with its lunar program.

11 As a young man of 23 I was thrilled to witness the first human footprints on the Moon live on Television. I have never forgotten the excitement of that day and always hoped I would live to see humans return to the Moon to stay. In these intervening decades the global annual commercial space economy has grown to tens times the volume of NASA's annual budget. We have only begun to see what can develop from further investments in our space programs economically, socially, and financially. The tide of development will bring back people to the Moon, not because of an exotic political and technological "stunt," but as a common place occurrence where humans routinely live and work. India has no cause to worry that its citizens will participate in that regard. That tide of development will also push us out to Mars and beyond. **DD**

Editor's Comments:

A good way - NOT TO SHUT THE DOOR - but without committing either, would be for India to JOIN THE INTERNATIONAL LUNAR RESEARCH PARK program underway on the island of Hawaii.

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

Currently involved and/or sponsoring or co-sponsoring this project are: the US state of Hawaii, United Staes (NASA), Canada (CSA), Germany (DLR), and Japan (JAXA). This is a project whose ultimate goal is to create an "International Lunar Research Park" on the Moon, in the cooperative precedent of the International Space Station.

By doing so, India could one day send scientists, engineers, and/or explorers to the Moon, without having to create a manned transportation system of its own capable of landing personnel on the Moon.

The international cooperation precedent established with the International Space Station, is proving its merits and staying power, involving nations, and their space agencies, that otherwise could not afford to have a station in orbit, much less on the Moon, of their own. PK

Competition and Resolving Potential Conflicts in "the Asteroid Business"

By Dave Dunlop January 05, 2012

To even use the term "asteroid business" is something of a stretch. In general, people who have made asteroids their business have been far and few between, historically an esoteric interest of solar system astronomers. The organization that keeps track of these objects is the Harvard-Smithsonian Small Planets Center.

The First Asteroid Discovery

This "field" of study can be traced to the discovery of Ceres, the first discovered asteroid in 1799, and the largest in the inner solar system. Ceres is now considered in the class of objects of Minor Planets sharing that distinction with Pluto and other large Kuiper Belt Objects. Other large inner system asteroids include Pallas and Vesta.

Asteroid Missions

There have been several space missions that have been sent to asteroids and the dramatic Japanese Hayabusa mission which like Apollo 13 was a triumph of engineering creativity and resilience in the face of early misfortune in a sample return effort. NASA's Dawn mission spent a year orbiting Vesta 4 and is now on its way to visit Ceres in 2015. NASA's New Frontier Mission is headed out to the Pluto system also in 2015. JAXA is planning an Hayabusa II mission.

NASA's WISE mission also harvested a wealth of information about the volume of Near Earth Objects boosting the count considerably including those farther out with the Trojan positions of Jupiter.

What is likely is that there are many others to be discovered in the Lagrange positions of the large gas planets. Some have speculated that there may be more asteroids in the Trojan positions of Neptune than in the inner solar system belt between Mars and Jupiter.

Last year **Planetary Resources** made headlines with its announcement of innovative plans to launch small low cost missions with small telescopes to discover asteroids and subsequently to assay those found most promising for resource recovery. What would follow would be movement proximate to cislunar locations where these asteroids could be safely turned into profitable products such as fuels, and metals.

More recently yet the **B612 Foundation** which is concerned with planetary defense from potential impacts of Near Earth Objects. (http://b612Foundation.org)

NASA has made substantial progress but more remains to be done. The b612 Foundation is planning its own Sentinel mission of asteroid discovery. Their FAQ states :(http://b612foundation.org/media/faqs/

"We have mapped less than 1% of objects the size that hit Tunguska in 1908. More than 500,000 objects are larger than the object that hit Tunguska in 1908, about 40 meter (the size of an Olympic swimming pool) but destroyed an area about the size of San Francisco Bay area) NASA's Space Guard has identified over 90% of objects over 1 kilometer 1 diameter. Sentinel will discover more than 500,000 objects, an estimated 90 % that are operating 5.5 years, it will discover 98% of object 140 meter in diameter than can deliver a 100 megaton impact, that is 5 times the number of bombs dropped in all of World War II. The probability of a 100 Megaton asteroid impact is the same as an individual being killed in an automobile accident in any given year, 0.01%"

The Sentinel Program would permit citizen engagement in this exploration. Partners in this endeavor with the b612Foundation include the California Academy of Science and the Planetary Society.

Student engagement in this project is planned is also planned.

It would also be interesting to propose that this mission be tele-robotically serviceable. It might be possible to plan subsequent service missions via a space tug that could make this observation post a permanent observation post. By extending the time of operation one would suppose that the orbit calculations would be accordingly more precise and that undiscovered objects missed during the first 5 years would show up as the Sentinel Mission life is extended. An extended mission life for Sentinel as an element of solar system safety infrastructure is a strong arguments for an International Coalition in funding this mission.

As a not-for-profit enterprise mission concerned with planetary defense this mission could also further complicate the issue of utilization of asteroidal resources. The outer space treaty prohibits national claims of ownership but the questions of utilization and development are more ambiguous. Claims of first discovery or first arrival have been traditional justifications for "staking a claim". Development and utilization are also a basis for making a claim to land or resources.

As an internationally funded mission it could short circuit attempts (by Planetary Resources for one) to exclusive claims of discovery, subsequent assay, and subsequent exclusive use claims. As a privately funded initiative Planetary Resources asteroid map would be proprietary with no right of global access. They might withhold for example mention of discovery of an asteroid that they have determined is prime candidates for subsequent assay missions and to move to cislunar space in order to protect their discovery investment.

The very notion of moving objects that have impact potential into close proximity to Earth is another commercial assumption that needs further global scientific debate and legal consideration. Peter Kokh has said that "The suggestion that asteroid resources are a major resource of mankind is a good one but that the potential risks to Earth might warrant restrictions on the movement of such objects into the cislunar system but rather to Earth Sun Lagrange points. " Perhaps that is where O'Neil Colonies could be best built with not significant element of risk to the Earth Moon system.

A legal regime is needed to prevent a “legal fiction of private ownership of and exclusive use” of such objects. Though the Space Treaty has obstacles to claims by national states it remains to be seem how these would be enforced at present.

In the opinion of this editor, the “Common Heritage of Mankind Claims need to be address through an incentivized but regulated commercial model. Some claims based on invested capital, development activities, and an obligation to make global access to the resources feasible through such private investments are necessary. This model could both recognize and incentivize private investment and create a “fair market value” based on a “universal access via an open market philosophy” interpretation of "the common heritage of humanity language" of the space treaty as well as limitation on extortionate pricing beyond reasonable expectation of a return on private capital put at risk.

Some balance has to be struck between exclusive use by those who can afford to be "Sooners" in the asteroid belt and the ability to regulate what comes into the cislunar market place. “Cornering the markets by creating a monopoly position or crashing the market by flooding competitors with abundant new resources can be regulated in advance so that the potential robber barons of the future are not permitted to have their thumb on the scale of development or to compromise the global community of interest whose interests are compromised by such speculative market maneuvers. **DD**

Abstracts from USC ASTE Midterms Fall 2012

Madhu Thangavelu front centre and students at University of Southern California

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Rocket-Setting: An Architecture for Point-to-Point Travel

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Imagine a 30 minute flight from Los Angeles to Boston. Now imagine that you don’t use any wings. Instead of walking down a long aisle to board your plane and get to your seat, you are carried upward by an elevator until you reach your designated deck. Each passenger, seated face outward in a module stacked on top of a Falcon 9 rocket, is offered breathtaking views of the waves crashing against the beach through large windows. You are jettisoned into the sky; day turns to night, and you begin to see the curvature of the Earth.

Welcome to Space. Please brace for stage separation," a voice calmly instructs. The Falcon 9 rocket below you disconnects from the passenger vehicle and oats below you before you see it re-light, arcing back to Los Angeles Intercontinental Air & Space Port . The touch screen in front of your seat shows you that you are at 120 km altitude; you ride a swooping parabolic trajectory above the continental United States in mere minutes before the landing engines kick on and gradually reduce your speed. As your altitude drops, the engines adjust their throttle and the city lights of Boston come into view, reflecting off of the Charles River. You touch down on the pad, as a helicopter would, having just left the Pacific Ocean, reaching the Atlantic in the time it might take to drive from LAX to downtown LA.

High speed point-to-point travel has the potential to change the way we live our lives; from actually saving lives by opening up entirely new possibilities for urgent organ transportation in the medical field, to diffusing tension in hot spots across the globe before they are up in violence, to opening the skies to the public for city-to-city transits that take minutes instead of hours. Utilizing a fully and rapidly reusable vertical takeoff and vertical landing (VTVL) architecture with a Falcon 9 V1 first stage and a passenger module comparable to the fuselage of a 737, a network of terminals offering high speed Rocket Riding could be created with tweaks to existing infrastructure, linking the world's commercial hubs and great cities, allowing executives to enhance their global reach, keeping pace with new developments and opportunities around the globe.

We are at the onset of a great shift in history; a threshold in high speed transportation has arrived. As commercial space business begins to flourish, access to space will skyrocket and space technology will be advanced at an exponential rate and at reduced cost. Using technologies being developed by private industry right now, this architecture could be implemented in as soon as 5 years to utilize cheaper, reusable rockets and advanced guidance navigation and control software algorithms to revolutionize the way we get from point A to point B, making it possible for people to conduct work and business anywhere in the world with the ability to be back home in time for dinner.

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Intermediate Space (iSpace) Communications: Ad Hoc HighAltitude Wireless Networking

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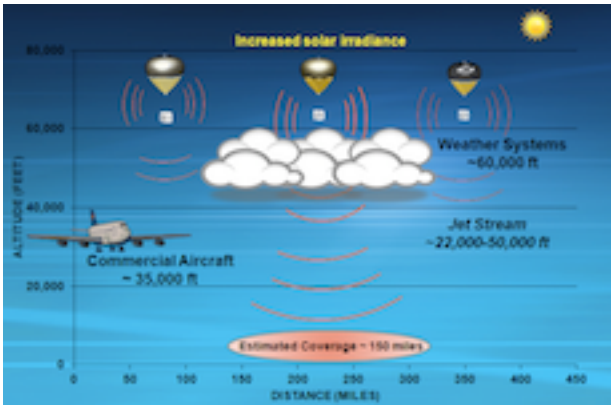

Wireless communication has become an essential asset to the US and the world. These networks seamlessly decipher, decode, and recode information across the country at lightning speed. As the majority of the population switches to a wireless device for primary communication, companies are continually upgrading their networks to handle the increased capacity within an allotted radio spectrum. Most users are unaware of the vast infrastructure required for these communications until there is a disruption. With the recent disaster of Hurricane Sandy, we have been reminded of the limitations of our current power and communication system.

An ad hoc cellular communication network using high altitude balloons powered by thin film photovoltaic cells can provide near-term communication during national emergencies. During a disaster such as an earthquake, hurricane, or solar storm, power can be disrupted for days if not weeks. After such a disruption, a cell on a balloon (COB) can be deployed at key areas within minutes and elevate to a desired altitude above weather and commercial aircraft. This allows a line of sight communication and surveillance to a large area as well as uninterrupted solar power for the cell. As each cell drifts due to the prevailing winds, additional cells can be deployed to continue coverage within a specific area and also communicate with the previously launched cell. This ad hoc network can provide key communication without the need of an infrastructure, ground based power or road access. This network can also be utilized for rural area communication or military deployment zones. Such a network can provide the necessary communication at times of greatest need.

Space Culinary Additive Food Engineering (Space CAFE)

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The need for food is inherent to all life, and humans are no exception. As we push the boundaries of space exploration and extend missions into endurance-class space travel that are potentially months to years in duration, it will be necessary to bring sustenance as well as develop the technologies to create a variety of foods and store it for future use. Due to extremely high monetary cost to launch payload of any kind, it will become essential to provide a better solution for generating and feeding humans in situ or during transit.

From deep isolation experience, ranging from deep-sea oil rigs and submarine missions to research done at the Antarctica, it has been proven that crew members appreciate good, fresh food much more than other creature comforts.

Current solutions for astronaut food production, from packaging to delivery, and nutrition are insufficient for longer duration space missions as well as for the settlement of the Moon, Mars or asteroids. There is ongoing research being conducted to help further develop food for astronauts to make it taste better, look better and even grow nutritious, fresh food and meats in zero gravity or microgravity. Some technologies, such as biological food growth chambers are sensitive to space environment and operate reliably only within a narrow range of varying parameters.

Newer and readily available technology for three-dimensional printing/extruding presents a quicker and more reliable option, opening up the possibilities of use in the concoction of new flavors, creative and aesthetically pleasing design and presentation of food and meats for space missions.

There is currently a large void in the industry for creative and custom food creation for space applications. Food production and consumption technology needs to ramp up to the next level of sophistication in order to keep the crew happy and productive while on long tours of duty.

This proposed technology also enables commercialization of 3D food printing for personalization of a variety of food products on Earth, both in the home setting as well as in restaurants and economy through consistency for high volume food production facilities.

The use of 3D extrusion of foods in space will not only provide essential sustenance but a creative and social outlet for long term missions. Other potential exists for expanding the utility of 3D printing for space missions, including fully recyclable form-fitted astronaut wear, and is the topic for further study.

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Large Space Cubesat Telescope (LSCT)

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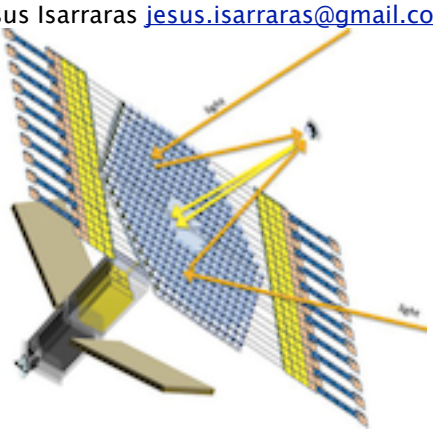

LSCT attempts to provide an alternate approach to traditional space telescope architecture design with the implementation of highly segmented mirrors with advanced position control of active optics and large cellular morphology aperture construct (CMAC) This approach focuses on reducing overall cost, aperture areal density, structural mass, and leveraging the growing global cubesat community to obtain telescopes with large primary mirrors for direct extrasolar-planetary observation. A global educational, participatory framework to execute, manage and share data from such a mission is proposed.

Cubesat missions have gained extreme momentum and focus during the past decade, due to their relative low cost in testing and demonstrations of innovative technologies for space science and developmental architectures. An area within the cubesat mission space that is seeing innovative concepts is the development of larger cubesat fractionated architectures, created with multiple cubesat clusters working together to execute a mission. One such approach will allow for large optical apertures to be realized at a fraction of the cost of current imaging satellites (e.g Hubble Space Telescope (HST) at $2.5B and James Webb Space Telescope (JWST) at $8.8B) which employ monolithic and large segmented primary mirrors, respectively.

In comparison to HST and JWST, the LSCT architecture will allow for a deployable primary mirror to reach a diameter of 20m. This is possible because LSCT removes current limitations on primary mirror area attributable to high production costs of large, finely figured, monolithic and segmented mirrors and associated support structures, substituting them with highly compact, modular cubesat elements and structures for efficient packaging.

LSCT will use proven technology and recent advances in materials and active optical figuring, ultra-lightweight optics and structures, mirror packaging, mirror segment deployment, autonomous freight formations (secondary mirror and heat shield), and advancements in guidance, navigation and controls.

The Earth-Sun Lagrangian point L2 is the potential orbit, since it provides opportunities for studying early universe phenomena, monitoring extremely faint and distant galaxies, as well as dark matter and dark energy problems confounding astronomers today.

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Surrogate Astronaut Robotic Avatars (SARA): Co-Robotics for Safe, Economic Space Operations

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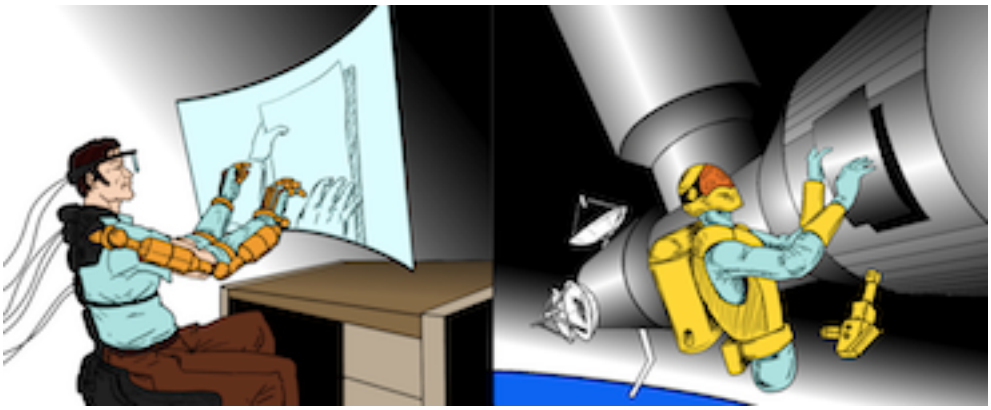

Manned spaceflight has been predominantly a government arena, with the high costs and risks to human life posing a major turn-off for private enterprises seeking involvement in space activity. As humans begin to reach out beyond LEO, missions will become increasingly complex and unpredictable, and manpower may still be limited by safety concerns and costs. A means of simplifying mission design elements, and improving human safety and economy is therefore necessary to help entice private space industries into operating directly in space, working alongside government agencies, to accomplish large-scale projects or hazardous missions. A solution lies in the newly evolving eld of real-time human-robot interaction and cooperation, or co-robotics.

With Robonaut 2 currently being tested for work aboard the International Space Station, the potential of co-robotic humanoids to operate efficiently in tasks alongside or in lieu of humans is a major consideration for future space mission design. Building on the development of Robonaut and other telerobotic advances, aided by faster computation and IT communications networks, and the rapidly declining costs of sensors and end-effectors, the creation of teleoperated, fully humanoid, robotic surrogates (or Avatars) would provide a medium through which humans can operate freely, safely, reliably and economically in the space environment without sacrificing the cognitive and dexterous advantages that are required in complex or poorly-defined and often unbounded operations.

In the near term, validating the capabilities of these Surrogate Astronaut Robotic Avatars (SARAs) aboard the International Space Station would provide a showcase of mission possibilities for potential enterprises hoping to engage in space-based development and activities, while ordering additional manpower to the station via telepresence. Eventually larger constructs, such as cislunar vehicles, lunar landers and habitats could be manufactured and assembled in space by surrogate workers, making interplanetary transit, habitation vessels and space stations cheaper and safer to develop without reliance on fully automated systems. Eventually, humans could also utilize these robotic extensions or secondary Avatar bodies to explore the universe in safety and confidence. ####

Global Last-Line of Defense System (GOLD)

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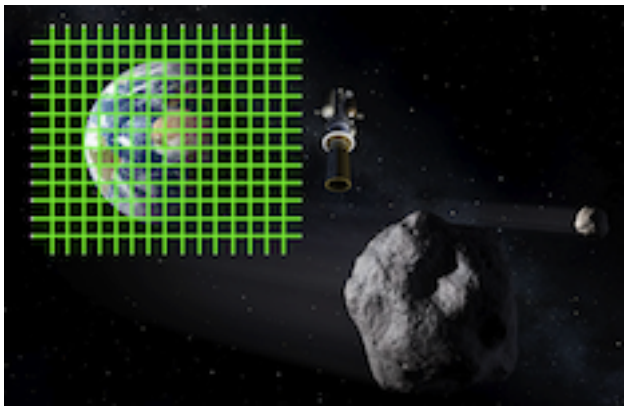

The need for a global planetary defense program can no longer be thought of as a Hollywood blockbuster starring Bruce Willis. Humans have known of the possible cataclysmic event and have still taken no real action to put up a credible defensive barrier between our home and the eventual impact of an asteroid. Earth also is no stranger to this phenomenon either; from the extinction of species to the powerful Tunguska event occurring just within the past 100 years, it has experienced a multitude of impacts, both big and small. But still, mankind stands idly by, confident that the unspeakable and unthinkable cataclysm would never happen, that we have mapped out all the possible threats within our reach, and have pushed aside any need for action, presently thinking, \Well deal with it when the time comes". This concept proposes a program to abandon this line of thought and establish a credible defense strategy given 21st century technology coupled with the worlds surplus nuclear arsenal allows us to do so, for the rst time ever in human history.

With our powerful ground and space-based sensors, we have the capability of detecting a body with a size on the order of 10 km with a significant lead time; but what of those bodies that are smaller, possibly still inflicting great damage to Earth with very little warning time? The GOLD system will be capable of launching at any point, on any timeline, towards any target, ensuring that we are ready to defend the planet from rogue asteroids.

Utilizing the technology already in use on several defense programs, the GOLD system will guide its interceptor autonomously to an incoming target, use powerful infrared sensors to pinpoint the best possible detonation point to within a ten meter accuracy, and deliver a powerful subsurface nuclear detonation, giving the asteroid a slight enough push, ensuring its trajectory will no longer be in Earths path. Through this concept we will show the necessity for a nuclear device to ensure the mitigation of the incoming threat, the possible scenarios the GOLD system will have to adapt to, as well as establishing a global planetary defense agency, working together towards the stability and safety of Earths biosphere.

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Long Term Radiation Belt Remediation (LT RBR)

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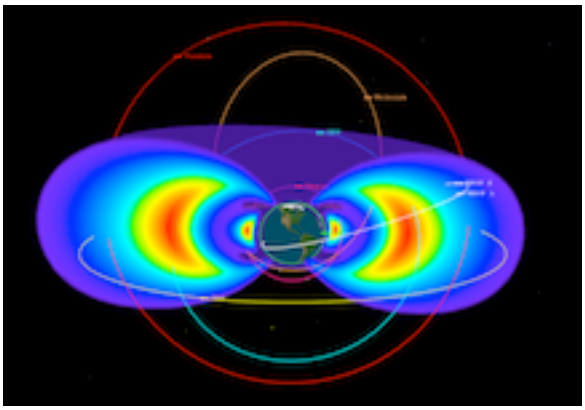

One of the major mission duration limitations for near Earth spacecraft is the total radiation dose accumulated by spacecraft traversing the Van Allen radiation belts. This radiation wrecks havoc on electronic and biological systems, forcing expensive redundancy and shielding while limiting mission life. No Near Earth Orbit (NEO) is outside of the radiation belts and so all missions must accept the restrictions and added cost of operating in such a

hostile environment. Every spacecraft system is affected including power, thermal, communications, sensors, data handling and storage as well as cryogenic and biological systems. Over the past few decades, on the shelf electronics have gotten smaller, faster, and cheaper, but spacecraft electronics have lagged behind due to the restrictions of operating in a radiation environment where the miniaturization of components has resulted in an increase in radiation related errors and failures. To this day the primary method of dealing with the environment has been to add shielding to sensitive electronics components, to use hardened components not easily available, to add multiple redundancies in the event of an electronic failure, and to design to end of life conditions which result from long term radiation exposure.

The radiation environment has been thoroughly studied since its discovery by the first U.S. satellite Explorer 1. Discoveries about the dynamic nature of the belts are still being made, and studies of how the environment reacts to solar and nuclear events abound. In these studies, several proposals for Radiation Belt Remediation (RBR) have been put forth to the community. Many of these studies focus on a rapid response remediation as a reaction to a large solar event or high altitude nuclear detonation, in which the radiation belts become infused with a large number of high energy particles which are particularly damaging. These studies also focus on the effect of flushing a large number of particles into the Earths atmosphere in a very short time period, which has several negative effects. A long term solution would focus on a gradual and continual remediation of the radiation belts in order to bring the ambient ux to within 1% of their steady state conditions while avoiding the nasty side effects of rapid remediation.

In this presentation a brief description of the known hazards of the radiation environment to manned and unmanned spacecraft as well as an overview of the processes that form the radiation belts are discussed. A proven method for remediation is put forth and the potential side effects are presented. Finally, a method for remediation without side effects is presented using current technology and existing architecture.

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Aggregation of Non-functioning Geosynchronous Spacecraft

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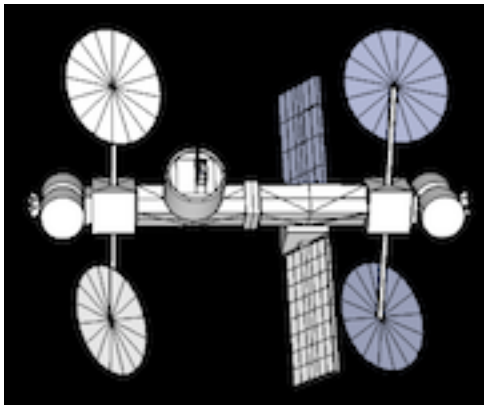

In October 1945, Arthur C. Clarke proposed using geostationary satellites as telecommunications relays. In the 1960s, the first geosynchronous (GEO) communication satellites started to be launched. The average lifetime of these stations are between 15-20 years. So, most of these decommissioned satellites continue to drift and orbit the Earth today, many of them in or near very useful GEO orbit, also known as the Clarke belt.

In addition, without station keeping, these spacecraft slowly drift in graveyard" orbits, causing interference to operational stations, and also increasing the likelihood of uncontrolled collisions, which have the potential to litter the regime with debris, making the entire geosynchronous orbit unusable.

While the industry has begun looking at extending the life of currently operating spacecraft, less focus has been given to what to do with these decommissioned, non-functioning spacecraft (NFS).

Through a combination of a teleoperated tug utilizing similar \docking" concepts as the life-extension vehicles and a storage platform for the NFS, the NFS will be aggregate all decommissioned stations, one at a time, into a single spacecraft. Eventually, the fully loaded storage platform will move to a different orbit for repurposing, recycling or salvage of useful components. This procedure is repeated until all decommissioned NFS are safely removed from graveyard orbits, thus making the Clarke belt safer for operational spacecraft and station keeping.

To this end, an international not-for-profit organization could be established, in the tradition of INMARSAT or INTELSAT; taking this route may help to overcome some initial policy hurdles and challenges. Eventually the organization might transition to a private for-profit company.

Aqua Lune: Water Prospecting and Reclamation of Volatiles on the Moon

Richard Seefeldt seefeldt@usc.edu

The story of humanity is one of exploration, discovery and the productive settlement of new frontiers. Drawing on the likes of Magellan and Cook, Lewis and Clark, Hillary and Armstrong humanity will reach out beyond our world to other destinations in our solar system and eventually extend our species domain outwards into the galaxy. This will be a learning process and the journey must be well planned.

The Moon, though barren in its magnificent desolation, due to its proximity is our first logical stepping stone. But just like the great explorers of our past, future pioneers will have to learn to live off the land; to draw resources from the environments they find themselves a part of. The most critical in-situ resource will be water. It will most certainly be impractical to take large quantities of it with us. As conclusively indicated by missions such as LCROSS and Chandrayaan, there are substantial reservoirs of water-ice on the Moon.

The next step is precise location and quantification of these reservoirs. Several nations and private companies are already in the planning stages to harvest this lunar water and volatiles for such things as propellant and oxygen for atmospheric replenishment. The concept architecture presented here outlines a system of off the shelf components such as modified Athena-class MSL rovers with specialized payloads like GPR-deep drill attachments, ASRG power supplies deployed by an appropriate class of landers that could be implemented immediately to really gauge this valuable resource for extraction. As we expand our civilization beyond Earth its clear that water will be the gold and oil of space development and those who know how to prospect for and utilize it will undoubtedly be the barons of the next frontier. ###

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About the ASTE 527 program: ASTE (ASTronautical **E**ngineering**)**
at the University of Southern California, Los Angeles, California, USA

http://astronautics.usc.edu/academics/courses/

ASTE 527 Space Exploration Architectures Concept Synthesis Studio

- Programmatic/conceptual design synthesis/choice creation methods for complex space missions.
- Aerospace system engineering/Architecture tools to create innovative projects.
- Evaluated by faculty/industry/NASA experts.
- Prerequisite: graduate standing in engineering or science; recommended preparation: ASTE 520 or experience in space industry.

Madhu Thangavelu is the Director of the ASTE 527 Space Exploration Architectures Concept Synthesis Studio
Contact: thangavelu-girardey@cox.net

The successful pioneer is one who, coming upon an obstacle,
Studies it from different perspectives,
Until he/she sees it as **an opportunity**. - Simon Cook

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

GREAT BROWSING LINKS

SPACE STATIONS + COMMERCIAL SPACE

http://www.space.com/18283-**spacex-dragon-capsule-recovery**.html
http://www.space.com/18378-**nasa-space-station-text-messages**.html
http://www.space.com/18537-**soyuz-spacecraft-rare-night-landing**.html
NASA Selects Small Businesses for Continuation Of Innovative Research and Technology Projects
http://www.spaceref.com/news/viewpr.html?pid=39174
Bed rest experiment may suggest ways to deal with effects of weightlessness, and lower gravity
http://www.esa.int/esaHS/SEMYK072Q8H_index_0.html

MOON

http://www.space.com/18276-**moon-dark-spot-ocean-storms**.html
http://www.space-travel.com/reports/**Proof_at_last_Moon_was_created_in_giant_smashup**_999.htm
http://www.space-travel.com/reports/
Astrium_presents_results_of_its_study_into_automatic_landing_near_the_Moons_south_pole_999.html
http://www.space-travel.com/reports/**European_mission_to_search_for_moon_water**_999.html
http://www.space.com/18549-**moon-water-private-spaceflight.html**

MARS

http://www.space.com/18286-**mars-rover-curiosity-soil-analysis-chemin**.html
http://www.space.com/18339-**mars-methane-alien-life**.html
http://www.space.com/18333-**mars-rover-curiosity-methane-measurements**.html
http://www.space.com/18546-**mars-caves-sample-return-mission**.html
http://www.space.com/18596-**mars-colony-spacex-elon-musk.**html - (story & 3 videos)
http://www.space.com/18980-**radiation-manned-exploration-deep-space.**html
http://www.space.com/18513-**curiosity-detects-but-can-t-see-dust-devils-on-mars-video.**html
http://www.space.com/18769-**mars-rover-curiosity-mission-extension**.html
http://www.space.com/18771-**nasa-next-mars-rover-sample-caching**.html
http://www.space.com/18753-**mars-radiation-manned-mission**.html **Curiosity analyzes Martian soil sample -**
http://www.nasa.gov/home/hqnews/2012/oct/HQ_12-383_Curiosity_CheMin.html
http://www.nasa.gov/home/hqnews/2012/oct/HQ_12-387_**Mars_Atmosphere**.html
Making Mars a Nicer Place http://www.thespacereview.com/article/2152/1

MERCURY

http://news.yahoo.com/blogs/sideshow/**nasa-says-enough-ice-mercury-encase-washington-dc**-194415297.html
www.space.com/18647-**how-big-is-mercury.html** - www.space.com/18646-**mercury-distance.html**
www.space.com/18645-**mercury-temperature.html** - www.space.com/18644-**mercury-atmosphere.html**
www.space.com/18643-**mercury-composition.html** - www.space.com/18641-**mercury-formation.html**

ASTEROIDS

http://www.space.com/17827-**vesta-troughs-asteroid-collision.html**
http://www.space.com/18326-**asteroid-belt-evolution-alien-life**.html
http://www.space.com/18373-**presidential-election-obama-nasa-future**.html
Asteroid Belts at Just the Right Place, Friendly to Life www.astrobiology.com/news/viewpr.html?pid=39111

OTHER PLANETS + MOONS

http://www.space.com/18272-**jupiter-io-volcano-eruptions-pizza-moon**.html
http://www.space.com/18308-**saturn-moon-titan-glow**-cassini.html
http://www.space.com/18363-**venus-express**.html
http://www.space.com/18875-**titan-nile-river-cassini.**html
http://www.space.com/18584-**dwarf-planets-solar-system-infographic**.html
http://www.space.com/18583-**dwarf-planet-makemake-atmosphere**.html
http://www.space.com/18583-**dwarf-planet-makemake-atmosphere**.html
http://www.space.com/18628-**pluto-atomosphere-larger**.html
http://www.space.com/16538-**pluto-moons-explained-infographic**.html
http://www.space.com/18679-**enormous-vortex-on-saturn-snapped-by-spacecraft**-video.html
http://www.space.com/18508-**asteroid-protection-nuclear-bombs.**html
http://www.space.com/18901-**nasa-mission-jupiter-moon-europa.**html

ASTRONOMY + ASTROBIOTICS

http://www.space.com/18474-**alien-planets-multiple-stars-tilted-orbits.html**
http://www.space.com/18461-**rogue-alien-planet-discovery.html**

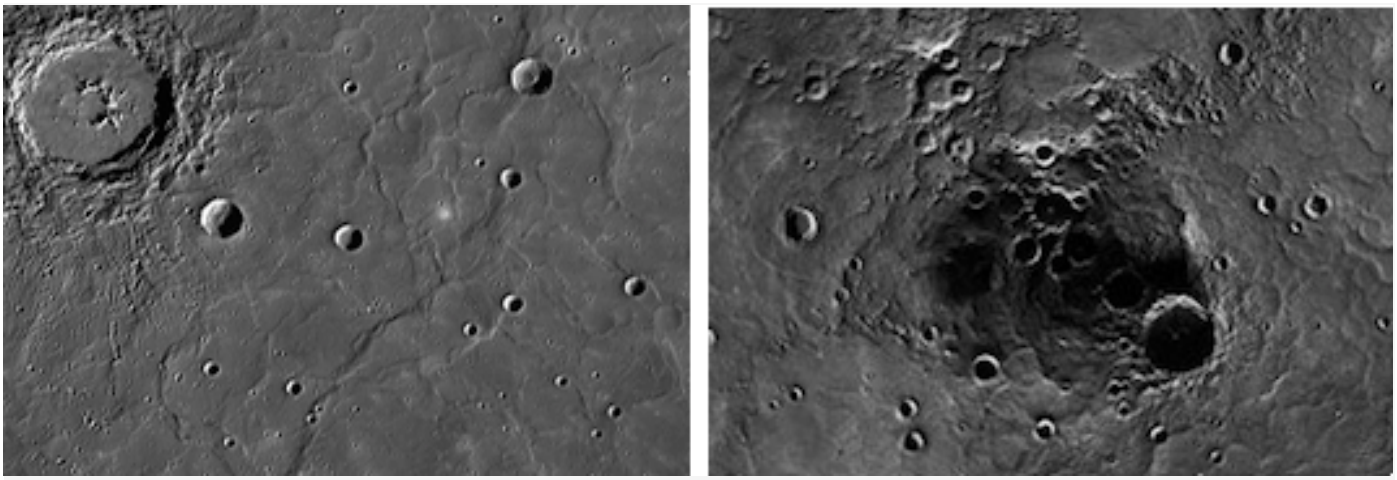
GREAT SPACE VIDEOS

http://www.space.com/18328-**curiosity-x-rays-mars-soil-first-results-video**.html
http://www.space.com/18599-**what-did-curiosity-find-on-mars-video**.html
http://www.space.com/18436-**curiosity-inhales-mars-gets-carbon-dioxide-buzz-video**.html
http://www.space.com/18767-**curiosity-s-sister-to-launch-to-mars-in-2020-video**.html
http://www.space.com/18375-**stars-the-life-and-death-of-stellar-fusion-engines-video**.html
http://www.space.com/17919-**life-on-titan-saturns-cold-moon-fascinates-scientists-video**.html
http://www.space.com/18666-**captain-kirk-touts-medical-tech-spun-from-nasa-video**.html
http://www.space.com/18718-**polar-ice-melt-causes-sea-level-rise-satellites-find-video**.html
http://www.space.com/18757-**3-d-printers-on-moon-to-print-space-parts-video**.html http://www.space.com/18801-**private-company-wants-bootprints-on-the-moon-by-2020-video.htm**
http://www.space.com/18796-**back-to-the-moon-for-power-scientist-says-go-video.html**
http://www.space.com/18792-**enceladus-sample-return-mission.html**
http://www.space.com/17540-**how-did-mars-lose-its-atmosphere-maven-aims-to-find-out-video**.html
http://www.space.com/18931-**nasa-gangnam-style-music-video-parody-with-a-purpose**.html
http://www.space.com/18972-five-planets-discovered-one-potentially-habitable.html
http://www.space.com/19130-**asteroid-vesta-crater-3d-photo**.html (do watch!)
www.space.com/18400-**jupiter-s-moons-some-icy-some-volcanic-and-some-larger-than-our-moon-video**.html
http://www.space.com/13139-**space-fully-reusable-rockets-works.html**
http://www.dailymotion.com/video/xw8h0c_**nasa-reveals-new-spacesuits_travel**#.UN5kAaV5nz**J**
Study of Nearby sun-like star Tau Ceti indicates it may have 5 planets, one in "habitable zone"
http://www.space.com/18972-five-planets-discovered-one-potentially-habitable.html (video)
Cassini15 Years Exploration - http://www.nasa.gov/multimedia/videogallery/index.html?media_id=154837611
SKA - Square Kilometer Array South African section
http://www.ska.ac.za/media/animations/**meerkat_2011.mov** **(24.2 Mb)**
NASA Johnson Style (Gangnam parody) - http://www.youtube.com/watch?v=2Sar5WT76kE

VIDEO TOUR OF ISS by guide Sunita Williams

http://www.space.com/18598-**iss-tour-cupola-weightlifting-and-a-closet-module-video**.html
http://www.space.com/18597-**iss-tour-russian-segment-soyuz-spacecraft-video**.html
http://www.space.com/18591-**iss-tour-labs-exercise-bike-space-suits-video**.html
http://www.space.com/18590-**iss-tour-kitchen-bedrooms-the-latrine-video**.html
http://www.space.com/18618-**rocket-sled-nasa-retro-tech-tests-future-planetary-descents-video**.html
Small Reactor for Deep Space Exploration - http://www.youtube.com/watch?v=KobRfGqlpGc&feature=youtu.be
For more, go to http://www.youtube.com/?tab=wy and search for "ISS Tour"

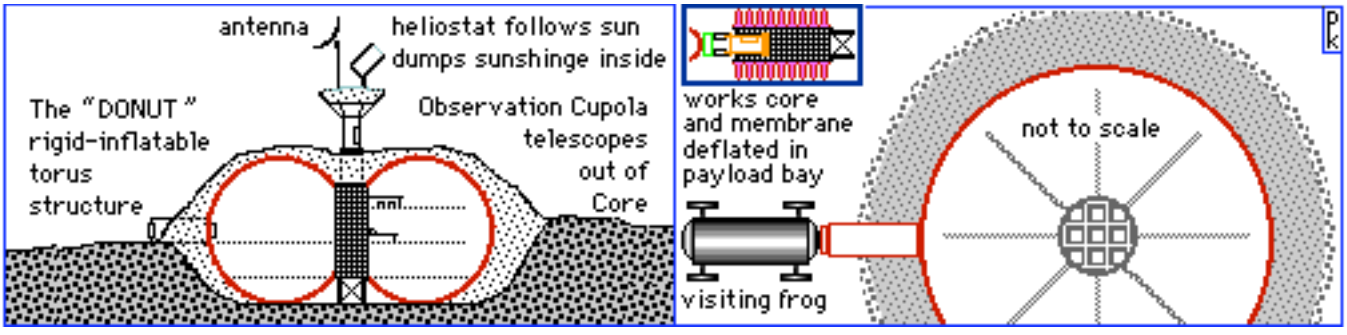
M3IQ PHOTO GALLERY



Left: This view from NASA's Messenger spacecraft orbiting **Mercury** shows a region of smooth, volcanic plains heavily modified by tectonic "wrinkle ridge" structures, low, sinuous features that form when lavas cool and subside, causing the crust to contract. This area is likely to have many intact sheltering lavatubes.


Images from the 2012 NASA Sample Return Robot Return Challenge at WPI
http://www.nasa.gov/home/hqnews/2012/oct/HQ_12-377_NASA-WPI_2013_**Robot_Competition_Registration**.html

Earliest Inflatable outpost concept dates from 1961 – reinforces advantage of the stable footprint of the torus, as well as the low height to volume ratio, for ease of shielding. Torus units can also be stacked, or multi-floored. The torus also adds an element of safety: in an emergency, any point is accessible from two opposite directions. The empt core can be packed with equipment and provide access to the surface above the moondust shielding.
http://www.space.com/18772-inflatable-station-concept.html
For more on this concept, see "The Lunar "Hostel": An Alternate Concept for First Beachhead and Secondary Outposts, part 2 http://www.moonsociety.org/publications/mmm_papers/hostels_paper2.htm Figure 7



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

Editor's Selection ------2013 -----

Jan 7 – Feb 8 — **International Space University, University of South Australia**, Adelaide, Australia: Southern Hemisphere Summer Space Program.

Jan 21 — **Space Age Publishing Company**, Hawaii Island HI and Silicon Valley CA: 'Jupiter Mission Design Competition' Re-Launch for Human Jupiter Mission research and development, following 25-year suspension of JMDC in 1988, after its Launch Jan 20, 1984; further info TBA.

Mar 5-7 — **International Space University**, Strasbourg, France: 17th ISU Annual International Symposium: 'Space Technology and Tele-Reach: Benefiting Humanity on Earth and Beyond.'

May 23-27 – International Space Development Conf. (NSS), San Diego, CA – monitor the NSS 2013 ISDC Student Website for Current Updates / New Information: https://sites.google.com/site/**isdcforstudentcompetitions**/

Mid-2013 — **NASA, ESA, Launch Lunar Atmosphere and Dust Environment Explorer (LADEE) / Minotaur V**, Wallops Island VA: 160 day mission to Moon to transmit laser signals to NASA stations in California and New Mexico as well as ESA's Optical Ground Station in Tenerife, Spain.

Apr 4-5 – National conference on Space and Astronomy (NCSA2013) in **Chandigarh, Harayana** The conference is being organised jointly by International Space Society (ISS) & Society for Promotion of Science & Technology in India (SPSTI). The conference theme is "Astronomy." Eminent speakers such as Prof. Jayant Naralikar and others will address more then 3000 students from India and around the world. The topics chosen aim to create awareness among the students and inspire them to take careers in Astronomy. Some of the topics for example are: " Why Study Astronomy" and "Search for Micro-Life in Earth's Atmosphere."

NET Apr — **ISRO, Launch GSLV / GSAT 14**, **Sriharikota, India:** An ISRO Geosynchronous Satellite Launch Vehicle with Indian-built cryogenic 3rd stage set to launch GSAT 14 communications satellite.

Apr 15-19 — **IAA, NASA, ESA**, Flagstaff AZ: '2013 IAA Planetary Defense Conference.'

Apr 22-26 — **International Space University**, Strasbourg, France: Executive Space Course.

May 5-8 — **Planetary & Terrestrial Mining Sciences Symposium, Space Resources Roundtable, Canadian Inst of Mining**, Toronto, Ontario, Canada: 4th Annual PTMSS/SRR Symposium; in conjunction with CIM 2013 Convention.

May 20-24 — **NASA, Kennedy Space Center**, Titusville FL: NASA 4th Annual Lunabotics Mining Competition; for university-level students to design / build innovative excavators (Lunabots) able to mine and deposit at least 10 kg of lunar simulant within 10 minutes.

May 23-27 — **The National Space Society**, San Diego CA: '32nd Annual International Space Development Conference.' Moon Society to host Track on Lunar Lava Tubes

Jun — **CNSA, Launch Long March 2F / Shenzhou 10**, Jiuquan, China: Long March 2F to launch Shenzhou 10 spacecraft for crewed mission to dock with Tiangong 1 laboratory; China 5th human space mission.

Jun 17 – Aug 16 — **International Space University, National Institute for Space Research,** Sao Jose dos Campos, Brazil: The International Space University's 26th Annual Space Studies Program; held at the National Institute for Space Research (INPE) campus

Jul — **CNSA, Launch Long March 5 / Chang'e-3**, China: 3rd robotic Moon Mission with 1st lunar rover; to be 1st soft landing on Moon since 1976 if successful; anticipating 3 months of lunar work; sample return planned for 2017.

Jul 25-27 — **Space Frontier Foundation**, Silicon Valley CA: NewSpace 2013 Conference.

Nov — **ISRO, Launch PSLV / Mars Orbiter**, India: Augmented version of 4-stage Polar Satellite Launch Vehicle set to launch Orbiter carrying 25 kg of scientific payloads to Mars.

Nov — **NASA, Launch Atlas V 401 / MAVEN**, Cape Canaveral AFS FL: Mars Atmosphere and Volatile EvolutioN (MAVEN) to determine Martian upper atmosphere, role of atmospheric gas loss in changing Martian climate over time; mission to last 1 year; launch window Nov 18 – Dec 7; Nov 18 launch expected to reach Mars Sept 16, 2014.

------2014 -----

NET 2014— **NASA, Launch Ares 1 CLV / Orion CEV**, Cape Canaveral AFS FL: Unpiloted orbital Exploration Flight Test-1 of Orion Crew Exploration Vehicle.

NET 2014 — **ISRO, Launch GSLV / Chandrayaan-2**, India's 2nd Moon Mission with Russian lander/rover.

NET 2014 — **SpaceX, Launch Falcon 9 / Flight 6,** Cape Canaveral AFS FL: Powered for the first time by Merlin 1D engines, which will enable a full range of payloads to orbit, the SpaceX Falcon 9 rocket set to launch flight 6 to ISS for resupply.

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

Trivia hint for non-Indian Readers

As in 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 pronounce letter by letter "I"-"S"-"R"-"0" (4 syllables) but **Is**-Ro (2 syllables.

Moon Miners' Manifesto Resources

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

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

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

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

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

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

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

www.moonsocietyorg/publications/mmm_classics/

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

www.moonsociety.org/publications/mmm_themes/

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

www.moonsociety.org/publications/m3glossary.html

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

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

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

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

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

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

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

Help Circulate MMM-India Quarterly

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

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

MMM-India Quarterly will remain a free publication.

Space Organizations in India

The International Space Society

Survival
Growth
Prosperity
Curiosity

Membership in ISS is open to students, entrepreneurs, and all other space enthusiasts

Headquartered at Dikshant International School, Zirakpur

REGD. Office 1310 Sec. 21, Panchkula, Harayana, (India) – 134116,

http://www.internationalspacesociety.org – mitul@internationalspacesociety.org Mobile +91 98141 35504

"The Vision of ISS is people living and working in thriving communities off the Earth, and the use of the vast resources of space for the dramatic betterment of humanity"

The Mission of ISS is to promote social, economic, technological, and political change in order to expand civilization beyond Earth, to settle space and to use resulting resources to build a hopeful and prosperous future for humanity. Accordingly, we support steps toward this goals, including human space flight, commercial space development, space exploration, space applications, space resource utilization, robotic precursors, defense against asteroids, relevant science, and space settlement oriented education.

ISS wishes to serve schools, cities and towns across India having a special interest focus on rocketry astronomy clubs, educational / community outreach program by organising events, communicating with the public on the merits and benefits of space exploration, working to educate political leaders, inspiring new generation of space activists. The purpose of the Society includes: **space advocacy, education, volunteering, and technical projects** that can excite and energize the grass roots space movement. We plan to invite Astronauts and space scientist from across the world and to organise International Space Development Conferences across India

International Space Society Rationale [language below same as that of the National Space Society]

A. Survival – Of the Human Species and of Earth's Biosphere

It is the nature of every from of life, whether animal or plant to strive to survive. The human species is encountering increased natural, man-made, and extraterrestrial threats, including disease, resource depletion, pollution, urban violence, terrorism, nuclear war, asteroids, and comets.

Many forms of animal and plant life on Earth are suffering increase loos of population and quality habitat because of the growing presence of humans on planet Earth, via expansion, pollution, deforestation, fishing, farming mining, and promotion of certain species of animals and plants.

Space technology provides both means to monitor threats to life on Earth and ways to help curtail them. Space industrialization and settlement provide safety valves to relieve the pressures that cause Earth bound threats. They also provide escape routes in case of catastrophic man-made or extra terrestrial threats. Humanity has inherited the stewardship of the planet Earth. It will therefore need the vast resources of outer space to reverse the damage it has caused to the Earth's biosphere, and ultimately enhance all life on Earth.

B. Growth – Unlimited Room for Expansion

It is the nature of every form of life, whether animal or plant to grow and multiply. The human species, as well as all other animal and plant life on Earth, need room to grow and multiply. Earth has a finite supply of land, air, and water for which humans, animals, and plants must compete. Of all Earth species on humans have or can acquire and utilize the knowledge to create new habitats on other worlds or in space from the raw materials of moons and asteroids.

To provide the human species with a new "frontier" for exploration and adventure, and to thoughts and expression, culture and art, and modes of government. The opening of 'the New World to western civilization brought about and unprecedented 500-year period of growth and experimentation in science, technology, literature, music, art, recreation, and government (including the development and gradual acceptance of democracy). The presence of of a frontier lead to the development of the "open society" founded on the principles of individuals rights and freedoms. Many of these rights and freedoms are being placed under increasingly stringent limitations as human populations grows and humanity moves towards a "closed society." where eventually everyone eats the same, speaks the same, and dresses the same. "**Cultures that do not explore, die**."

C. Prosperity – Unlimited Resources

It is the nature of the human species to strive to improve the quality of its many lives and to provide a better future for its children. Improved Standards of Living: To provide humanity with the resources it needs to improve the quality of life for all humans on the planet. The majority of humanity that is far below that of the Western democracies. Outer space holds virtually limitless amounts of energy and raw materials, which can be harvested for use both on Earth and n space. Quality of life can be improved directly by utilization of these resources and also indirectly by moving hazardous and polluting industries and/or their waste processes off planet Earth.

Economic Opportunity: To provide every human individual with the opportunity to improve the well being of hum/herself, and his or her family. Vast new resources must be developed if all persons are to be given economic opportunities for themselves and their children even marginally equal to what many would consider minimally tolerable standard of living.

Technological Development: To provide remote locations for the development, testing, and "perfection" of promising, but potentially hazardous technologies, such as biological experimentation; nuclear, fusion, chemical and antimatter power generation; and space propulsion. Such developmental facilities could be placed either in space or on other words far from both space settlements and unrelated facilities.

D. **Curiosity - The Quest for Knowledge**

It is the nature of the human species to learn more about its origins, its past, its fellow life forms, it environment, its limitations, and its possibilities for the future. Earth is but a tiny container of knowledge compared to the entire incredibly vast universe. "We are part of the universe, Through our eyes, ears, and minds the universe may know itself."

International Space Society Principles

These are the guiding principles of the ISS, by which we will conduct our mission.

- **Human Rights:** ISS shall promote the principle of fundamental human rights of every human being.
- **Ethics:** ISS shall observe, practice, and promote ethical conduct.
- **Pragmatism:** Within the bounds of these Principles, ISS shall promote any and all methods and practices that support achievement of our vision.

International Space Society Beliefs

While we cannot say that the following are absolutely essential for space settlement, we believe and support the following.

- **Individual Rights:** ISS believes that space development and settlement will occur most efficiently, and humanity's prosperity will be best ensured, if every human being is given the freedom of thought and action.
- **Unrestricted Access to Space:** ISS believes that space development and settlement will occur most efficiently, and h to humanity's prosperity will be best ensured, if every human being is allowed the opportunity to travel, live, and or work in outer space.
- **Personal Property Rights:** ISS believes that space development and settlement will occur most efficiently, and humanity's survival and growth will be best ensured, if every human being is allowed the opportunity to own property in space and/or on other worlds. travel live
- **Free Market Economics:** ISS believes that space development and settlement will occur most efficiently, and humanity's prosperity will be best ensured if the "free market" drivers of competition and profit are used.
- **Government Funding of High Risk Research and Development:** ISS believes that space development and settlement will occur most efficiently, and humanity's prosperity will be best ensured, if national government funds research and development of space technologies deemed too high risk by their industries.
- **International Cooperation:** ISS believes that space development and settlement will occur most efficiently. and humanity's survival and prosperity be ensured, if nations cooperate on space research and development, and leave competition to individual companies.
- **Democratic Values:** ISS believes that humanity's growth and prosperity will be best ensured if the fundamentals of democracy are applied to and incorporated by space settlements.
- **Enhancement of Earth's Ecology:** ISS believes that one of the goals and benefits of space development and settlement is to restore and enhance the biosphere of planet Earth.
- **Protection of New Environments:** ISS believes that space development and settlement shall be pursued in a manner that safeguards alien life forms, natural wonders, and historical monuments.

WEBSITE MENU: About us – Membership – ISS Philosophy – Board of Directors – Activities – Awards – Press Releases – Annual Conferences – Contests – Space Settlements – Space Tourism – Home – **www.internationalspacesociety.org**

http://www.indianexpress.com/news/**international-space-society-to-hold-meet-in-february**-next-year/1008407

Membership fees: Students 1,000/–; institution (20 students) 5,000/–; Professionals 5.000/–

NOTE: The ISS will hold its 2nd **National Conference on Space and Astronomy** in Chandigarh, **April 4-5, 2013** – contact information above

Students for Exploration and Development of Space - India

http://india.seds.org/ -

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

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

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

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

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

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

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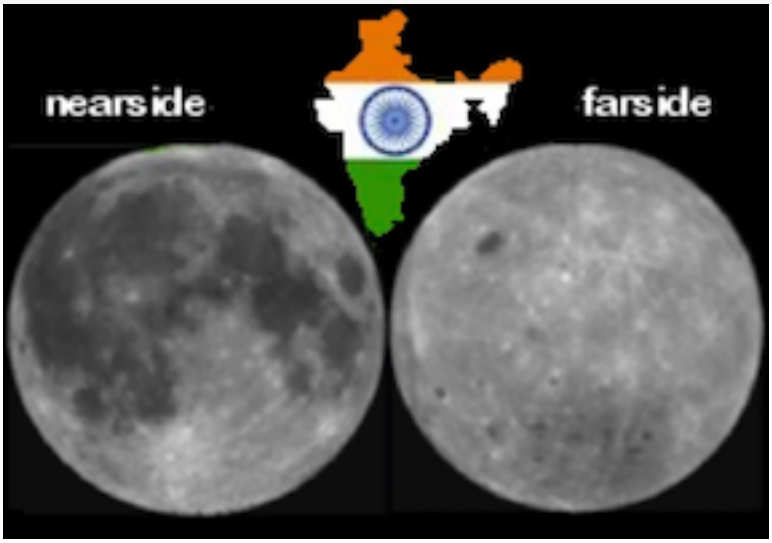

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