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

Moon Miners' Manifesto

India Quarterly Edition www.moonsociety.org/publications/mmm-india/

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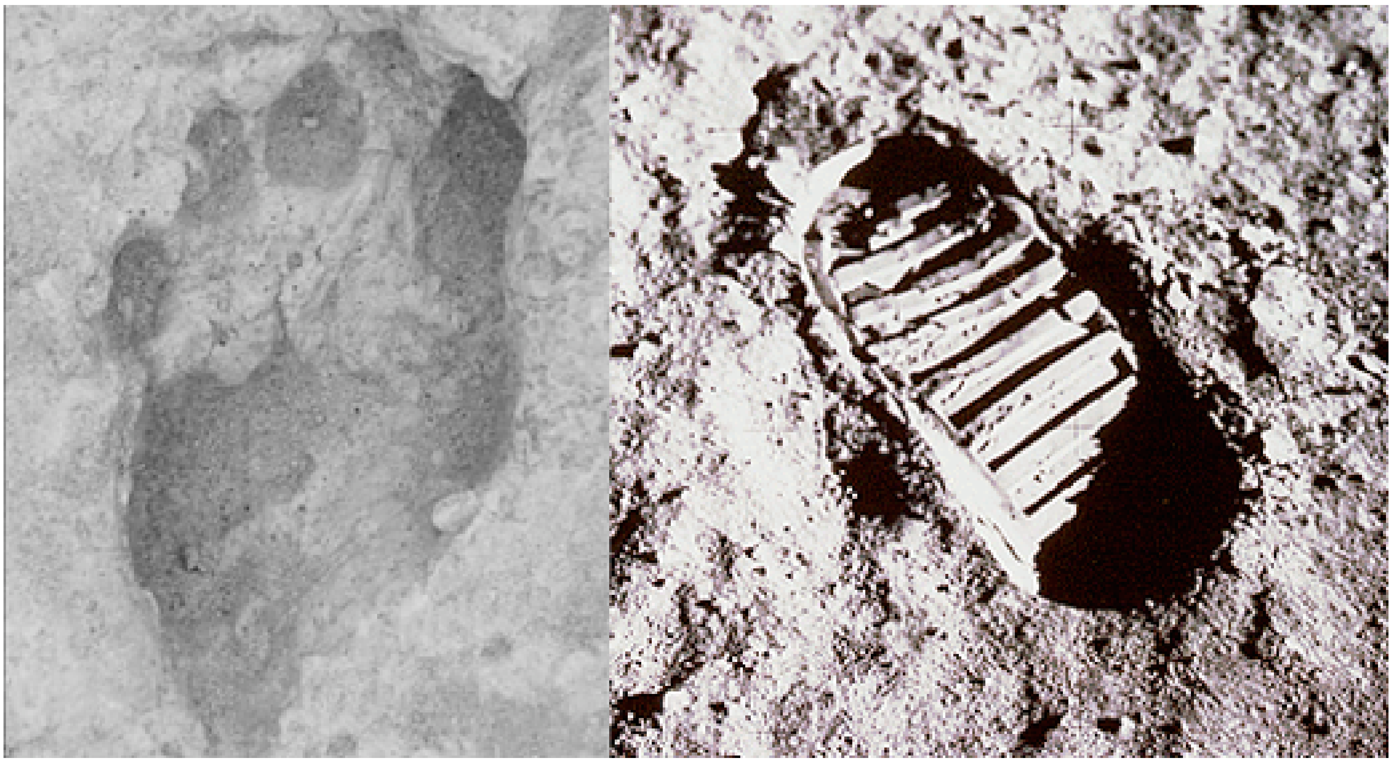

Our epic saga: *From the oldest known human footprint, 1.5 million years ago in Kenya, to the first bootprint on the Moon.*

Feature Articles in This Issue

Shifting Our Publication Schedule

This issue appears five months after the previous one, not three. Our intention is to stretch out the interval at which #4 will appear also. There is a practical reason for this. The M3IQ editor, who also produces the regular issues of MMM, has a semi-annual break in July and January, with MMM being published ten times a year. It makes sense that two M3IQ issues come out in those months, i.e. January and July, cutting in half the number of issues published in the same months as MMM.

So our new M3IQ schedule that looks like this: **January, April, July, October**. Putting less stress on the Editor will better insure longevity of this publication venture.

Why did we start M3IQ when we did? That is simple. We wanted to follow the Chandrayaan-1 launch as closely as we could, to take advantage of the significant rise of public enthusiasm in India. Indeed, without that incentive, M3IQ #1 might have never appeared! -- <PK>

About The Moon Society

http://www.moonsociety.org

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

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

Moon Society Strategy
We seek to address these goals through education, outreach to young people and to people in general, contests & competitions, workshops, ground level research and technology experiments, private entrepreneurial ventures, moonbase simulation exercises, tourist centers, and other legitimate means.

About Moon Miners' Manifesto

http://www.MoonMinersManifesto.com

MMM is published 10 times a year (exc. Jan. and July) The December 2009 issue will begin its 24th year of continuous publication.

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

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

Issues #145 (May 2001) forward are available as pdf file downloads with a Moon Society username and password. Moon Society International memberships are $35 US; $20 students, seniors – 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 lag is kept between the MMM Classic volumes and the current issue. The **1st 20 issues** are freely accessible to all, no username or password needed, at:
http://www.moonsocietyorg/publications/mmm_classics/
The start of a glossary is online at:
http://www.lunar-rcclamation.org/papers/m3glossary.html

Editors of MMM-India Quarterly:
Peter Kokh kokhmmm@aol.com
Madhu Thangavelu thangavelu-girardey@cox.net
David A. Dunlop dunlop712@yahoo.com

About MMM-India Quarterly

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

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

Background

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

The contest was designed to help students learn about various objects in the solar system as they compete in the design of a mission.
http://www.youthplanetary.org/moon_mission_contest.html

Why an MMM-India Quarterly?

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

And – *India is now at the Moon!*

In short, we wanted 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 environmental degradation in the process. In short, we would like to share our glimpse of an emerging greater Earth-Moon Economy.

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

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

Free Access:

MMM-India Quarterly issues will continue to be available as free access pdf file, downloadable from the Internet. We encourage readers to share these files with others freely, and to use this publication to grow and cultivate widespread 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.

Call for a Global Space Revolution

by Shaun Moss, Melbourne, Victoria, Australia
shaun@starmultimedia.biz

The world stands on the brink of imminent global change. The challenges currently being presented to human society by instabilities in the global climate and economy are significant; finding solutions will assuredly occupy much of our attention over the coming decades.

However, in perfect balance, we also find our-selves at the doorstep of the greatest evolutionary leap that Earthian life has encountered since it crawled out of the oceans. We are poised to enter space – not simply as a handful of select persons or machines, but as a species.

The development and implementation of new systems for global environmental and economic management is widely understood to be of the utmost urgency, and, fortunately, steps are already being taken in this direction by great leaders and thinkers around the globe. However, what seems less apparent are the astronomical rewards for humankind that will result from expansion into the Solar System.

The potential benefits of space exploration and colonization include:

The Overview Effect

By all astronaut reports, nothing compares with viewing the entire Earth from space. From this perspective the planet appears as a single, whole entity: a shining jewel, a living, breathing organism with no borders or other visible signs of separation between its inhabitants. It becomes more difficult to imagine that one is from any specific city or nation; rather, one sees the entire planet as "home". From space, all people and nations are equal, bound together by the one thing we all have in common – the planet of which we are all a part.

This perspective of Earth will lead to a greater unity among its peoples, an effect that will only increase as we colonize other worlds such as Luna and Mars. From space, any place on the surface of Earth is equally accessible; the differences between so-called "developed" and "developing" nations are not apparent, and indeed, from this perspective it becomes difficult to understand why such extreme variations in economic standards exist on the surface.

This profound shift in human consciousness from viewing Earth as a collection of distinct tribes to a single living world, experienced by increasing numbers of people, will automatically lead to the formation of new strategies for global environmental and economic management.

Access to Abundant Resources

Space is infinite, and contains infinite energy and material resources. By developing the necessary technologies and systems, humans can access these resources.

Once you see beyond religious, ideological or other purported reasons, conflict on Earth is almost always about natural resources such as energy, metals or land. Although limited on Earth, all of these are available in extreme abundance in space:

- Solar power, collected in an environment where the sun never stops shining and is never occluded by clouds or dust, can be efficiently and safely beamed to Earth (or anywhere else in the Solar System) to provide continual, limitless and reliable energy.
- Over 400,000 asteroids have been identified in our Solar System, with more being discovered all the time; the estimated total is over 1 million. Many of these orbit near Earth, and many are composed of almost pure metal, while others are plentiful sources of carbon or water. Access to these resources will mean an improved Earthian economy, reduced need to damage Earth's environment through mining, reduced international conflict, and an abundance of the necessary materials for constructing space cities and vehicles in Earth orbit and other locations throughout the Solar System.
- Mars has a surface area approximately equal to the land area of Earth. The colonization and subsequent terraforming of Mars will therefore provide the human race with almost double the territory in which to live. This will only be the beginning; the experience of inhabiting and developing just one such planet will teach us how to colonize many more.

Survival

While infrequent, it is known that mass global extinctions caused by asteroid impacts have occurred several times in Earth's history, and will almost certainly occur again. Hence, in order to ensure the long-term survival of humans as well as many other Earthian species, there are only two reasonable options:

1. Establish human colonies at other locations in space, so that in the event of a major impact the human species will survive and may potentially re-inhabit Earth afterwards.
2. Learn how to modify the orbits of asteroids, or how to break them into smaller pieces, so that a potential extinction-causing impact can be prevented.

Both of these solutions require increase technical capability in space.

If an impactor asteroid or comet is above a certain size or velocity, it will be impossible to divert or destroy it; furthermore, extra-terrestrial colonies will probably be dependent on resources from Earth for centuries. Hence, the optimal strategy for the long-range survival of humanity requires both of these solutions.

Increased Global Collaboration

At our current level of technology, exploration and development of space is still fairly expensive and complicated. Furthermore, considering that the effects of space research are often global in application rather than restricted to specific nations, there is overwhelming incentive for international collaboration in space activities. This has been one of the primary benefits of the International Space Station, which has brought together some of the greatest countries of Earth into a noble and productive exercise.

During the past century several arenas of activity have replaced military conflict, including sport, tourism, international trade, political union, and collaboration on technological development. The nations of Earth have started to realize that co-operation, instead of competition, leads to an improved outcome for everyone. By building on the success of the ISS and continuing with international collaboration on space development, the nations of Earth will be drawn into an even closer partner-ship. This can only lead to peace and an improved quality of life for everyone on Earth.

Technological Innovation

Countless examples already exist of technologies that were developed for space and have since been applied on Earth (computer technology, structural analysis, the hand-held video camera, communications, IT, sports training, energy storage, robotics, materials, etc., etc.). The question is, would these technologies have still been developed if people were not striving to solve difficult problems in space?

When given inspiring and challenging problems, the human mind begins experimenting with solutions and gathering information, consciously and subconsciously alike, with the result being eventual inspiration and breakthroughs. The challenging environment of space presents unusually hard problems, which thus tends to attract the most brilliant minds, resulting in especially innovative solutions that can have enormous application and value on Earth.

For example:

- Technologies developed for space settlements such as atmosphere processing, in-situ resource utilization, recycling, etc., can similarly be applied to open up huge uninhabited regions of Earth, while also improving the efficiency and function of existing cities.
- Advanced robotics technology developed for exploration, mining and construction in space can be applied on Earth to an extremely wide variety of tasks, decreasing the cost of materials, products and services, and improving health and safety.
- Energy production methods developed for space applica-tions, such as space solar power or nuclear fusion, can be applied on Earth to provide abundant electricity and thus improved quality of life to all people.
- Biotechnology developed for space agriculture or terra-forming can be applied on Earth to drastically improve global food production and health.
- Carbon nanotube technology developed for space elevator applications can be applied to create all manner of ambi-tious structures and equipment on Earth, as well as space structures and vehicles.
- Planetary engineering strategies developed for terraforming Mars can be applied to Earth in order to improve the global environment, including cleaning the atmosphere and oceans, bringing life to the deserts, and stabilizing global climate.
- Vehicle technology, developed for space applications, will increase the speed and lower the cost of travel on Earth, vastly improving the efficiency of human transport, resource distribution, package delivery and emergency response.

The colonization of space offers hope for humanity. It is simply the only path to an abundant and peaceful future for an expanding human civilization. It will bring us every-thing we need to develop and grow; without it, our future will be one of increasing restriction, compromise, difficulty and conflict. If the number of people continues to increase while the amount of avail-able resources remains the same, then, logically, this means a reduced share for all. The only other option is population control, which is not freedom; in fact, it would require increasing control by global authorities, and we would ultimately lose many of our technological capabilities along with our peace and freedom.

As an analogy, consider a tribe living on a small island. Their population steadily increases, but the amount of land they have available to grow food remains the same. They know that across the sea is a large, uninhabited continent with abundant resources, but they decide not to risk investing in trying to reach this place, and to focus all their energy on the immediate problems of survival. Eventually they begin to fight over the dwindling resources and further damage is inflicted on the island, and the tribe, until only a few remain to pick up the pieces.

Compare this with another tribe in a similar situ-ation. They, too, are growing in number and approaching the population limit that the island can sustainably support; they also know about the abundant resources across the sea. Even though they are experiencing challenges, they realize that these problems will only get worse unless they find a way across the sea, so they begin researching boat technology while also tending to their immediate problems. This tribe is more optimistic – they know that their problems are temporary, and that soon a new era in their civilization will begin: one of peace, expansion and security.

At this juncture in human history, with the chal-lenges that now lie before us, opening up space should be made an absolute global priority. It should not be something of marginal interest, or a heavy load to be pulled along by a dedicated few, or something we will do "when we get around to it" or "when things are better". The sooner we become a space-based civilization, the sooner tensions on Earth will be relieved and we can enter an golden era of peace, harmony, expansion, abun-dance, adventure, freedom, health and happiness. It should be commenced immediately, and should be under-taken with wholehearted passion and commitment by the entire global community.

The following strategy is suggested:

1. The establishment of an Earth Space Consortium (ESC) comprised of governments and government agencies, private corporations, academic institutions, space advocacy groups and philanthropists. This organization would be funded by both public and private money, with each member contributing an appropriate percentage of GDP or profits. The function of the ESC will be to organize a substantial fraction of Earth's resources (in particular, at least 10-30% of Earth's finest minds) into a unified and cohesive strategy for providing the people of Earth with access to the abundant resources and limitless expanse of space.
2. Government-sponsored financial benefits, including tax exemption or discounts, and/or investment, should be available for all companies involved in space exploration and development, environmental engineering, and the

development of critical enabling technologies such as aerospace vehicles, solar power and robotics. This will hasten the development of solutions to immediate global problems, and more quickly secure a better future for all people.

3. A dedicated, coordinated and well-funded global program for reducing the cost of access to space. Everything depends on it; at this point, the primary obstacle preventing humanity from becoming a space-faring civilization with the resources of the Solar System at its fingertips is the exorbitant cost of reaching free space from Earth. The initial phase of a unified Earth space program should be primarily focused (90%+ of expenditure) on advancement of space transport technology.
4. A global program to develop space solar power as a method of providing continuous, reliable and abundant clean energy to Earth, while simultaneously increasing our capabilities in space and developing technologies for on-orbit construction.
5. A global program to develop space tourism as a viable economic motivator for the private space sector, a source of inspiration and adventure to the people of Earth, and an essential precursor to space property development and colonization.
6. Development of a robust and profitable space mining industry. This will simultaneously provide three enormous benefits: an economic incentive for space development; a great abundance of metals, carbon, water and other materials necessary for construction of a space civilization; and the development of technologies and methods for defending Earth from asteroid impacts.
7. An international collaborative effort to establish permanent human settlements in Earth orbit and on Luna and Mars. These seeds will become new branches of human civilization, thus ensuring the long-term survival of humans and many other Earthian species. The exercise will also teach us about advanced recycling, nanotechnology, robotics, resource management, advanced biology and chemical engineering, planetary engineering, the successful formation of harmonious, close-knit communities, and many other things that can be applied with tremendous benefit on Earth.

The time is now. It will only become more difficult over the coming years. The past doesn't matter, and neither do our petty conflicts over resources; all that matters now is creating a positive future for ourselves and for our descendants. The sooner we make space development our utmost priority and open up space for the people of Earth, the sooner we will enter an amazing new chapter of human civilization. We need to pull together as a team, get organized and focused, and create an exciting new future of peace and freedom – in space. **<SM>**

Shaun Moss was born in Melbourne, Victoria, Australia, but has lived most of his life in Brisbane, Queensland, Australia. Shaun has been a Moon Society member since shortly after the Society was formed. Earlier this year he joined the Moon Society Leadership Council and in August 2009 will become a member of the Board of Directors.

Widely traveled, Moss brings an international perspective to his work and to the organizations to which he belongs. Shaun, like the editor, has also long been a avid member of the Mars Society, and tends to see things in perspective of how both frontiers can open together and to each other's benefit.

He hopes to unveil his new project shortly, the new interactive www.moon-mars.com website, which will serve enthusiasts of both frontiers. **<MMM>**

moonmars.com

www.moonmars.com is a new online social network dedicated to everyone interested in **exploring & colonizing the Moon & Mars**.

A place where enthusiasts, professionals, businesspeople and students can **connect**, **communicate** and **collaborate**, as we work together towards an exciting future in space.

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(don't worry - we will never share your information)

Launch Date: Summer, 2009
Email Shaun Moss: shaun@starmultimedia.biz

If the surface of Mars is as expansive as that of all seven of Earth's continents together, how large is the surface of the Moon?

Various valid answers on page 13 *below.*

20 Questions about Resources from the Moon

Q. What is the Moon made of?

A. Tests on Apollo Moon rock samples showed that they contain high percentages of Oxygen, Silicon, Iron, Aluminum, Titanium, Magnesium, and Calcium with lesser amounts of many other elements

Q. Are not these elements common enough of Earth?

A. Yes, these same principal eight elements are the major constituents of Earth's own crust.

Q. Then what is the advantage of extracting such commonplace resources from the Moon?

A. There is no advantage at all if the idea is to bring them to Earth itself. But because of the Moon's much lower gravity, 1/6th that of Earth's, it would take only 1/20th the fuel or energy cost to transport these raw materials all the way back to Low Earth Orbit (LEO) or to Geosynchronous Earth Orbit (GEO) rather than rocket them up the short distance from Earth's surface. In LEO and GEO, we could then afford to use building products made from these raw materials to do a lot of interesting things.

Q. What sort of useful building products could be made from these few elements?

A. Eventually, we should be able to make high-quality metal alloys such as steel (from iron), aluminum, titanium, and magnesium – the four "engineering metals." But this would require an elaborate industrial complex. In the short run, it would be relatively easy to make serviceable sintered iron products, glass, fiberglass, and a glass-glass composite on the analogy of fiberglass-reinforced plastics. We can also make some ceramics and even concrete (on Earth, the #1 building material by far.)

Q. What things in particular would these cheaper lunar resources allow us to build in space?

A. Much larger "space stations" than we can now afford to haul up from Earth module by module is one example. And only with these "cheaper" raw materials could we ever afford to build orbiting factories to take advantage of vacuum and micro-gravity to make things that can't be made on Earth's surface, or orbiting hotels and resort complexes for tourists to enjoy spectacular views of Mother Earth, or the large orbiting Solar Power Satellites to provide Earth with inexhaustible clean power.

Q. Given Earth's two most pressing problems, our deteriorating environment and poverty in developing nations, how can we justify the high up-front costs of tapping lunar resources?

A. Many things are contributing to our deteriorating environment, but easily the number one villain is electrical power generation from coal and oil burning plants that fill the air with acid rain and greenhouse gases that will eventually destroy the climate. Even if the more developed nations would switch to all nuclear power generation, an option with its own unwanted consequences, people in the developing nations would have no way to catch up in standard of living except by burning even more fossil fuels tha we do today, specifically coal. Space-based power generation is ultra-clean and there is no end to the amount available where the Sun provides it free full-time. Without such spade-based electrical power generation, Earth's environment and the World's developing populations will share the same death sentence.

Q. Besides the more abundant elements mentioned, does the Moon have truly strategic resources?

A. A big surprise was that the Apollo Moon Rocks contained 600 times as much of a rare form of helium, helium-3, as is found on Earth. This endowment is not native to the Moon and is only to be found in the upper meter or so of the ubiquitous rock powder blanket (regolith). It was apparently put there by eons of buffeting of the Moon by the wind or particles streaming out from the Sun's hot atmosphere, the "Solar Wind." If we ever succeed in engineering workable fusion power plant, Helium-3 would be the ideal fuel as burning it produces no radioactive particles, not even neutrons, only charged particles that can produce electricity directly. There is enough of this "ultimate fuel" in the Moon's dust blanket to provide Earth with all the power we want for thousands of years.

Q. What chance is there of unhappy side effects of generating our electrical power in space?

A. Power from orbiting Solar Power Satellites will have to be beamed down to Earth either by laser or by radio waves in the microwave range – *but not the same as those in your oven, which would be dissipated by water vapor in the atmosphere!* Tests to date deliberately using insect and bird species that might be most vulnerable to such waves have encouragingly shown no ill effects. There are fail-safe ways of controlling the beam and keeping it on target to ground-receiving stations (rectennas.) But some economic dislocation of coal miners and petroleum workers is the unavoidable price we'll have to pay for either a Solar power Satellite Network or a Helium-3 fusion plant system Yet putting these systems in place could employ even more people than those put out of work, especially in developing countries. A clean Earth and a decent standard of living for all are the reward.

Q. Where on the Moon is this wealth to be found, and just how would we go about extracting it?

A. On the Earth, long and powerful geological processes in the presence of water have worked to concentrate much of the mineral wealth in scattered veins and lodes of ore. On the Moon this did not happen and these minerals lie everywhere in similar concentrations. The dark maria or Seas are richer in iron and titanium, the light highlands richer in aluminum, magnesium, and calcium. There need be no race to "stake out claims." Eons of meteorite bombardment have pulverized and "gardened" the Moon's surface into a powdery blanket 2-10 meters deep. All we need is here, and much of the "mining work" has already been done for us.

Q. Won't mining operations scar the Moon with open pits and unsightly piles of unwanted tailings?

A. As we've just seen, the mineral wealth of the Moon is lying loose on the surface. In essence, we just need to rake the top meter or so of the moondust to harvest what we need. We will want to do this in generally flat areas, going around big craters, etc. So there will be neither deep mines nor open pits, and the minerals not needed will be left in place. A visitor would have to come very close to tell that anything had been done. There will be no insulting eyesores. From Earth, even with the most powerful telescopes, there should be no visible clues.

Q. How large a crew would be needed on the Moon?

A. Simple resource recovery operations could begin with perhaps a dozen people using tele-operated equipment where feasible. Liquid oxygen to use for air, and to combine with hydrogen to make water, and for rocket fuel would be the first product. With a few more people we could begin making things from cast basalt, and sintered iron; concrete objects and glass-glass composite products would be next.

Q. How could people live in such a barren place?

A. The first shelters will be compact space station type habitat modules and inflatable structures brought from Earth, covered with 2-4 meters of moon dust for protection from cosmic rays, solar flares, micrometeorites, and thermal extremes. Essentially this dust blanket will do for Lunan pioneers what our atmosphere blanket does for us. But fairly soon, crews should be able to move into much more spacious structures built from raw materials on hand. These roomy quarters could be flooded with piped-in sunlight and filled with plants to keep the air clean and fresh as well as providing fresh fruit and vegetables.

Q. Would miners sign up for short tours of duty? Or go on to stay and bring their families along?

A. Certainly, the first volunteers will only stay a few months at a time. But as the outpost grows, a point will be reached where it is cheaper to provide the facilities a permanent population will need rather than to keep shuttling personnel back and forth from Earth. As soon as possible, it will be helpful for some crew to volunteer as trial settlers, even raising some children. For until we can see how native-born children grow up, we cannot be absolutely sure that genuine settlement an long be maintained. To find that out, we need to take the plunge.

Q. What long-term consequences will there be for permanent pioneers and their children?

A. We can expect some loss of muscle tone and mass in adjusting to a lower gravity, but this loss should level off at an acceptable, healthy plateau. The longer we put off allowing volunteers to stay long-term, the longer we will have to wait to find out if this expectation is correct.

Q. Wouldn't a settlement of any real size need a continuous infusion of very costly imports?

A. The Moon has very stingy amounts of hydrogen to make water by combining with abundant local oxygen, and stingy amounts of carbon and nitrogen, all essential for growing food and fiber. These elements are present in the loose dust blanket, again as a gift of the Solar Wind, and we can harvest them by heating the dust to about 600 °C. If we do this religiously whenever we handle moondust as in road construction, site preparation, and mining and manufacturing methods, and recycle, again religiously, we should manage. The alternative is to import these elements at great expense. Eventually, richer sources of these "volatile elements" can be mined on nearby asteroids, even from the two small moons of Mars.

Q. To build a healthy, diversified economy, what else could the colony export besides building materials, rocket fuel, and fusion fuel?

A. Almost everything the pioneers would make for themselves to avoid unnecessary imports, will also find a ready export market in space-based installations in Earth orbit and elsewhere, "killing two birds with one stone."

Q. Even if all this development does not scar the Moon, won't it cause pollution there?

A. The settlement will need to operate as closed biosphere, recycling its air, water, and biomass. As settlers will have to live "downstream and downwind of themselves," they will have to keep their little oases of life fresh and clean. The host Moon itself has no atmosphere, groundwater or ecology of its own to pollute.

Q. What about the suggestion that the Moon might be used as a dump for Earth's problem wastes?

A. Even if waste disposal authorities on Earth become desperate enough to pay the high freight charges to send some problem wastes into space, it will be cheaper to let the Solar Wind slowly blow them out of the Solar System altogether than to land them on the Moon. If however in the toally safe, sterile vacuum and biological isolation of the Moon, it proves possible to "mine" such wastes for elements rare on the Moon, the settlers may welcome them.

Q. How far off in the future is all of this and how much scarce money will we have to invest?

A. The first genuine Moonbase is still on the drawing boards. Genuine settlement will require technologies NASA is neglecting such as closed biospheres and manufacturing under lunar conditions. It will be essential to get private enterprise involved. A lunar settlement could eventually become a very profitable undertaking, especially considering the limitless potential for electrical power sales. The up-front costs, admittedly high can be borne by utility energy consortiums rather than by public taxes.

Q. How inevitable is such an Earth-Moon economy?

A. Before private enterprise can get involved, the "infrastructure" to get us "back to the Moon to stay" must be in place whether through government or corporate funding. Tax monies "invested in the future" rather than "spent on present itches" may be needed. Earth-bound enterprises must be enticed to pre-develop technologies needed later, on the Moon and in space, for any profitable terrestrial applications that can be identified, now. This is called "spin-up" the very reverse of the much-heralded "spin-off" process about which most taxpayers could care less. Spin-up addresses the "What's in it for me?" question.

We can do it! ***###***

Chandrayaan-1 Reports

Jan 24, 2009 **C1XS catches 1st glimpse of Moon X-rays**
http://www.spaceref.com/news/viewpr.html?pid=27420

April 2, 2009 **Mini-SAR completes First Mapping Cycle**
www.nasa.gov/mission_pages/Mini-RF/news/mini-sar_first_map_cycle.html

Says Dr. Paul Spudis, principal investigator for the Mini-SAR instrument, Lunar and Planetary Institute in Houston:

"We are hard at work finishing the calibration of our instrument, required in order to make definite statements about the nature of the radar backscatter signature, the tell-tale sign of the presence or absence of water ice."

A Dozen Early Chandrayaan-1 related Papers

http://www.ias.ac.in/currsci/feb252009/contents.htm
(Scroll down to SPECIAL SECTION CHANDRAYAAN-1)

486 Chandrayaan-1: India's first planetary science mission to the moon - J. N. Goswami and M. Annadurai

492 Terrain Mapping Camera: A stereoscopic high-resolution instrument on Chandrayaan-1 - A. S. Kiran Kumar, A. Roy Chowdhury, A. Banerjee, A. B. Dave, B.N. Sharma, K. J. Shah, K. R. Murali, S. R. Joshi, S. S. Sarkar and V. D. Patel

496 Hyper Spectral Imager for lunar mineral mapping in visible and near infrared band - A. S. Kiran Kumar, A. Roy Chowdhury, A. Banerjee, A. B. Dave, B. N. Sharma, K. J. Shah, K. R. Murali, S. Mehta, S. R. Joshi and S. S. Sarkar

500 Moon Mineralogy Mapper (M3) on Chandrayaan-1 - Carle M Pieters, Joseph Boardman, Bonnie Buratti, Alok Chatterjee, Roger Clark, Tom Glavich, Robert Green, James Head III, Peter Isaacson, Erick Malaret, Thomas McCord, John Mustard, Noah Petro, Cassandra Runyon, Matthew Staid, Jessica Sunshine, Lawrence Taylor, Stefanie Tompkins, Padma Varanasi and Mary White

506 Near Infrared Spectrometer SIR-2 Chandrayaan-1 - Urs Mall, Marek Banaszkiewicz, Kjell Brønstad, Susan McKenna-Lawlor, Andreas Nathues, Finn Søraas, Esa Vilenius Kjetil Ullaland

512 Lunar Laser Ranging Instrument (LLRI): a tool for the study of topography and gravitational field of the Moon: J. A. Kamalakar, A. S. Laxmi Prasad, K. V. S. Bhaskar, P. Selvaraj, R. Venkateswaran, K. Kalyani, A. Goswami and V. L. N. Sridhar Raja

517 The Chandrayaan-1 X-ray Spectrometer - Manuel Grande, Brian J. Maddison, P. Sreekumar, Johani Huovelin, Barry J. Kellett, Chris J. Howe, Ian A. Crawford5, D. R. Smith, C1XS Team

520 High Energy X-ray Spectrometer on Chandrayaan-1
P. Sreekumar, Y. B. Acharya, C. N. Umapathy, M. Ramakrishna Sharma, Shanmugam, A. Tyagi, Kumar, S. Vadawale, M. Sudhakar, L. Abraham, R. Kulkani, S. Purohit, R. L. Premlatha, D. Banerjee, M. Bug and J. N. Goswami

526 Investigation of the solar wind–Moon interaction onChandrayaan-1 mission with the SARA experiment
Stas Barabash, Anil Bhardwaj, Martin Wieser, R. Sridharan, Thomas Kurian, Subha Varier, E. Vijayakumar, Veena Abhirami, K. V. Raghavendra, S. V. Mohankumar, M. B. Dhanya, Satheesh Thampi, Asamura Kazushi, Herman Andersson, Futaana Yoshifumi, Mats Holmström, Rickard Lundin, Johan Svensson, Stefan Karlsson, R. Daniele Piazza and Peter Wurz

533 Mini-SAR: an imaging radar experiment
Paul Spudis, Stewart Nozette, Ben Bussey, Keith Raney, Helene Winters, Christopher L. Lichtenberg, William Marinelli, Jason C. Crusan and Michele M. Gates

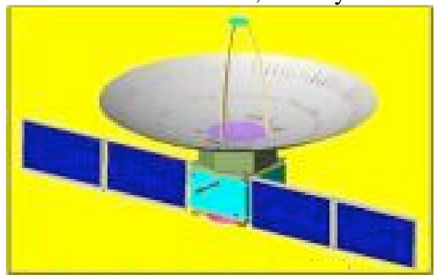
540 The Moon Impact Probe on Chandrayaan-1
Y. Ashok Kumar and MIP Project Team

544 Monitoring lunar radiation environment: RADOM instrument - T. Dachev, B. Tomov, P. Dimitrov, Y. Matviichuk

PSLV-C12 launches RISAT-2 and ANUSAT

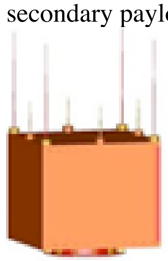
from Sriharikota launch complex, April 20, 2009

RISAT-2, or **Radar Imaging Satellite 2** is a radar reconnaissance satellite, built by Israeli Aerospace Industries,



based on the Israeli TecSAR satellite which was launched in 2008. Israel had previously offered to provide radar technology to India after India provided launch services for TecSAR. Its primary instrument is a synthetic aperture radar system to allow it to return images at any time of day, and in any weather conditions.

The **ANUSAT** student microsatellite (Anna University Microsatellite) was flown aboard the same rocket as a secondary payload. Part of the CubeSat program requiring a



cube with 600mm (24 in) long sides, and a mass of 40 kg (88 lb), Anusat carries a radio and some technology demonstration payloads. ANUSAT is in a sun-synchronous polar orbits. Annu Univ. is in Chennai, fka Madras. VIT is nearby

What's next for Europe after SMART-1?

A letter from Bernard Foing, Project Scientist for SMART-1

"On the occasion of the launch of LRO/ LCROSS on Thursday, 18 June, … [here is] "a summary of answers to some questions I received about SMART-1, LRO and LCROSS and lunar ice. (Parts omitted, skipping to following)

"What is Europe doing about lunar exploration and future landers? After the SMART-1 development, operations and data analysis, ESA has been involved in Chang'e-1 Chinese lunar mission, and contributed 3 instruments to Indian Chandrayaan-1 lunar orbiter, still delivering new data.

"ESA studied lunar polar lander with objectives to search and characterise polar regions. ESA released a call for ideas for techniques, instruments techniques and experiments that could be accommodated on a lunar cargo lander launched with an Ariane 5 and deploying 1 ton of equipment in support of future human lunar exploration. In April 2009, ESA received 194 proposals to this call showing a large interest from the community." [The above is only part of the letter.]

भारतीय वायु सेना
INDIAN AIR FORCE

IAF Crew for 1st Indian Manned Space Mission

Report *and Commentary* by Peter Kokh

Multiple Sources:

www.thaindian.com/newsportal/sci-tech/iaf-personnel-to-be-on-first-manned-space-mission_100166891.html

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

www.moondaily.com/reports/India_Maps_Out_Manned_Exploration_Program_999.html

India's first manned space mission, likely in 2017, will have two Indian Air Force (IAF) personnel on board, not one IAF and one ISRO astronaut as proposed by ISRO. The IAF is to train two airmen for the mission, in collaboration with the Indian Space Research Organisation. This flies in the face of Western experience which suggests that two or three times the number immediately needed should be trained.

The two-member IAF crew will become the 4th and 5th Indians to go into space after Squadron Leader **Rakesh Sharma**, who was on a MIR crew as part of a joint space programme between India and Russia in 1984, **Kalpana Chawla**, who was on the fatal Columbia mission, and **Sunita Williams**, a US citizen born of Indian Parents from Gujarat.

India's first manned mission would attempt to put two people into space orbit at 274 km above the earth for seven days. For this project, the IAF is gearing up its infrastructure for training its own astronauts: the option would be training by NASA or Roscosmos. ISRO proposes an astronaut training centre in Bangalore. This rivalry is in need of resolution. In the US, Europe and Japan, manned space operations are under civilian control. Either way, having its own astronaut training program and facilities would boost India's image as a leading space power.

For training purposes, a Russian IL-76 would provide "vomit comet" experience with weightlessness. The spacecraft itself, as presently conceived, would include an ejection capsule instead of an add-on abort system. The actual launch to LEO would be courtesy of India's GSLV-Mk II vehicle.

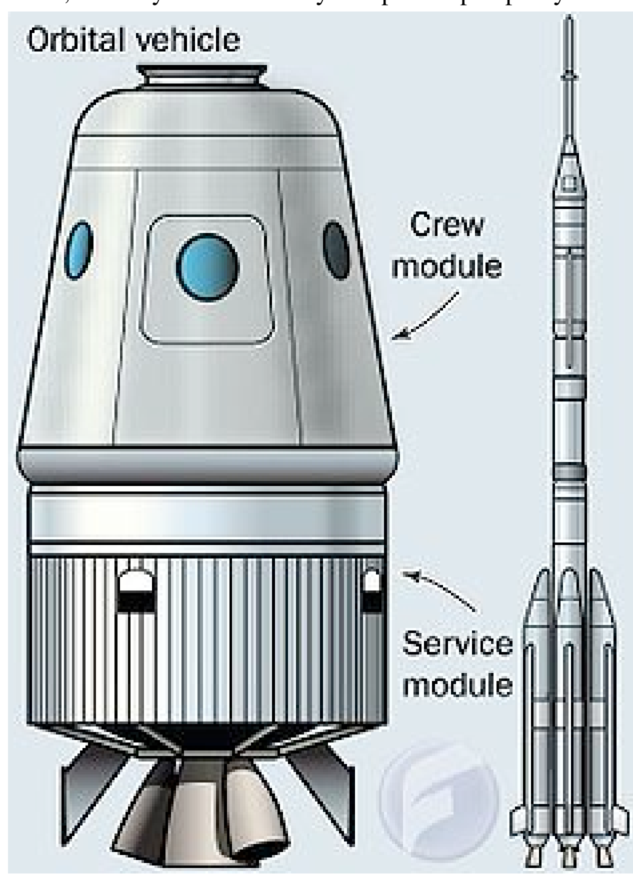
The proposed manned space program is a follow-on to India's successful launch of the Chandrayaan-1 lunar probe last year. If the manned space initiative proceeds as planned, India will be the fourth country - after the US, Russia and China - to have an active manned space program. Japan is revisiting the idea as well. Iran has recently boasted that it will attempt a manned space flight by 2021.

Dismissing the criticism of the huge costs involved in India's proposed manned missions, military officials consider acquisition of an ICBM-capable rocket as a strategic plus. The need for India to have a global communications network would also be advanced. Given the uneasy peace in the subcontinent, the fact that the military should want control is understandable, yet also alarming.

Development of a manned space program should not only win India an equal role in the continued build-out of the International Space Station, but a place in some future International Lunar Research Park. Indeed, India's current focus seems to be on the Moon, not ISS. The Moon is indeed the ideal place to study Earth's geological past, as the forces that have shaped the Moon, have also shaped the Earth, on which most of that evidence has been erased by active geological processes and weather. We need to understand that past if we are to correctly fathom what our cosmic future may hold.

The context for India's decision to move forward with its own manned space program is China's significant steady and deliberate progress in space, having completed its first space walk last year, and with a Chinese space station in the works. China may be ahead for the moment, but India, likely to surpass China in population within a few decades, hopes to pull ahead in space as well. Those who value democracy over military might, can be expected to cheer India on.

India's long-range vision, at least as put forward by former President Kalaam, includes a network of Solar Power Satellite both to supply abundant clean energy and to desalinate sea water for abundant clean drinking water. Indeed, this may be India's only real path to prosperity.



That an increasing number of nations are daring to think in terms of the wider terrestrial setting, and even of the already begun build-out towards an Earth-Moon Econosphere, bodes well. As fellow humans we need to take joint ownership of our future. As fellow children of Africa, we need to continue our Epic of Pioneering New Frontiers together. India, with deep roots in history, will share leadership in this continuing human saga.

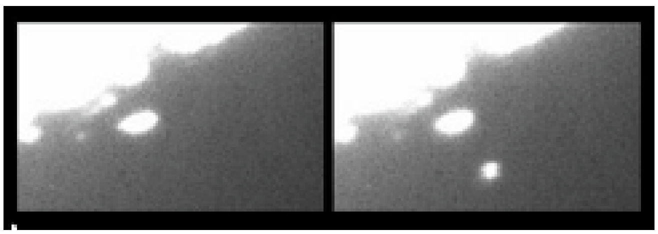
<PK>

Elsewhere In Asia

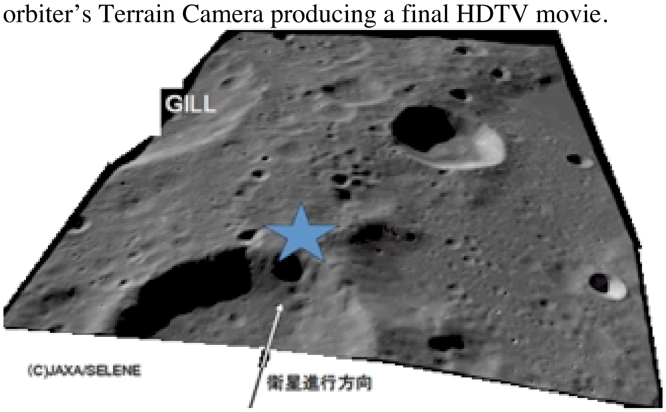
JAXA's Kaguya/Selene Mission Ends Well

(M3IQ Report compiled from many sources)

June 11, 2009 – Its extremely productive mission over, the Kaguya/Selene lunar orbiter was sent by JAXA, the Japanese Space Agency, to **a calculated impact** with the lunar surface near at 65.5°S, 80.4°E, near the 66 km wide **Gill crater** near the southeastern limb of the Moon's nearside.**Success** The impact area was to the dark side of the day/night terminator so that the flash of the impact could be observed (second frame below) by the AAT, the Anglo-Australian Telescope, in Coonabarabran, NW New South Wales, Australia.



Kaguya had spent a year and nine months orbiting the Moon sending back high definition television photos that covered the Moon's surface. Working until the end, the orbiter's Terrain Camera producing a final HDTV movie.



Impact point at star above

Kaguya had also completed the best altitude map of the Moon yet, showing both the lowest and highest elevations to be on the Moon's farside.

Timed to coincide with the worldwide celebration of the 40th anniversary of the Apollo 11 moon landing, JAXA will hold a public event in Tokyo, the weekend of July 18th and 19th – "Fly Me to the Moon."

The flawless mission had had a rough time getting to the starting gate. JAXA had been preparing the mission for a decade before its launch. It was worth the wait.

The original intent of the Beijing Declaration was to have all orbiters impact in permanently shaded south polar craters in hopes of finding water vapor in the splashout.

Congratulations to Japan for a splendid mission! ###

China's Successful Chang'e-1 Mission to be followed by Chang'e-2 later this year

(M3IQ Report compiled from many sources)

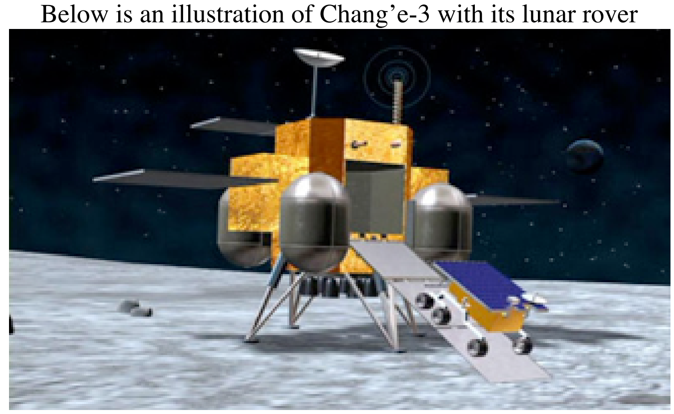
Launched on October 24, 2007, Chang'e-1 began orbital operations on November 26th. Its mission was to have lasted a year, but was extended three months, and the craft was directed to a final impact March 1, 2009. The impact point was just south of the lunar equator, at 52.36°E in Mare Fecunditatis, the "Sea of Fertility".

Chang'e-2, which could be launched later this year or in 2010, will conduct research at a 100-kilometer-high lunar orbit, identifying target areas as a preparation for a soft landing by Chang'e-3, which, according to a March 3rd CSNA press release, should occur before the end of 2013. Chang'e-2 will also be tasked with testing key technologies of soft landing and with lowering technical risks for the Chang'e-3.

A Chang'e-4 mission is contemplated but its mission goals have not been announced, as they will be developed according to technological needs identified by Chang'e-2 and Chang'e-3. Moondust sample returns are high on the agenda.

Illustration of Chang'e-2 in lunar orbit

Below is an illustration of Chang'e-3 with its lunar rover



news.xinhuanet.com/tech/2008-03/06/xinsrc_4420305060924906056717.jpg

Logo of CNSA

China National Space Administration

Space News from North and South America

NASA Launches LRO: Lunar Reconnaissance Orbiter & piggyback LCROSS

[http://lunar.gsfc.nasa.gov/mission.html and other sources]

On June 18th, the latest Moon-bound craft successfully lifted off its pad at Cape Canaveral. Rendezvous with the Moon is set for June 23 at 5:47am EDT, when the orbit insertion burn will begin. Visualization of LRO orbit insertion: http://svs.gsfc.nasa.gov/vis/a000000/a003600/a003612/lro_orbit_withTime_iPod.m4v

LRO's objectives:

- Find **safe landing sites**
- Locate **potential resources**
- Characterize the **radiation environment**
- Demonstrate **new technology**

From its low polar orbit (50 km), LRO will return global data, such as day-night temperature maps, a global geodetic grid, high-resolution color imaging and the Moon's UV albedo.

The emphasis will be on the polar regions of the Moon where near-continuous access to solar illumination may be possible and where the prospect of water in the permanently shadowed regions at the poles may exist.

Exploration first, then science

The principal objectives of LRO are explorative in nature, but the payload includes instruments with considerable heritage from previous planetary science missions, enabling transition, after the first year in orbit, to a science phase under NASA's Science Mission Directorate.

More information:

http://lunar.gsfc.nasa.gov/images/LRO-Fact-Sheet.pdf

In search of ice – LCROSS

Piggybacking a ride to the Moon an LRO is the **L**unar **CR**ater **O**bservation and **S**ensing **S**atellite, LCROSS, will separate after five days on June 23rd and perform a lunar swing-by to enter into an elongated Earth orbit to position LCROSS for impact at the south pole, on October 9th. Aimed at the floor of a permanently shadowed crater, the impact splashout will be directly sampled by LRO as it passes through the debris cloud, in hopes of determining whether or not frozen comet-derived volatiles, including water-ice, are present below. If there is a positive finding, the race will be on to fly a "ground-turth" probe to assay the percentage of ice in the soil and its possibilities for extraction to serve early outpost water and return fuel needs. **###**

Latin American Space Agencies

Background: Latin America boasts several existing space agencies, for the most part concerned with communications and Earth-sensing, in these nations:

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

- **Argentina - CONAE**- Comisión Nacional de Actividades Espaciales (National Space Activities Commission) 1994
- **Brazil - AEB** Agência Espacial Brasileira (Brazilian Space Agency)
- **Columbia - CCE** Comisión Colombiana del Espacio (Colombian Space Commission)
- **Ecuador - EXA** Agencia Espacial Civil Ecuatoriana) (Ecuadorian Civilian Space Agency)
- **Mexico** - **CONEE** - Comisión Nacional del Espacio Exterior (National Commission for Outer Space) – Note: Mexico's involvement is about to escalate - see report below on **COMEXCEBA** and **AEXA**
- **Peru - CONIDA** Comisión Nacional de Investigación y Desarrollo Aeroespacial (National Commission for Aerospace Research and Development)
- **Uruguay - CIDA-E -** Centro de Investigación y Difusión Aeronáutico-Espacial (Aeronautics and Space Research and Diffusion Center)
- **Venezuela - ABAE -** Agencia Bolivariana para Actividades Espaciales (Boliv**ar**ian Agency for Space Activities) (nb. Simon Bolivar is a hero to most people in South America, thus the use of this name does not imply an association with the country of Bolivia.)

BRAZIL: this South American giant's space program is by far the most advanced and most ambitious, and a place on the International Space Station is only a matter of time.

MEXICO may create a new Space Agency

The effort to ramp up the nation's space efforts is strong. A new space advocacy group "COMEXCEBA" (Colegio Mexicano de Ciencias Espaciales y Bioastronautica) (Mexican Council of Space Sciences and Bioastronautics) has been launched to push the bill to set up a Mexican Space Agency, **AEXA** (Agencia Espacial Mexicana), through Congress, hopefully this year. The Moon Society has been supporting both efforts. One Mexican has been in space.

CHILE's Air Force Plans a "Moon/Mars Atacama Research Station"

At the FIDAE 2010 International Air and Space Show in Santiago next February, the Chilean Air Force will announce Chile's first contribution to Moon/Mars outpost planning; a "Moon/Mars Atacama Research Station" will be constructed in northern Chile, an effort that involves The Astronaut Teachers Association (TATA) of San Diego, California, **The Moon Society**, and possibly The Mars Society and other groups. The core of the analog facility will be the wingless fuselage of a surplus **Hercules C130B cargo plane** donated by the Chilean Air Force, to be outfitted in Santiago, then towed to the location. It is expected that M/MARS will start up with one or more additional modules. The location is near the growing complex of world-class observatories in northern Chile such as ALMA, the Atacama Large Millimeter/sub-millimeter Array.

Why Should India Send People to the Moon?

By Madhu Thangavelu thangavelu-girardey@cox.net

I have heard friends and colleagues say that India should go to the Moon and Mars to tell the world that her time to take a seat among the economic superpowers has arrived. International prestige currency, they say. I am not sure if that holds much meaning. Just look around and see how strapped the superpowers are!

I have heard others say that India must go to the Moon since ISRO needs bigger challenges to keep the agency's workforce from ennui which set in from building, launching and tracking satellites all day long, day after day. Well, that might seem to be a bit selfserving, don't you think?

Then I heard that India is turning out more and more qualified engineers and scientists and they need jobs, better jobs, high paying jobs and so on. Wait a minute. Others say India needs engineers and scientists to solve a myriad other problems that the country faces and that space science may not be in that highest rung of priorities.

I also heard from a similar camp that India should stop wasting precious resources on "also ran" projects that were done by other nations decades ago, just so she can prove her mettle, and instead focus on uplifting the multitude…. to do what?.. and to what end?… and how are we going to do those magnificently complex projects if we don't build up the infrastructure to accomplish smaller ones?

Another scientifically inclined group preaches that robot missions are much cheaper than human ones and India could save billions by shelving the astronaut program and instead focus on cutting-edge robotics, which can bring the same results and for better value. Comparing robots and humans is like apples and oranges. Would we all be satisfied if "cool" lunar robots built habitats and lived in them, so we could watch it all on TV?

These are the voices of the world's largest and vibrant democracy in the 21st century and I think all these points have roots in reason and validity.

Let me posit yet another reason. I think India wants to go to the Moon to extend humanity's reach into the cosmos; not just to understand how our universe operates by gleaning through Vishnu's ever more intricate management techniques, but to engage it more fully; to fully live in and love Brahma's awe-inspiring creation, which seems to reveal her mysteries and magic ever so slowly. India wants to go to the Moon to rejuvenate and transform society with the daring and deftness of Shiva's dance.

I think India wants people to go to the Moon and beyond because the complexity of the projects that it entails requires developing tools and systems that will challenge the most daring, best and brightest of minds in ways which will radically change the ways in which we educate our scientists and engineers, lawyers and doctors, artists and craftsmen.

It is changing the way governance is administered, commerce is conducted and demanding efficiencies that will make the nation's infrastructure more agile and responsive to cope with a variety of issues ranging from climate change and weather monitoring to agriculture and disaster mitigation to digital media and distribution, not to mention telemedicine and electronic distance education for all, and not just for those in the crowded, throbbing metropolises but much more for those in the villages, where the soul of the nation lives, as Mahatma Gandhi said. Yes, human space activity and allied technologies, which include broadband satellite communications, are poised to bring all this about.

But in order to achieve this, some structural changes are happening in how institutions of higher learning and technology purvey a well-rounded professional education. Schools are experimenting to see if it is possible to integrate knowledge from diverse disciplines and structure it in such a way to produce professionals who can create new opportunities by innovative handling of rapidly accumulating knowledge or "intelligence explosion" and complexity of the real world, which seems to be accelerating at an exponential rate.

Centuries ago, India's rich tradition of schools like those at Nalanda and Taxila, Vikramasila, Kanchivaram and Varanasi offered that ultimate interdisciplinary education. The Ashram and Gurukulam models stressed intense one-on-one teacher student dialogs and debates on a variety of disciplines deemed necessary to hone the erudite mind. It is only in the 19th- 20th century that modern education became highly compartmentalised and the knowledge explosion gave birth to academic disciplines partitioned into various departments, creating specialists who delved deeper into narrow fields of study. While this system helped the administration for organizing and budgeting purposes, it also created artificial walls and gates in the natural continuum of knowledge.

The exception to this conventional system appears in the education of architecture, medicine and law professionals. Through the practice of apprentice and internships, architects, doctors and lawyers have long had the luxury of an interdisciplinary education, perhaps due to their essential and constant contact with humanity.

The internet and information technologies of these past decades have changed the specialty paradigm once again. They allow breath and depth of study simultaneously and efficiently.

Even though it is difficult to exactly estimate the impact of the melding of super fast computation systems, information and communication technologies in the lives and productivity of science and engineering professionals and their continuing education, it is quite clear that universities and specialized schools are seeking new models of interdisciplinary curriculum and fostering research in fields which combine many orthodox and traditionally independent disciplines. A system architecting heuristic says that maximum leverage exists at the interface of disciplines.

It is in interdisciplinary curriculums, employing merging and crosscutting disciplines, that we now hope to make fundamental advances and technological breakthroughs. A quarter century ago, Vernor Vinge, and more recently Ray Kurzweil, refer to this convergence phenomenon as technological singularity.

The International Space University offers a prime example of a school that was born of the need to educate and train professionals in the space activity arena by providing an interdisciplinary education. The Singularity University now proposes to elevate this interdisciplinary education model to a new level of sophistication.

I think India should go to the Moon to foster more interdisciplinary education in schools and universities. Space activity and returning people to the Moon could be a starting block for this paradigm-shifting endeavor.

I think the children of Vedanta want to go to the Moon to extend the legacies of Vyasa, Sankara and Thiruvalluvar. Thinking big and dreaming bold visions belongs in India's best tradition.

I think India might truly wish to go to the Moon because the children of Ashoka and Aryabhata, Bhaskara and Kalidasa aspire to live, work, play and dance among the stars. ###

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

Unnecessary Prison

"No grimmer fate can be imagined
than that of humans, possessed of god-like powers,
confined to one single fragile world." - **Kraft Ehricke**

Halfway to Anywhere

"Reach low orbit and you're halfway to
anywhere in the Solar System." **- Robert A. Heinlein**

Cosmic Attitude

If the forces of creation deserve our worship,
they do so from every corner of the universe,
not just from this nest-world we call Earth.
This we cannot do by staying home.
Go and fill ye the empty cosmic spaces
and let your soul sing in praise,
in endless new ways. **– Simon Cook**

Cradlebreak

Earth is the Cradle of Mankind.
One does not stay in the cradle forever.
- **Konstantin Tsiolkovsky**

From now on ...

From now on, we live in a world
where men have walked on the Moon.
And it wasn't a miracle!
We just decided we wanted to go.
- **Jim Lovell**, in "Apollo 13"

New Hopes for Water on the Moon

By David A. Dunlop dunlop712@yahoo.com

The Moon has been accepted as a parched world devoid of that essential for humman and other terrestrial life: water. The desiccation of the Moon's surface is from the extensive heating of the material during the collision of a "Mars-sized impactor" with the proto-Earth, the outgassing of this excavated material having formed a ring around the Earth until it coalesced as the Moon.

An as a newly formed body being heated by accretion, bombardment of other impactors, the high density radioactive elements that sank into the center forming a presumed small core it also formed a magma ocean which further outgassed and so continued to let the solar wind sweeping gases into the vacuum. This is the picture of lunar formation developed after the Apollo expeditions and the rationale for the absence of water on the lunar surface.

The hope for water on the lunar surface has been from the harvesting of hydrogen implanted by the solar wind and combining it with extracted oxygen which is approximately 46% of the regolith blanket by weight.

Now however we have new hope for water sources as reported in sessions at the 2009 Lunar & Planetary Institute conference. The Chandrayaan-1 Mini-Sar radar returns from the permanently shadowed regions of Peary Crater would suggest a surface composition different from thst of the sunlit regions of the crater. As the crater has a smooth bottom surface this might be an inference of water ice in the shadowed area, as the sunlit portion of the crater shows readings similar to those of mare areas. ###

Detailed Kaguya Map shows Moon "Dry to the core," Mars somewhat less so

www.moondaily.com/reports/Detailed_map_shows_dry_Moon_999.html

Multiple Answers to "How Large is the Surface of the Moon?"

From page 5

The Moon's surface area **37.9** million km^2
or 14.6 million mi^2

In Comparison:

Africa and Australia together: ***Closest match***

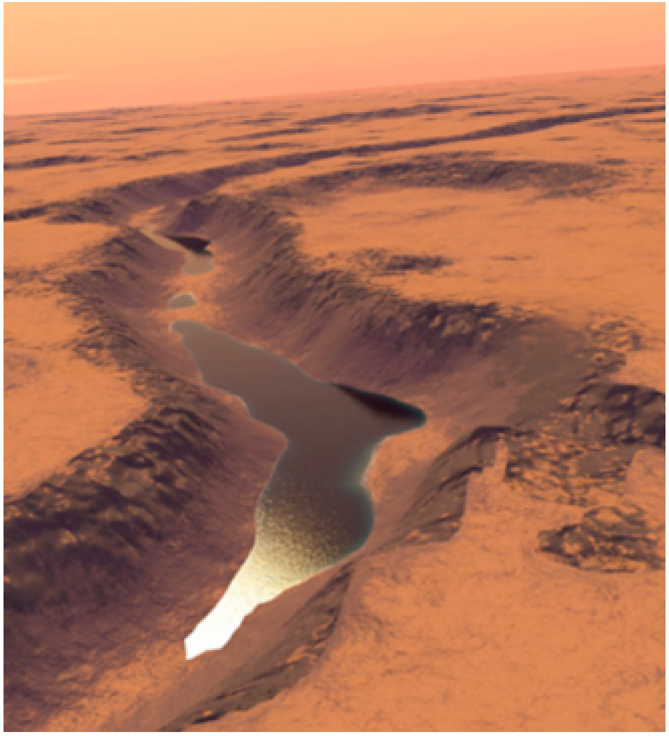
Africa: 30.2 million km^2 (11.7 million mi^2)
Australia: 7.68 million km^2 (2.97 million mi^2)
Together: **37.88** million km^2 (14.67 million mi^2)

The frequent Comparison with Africa alone is way off!

Second Best Approximation:
Canada+US+Brazil+China = 37.24 mi km^2 (14,38 mi^2)
(Picture Canada/US on Nearside, China/Brazil on farside)

3rd and 4th best Approximations
Africa + Europe – Russia = 35.48 million km^2 (13.70 mi^2)
Asia – Middle East and all Islands might be compare also

MMM - INDIA GALLERY

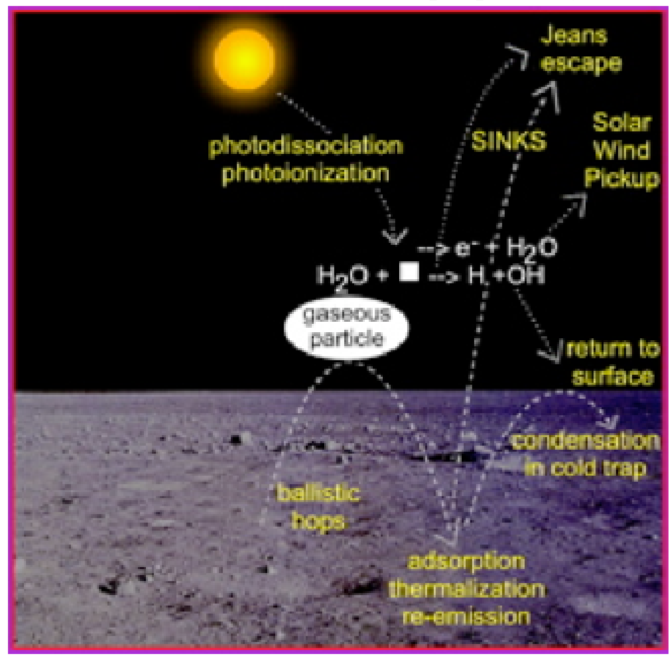


MARS Lake Picture: 1st Proof of Ancient Shores Found
http://news.nationalgeographic.com/news/2009/06/090618-mars-lake-proof-picture.html

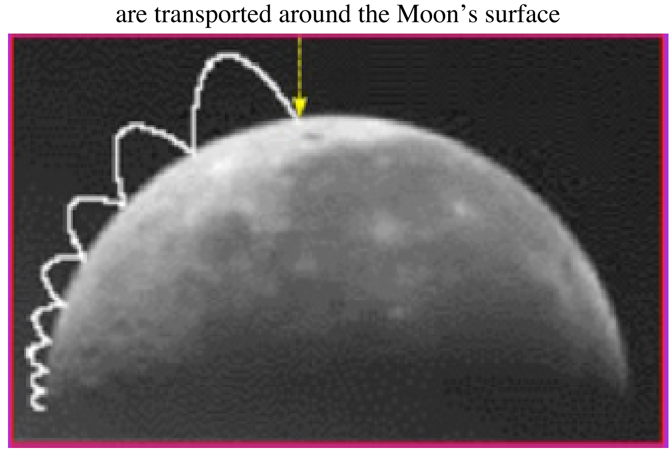
Lunar Reconnaissance Orbiter Ready to launch

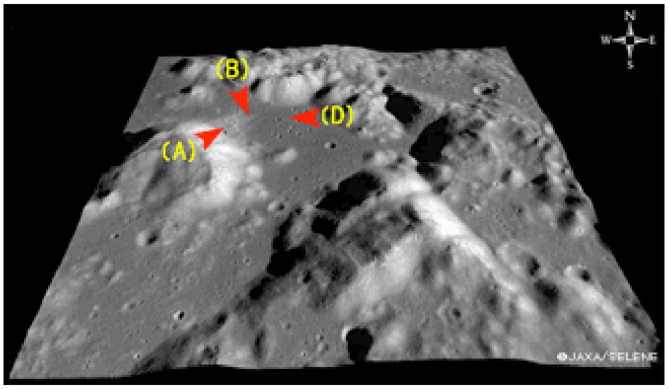
Aditya, India's Solar Probe headed for a 2012 launch

Sketch of China's Mars Probe to be launched with Russia's Phobos-Grunt, both now postponed 2 years

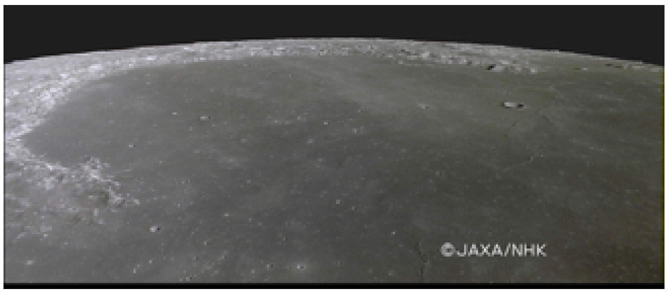


Sketches showing how solar wind and cometary volatiles are transported around the Moon's surface

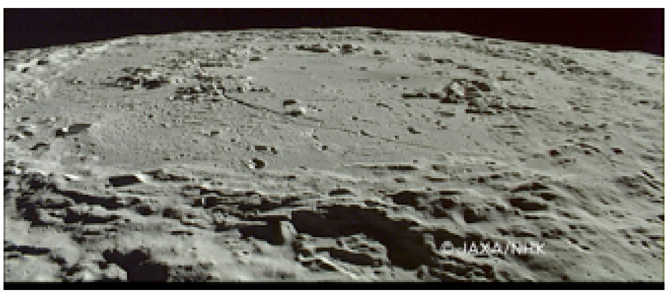




3D view image of the **Apollo 17 landing site** by Kaguya's Terrain Camera – (A) avalanche deposit from South Massif; (B) Shorty Crater; (D) Challenger landing spot. 12/25/2007



Kaguya 3D image of **Sinus Iridium** (Bay of Rainbows)



Kaguya 3D image of **Schrodinger Crater** on the farside just beyond the South Pole 2007:11:11

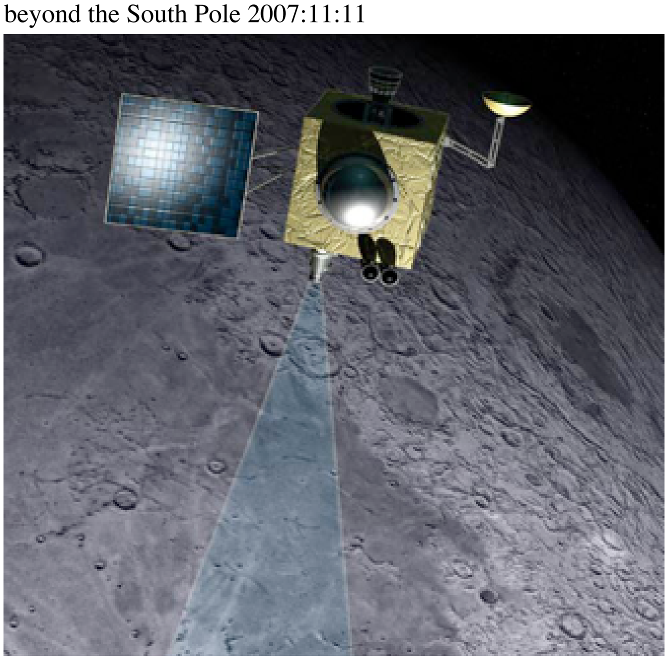
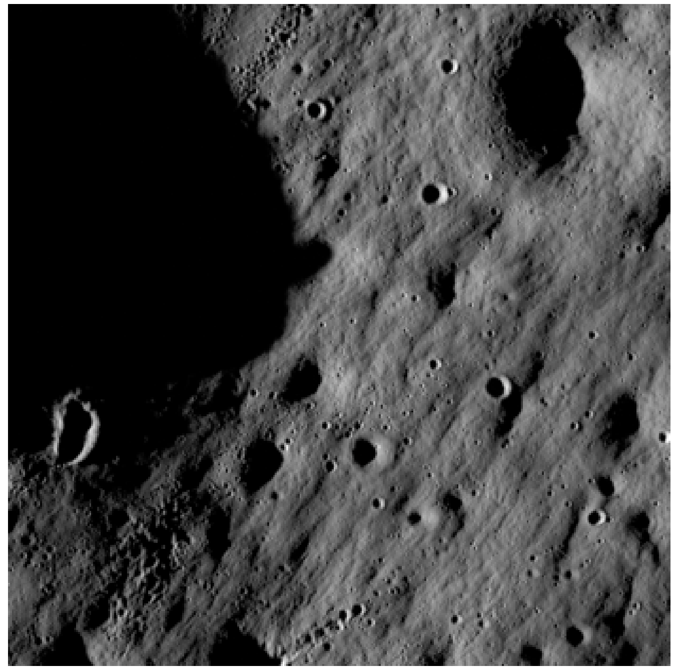


Illustration of Chandrayaan-1 at work over the Moon


One of first photos taken by Lunar Reconnaissance Orbiter after arriving in lunar orbit. Note crater chain bottom center.

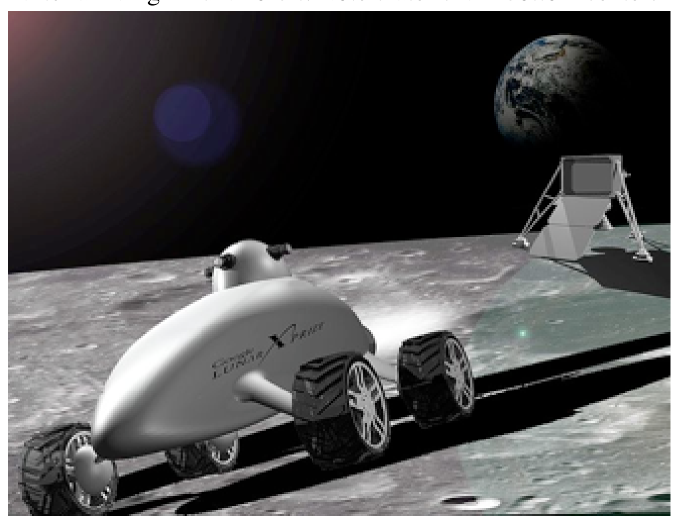

Selena 1 lander (R) and LuRoCa 1 lunar rover (L)
One of the Google Lunar X-Prize entries

Illustration concept for Chandrayaan-2 Rover
Compare with design on M3IQ#2 p. 4

Photos wanted for this section of M3IQ. Send as attachments to mmm-india@moonsociety.org (no compensation)

ISDC 2009 Conference Brings New Moon Society Connections in India

David Dunlop – dunlop712@yahoo.com
Moon Society Director of Project Development

At the 2009 International Space Development Conference in Orlando, Florida, May 27-31st, the Moon Society was fortunate to have a booth directly across from Indian students participating in the Space Settlement Design contest. This was a wonderful opportunity to make new friends, show the Moon Society activities, and develop new chapter connections.

Present at the Moon Society Booth were Moon Society President Peter Kokh, Board member Fred Hill and Vice President Charles Radley, David Dunlop Director of Project Development, and Green Bay Moon Society Chapter President Dan Hawk. Our booth attracted a lot of attention with a model of the Space Solar Power Satellite, a 16 foot rocket from the College of Menominee Nation, a model of a Moon Base in a lava tube loaned to us for display by the Wisconsin Space Grant Consortium, and samples of lunar stimulant, gravity jugs, and pictures of plants grown under lunar lighting conditions in lunar stimulant by at the College of Menominee Nation lab as part of the LUNAX [Lunar Agricultural eXperiments] Experiments.

A local news station chose the Moon Society booth as a backdrop for an interview with Apollo 11 Astronaut Buzz Aldrin.

The **Ravindra Bharath School** of Visakhapatnah, in Andhra Pradesh was represented by their **Principal, Mrs. G.R. Vasantha** and student team which had put together a very impressive design presentation. They demonstrated a well-developed computer presentation and parallel personal communication skills. Mrs. Vasantha indicated that they would like to start a student chapter of the Moon Society at the school and two students volunteered to take leadership roles. Rom Harsha (Ravihdra Bharati, Vizag will be the MS point person at the school. Another student from the school Chandra Kovvali and her mother Mrs. Aruna Kou are moving to Houston Texas and wished to create a student Moon Society chapter in Houston. We were able to present Artemis Society posters to each of the students present and demonstrate gravitational differences with Peter Kokh's gravity jugs.

http://www.nsschapters.org/hub/gravityjugs.htm

Above: The woman in yellow is the principal, Mrs. G.R. Vasantha. The girl dressed in black to the left of her is Chandra Kovvali who will be will be moving to Houston with her mother Mrs Aruna Kou. The tallest boy in the middle is Ravihdra Bharati, Vizag who will lead the club at the school in Visakhapatnah, Andra Pradesh.

The NSS Chapter in **Pune**, India also was present at the ISDC 2009 and was been recognized as a foundational chapter in India by the National Space Society.

Above: Standing rear center is the president of this chapter is **Suresh Naik,** a former Group Director with ISRO. Also represented were **Sandeep Joshi, Secretary** and Director- Guardian Education, and **Leena Bokil, Treasurer and** Honeywell **Educator** (the long-haired woman second from the right.) They also indicated an interest in working with the Moon Society and developing a student chapter as part of a joint educational initiative. I believe Sandeep Joshi, the Secretary of the chapter is also pictured.

Both groups were present as **Dr. Devi Prasad Karnik**, Space Counselor at the Indian Embassy in Washington, DC, and a scientific delegation from the ISRO received a Pioneer Award from the National Space Society for the Chandrayaan-1 mission. These dignitaries also visited the student's booth and saw their presentations, signed autographs and took.

We are delighted to have had the chance to make new friends and connections with India and to admire India's growing accomplishments in space. The unqualified success of Chandrayaan-I is only the first step of what we expect to be to be many steps leading India beyond LEO and GEO to explore the Moon and other targets farther out in the solar system. The flood of data received from Chandrayaan-I will require time to digest, and students should expect a Welcome Sign from the Indian Space Research Organization according to their leadership. We hope the Moon Society and especially its student chapters in India can be part of this great adventure. **<TMS>**

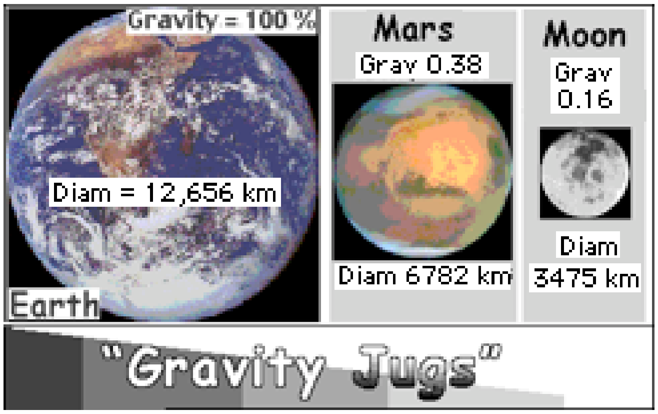
"Only those who risk going too far can possibly find out how far one can go."

- T. S. Eliot

'For once you have tasted flight you will walk the earth with your eyes turned skywards, for there you have been and there you will long to return."

- Leonardo da Vinci

Demonstrate the Difference in Gravity Between Earth, Mars, the Moon For less than 250 Rps, in under an hour



Lift any 2 Juga at a time to transport people to the Moon or Mars for a brief brain-expanding instant

You will need:

3 Jugs with handles: Jugs of Bleach (cheaper and more durable jugs of milk or jugs of liquid detergent and you can always use the bleach

Some Styrofoam Peanuts: if you haven't saved any from packages you have received, you can buy them from package mailing stores or from packaging materials suppliers.

Water

Directions:

Remove labels from all jugs

Earth jug: replace bleach with water

Moon and Mars jugs: empty out bleach, rinse, and fill with Styrofoam peanuts

Mars Jug: add 3/8ths the amount of milliliters of water that the jug says it holds.

Moon Jug: add 1/6th the amount of milliliters of water that the jug says it holds.

Note: the Styrofoam peanuts distribute the mass of water more evenly, and prevent sloshing

Note: Neither the weight of the plastic jug, nor of the styrofoam peanuts are factored in, being dismissed as practically negligible. Making the exact adjustment would not materially affect the sensing of different gravities.

Print out labels from this page: http://www.nsschapters.org/hub/gravjug_labels3.htm

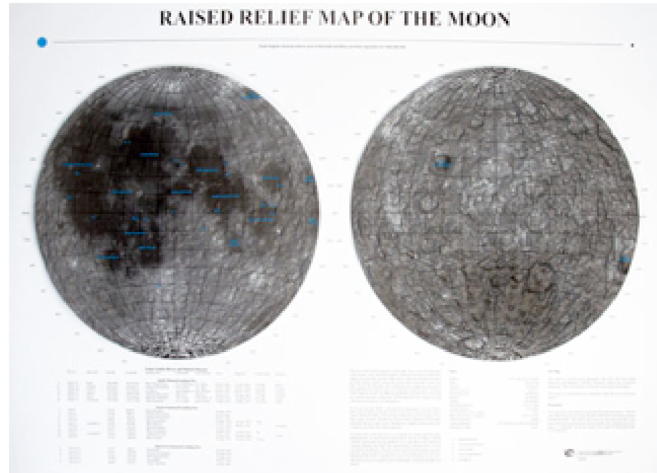
Remember to tell everyone:

"Pick up any two at a time!"

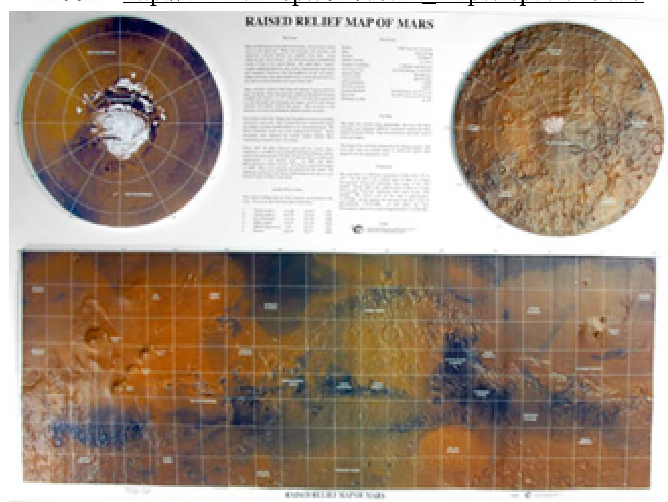
[Educational Resources: new products]

Table-top or Wall Mount Raised Relief Maps of The Moon and Mars released by US Firm

36x86 cm unframed $34 – frames available



Moon - http://www.amep.com/detail_maps.asp?cid=5037



Mars - http://www.amep.com/detail_maps.asp?cid=5029

[The foregoing is not a paid ad but a free reader service]

[Must Reading from The Space Review]

Should India and the US cooperate on space solar power?

While the United States has a clear interest in alternative energy, India's needs are arguably even greater.

Taylor Dinerman argues that the two countries should work together to develop space-based solar power solutions that can benefit them both.

> "Photovoltaic panels on rooftops and solar water heaters all make excellent small-scale contributions to the solution, but they cannot by any stretch of the imagination fulfill the requirements of a huge growing economy like India's. Only SSP, which operates 24 hours a day, 7 days a week, year after year, can hope to meet this need."

http://www.thespacereview.com/article/1389/1

If India's plans are to include a Lunar Outpost, a near future Lunar Analog Research Station might be a Good Idea

By Peter Kokh, (veteran of two crews at the Mars Desert Research Station in Utah) kokhmmm@aol.com

While I am also a member of the Mars Society I seized my first opportunity to go to MDRS in early 2005 in order to see if this would be a good spot to do Lunar Analog Research as well. While the terrain and its coloration "scream Mars!" we thought it would be worthwhile for a Moon Society crew to so a 2-week stint in Utah to determine what we would want to do the same, and what we would want to do differently. Our crew, the next year, was in that respect successful. The research goals of Moon analog station and a Mars analog station are clearly different.

For Mars advocates, the goal to be defended, the feasibility to be demonstrated, is that humans and robots together can explore Mars much more effectively and thoroughly than robots alone. For Moon advocates, the Apollo missions amply demonstrated this, 40 years ago.

A Lunar analog Research Program *should*:

- Determine which operations can be done effectively by teleoperation from Earth in order to dedicate precious man-hours on location for those things that cannot be done as well by teleoperation.
- Demonstrate the methods and tools needed for expansion of anoutpost into a settlement
- Demonstrate the options for using local lunar resources to accomplish that goal
- Demonstrate the savings on dayspan cooling power demands and nightspan heating demands by shielding the base with a meter or more of local soil or equivalent – this implies a horizontal architecture rather than a vertical one such as used in the two Mars Society installations
- Demonstrate the benefits and identify the problems of a modular approach to biological life support including air and water purification. Etc.

Site Considerations – ***see map page 26***

No site on Earth can come close to simulating lunar conditions. It is necessary to pick one's battles. A site should be sufficiently isolated, or off traffic routes, to enjoy isolation and freedom from frequent disturbance by well-meaning visitors. To create the mood, it should be fairly devoid of vegetation. Desert type areas (free of sand dunes!) might work. In India, the northern cool dry "rain-shadow" mountain valleys of Ladakh, Lahaul, Spiti, Kinnaur and Bharmour (H.P.); pockets of nothern Uttaranchal; and Sikkim are worth investigating. **Below**: a scene not far from Leh in Ladakh.

To the south, dune free areas of the Thar or Great Indian Desert in Western Rajasthan near the Pakistan border might work. Heat might be a problem, but also an opportunity to demonstrate the value of simulated moondust shielding. Basaltic areas could provide an opportunity to see what might be done with an early cast basalt industry.

The Mars Society operations on Canada's far north Devon Island and in south central Utah in the United States use a vertical two-story "double tuna-can" structure with room for a crew of six. In our opinion a vertical structure is a non –starter as it can't be easily shielded. And trying to cram everything into one structure fails to use the opportunity to demonstrate how *any* outpost could expand by adding additional modules to make room for more functions and larger crews. This design decision limits research options.

The Moon Society has not found the funds to deploy its own Lunar Analog Research Station. We do have a short list of potential sites, but have not visited any of those yet. An idea of how we could start small and grow just as a real outpost would grow can be gathered from this presentation:

http://www.moonsociety.org/moonbasesim/proposals/AnalogMoonbaseProposal.pdf

NASA's inflatable Quonset analog outpost in Antarctica.

http://www.nsf.gov/news/news_summ.jsp?cntn_id=110657
http://www.sti.nasa.gov/tto/Spinoff2008/images/pn-14.jpeg
http://regmedia.co.uk/2008/10/23/inflatahab.jpg

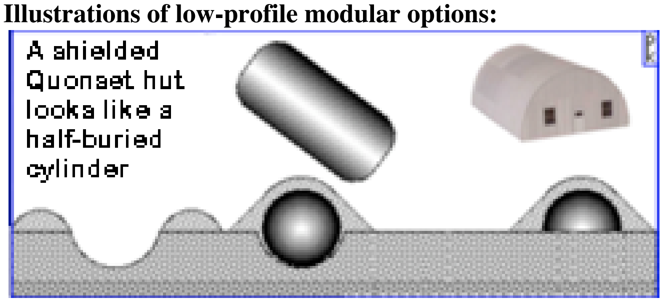
In northern Chile, the Chilean Air Force is planning to deploy a Moon/Mars Atacama Research Station near the growing complex of major astronomical observatories. The core of what will likely be a growing modular complex will be the wingless fuselage of a retired Hercules C130B cargo plane. This should become operational by the spring of 2010.

Designing a Lunar Analog Research Station is an ideal Opportunity to Experiment with Design Options

As a veteran of two crews (#34 and #45) at the Mars Society's Mars Desert Research Station in south central Utah, I have come to dislike what has been called, sometimes affectionately, the "double tuna can" 2-floor vertical cylinder design. While such a design might be ideal for transport to the surface Moon or Mars, it has many real drawbacks.

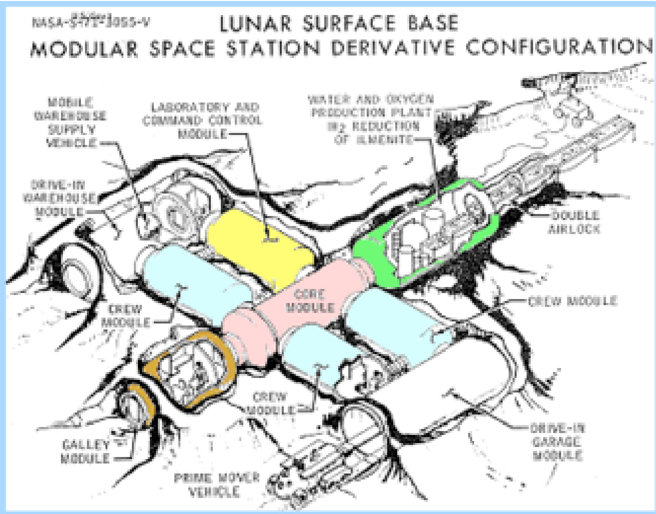
- The ladder between the two decks is the # 2 source of all crew accidents and injuries.
- The tall profile makes it difficult to "shield." Even here on Earth where radiation and micrometeorite rain are not an issue, there are major thermal management benefits from covering the facility with a blanket of local dust, as is, in sandbags, or in blocks – extension of the "field season."
- A real outpost would be constantly expanding and thus should be designed in modular fashion.

Illustrations of low-profile modular options:



The proposed Moon/Mars Atacama Research Station – MMARS – in northern Chile will be built in modular fashion, starting with a wingless Hercules C130B cargo plane fuselage. The options are endless.

Below, a file NASA illustration:



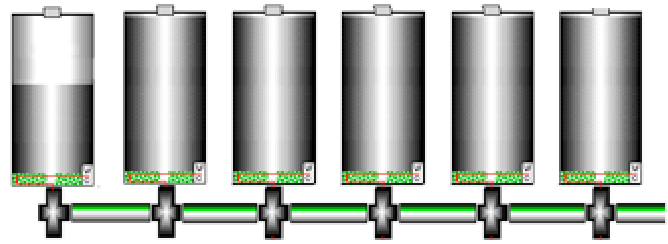
Who should run such an installation?

In India, lunar analog activity could be conducted by ISRO. But, as elsewhere, it could also be done by a non-profit space advocacy organization. A third alternative is for the station to be constructed, expanded, and maintained by a consortium of Indian universities, also responsible for organizing and nursing along the stations Research Program and goals.

India is a long ways yet from landing on the Moon and erecting any kind of structure. But as such an effort can only benefit from research and simulation exercises done in the interim, the time to start such an analog Moonbase in India is now. Nor is it just for "let's pretend" fun. The whole purpose is to learn by going through the motions, so that when the time comes to build a real station on the Moon, India will know how to do it right, to do it in a way that is open-ended, allowing expansion if we do indeed see a market for lunar building materials in the build-out expansion of money-making operations in Low Earth Orbit – LEO – and in Geosynchronous Earth Orbit – GEO. The time for making mistakes is when we have time to correct them, not when we are on the Moon and every minute counts.

But a lunar analog research program would make an ideal complement to India's manned space program. In the US and elsewhere, Moon and Mars analog stations have attracted a lot of media attention and public interest. They help bring home what might be possible with real lunar and Martian outposts someday, thus motivating students and young people in general.

More important is the education of the mass media which is so influential in the development of public opinion. If a visitor center is *carefully* mated with the research facility and surrounding grounds that will help also. But we say "carefully." Visitors must be able to see without being seen, so as not to interrupt research or destroy the mood of being "on the moon," so important to good work. Web cams and "duckblinds" along hidden peripheral paths would work. **##**



The development of a lunar analog research program could help build broader national support for ISRO's new manned space program

Comment by Dave Dunlop

The picture of the proposed lunar analog location [in the previous article looks rugged and dry, and the gray dusty lunar setting looks realistic.

http://www.mayin.org/ajayshah/MISC/TRIPREPORTS/LADAKH/2002_08_15_Ladakh/dscn1012.jpg

A lunar analog research program can accomplish much to develop ISRO's human space flight program as well as acquire mission planning experience, with this facility and the personnel stationed there in a succession of crews..

Why an ISRO political strategy in beginning a lunar analog research program might be successful:

A. **Public Interest would be generated** by a lunar analog research station, serving to spread "Moon Fever" among the population, and make national politics work to broaden support of the program, particularly among young people, as well as among university and industry researchers who might want to validate their research at this facility.

B. **A Lunar Analog Research Station is not too expensive to do at all in the near term.** It could start with basic facilities and expand in modular fashion even as a real lunar outpost would do. This expansion itself, like that of the International Space Station, would continue to draw interest among the public at large and among youth in particular.

C. **Scenario:** ISRO launches their Indian Astronauts program and astronauts are selected. Indian Astronaut training begins and uses the new analog facility.

D. **A new ISRO human mission control facility must be built** so this could be located perhaps in a northern city to spread the ISRO political capital around the country.

E. **Photos and videos** of Indian "robots roboting around." This broadens the ISRO technical base and makes human-robotic synergy part of the purpose.

F. **As an educational project**, this would generate a great deal of excitement as students could be "virtually" there with the analog astronauts and their robots.

G. **ISRO's Chandrayaan-2 lunar lander/rover mission** is approved, so this analog facility, serving as a proving ground, maintains interest and momentum for the next missions.

H. **A Chandrayaan-3 moon dust and rock sample return** has been proposed. This moves the pieces forward on the game board and sets an agency target for the public interest and support.

Aspects of Lunar Analog Research Facilities as precursors of an International Lunar Research Park; how we might go about designing them

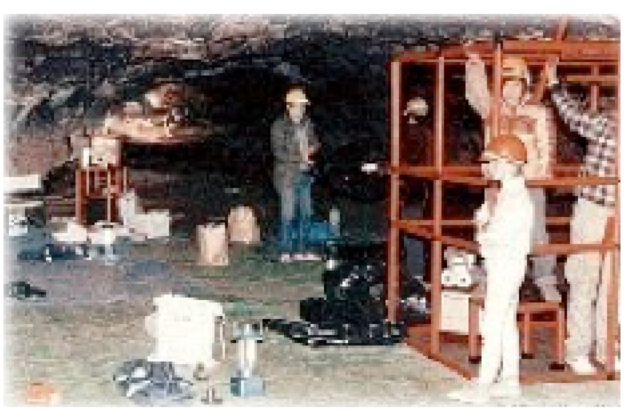
The Challenge of Lunar Analog Environments

The Moon Society has long been interested in the challenge of developing lunar analog programs. First, the challenge of doing so on Earth has value as a test bed for understanding the "systems issues" in terms of the sequence of development and the processes that can be used. It is less expensive and less risky to try things out in an analog of the lunar environment than on the Moon. We could not afford to do otherwise. It is also a challenge to our imaginations. The Moon is a harsh and hostile and unforgiving environment. It will demand the best efforts we can muster to really go there and learn to live and work in that environment.

It is also a Challenge to our Learning and Skills Development. It is one thing to write about or design something on paper or in virtual space, but it another thing to carry out the process in the "real" world. Both stages of design are essential. We learn by trying things out. We learn by making mistakes, finding out what went wrong, and coming up with alternative solutions. We also derive pleasure from this process as physicist Richard Feynman wrote in "The Pleasure of Finding Things Out".

Now we can develop and explore ideas in the virtual world and modify and learn at less expense and effort than if we had to physically build everything. We want to see how what has evolved in a virtual design environment will actually work in real world operating conditions. Rapid prototyping allows us to join these two aspects together so that new things can be quickly designed and produced. Testing them allows us to evaluate whether we have been successful and to what extent. Rapid prototyping technology is used to develop fairly small object such as metal or plastic parts. On the other end of the scale Contour Crafting of liquid materials such as concrete is now proposed for large scale structure and buildings. The computer aided design and manufacturing process will be the critical core for the effective colonization of the Moon. It is exciting and transforming that the whole scale of lunar base development and operations is being opened and advanced by virtual efforts.

The Oregon L5 Society National Space Society chapter had conducted simulation exercises in lavatubes outside Bend, Oregon under a NASASBIR Phase I grant.



Under team leader Bryce Walden, the chapter is now exploring the use of "Second Life" software to create a lunar lavatube base environment

Another exciting software project called Lunar Explorer is being developed by Moon Society member Manny Pimenta which will open up the challenge of lunar design to the world. He is working with Google and NASA to provide a software program that will permit people all over the world to participate in designing lunar cities and developing design ideas and solutions to complex challenges. This will permit large number of students and adults all over the world to "take on the Moon" as they develop their science and engineering skills. The Moon Society welcomes this advance as a way of letting the world participate and anticipate the development of an Earth Moon economy benefiting enriching, and protecting the Earth by opening the resources of space.

It is no doubt as important to engage multitudes of people in the challenges of designing because of the impact on them and on Earth's society as it is to solve the design challenges themselves. The process of engagement, the ideas, the educational benefits, the entrepreneurs and business that result from the process are the major benefits of undertaking on this challenge. Perhaps the best way to open the frontier of the Moon is to bring that frontier within the grasp of every student and everyone connected to the Web.

International Interest in Moon/Mars Analog Programs

Analog programs seems to generate a great deal of interest, and people like to participate. MS members and in affiliated National Space Society chapters have many ideas and ambitions regarding analog programs. On Canada's far north Devon Island, a kilometer from the Mars Society's Flashline Mars Arctic Research Station, the Canadian Space Agency with NASA and the Mars Institute as cosponsors, has an ongoing Moon/Mars analog program.

The Mars Society has another analog station in south central Utah, the Mars Desert Research Station.

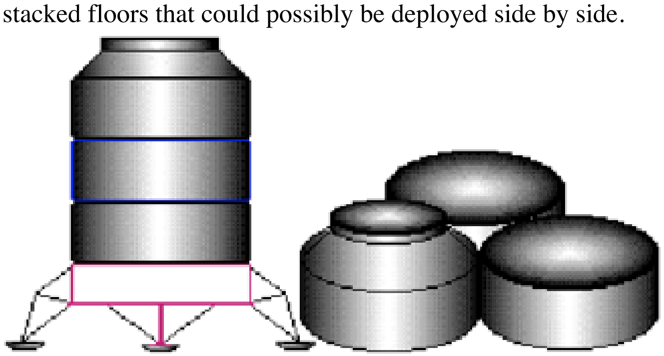
Here, six Moon Society membeers, commanded by Society President Peter Kokh, a veteran of a previous MDRS crew, conducted Moonbase simulation exercises here in 2006.

These are probably to largest, best known and best funded efforts. But NASA too is getting into the act, having recently erected an inflatable lunar analog facility at McMurdo Sound, in Antarctica. See illustration, next page.

In Alberta, Canada, the Calgary Space Workers led by Michael Bakk is working on a mobile modular lunar analog outpost to be located 90 miles east of Calgary near Drumheller. The command module, the first to be fully outfitted, is a used 10 meter long Airstream travel trailer.

In Sweden MS member Niklas Jarvstrat is redeveloping an old iron mine as an underground lunar analog.

In Mexico Jesus Raygoza has been advocating an analog initiative called MexLunaHab and has formed a new organization COMEXEBA to move this project forward. This project could be adopted the New Mexican Space Agency once the Mexican Congress has approved AEXA's formation. The structure is to be a Lander type, with three stacked floors that could possibly be deployed side by side.



Several sites are under consideration for this station.

In Chile there is also interest in developing a Moon/ Mars Atacama Research Station in the Atacama desert region in northern Chile near the growing complex of major world class observatories. The Association of Teacher Astronauts (TATA) based in San Diego, led by Maria Catalina, has been working with these observatories on educational outreach. Now TATA has been approached by a Chilean Air Force General to engage Moon Society assistance in the design and outfitting of MMARS. Its core module will be the wingless fuselage of a retired Chilean Air Force Hercules C130B cargo plane. Other "modules" will be added as the project develops.

There is such a long list of research directions to be advanced at such facilities, that this multiplicity is most welcome. Different facilities can specialize in different areas.

Inside a spacious warehouse with windows and walls painted black to keep out external light, it would be relatively easy to simulate the sequence of 2-week long "dayspans" and equally long "nightspans."

Experiments in low energy nightspan activities would be easy.

In the US, the largest private effort to develop a space analog was the Biosphere II program in Oracle Arizona during the 1990's. NASA developed its own Bioplex effort at Johnson Space Center in the late 1990's but ended those for budgetary reasons as it did the complementary NSCORT program at Purdue and other institutions conducting controlled environment agriculture and CELSS systems. *While NASA has left a research vacuum in the US for this type of work, this short-sighted program reduction leaves an opportunity for other nations. The Moon Society supports forward thinking and research that will advance the agenda of Settling the Moon and saving the Earth no matter where it occurs in the world because nothing less is acceptable.*

The Mars Society's Desert Research Station outside Hanksville, Utah was used for a two week "Moonbase simulation" exercise February 2006, cosponsored by the National Space Society. The Moon Society has been developing its own analog modular multi-phase facility design and research program, in which the National Space Society has again shown interest in cosponsoring.

http://www.moonsociety/moonbasesim/proposals/AnalogMoonbaseProposal.ppt.

How an analog station is designed depends in part on how it is going to be used;

• As a model a self-contained lander to serve as a base for human-robot team exploration; or

• As the initial core of an open-ended expansion in support of mining and manufacturing. The Mars Society stations follow the former design constraints. The proposed Moon Society / National Space Society analog station would start with a few modules to serve as a core, and keep on expanding to model the way an initial outpost might grow towards a genuine small settlement.

Analog Station Research Programs (from Peter Kokh)

At the two Mars Society stations, the primary focus is on testing and perfecting geological and biological research tools so that they are easy to use while wearing a space suit. Robotic assistants that can be remote-operated at close range to avoid time delay loops, are also a major focus. Robots and humans work best together, contributing their complimentary strengths. *To favor one over the other is not helpful.*

For Moon analog research programs, if a significant part of the host rock and soil are chemically, if not minralo-gically similar to some regolith types, experiments to see what could be made from it might be on the agenda. Easy things are sand bags and sintered blocks for construction and shielding purposes. If the area is basaltic, experiments with cast and/or hewn basalt might be feasible.

But if the design of the station is open ended, experi-ments with different types of modules and with a modular bioshphere component would be most valuable. That way, as the physical complex grows, the host biosphere grows with it.

Even at the poles *the sun does not shine eternally,* and some power storage is necessary. Power storage experi-ments are very appropriate. And to meet the problem half way, experiments resolving a particular operation into energy intensive (and perhaps labor light) portions and energy-light portions that could be labor-intensive, ideally to be performed in dayspan and nightspan respectively would be most useful. Now, not all areas of activity will neatly precipitate into two such task sets that can be done sequentially. But every bit of progress made in that direction will make nightspan power supply less of a problem. *Let's not fear the lunar night!*

Siting Considerations (from Peter Kokh)

We have already addressed some siting options in the section above. Here are some additional suggestions:

• Convenience: Sources of resupply (food, water, fuel, parts, etc.) should be within a daytime round-trip drive. If a volunteer "jack-of-all-trades" engineer or handyman is avail-able in a nearby town or village and agreeable to be on call, he/she will prove to be invaluable. *Things will break down. You will run out of supplies.* Similarly, if there is a nearby school where volunteer assistance can be found, that would be helpful also. Logistics can be expensive. Ideally, the site should be only a few hours drive from a major airline hub.

• Environment: The ideal is a site with *no, or very sparse vegetation.* There is no vegetation on Moon or Mars, and seeing vegettion breaks the spell if you are trying to pretend that you are on one of those worlds in order to get in the spirit of what you need to be doing. The locations identified in the article on page 18 are relatively vegetation-free.

Urgency of Earth Applications of Lunar Analog Research

Now there is also another dimension to the issue of lunar base analogs that addresses the most urgent problems on Earth, the use of scarce resources and the management of the environment. A Moon Base is a small village on the surface of the Moon. It must, because of transportation expenses use the least amount of resources possible to meet the needs of its crew in safety and comfort, while recycling wastes, atmosphere, and water, and growing its own food and becoming as self sustaining as possible while also enabling a diverse ranges of research and commercial activity.

On the airless, waterless Moon, each outpost and settlement must provide its own mini-biopshphere. Within such environments, pioneers must learn quickly to "live downwind and downstream of themselves." They must also learn to reduce throughput of new matter to trash, designing everything to be reused and/or recycled. Design philosophies, technologies and systems that would make such living practical will be invaluable in the terrestrial world at large. Use of non-flammable low volatiles materials would be ideal.

For modeling vegetation-based graywater systems, as with greenhouse activities in general, year-around opera-tion may be necessary. Many other lessons learned may be of help in tackling real live world problems, especially those common in developing countries. Lessons learned in the redesign of all operations and activities to run high-energy and low-energy tasks sequentially (to fit the lunar 29.5 day dayspan, nightspan cycle) will have invaluable application on Earth as well, were energy is in short supply.

Development at analog sites, of building materials that incorporate only elements reasonably abundant in lunar regolith, such as glass-glass composites, could lead to signi-ficant economic development in countries rich on rock and sand, low on vegetation and fossil fuels. In short, lunar analog research stations could lead to overdue changes in the way we live here below, as well as prepare the way for timely deployment and buildout of outposts on the Moon. Tweaking analog station design and research programs to do this, is the way to justify analog research to populations in developing countries in which the "here and now" demands much more attention than the "out there and later."

The disciplines and designs which will allow us to live and work on the surface of another planet will enable us to lift standard of living and preserve the environments of some of the poorest people on Earth. This is the payoff for a country such as India with some 600,000 villages whose productivity can be increased and whose people can aspire to a "Moon Standard" of living. Of course India is not alone in this respect as there are many people living in small village in rural poverty in countries across the world.

India deserves special mention because it has from the very beginning of its space program justified what they did in developing satellites and launch systems in support of programs which address the human problems of the country in agriculture, environmental remote sensing, meteorology, communications, and education. The ISRO could initiate a lunar analog program for the very same reasons and in the best of its scientific and educational heritage. No doubt, other pro-space organizations and aerospace industries in India may wish to be involved in such an effort.

Design Elements of a Lunar Analog Base/Research Park

The potential locations of a lunar analog are many. We have already discussed virtual space as the first step. But many will not be satisfied to limit their efforts to the virtual world. There is also a case for proving and demonstrating in the real world and to have real world simulatIions. As we have already discussed there have been a variety of efforts in a wide-ranging variety of environments. Some might be selected because the natural terrain has a lunar appearance; others, because the geology and mineralogy are right; still others, because of climate considerations favoring a longer annual "field season." [Note: in most temperate climate zones there will be a distinct advantage to shielding the analog station with soil, either loose, bagged, or sintered into blocks. This will moderate thermal extremes, even to the point of making all-year operation practical. That will mean more research per facility investment dollar or Rupee. – PK]

The lunar terrain and environment is unique and no one terrestrial site can model more than a few of its characteristics. Site choice should follow the needs of the research program desired. If modeling the 29.5 day-long lunar dayspan-nightspan cycle is essential, an analog station might be constructed entirely with the confines of a building in which lighting can be controlled. Such a facility could be in the middle of a city in order to reduce expenses in transport of people and supplies and to build a simulator environment that is also physically accessible to large number of people. The Bioplex effort at Johnson Space Center in Houston, Texas followed this strategy.

Because there are many aspects to analog considerations, there is value in encouraging a wide range of efforts and approaches. The following elements of design should be part of a comprehensive analog effort.

A We have the advanced prototype Lunar Greenhouse at the CEAC Center (Closed Environment Agricultural Center, at the University of Tucson) in which a Prototype Lunar Greenhouse has already constructed. CEAC is looking for more funding and the credibility of their systems could attract capital to a larger Analog Program which would have something no one else has : a working bio-remediated CELSS systems growing food.
http://ag.arizona.edu/ceac/
http://ag.arizona.edu/ceac/index_files/INDEX4.jpg
//ag.arizona.edu/ceac/CEACresearch/International/004.htm

What is missing from their system is further robotic capabilities. That would take another level of funding and engineering expertise focus on the operational of a Controlled Environment Greenhouse

What is also missing is an educational vision that could involve lots of students. CEAC has a good start on this as well and some synergies with the Lunar Explorer program might be explored.

B We should develop working models of the autonomous lander and deployment systems expanding Greenhouse systems telerobotically proposed by CEAC.

C We should demonstrate a complete end-to-end system from the harvesting of food crops to their preparation and storage using robotic and telerobotic capabilities.

D Another valuable contribution would be developing a working surface infrastructure system that shows how things will be landed, moved around, and protected from surface extremes.

E The experience at McMurdo Sound in Antarctica is that effective warehousing of incoming supplies, spare parts, recyclables, etc. is a science not to be ignored.

F We must demonstrate how tank farms can be assembled from empty landing vehicle tanks to enable ISRU demonstrations at first, then full industrial production. No fuel tank should arrive on the Moon that is not designed for reuse.

G We must demonstrate how curation receiving facilities would operate collecting, dividing samples for shipping to Earth from those maintained and protected on the Moon.

H We should demonstrate an architecture for extended surface exploration which shows a progressive build up and reutilization of what have here to fore been expendable equipment. At what pace of activity does a crude rail system make more sense than roads?

I We should demonstrate the utilization of solar energy systems and not only PVC arrays but solar thermal turbine systems, and the utilization of "solar wadi" systems which use the latent heat stored in processed iron enriched materials derived from the lunar soils.

J We should demonstrate the operation of solar power laser transmission systems to power lunar surface vehicles.

K We should demonstrate the telerobotic operation of mining vehicles that can process the surface regolith. The miner concept developed at the Fusion Research Institute at the University of Wisconsin was focused on the capture of solar wind implanted volatiles. Other materials process issues could also be coupled to these mining machines so that a cascade of materials processing events and process can be understood, designed, and prototyped. (See Q)

L We should have modular habitation and lab systems perhaps using Bigelow Aerospace inflatable modules or other designs, such as the inflatable torus.

M We should explore the use of contour crafting construction technology in construction of lunar base structures and explore how this type of machinery could be designed, shipped, deployed, and tele-operated in the context of a lunar base operation.

N The development of feedstock for lunar concrete utilized by the contour crafting system is another aspect of in situ resource utilization studies, This aspect is also a significant systems development challenge based on the variability of lunar surface materials.

Now this list is not intended to be exhaustive but to merely illustrate the rich possibilities for research and engineering in a lunar analog context.

We did not discuss the energy and resource systems management research alluded to in regards to the Earth side applications. Those issues will be addressed in future issues.

But the essential message of this analysis of the opportunities suggest that India and other nations considering manned space operations, would do well to get into serious lunar analog research programs. **<DD>**

THE MOON IN HISTORY QUIZ

Reprinted from MMM #16, June 1988

QUESTIONS

1. What evidence was there for early man that the Moon was spherical and not just a round disk?
2. How long ago was it first realized that the Moon was world-sized and that the Earth was not alone in this respect?
3. For how long have people been writing science-fiction stories about trips to the Moon?
3. When was it first realized that the lunar environment was probably airless?
5. How long after a realistic picture of the Moon became common, did the first modern science-fiction work appear about visiting the Moon?
6. When did something manmade first reach the Moon? This is a trick question.

ANSWERS

1. If the Moon were a flat disk lying all in one plane, the Sun would either shine on all of it, being this side of that plane, or on none of it, being on the other side of the plane. As it is, the terminator or line between day and night creeps slowly across the Moon, at a varying pace, giving us the familiar phases. This can only be if, the side facing us at least, is spherical.

2.In 130 BCE [before common era], about 2120 years ago, the Greek Hipparchus of Nicaea (SE of Byzantium, now Istanbul) demonstrated that the Moon was 30 Earth-diameters distant. Earlier, in 240 BCE, Eratosthenes had deduced from the Sun's lower noontime elevation in the sky in Athens as compared to Egypt at the same time of year, that Earth's diameter was of the order of 8,000 miles [the true figure is 7,926 mi.] Hipparchus thus concluded that the Moon was about 240,000 miles distant [actually 238,857 on average] and then figuring in the Moon's apparent angular diameter in the sky of 1/2 degree, used Greek trigonometry to arrive at a lunar diameter of 2,000 miles [actually 2,160.] Prior to this, there exists one reference to a belief that the Moon must be larger than the Peleponesus, the southern peninsula of Greece, about 130 miles across. But perhaps most people, then as now, never thought of the question, or cared.

3. The first known such story is by Lucian of Samasota who in his "True History" (2nd Century CE) wrote of a hero who sails into the Atlantic and is carried to the Moon on a waterspout. He spoke of the Moon, the Sun, and Venus as inhabited worlds. Along with most ancients, he took it for granted that air pervaded all space and therefore travel between worlds would pose no special problem of discomfort or inconvenience.

4. In 1643 CE Evangelista Torricelli first measured the pressure of air and realized that the atmosphere had to be confined to within a few miles of the Earth's surface. In 1687, Newton's Principia Mathematica explained that our blanket of life-sustaining air is held to Earth by gravity. The Moon's smaller size and expected lower gravity would not be able to maintain such an asset for long and it would be airless and waterless. The Moon's rough mountainous and crater-pocked surface had been revealed a bit earlier with Galileo's invention of the telescope in 1609. So by the 17th Century, a rather modern understanding of the Moon's nature had emerged.

5. Not until two centuries later when Jules Verne published his "From Earth to the Moon," still a classic, in 1865. He even had the necessary escape velocity from Earth figured quite accurately.

6. In 1949, when we first succeeded in bouncing a radar beam off the Moon and successfully recorded the echo. This was our first baby step in the long saga of trying to touch the stars, and the first hint that the Space Age would soon be upon us.

This feat was just repeated by the Moon Bounce Project, http://echoesofapollo.com/moon-bounce/

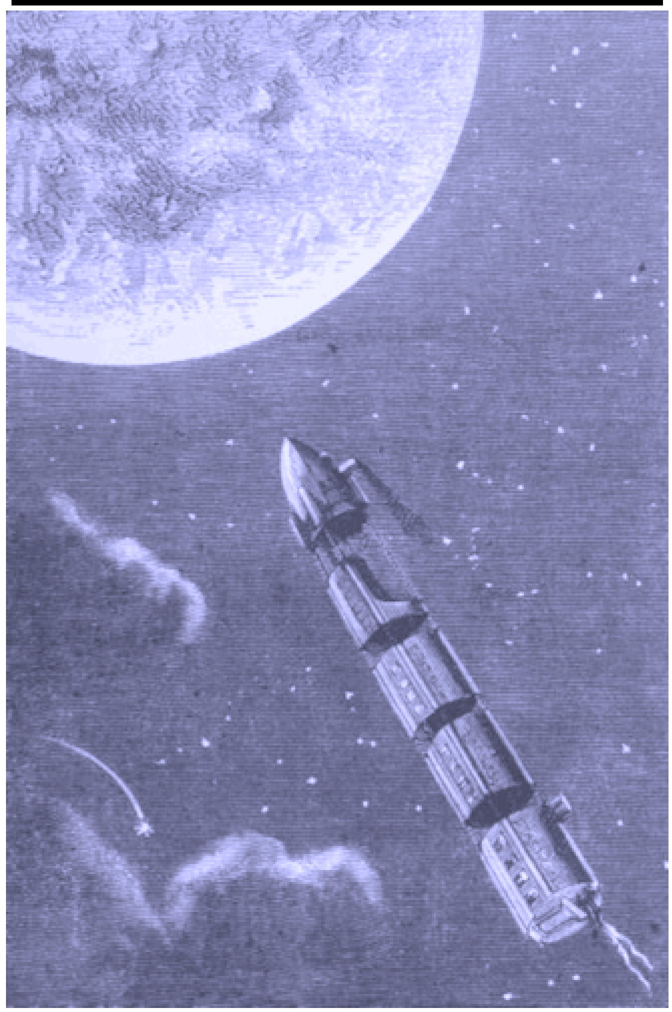


Illustration of projectile train traveling to the Moon from Jules Verne's Nineteenth Century science fiction fantasy "From Earth to the Moon."

Welcome to The Space Chapter Hub

http://nsschapters.org/hub/

The Space Chapter HUB is a **Clearing House** of Information for Local Chapters, of whatever affiliation, involved in public space outreach. The Hub is a collaborative website shared by chapters of **The National Space Society, The Mars Society, and The Moon Society.**

Agendas and priorities may differ. But we all face the **same set of challenges** and have **the same set of methods and tools available to us.** Our Mission is to make easier the tasks facing us all through a common watering hole where we can all trade know how and techniques.

On the website, click on the Hub image or on the pulsing Sun to enter. **The Hub Main Menu** appears:

Here you will find pages to provide your chapter with handy tools and information gained by experience:

Meetings and Agendas	Flyers to download
Newsletters	Transparency sets
Project Ideas Unlimited	Presentations
Event Calendars	Display Blueprints
Publicity/ Media Contacts	Models & Exhibits
Political Contacts (USA)	Chapter Videos
Educational Contacts	Speakers Bureau
Chapter Scrapbooks	Conferences
Science Fiction "Cons"	Websites
Image Libraries	Merchandise

Note: This site was created by the editor, to fill a promise made as Chair of the National Space Society Chapters' Assembly in 2000. It was intended to be a place where all chapters of whatever organization could share their experiences and know-how. Unfortunately, to date few chapters have contributed anything. Most of what is on the site comes from the NSS Milwaukee (Wisconsin, US) chapter the "Lunar Reclamation Society."

Chapters of any space organization in India, including ASISC and SEDS should feel welcome to share their tricks and outreach products. Our goal is one: to increase public support of Space Exploration and Development whether by government agencies or by private enterprise.

We all share the goal of expanding mankind's presence throughout the whole of our environment: from Mother Earth to Father Sky. *Write the Hubmaster:* kokhmmm@aol.com

MMM-India Quarterly Editoral Team:

Peter Kokh kokhmmm@aol.com
Madhu Thangavelu thangavelu-girardey@cox.net
David A. Dunlop dunlop712@yahoo.com

Help Wanted !

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

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

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

mmm-india@moonsociety.org

[This email address goes to the whole editorial team]

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

Guidelines for Submissions

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

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

Submissions should be short, no more than a few thousand words.

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*

Readers are encouraged to share and to distribute this first edition widely, either as an email attachment, or via the direct download address:

http://www.moonsociety.org/publications/mmm-india/m3india1_fall08.pdf

MMM-India Quarterly is a free access publication

We will set up an online subscription service so that each issue is emailed to your email box directly, if you wish.

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

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

Lunar Trek – the first National Rover Competition at SINC 09

http://www.vit.ac.in/sinc09/html/lunartrek.html

By Avinash Siravuru

[See MMMIQ #2 page 18 for preview report]

For the Lunar Rover Competition at SINC 09, we had over 25 teams participating from NIT Warangal, MLRIT Hyderabad, IIIT Hyderabad, SRMU Chennai, and our very own VITU, Vellore, host of SINC 09 and of the competition.

Lunar Trek was a visual feast to all the participants, school students who had been invited to visit the conference, faculty members et al.

The competition saw students particularly freshmen boys (a few girls) and sophomores coming up with brilliant designs and mechanisms to make the both lighter and yet be powerful enough to go over an uneven terrain. [photo below]

The dean of the School of Mechanical and Building Sciences, and the dean of the School of Computing Sciences, etc., were some of professors who were invited over to the arena. They were pleasantly surprised to see that most of the teams had young engineers, and that yet their designs and ideas were so thoughtful.

The event was also covered by a few newspaper reporters and I am also collecting the photos and videos of the conference per se which will give a gist of what all transpired here in the past few days.

I was also able to interview of Mr. Pallava Bagla, Science Editor, NDTV whose book, *Destination Moon: India's Quest for the Moon, Mars and Beyond*, was reviewed in the latest MMMIQ.

I thank The Moon Society once again for being by my side and helping me make this event a huge success.

[The Moon Society was happy to provide $200 to support this lunar rover competition, along with special prizes for the three top contestants:]

- First prize: a CD of the Lunar Source Book and a 2-CD Consolidated Lunar Atlas.
- Second prize: a CD of the Lunar Source Book.
- Third prize: the CDs of the Consolidated Lunar Atlas.

The winning rover above! - First Prize winner below

India's Future in Space lies with its Students

By David Dunlop **dunlop712@yahoo.com**
Moon Society Director of Project Development

Forward

In late March of this year, I had an opportunity to speak with Professor Goswami at the Lunar and Planetary Institute Annual Conference in Houston, Texas and to make him aware of the MMMIQ publication and of the enthusiastic interest and activities of students including the first all India SEDS conference, SINC09, with its lunar Rover competition.

Dr. Goswami said that one of his highest priorities is the engagement of student interest and participation with ISRO as it plans new space missions and develops new goals. I indicated that I would forward our MMMIQ to him, solicit new project and proposals for student engagement from our readers, and suggest ideas where student participation could occur.

Let India Stake Its Future in Space with Students

India's ISRO has a formidable record of accomplishment over several decades in bringing benefits to the nation of India and to other countries as well. Its successful Chandrayaan-I lunar orbiter mission is only the most recent example of its advancement and progress in capabilities. ISRO however looks beyond its current triumph to fully develop as a major spacefaring power reaching out to plan lunar landings, missions to Mars, heavy lift launchers, and more. These ambitions will require that India solicit the interests, and efforts, of it's best and brightest as it set forth new goals, develops implementation plans, and builds technology.

India could not make a better investment in its future than by engaging its students and assisting them to make contributions. MMMIQ can play a role in this effort by soliciting ideas and proposals, publishing them, and suggesting new initiatives. MMMIQ proposes that the ISRO build on its sponsorship of the first all Indian SEDS Conference with a number of competitions announced for next year's SEDS Conference.

A Competition of Ideas

First, we propose a competition of ideas in both science and engineering. There are many scientific goals that have been identified for the exploration of the Moon which are shared (See Report, The Scientific Contest of the Exploration of the Moon) by the ISRO and the international scientific community. A competition for proposals should be initiated for students at the secondary, undergraduate, and graduate levels and the winners selected on the basis of merit and innovation. The winning proposals could be identified as proposals given consideration by the ISRO in planning subsequent Chandrayaan series missions an in selection and development of associated instrumentation. Students winning these competitions would receive a full academic scholarship at their home academic institution, as well as an ISRO internship with it scientific staff planning lunar missions.

A Competition of Engineering

Second, we propose a competition in the area of engineering that will build on this year's first lunar rover competition at SINC09 with the goal of building and landing a micro rover on the lunar surface on either the Chandrayaan-2 or proposed Chandrayaan-3 missions. This competition would provide the winning team and its academic institution with an official place on the mission planning team, official ISRO-funded internships for the project team with ISRO mentors, and appropriate technical and laboratory support for the winning institutions lab facilities to enable it to build the lunar lander.

We propose the ISRO present its requirements for micro rovers as a set of design and performance criteria, and that these criteria form the basis for a contest rubric for evaluation of proposals. Teams competing at the SEDS competition would be evaluated by a team from ISRO, which would undertake an organized design review before the first round of competition at the conference. In this first the ISRO judges could select up to 5 teams for secondary participation.

Designs selected in the 1st round would receive funding and support for a 2nd round of engineering development. Such development would include use of high cost materials use of ISRO testing facilities and laboratories, and to take the design to a "space qualified" level.

Students selected would receive funded ISRO internships, and in collaboration with their academic institution be permitted to focus on their project as an "exceptional opportunity" option in their engineering program. Faculty sponsoring the selected teams would also become part of the engineering development team with both financial and equipment incentives provided to their academic institutions.

In this process, ISRO would gain the ability to select a variety of creative engineering proposals, mentor the originating teams, develop, test, and evaluate "flight hardware, and make a comparative adjustment of the platform most useful to ISRO lunar surface requirements. It would in the process build strong relationships and support the research facilities and faculty of participating academic institutions.

A Competition of Entrepreneurship and Commercial Applications

We also propose an open competition for students at secondary, undergraduate, and graduate levels to propose new space related commercial services that could benefit the Indian global economy. These proposals would be evaluated by a panel from ISRO and ISRO commercial contractor firms and proposals would be selected an given development grants for the young entrepreneurs as well as internships and mentors from the ISRO and ISRO commercial contractors. These development grants would enable the development of a mature business plan, and evaluation of technical requirements and production requirements. This competition would encourage India's student scientists and engineers to also focus on commercial applications and business models for their ideas.

Support of these competitions by ISRO could further energize the level of participation of Indian students in science, engineering, and entrepreneurial activities that would strengthen India as a global space power. They would also strengthen ISRO's academic partnerships, and build momentum for a growing workforce in space and advanced engineering and commercial development. <DD>

Student Space Organizations in India

The Planetary Society of Youth (TPSY)
http://www.youthplanetary.org/

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

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

Astronautical Society of India Student Chapter (ASISC) - http://www.indianspace.in/

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

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

SEDS-India
(Students for the Exploration & Development of Space)
http://india.seds.org/

SEDS India,
National Headquarter - SEDS VIT,
C/O , Dr. Geetha Manivasagam,
Room No. 403 , CDMM Building , VIT
University,
Vellore-632014, Tamil Nadu
Phone No. : +91-9952281231
Anmol Sharma
(Director, Chapter Affairs)

SEDS INDIA Chapters:
1. SEDS VIT - Vellore Institute Of Technology University (Vellore) http://www.vit.ac.in/seds_vit/index.html
2. National Institute Of Technology (Suratkal)
3. National Institute Of Technology (Trichy)
4. Jawahar Lal Nehru Technical University (Hyderabad)
5. Kumaraguru College Of Technology (Coimbatore)

Astronautical Society of India Student Chapter NEWS

Source: M. Sathya Kumar rocket@indianspace.in

A Student-Designed, Student-Built Satellite

With approval of ASISC President, MAnbarasan, ASISC Projects Director, M. Sathya Kumar has proposed an ambitious **Student designed and built satellite**.

The Features of the satellite will be [in brief]
1) Optical Telescope [with Zerodour/Pyrex optics] as the main instrument. with an option of mechanically switching between visual imaging and other bands.
2) OFC fed Spectroscope as auxillary instrument.
3) 3-axes stabilization using cold gas thrusters or momentum wheels.
4) will be a Hexagonal Structure of 2.5ft height and 1ft diagonally. (this is much larger than ANUSAT)
5) Will have body-mounted solar panels.
6) S-Band communication.

The following resources are needed:
1) Scientific Expertise in the form of ISRO scientist help.
2) Personnel with interest and expertise in Programming. Must develop a Real Time Operating System [RTOS]
3) Electronic engineers with Satcomm expertise/interest
4) Mechanical Engineers for the Hardware design.

Interested people please mail rocket@indianspace.in

8th Low Cost Planetary Missions Conference

"LCPM8" will be held in **Goa**, India between August 31, 2009 and September 4, 2009. The Conference is held by the Astronautical Society of India (ASI) with the support of the Indian Space Research Organisation (ISRO) on behalf of the International Academy of Astronautics (IAA).

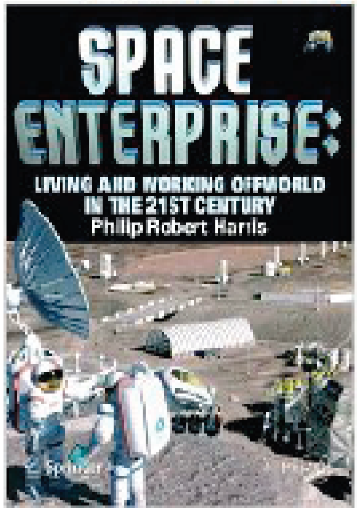
The programme of the conference includes:
1. Low Cost Planetary Missions: Science, Perspective and Challenges
2. National and Joint International Programmes in Planetary Exploration
3. Reduction and optimisation of the cost of Planetary Missions
4. Recent Low Cost Planetary Missions
5. New Results and Discoveries in the field of Planetary Exploration
6. Low Cost Missions currently in Definition or Develop ment Phase
7. Science Instruments for Low Cost Missions
8. Utilisation of existing Mini Satellite buses for Planetary Exploration
9. Advanced Technologies for Future Low Cost Missions
10. Advanced Concepts for future Low Cost Solar Exploration missions

Announcement of opportunity to participate :
www.isro.gov.in/conference/LCPM8_Goa_1stAnn.pdf

Pre-registration contact:
Dr. D Gowrisankar: lcpm2009@isro.gov.in

Further details on the conference:
1. Dr. J N Goswami - director@prl.res.in
2. Dr. M Y S Prasad - mys@shar.gov.in

THE book WORM



Space Enterprise: Living and Working Offworld In the 21st Century

By Philip R. Harris

Springer Praxis Books / Space Exploration
[Illustrated] (Paperback) ISBN 978-0-387-77639-2

1. Toward a global space vision, ethos, and enterprise
2. Human space exploration and settlement
3. Space habitability and the environment
4. Cultural implications of space enterprise
5. High-performing spacefarers
6. Orbital deployment systems and tourism
7. Macrothinking in strategic space planning
8. Macromanagement of space enterprise
9. Challenges in offworld private enterprise
10. Lunar enterprises and development

Author **David G. Schrunk** (The Moon: Resources, Industrialization and Settlement) writes:

"From both scientific and historic perspectives, the evolution of humankind into a spacefaring civilization is inevitable. In Space Enterprise, Dr. Harris reflects upon his 60+ years of space research to explore the significance and opportunities of the emergence of humankind as a multi-world species. He emphasizes that we now have the opportunity to make advance plans for the emergence of our "space culture" - a culture that will be able to tap into the unlimited resources of space for the benefit of all humankind. I highly recommend Space Enterprise; it is thoroughly researched and provides a stimulating insight into the future course of humankind.'

Also by Philip T. Harris

Launch Out

paperback 2003, Infinity Publishing ISBN 0-7414-1487-2

"Space is not a luxury, The space program is not intended merely for exploration and adventure..."

Topics: interplanetary enterprises, lunar industrial park, corporate astronaut, more ….

Pro-Space Organizations in India

Astronautical Society of India
http://www.asindia.org/default.aspx

IndianSpaceTalk@groups.indianspace.in

National Space Society Kolkata chapter
http://chapters.nss.org/a/lists/International/ChapList_IN.shtml
Dr. Satadal Das
drsatdas @ hotmail.com 91-33-24683336
76 Satyen Roy Road, Kolkata, WB, 700 034 India

National Space Society Pune chapter
Mr. Sandeep Joshi 91-20-30224216
mazabharatmahan@yahoo.com
Guardian Holidays
101 Citi center Karve Road, Pune, MAH, 411 004 India

Planetary Society of India [promoting astronomy]
http://planetarysocietyindia.blogspot.com/2008/08/space-camp-india-astrounaut-training.html
http://planetarysocietyindia.blogspot.com/
http://planetarysocietyindia.org/

Space India - ISRO Newsletter - twice a year
http://isro.gov.in/newsletters/newsletters.htm

Aeronautics & Aerospace Journals & Magazines Published in India (Stress on AEROspace)

International Aerospace Magazine India
http://www.internationalaerospaceindia.com/default.htm

Vayu Aerospace Review – www.vayuaerospace.in/

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Feel free to send us email addresses of others Individuals and/or organizations or lists that you think would like to receive future issues.

Moon Society Chapters in India?

The Moon Society is interested in helping to establish local chapters within India:

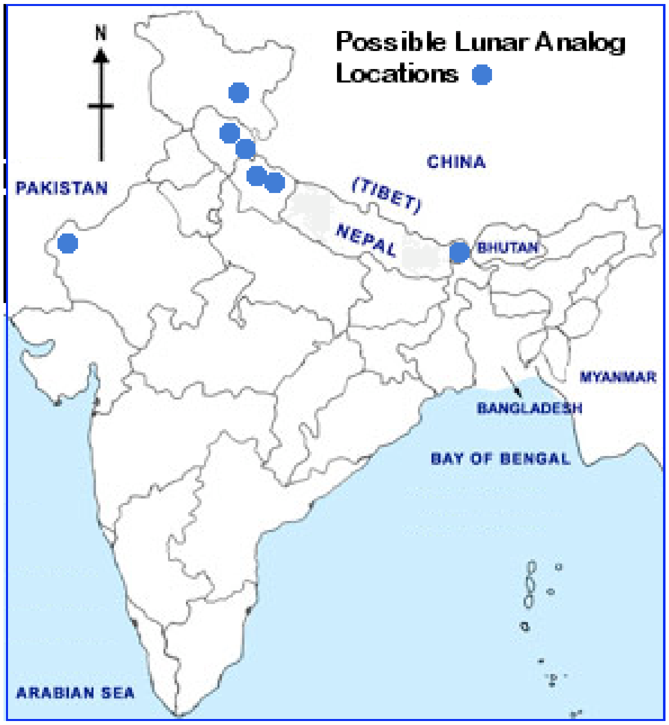
Both **School-based student chapters** and **General population community-based chapters**

We also foresee an India-wide **Council of Moon Society India Chapters** with its goals, projects, etc.

For information on how to proceed, write:

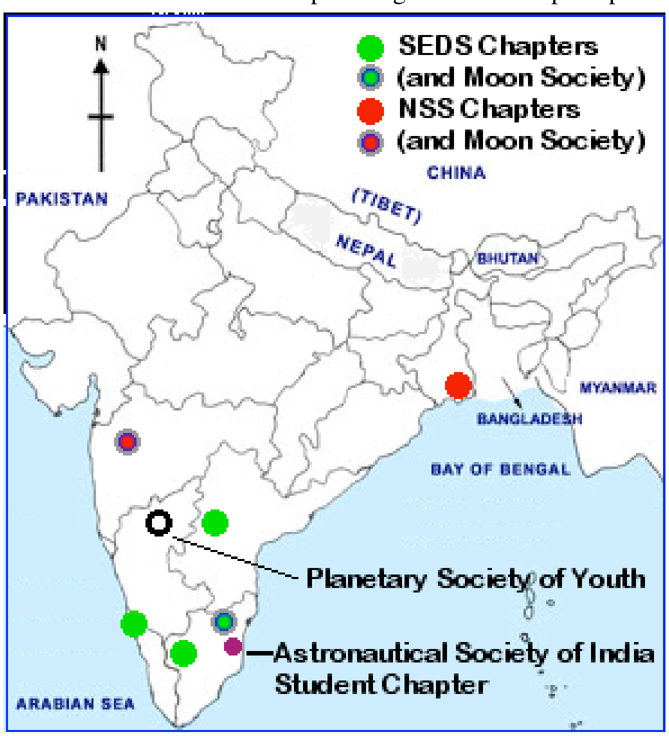
chapters-coordinator@moonsociety.org

Put "India Chapter" in the subject line of your email



Above: Possible Lunar Analog Research Station Sites: p. 18

Below: Student and Other Space Organization Chapters p 24



Have an Idea for an Article?
Topics you would like to see addressed?

Send us a letter an / or your comments!

mmm-india@moonsociety.org

MMM-India Quarterly #3 - July 2009
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The Editors hope that you enjoy this issue. Pass it on!

Send comments to: mmm-india@moonsociety.org