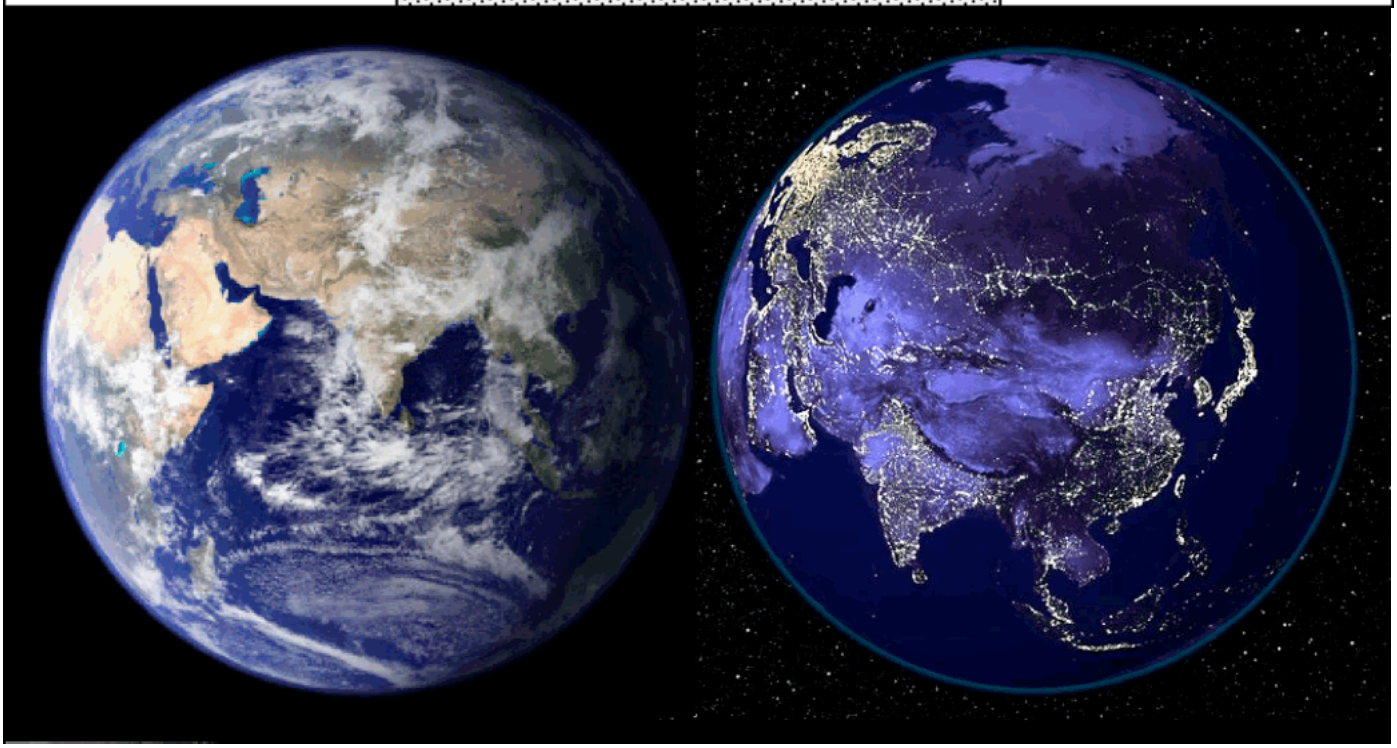
"Towards an Earth-Moon Economy - Developing Off-Planet Resources"

Moon Miners' Manifesto

India Quarterly Edition

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

#5 WINTER 2010



During cloud-free days or cloud-free nights, from Space, India stands out clearly

Feature Articles This Issue

Water Politics on the Moon
Srivinas Laxman page 3

Discovery of Water: Promises and Concerns
Pradeep Mohandas page 5

Predictions of the Impact of Discovery of Water on the Moon
David Dunlop page 6

Strategic Role for India in the Commonwealth
David Dunlop page 10

Electric Power to India via Space
Peter Kokh page 19

Beyond Simple Rovers – Robo-Ants
Peter Kokh page 22

Lunar Analog Stations without Moolie Terrain
Peter Kokh page 26

Complete article & feature index *on the last page*

Welcome to Moon Miners' Manifesto India Quarterly Edition #5

This issue begins "M3IQ's" second year of publication. Issues #s 5-8 [Winter, Spring, Summer, Fall '10] are scheduled for January, April, July, and October 2010.

In the last issue, we were happy to announce the formation of Moon Society India. This issue brings major contributions from our two Indian Editors, Pradeep Mohandas and noted space writer Srivinas Laxman. We hope you will appreciate the mix of commentary, speculation, and information. Moon Society India will have even more influence over the coming issues, and hopes to take over the publication entirely next year.

For Moon Society International editors Peter Kokh and David Dunlop, this transition is both promising and rewarding: it will mean success. Readers can send comments, whether favorable or constructively critical, to mmm-india@moonsociety.org

The future of India in space appears to be a bright one, and we hope to have helped stir Indian youth support.

About The Moon Society

http://www.moonsociety.org

Our Vision says Who We Are

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

Moon Society Mission

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

Moon Society Strategy

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

About Moon Miners' Manifesto

http://www.MoonMinersManifesto.com

MMM is published 10 times a year (except January and July. The December 2008 issue will begin its 23rd year of continuous publication.

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

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

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

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

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

www.moonsocietyorg/publications/mmm_classics/

Editors of MMM-India Quarterly:

Peter Kokh kokhmmm@aol.com
Madhu Thangavelu thangavelu-girardey@cox.net
David A. Dunlop dunlop712@yahoo.com
Pradeep Mohandas pradeep.mohandas@gmail.com
Srivinas Laxman moonmission.srinivas@gmail.com

About MMM-India Quarterly

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

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

Background

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

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

Why an MMM-India Quarterly?

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

And – *India is going to the Moon!*

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

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

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

Free Access:

MMM-India Quarterly issues will be available as a 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 wide-spread interest in the open-ended possibilities of space among the people of India, and to encourage the rise of additional citizen support space organizations within the country.

Chandrayaan-1 Report

Water Politics on the Moon

Giving Credit Where Credit is Due

By Srinivas Laxman

India's Moon Impact Probe hits its target

On the night of November 14. 2008, as Children's Day celebrations were slowly coming to a close all over India, the nation was all set to leave its imprint on Earth's nearest neighbour at a distance of 386,000 kms away. This event, which rocketed this country into a truly global space power, has been considered the greatest gift to the children of India.

At 8.06 p.m. (IST) sharp a 34-kg India-designed scientific instrument, called the Moon Impact Probe (MIP) measuring 375 mm by 375 mm by 470 mm with the Indian tri colour painted on all its sides detached from the main Chandrayaan-1 orbiter at an altitude of 100 kms from the lunar surface, and headed for the Moon at a whopping velocity of 1.7 kms per second.

The MIP, a last-minute addition to the Indian Moon mission which was introduced on the suggestion of APJ Abdul Kalam, had three instruments—a video imaging system which took pictures of the while it was flying towards the Moon, a radio altimeter for recording the rate of descent and a mass spectrometer which studied the Moon's atmosphere.

As it zoomed towards the Moon, the atmosphere in the hi-tech Chandrayaan mission operations control room at Peenya in Bangalore was one of nervous apprehension with the scientists keeping their fingers crossed and praying that the mission should go off without a hitch. Among those in the control room that historic night was Kalam, the brain behind the MIP, who was tracking the flight of the probe along with other top ISRO scientists on the big screens.

Then 25 minutes after it had detached the main orbiter, at 8.31 p.m. sharp, the MIP crash landed on the Moon in the south pole region near the Shackleton crater, making India the sixth member of the exclusive lunar club—the others being the US, former Soviet Union, the ESA (17 nations), China and Japan. The slamming into the surface of the Moon of the probe along 14 degrees E meridian from 45 degrees N to 90 degrees S latitude triggered a huge round of applause in the control room accompanied by warm exchange of embraces and congratulatory handshakes among the scientists and engineers. Later that night Kalam was presented with a model of the Moon by ISRO with the Indian flag painted on it.

As the country was celebrating its arrival on the Moon, there was a feeling among many people that the presence of the MIP on the lunar surface was merely symbolic and honestly it was devoid of much scientific value. They felt it was an exercise to reinforce Kalam's oft repeated stand that no one country can claim any portion of the Moon as its own. The MIP mission was at that time called a technological forerunner to a soft landing of a rover on the Moon during the Chandrayaan-2 slated for lifted off between 2012 and 2013.

The images taken by the MIP were displayed on the ISRO website which initially generated a lot of thrill and excitement, especially among the younger generation. The pictures were sharp and clear, which attracted a lot of praise from the international space community, especially NASA. But, as time went by other critical issues relating to the Chandrayaan-1 mission began to overshadow the role of the MIP and consequently it got pushed into the background. Though briefly.

Ten months after the MIP crash landed on the Moon, it became amply clear that its role was after all not symbolic: it had an important function which was not known to many: it successfully fulfilled a major mission of Chandrayaan-1---it discovered water along with another Indian payload called the Hyper Spectral Imager. Chandra's Altitudinal Composi-tion Explorer in the spectrometer found the water molecules in the lunar atmosphere.

The important discovery by the two Indian payloads of Chandrayaan-1 was kept under wraps by ISRO for 10 months, and was announced by former ISRO chairman Madhavan Nair, during a media interaction on September 25,2009. His rationale for keeping it away from the public was that since the flight of the MIP was only for 25 minutes, ISRO was looking for more concrete evidence about its sensational discovery, which it finally got. Nair said that the MIP picked up signals about the presence of water as it flew down towards the Moon.

A day before Nair's announcement, on September 24, 2009, Carle Pieters, principal investigator of the Moon Mineralogy Mapper (M3) on board Chandrayaan-1 declared at a Washington press conference that M3 had discovered water. In the course of the media meet she paid full tributes to ISRO saying that without the help of the Indian space agency, NASA could not detected water. She said that the discovery has been confirmed by two other NASA's spacecrafts — Cassini and the Deep Impact.

Though she was all praise for ISRO, yet for reason still unknown Pieters failed to identify the two Indian instruments, which had also found evidence of water molecules along with M3. Her failure to mention these two payloads has shown that even a barren region like the Moon has not been spared of petty politics! It was politics of course which set off the race to the Moon between the US and the former USSR during the cold water, but this is an instance when politics is taking place on the surface of the Moon! The feeling was that ISRO should have made the announcement prior to NASA and taken full credit for the important find.

The discovery of water has lead to what is known as lunar water politics triggering speculation whether NASA is taking credit and not sharing it for a discovery done by India! Otherwise, as many Indian space scientists pointed out why could Pieters not have generously highlighted the significant role of the MIP and the Hyper Spectral Imager during the press meet? As they state, a mere tribute to ISRO is not adequate. On record, however, senior ISRO officials refuse to be drawn into any discussion on this sensitive issue saying that the water discovery was a joint effort of ISRO and NASA, and a wonderful example of international teamwork.

Its achievements have not gone unrecognized and Chandrayaan-1 has won many international awards inclu-

ding one from the prestigious American Institute of Aeronautics and Astronautics. It has been considered as one of the most successful international space missions.

Again 30 minutes past midnight on August 21, 2009, both Chandrayaan-1 and NASA's Lunar Reconnaissance Orbiter (LRO) flew over the Moon's north pole for four minutes to detect water ice. It was a bi static experiment. On August 22 both the agencies---ISRO and NASA—said that the mission went off well. But, to the surprise of ISRO officials, exactly three weeks later, Paul Spudis, principal investigator of Mini-Sar, a NASA payload on board Chandrayaan-1 who was also a part of the LRO programme regretted that the bi static experiment was a failure and put the blame on Chandrayaan-1. According to him, the antenna of Chandrayaan-1 was not pointing towards the Moon during the mission. His allegation has been completely refuted by ISRO officials,who insist that there was absolutely nothing wrong with the Indian lunar orbiter. They expressed shock over Spudis' remark.

Again this lunar water rivalry is not only between NASA and ISRO, but among NASA scientists too. Clearly, a game of one-upmanship is on in the US space agency! Along with the M3 on board Chandrayaan-1, one of the roles of Mini-Sar was to discover water. But, it had got beaten by M3. Spudis has been saying that an important announcement is expected from Mini-Sar any moment. Whether this was by chance or pre-planned is yet to be ascertained.

The story of the water on the Moon does not end with Chandrayaan-1 and LRO. On October 9, 2009, NASA's LCROSS, which flew along with LRO, hit the South Pole region of the Moon in search of water. A month later NASA declared the mission a complete success saying that LCROSS had found a lot of water. Many in the space community, both in India and abroad say that the discovery had only endorsed the one made by Chandrayaan-1!

Water and its significance

Whatever it is, what had been hinted about the possibi-lity of water being on the Moon by NASA's Clementine and Lunar Prospector missions earlier has now been confirmed by Chandrayaan-1 and LCROSS missions. The main significance of this is that it widens the possibility of long-duration manned missions to the Moon, and also launching inter-planetary flights from the lunar surface. Former ISRO chief K. Kasturirangan told M3IQ in a recent interview felt that there should be an international manned flight to the Moon, as it would considerably reduce costs.

While addressing students of the prestigious South Indian Education Society College (SIES) in Mumbai on September 26, 2009, Chandrayaan-1 project director, Mylswamy Annadurai, revealed that the mission had thrown light on another important factor---for the first time it was found that the water molecules found on the Moon were not from an external source like cometary bodies, but had been generated internally.

Annadurai's announcement has set off a lot of discus-sion in scientific circles and further research is in progress about the Moon's internal source of water. Yes, India has really shown the way on the Moon and it will continue to do so with Chandrayaan-2. SL

An Interview of Shyam Bhaskara

By Srinivas Laxman

A hitherto unknown aspect of the Indian moon mission is that a space scientist, Shyam Bhaskaran, who was born in Matunga, a locality in Mumbai, was a navigation consultant for the Chandrayaan-1 flight.

At present he has two roles at. First, he is the supervisor of 's Outer Planets Navigation Group at the Jet Propulsion Laboratory (JPL). The challenging job involves navigating spacecrafts to Jupiter, Saturn asteroids and comets. Second, he also leads a navigation team to take the Deep Space-1 spacecraft to Comet Hartley-2.

Former President APJ Abdul Kalam, praised Bhaskaran in the Parliament for his achievement as the team leader of the Deep Impact-1 mission that has successfully smashed into comet Tempel-1 in July 2005. He was one of the principal architects of 's autonomous navigation system used on Deep Space-1.

In interview to MMM1 from his dad's home at Thiruvanathanapuram, Bhaskaran, recalled that he was in Bangalore for two weeks during the Chandrayaan-1 launch and witnessed the lift off on the morning of October 22,2008, from ISRO's telemetry, tracking and command network (ISTRAC). ``I interacted with the navigators at Bangalore. It was a great and successful mission,'' he said.

Bhaskaran, who is currently on a vacation to India, said he was a part of the four-member team from JPL for the Chandrayaan mission. Their presence at ISTRAC and the ISRO Satellite Centre in Bangalore is understandable because the Indian orbiter carried two payloads, the Moon Mineralogy Mapper (M3, one of the instruments, which discovered water on the lunar surface along with India's Moon Impact Probe and the Hyper Spectral Imager, and the Mini-Sar.

About participating in the second Indian moon mission, Chandrayaan-2, Bhaskaran said if a decision to this effect were taken he would be happy to be a part of it. In an earlier interview to a national daily, The Hindu, he has been quoted as saying: ``I personally feel that the ISRO-collaboration should continue in the proposed Chandrayaan-2 mission ……..'' ``My opinion is personal and in no way reflects the official stand of ,'' he emphasized.

ISRO officials told MMMI that the foreign space agencies that had participated in Chandrayaan-1 were keen on coming back for Chandrayaan-2. So far, the Indian space agency has not taken any decision on this matter. Slated for lift off around 2013, it is an Indo-Russian venture. The launch vehicle and the orbiter will be India's contri-bution, while the lander and one of the rovers will belong to Russia. India is also sending its own rover in this mission.

In a personal tête-à-tête, Bhaskaran was all praise for the capability of the Indian space programme and added that there was no reason why India cannot undertake interplanetary missions in the near future.

Regarding Russia's recent proposal that China and the US should team up with Russia to deflect an asteroid which could pose a risk to earth around 2030, he assured that this asteroid was not going to collide with the earth, But he added at the same time: ``I think India can contribute towards such a mission.'' **M3IQ**

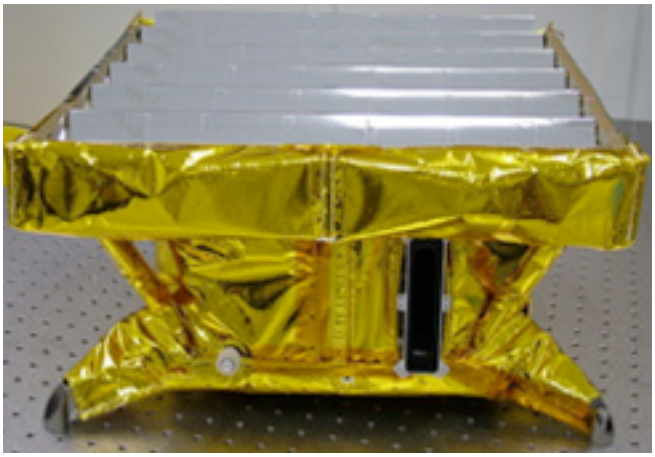
Chandrayaan Discovers Water

Chandrayaan: Promises and Concerns

By Pradeep Mohandas

December 7, 2009 - Students from across India were gathered in the room for the annual National Science Seminar, addressing the question, "Chandrayaan: Promises and Concerns". Today was the final inter-state competition. Everyone had added one more point to the promises section. The discovery of water on the Moon!

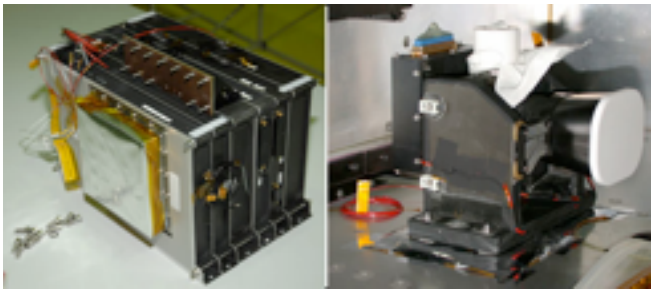
As the students edited their presentations, made new diagrams on their charts, former President Dr. A P J Abdul Kalam spoke about how he was told about the discovery at the Jet Propulsion Lab in California, USA, and a month before the paper came out. He said he immediately suggested to both ISRO and NASA to carry a ground penetrating instrument on Chandrayaan-II to reach where the Moon Mineralogy Mapper (M3) [*below*] could not reach.



In a similar session, Chandrayaan Project Director, Mylswamy Annadurai spoke to students at the SIES College at Sion, Mumbai. There he revealed the next step in this puzzle – where did the water come from? Studies by the Sub-keV Atomic Reflecting Analyser (SARA) [*below*] had revealed that the water could be produced from the hydrogen atoms absorbed by the surface moon dust from the Solar Wind. Hence, the water discovered by M3 had been produced in-situ and was not from any external source, as was previously thought.

The confirmed finding of the presence of water on the Moon will and has affected future lunar missions. Recently, Chandrayaan and Kaguya data was used to change the LCROSS target, which led it to find more water deposits on the Moon.

The discovery of water on the Moon was made as the Chandrayaan made one of its first few orbits of the Moon in November. The spectrometer on board India's Moon Impact Probe (MIP) also made the finding as did the Hyper Spectral Imager (HySI).



L: Moon Impact Probe – R: Hyper Spectral Imager

The results of M3 were published in September and on a historic night of September 24, Principal Investigator of M3, Carla Pieters, made the announcement in Pasadena, California. On the next morning, Dr. Madhavan Nair, Chairman of ISRO made the same announcement in India adding details of the findings of MIP and HySI. M3 works by sending out light in infra red on the lunar surface.

Studying the reflected light from the lunar surface, gave scientists an understanding of the various chemicals and minerals present on the Moon. Water and hyrdroxyl atom absorbs some of the light at a particular wavelength. The absence of reflected light at these wavelengths tells scientists that a particular atom has been detected. M3 used this technique to detect hydroxyl molecules on the lunar surface.

The result was further confirmed by archived data from Cassini and Deep Impact missions.

This data validation meant that Chandrayaan-I had become the first spacecraft to bring clinching evidence of the presence of water on the Moon.

The Next Step - In October 2009, SARA published its results as well solving another part of the jigsaw puzzle. India's two ground rovers traveling onboard Chandrayaan-II, which is expected to fly in the first quarter of 2013, may provide more data on the amount of these water reserves.

Students in the auditorium of the Nehru Science Centre [*below*] made presentation and were clearly well versed and very excited about the discovery and confirmation of water on the Moon. In the evening as they interacted with Dr. Annadurai they had come to the conclusion that although there were some concerns regarding Chandrayaan, they have been lessons learnt and the promises are still being delivered as the scientific results pour in **PM**

Nehru Science Centre, Mumbai

Major Omission in Chandrayaan-1 UTV Film

By Srinivas Laxman

It is like visiting Agra and not seeing the Taj. Or to give another example-it is something akin to describing the mighty Himalayas and all its peaks without making a mention of Mount Everest. It is a similar situation with the Chandrayaan mission in which the world has been kept in the dark about its maker by none other than the Indian government, triggering speculation whether this was a deliberate act resulting from petty politics or internal rivalry among the space scientists.

Yes, it is hard to believe that a recent 30-minute documentary produced by a private TV channel, UTV, about the Indian moon mission, specially for the external affairs ministry, has chosen to completely ignore the project director of Chandrayaan 1 and 2, **Mylswamy Annadurai**.

<<= Mylswamy Annadurai

An official of the ministry told M3IQ that DVDs of the documentary have been sent to Indian embassies and high commissions all over the world.

The idea is to show different segments capabilities of India's space sector. A good idea no doubt, but it has also successfully sidelined the important part played by Annadurai in the thumping success of the Indian lunar programme, and unfortunately the world will now not be aware of this!

An UTV spokesperson tried to justify the exclusion of Annadurai in the film by saying that the project director was not in Bangalore when his team went there to do the filming. According to ISRO officials this is a poor cover up for major failure because it would have always been possible for the TV crew to seek an appointment with Annadurai and carry his byte. It is, after all, not like the print media in which once a story has been filed and gone to print, additions and deletions are not possible.

Overall, the film has evoked a favourable response in the media. It is obvious that those who have seen the film and written about it do not have an in depth knowledge about the Chandrayaan-1 flight and are unaware of the part played by Annadurai!

When news about Chandrayaan-1's discovery of water hit the headlines on September 25, 2009, everyone recalled that it was under Annadurai's effective leadership that this challenging project moved from the drawing boards, then on to the laboratories and workshops and finally to the launch pad at Sriharikota, from where it blasted off during the early hours of October 22, 2008.

The spacecraft had 11 scientific payloads: six from abroad, and five from India. Annadurai accomplished the task of integrating the payloads, keeping in view the egos and clashes among the scientists and also the traditional differences between the scientists and engineers, without a hitch. As a result of his efforts India successfully provided a strong leadership to the world's first international lunar mission, which has won a number of international and domestic awards.

CHABDRAYAAN-1 INSTURMENTS

Indian Payloads

TMC - MIP or the Moon Impact Probe Terrain Mapping Camera
HySI - Hyper Spectral Imager
LLRI - Lunar Laser Ranging Instrument
EX - High Energy aj/gamma xray spectrometer

Payloads from other countries

C1XS X-ray fluorescence spectrometer (ESA)
SARA - Sub-keV Atom Reflecting Analyse (ESA)
SIR 2 - near infrared spectrometer (ESA)
M3 – Moon Mineralogy Mapper (NASA)
Mini-Sar (NASA)
RADOM-7 - Radiation Dose Monitor Experiment (Bulgaria)

It is against this background that one wonders why Annadurai has been excluded in the film. Consequently, after seeing the documentary one is left with a feeling of incompleteness. The producers have interviewed APJ Abdul Kalam, Krishnaswamy Kasturirangan, G. Madhavan Nair, T. K. Alex and S. K. Shivakumar, who have all made significant contributions towards the success of Chandrayaan-1. But, does this mean that Annadurai, the actual maker of Chandrayaan-1 should be dropped? No certainly not.

International Circulation of Film makes it worse

What has further shocked space officials is that the ministry of external affairs has sent this film abroad despite this serious omission. One really wonders what is the message it is trying to convey? **SL**

Predictions on the Impact of the Discovery of Water on the Moon for Future Lunar Exploration & Development

By David A. Dunlop

Until recently US lunar mission focus was almost exclusively on plans to land near Shackleton Crater and to explore the South Pole Aitken Basin. While this remains a significant target for geological studies, the concentration of water deposits in both polar regions, as well as the detection of water everywhere on the Moon's surface in trace amounts, now means that targets of interest for manned operations and development are global. Limiting human return activities to the South Pole was always short sighted.

Prediction I: *I predict that water discovery at the North pole will likely change that strategic blunder in the NASA Constellation strategy and broaden international lunar human exploration ambitions there as well.*

I also think that the then incoming Obama administration was about to scrap the Bush administration Constellation program and it's focus on getting back to the Moon. The Planetary Society and some Mars program advocates had been trying to knock out the lunar program in order to get a greater share of resources and to promote a manned Mars program. The discovery of water in amounts greater by far than previously imagined, may have stopped US abandonment or de-emphasis of the Moon "yet again."

The Augustine Commission *did not recommend a US manned Mars mission instead of to the Moon,* but rather a "flexible path" which included NASA depending upon commercial cargo and manned flights to ISS, and a range of options beyond LEO (still including the Moon) for exploration. That is a matter of politics internal to the US and the US space program, which we will see emerge as the Obama administration gets prepared to roll out a new space policy.

But the lunar water discovery also no doubt will also influence the other space faring powers as well. The International Lunar Decade declared by ILEWG at its 2006 meeting in Beijing (and which in fairness to the Planetary Society was strongly proposed by them as well) yielded important agreements including the coordination of International Space Exploration and agreement on an International Lunar Network of ground stations. The first wave of orbiters have flown, and a second wave of lunar lander missions were approved.

Now I think the interest in making use of the water discovery and the need to demonstrate recovery will shape future plans for all the international players. I will make some additional predictions.

Prediction II: This *lunar water discovery will result in announcement of an additional third wave of robotic precursor missions to the Moon*.

In this predicted "third wave" development of on site resources (ISRU) will be a strong theme. I look for some new ISRU lunar missions and perhaps an expanded ILN program to be developed. This was also recommended to NASA by their Lunar Exploration Advisory Group LEAG in their annual November meeting at the Lunar and Planetary Institute in Houston.

The increased momentum on the part of the international community to return to the Moon with humans will provide a rationale in each of these countries to "not be left behind." A recent strategic study of the role of the UK's BNSC [British National Space Council] made this point strongly to the British government. It also suggested a strong role for BNSC in the creation of a satellite lunar communications infrastructure. It concluded that a substantial increase in funding was needed for BNSC in order that the UK not be left behind technologically and economically.

Prediction III *This competition will increase the likelyhood of additional international cooperation in lunar development and some new/expanded lunar agreements.*

I think some coordination of human return missions will emerge in that crew safety, the potential for rescue if there are mission problems, and the practical potential of a coordinated supply chain to the lunar surface are win/win scenarios for all spacefaring nations that are "players" with lunar ambitions.

The new Moon race" is an arena for international competition, not so much to be "first" but perhaps more so not to be last or left behind.

China's resolve to develop its own capacity, and to demonstrate this by a human return to the Moon is a key part of this "technology prestige" competition. They are committed to put up their own manned lab in orbit. They are developing a new launch site on Hainan Island, as well as a new heavy lift launcher. They have announced a lunar sample return mission in 2017, which will serve as a dress rehearsal for a human landing / return mission in the 2020's.

The European Space Agency has placed more of a strategic emphasis on Mars than on the Moon. ESA has not seemed to be much in a hurry to develop a manned space capacity and has not envisioned introducing their own human rated vehicle until 2020 or after.

Prediction IV: *I predict that with an upturn in the economic fortunes in Europe, ESA will accelerate its humans to space program and include participation in a human lunar return as a significant strategic policy emphasis.*

ESA's announcement of a lunar cargo lander that can be launched on the Ariane V, lays a foundation for such a strategic shift. Many ESA partner nations have a signifycant interest in their own lunar missions including Germany, Italy, and the UK. If ESA does not match the lunar interests and ambitions of these strong ESA partners in its own strategic vision, then these may very well opt to collaborate on their own outside of ESA. This has already happened in the case of the NASA-UK **Moonlite** mission. While ESA lead the other space faring nations in its SMART I lunar orbiter early in the last decade its **MoonNext** mission is scheduled for 2016. A small Student Moon Orbiter mission is also underway.

Prediction V: *If I am right about a strategic shift toward the Moon by ESA, I will also predict an additional ESA precursor mission to emerge***.**

The Moonlite UK-NASA "precedent" might create some partnership precedent mission collaboration opportunities for the ISRO not just with the UK, but with other European countries, as well and the additional use of the mk III system as a launch platform.

The International Space University has developed a lunar base mission studies and with its far reaching network of alumni and strategic position in Strasbourg where the European Parliament is located perhaps they can help provide a new strategic lunar vision for ESA.

At the current pace of programme development, ISRO's manned orbital space capacity will emerge five years before ESA's. Once ISRO is successful in orbiting its own astronauts, the ISRO manned program will need someplace to go to justify its existence. For ISRO a colla-borative effort to go to the Moon with humans will make both economic and political sense, given the expense. *There is already an ISRO-Roscosmos agreement for lunar mission collaboration on which to build.*

Fortunately for ISRO, the Indian economy has seemed little affected by the economic slump in the US, Europe, and Japan because in part its internal regulation of its banking and securities markets did not permit the fraudulent use of credit default swaps and other speculative abuses that occurred in the US, Europe, and elsewhere. The prospect of joining with potential commonwealth partners such as Canada, the UK, and Australia in the push to the Moon and other space activities, could be of mutual advantage to all. This could lessen the amount of investment India would have to make on its own and this could also increase the use of ISRO launch systems.

Prediction VI: *The ISRO success with Chandrayaan I, near term plans for Chandrayaan II, will also result in the ramp up and institutionalization of lunar mission programs in the ISRO long term plan. I predict that some sort of Chandrayaan III and IV missions will be developed in this new decade as a means to maintain and accelerate the success of Chandrayaan I and II as part of India's on-ramp for human lunar missions, not withstanding other ambitions and plans for Mars.*

The strength and growth of the Indian economy are the basis for this prediction as well as India's tradition of international diplomatic leadership.

Japan also has slowly developed its launcher system, and the H-IIB and HTV can provide the foundation for a manned orbital transportation system.

Prediction VII: *I predict that, building on the success of its HTVcargo transport, Japan will also announce an accelerated program to put humans into orbit.*

Prediction VIII: *I also predict that their interest in a collaborative international approach to lunar human return will result in a formal agreement to do so in partnership with NASA. I expect and predict that some sort of lunar architecture coordination between NASA and JAXA will develop within the next four years.*

I would expect that the PICES program in Hawaii funded by both US and Japan will benefit from a stronger NASA/JAXA collaboration. In this second lunar age, the fact that President Obama is also from Hawaii and that he was raised in Indonesia, gives him a natural "Pacific rim" perspective that bodes well for a stronger collaboration in moonbase planning. No doubt this is already on the agenda of the new NASA OSEWG.

Russia has also announced its own Lunar Grunt [Russian "soil"] penetrator mission. It too is working on another booster and manned system with target dates for their debut in the next five years or so. With the renewed economic growth its economy, Russia will also benefit from higher oil and natural gas prices and this should means the growth of budgetary support for Roscosmos programs can continue its upward trend. Russia also does not wish to be constrained by US ITAR policies. It may therefore see itself benefiting from a strategic point of view in developing "ITAR independent" partnerships with countries that also chafe at US imposed technology trade restrictions. This might also be an opportunity for further ISRO-Roscosmos partnerships in general, as well as on lunar missions.

Prediction IX: *I predict that we will see new Russian lunar mission plans in the aftermath of a successful Chandrayaan II lunar lander rover mission. I would not be surprised to see the Russians undertake a new lunar sample return mission perhaps to the lunar North Pole.*

Prediction X: *I predict that Roscosmos will initiate a strong lunar initiative in its own strategic plans as its economy grows and as it wants to reestablish some of "the right stuff" and maintain the leadership of its space program. I do not feel that Russia will want itself locked into some US dominated lunar programme that is a new model of the ISS program. I do think however that Roscosmos will want to share risks and costs in some collaborative and equitable partnership with other partners including CSA, CNSA, ESA ,ISRO and JAXA.*

Such mission announcements would also be logical in anticipation ofdeployment of new Russian systems. Old Soviet/Russian technology has made the it a major space-faring power from the beginning of the space age until the present time. Its launch rate and high reliability are the envy of the world and a major force not only in the satellite industry, but in maintaining ISS. Yet with the emergence of a multi-polar economic world, the Russian economy is only able to support a comparatively modest level of funding for space. Russia faces the new challenges of maintaining its leadership role in space as other economic blocks increase their space technology investments and increase their space budgets. I have no doubt of the Russian intent to remain a space leader, and that an accelerated increased funding trajectory for Roscosmos is part of that intent.

Summary:

Prediction XI: *I predict that before the end of the current Obama administration (Jan. 20, 2013) that there will be an international collaborative partnership agreement(s) involving human return to the Moon. I also predict that this partnership will not be one where the US will have the dominant financial role but one where the funding formula for financial responsibilities will be more equitably apportioned based not just on the size of national economies but also on the specific operational capabilities of each partner nations space programme*

This will reflect economic realities. It will also reflect the strong preference of partners to build upon their space technology capabilities "in parallel," taking advantage of their unique strengths, but not foreclosing their independence or their interest in building their own national infrastructure, so far as their resources and ambitions permit.

I further predict that commercial components will be part of these lunar human exploration efforts, especially in the creation of supply chain infrastructure such as orbital refueling facilities, with fuel depots in LEO and LLO, unmanned landers and rovers, and lunar cargo, and lunar communications infrastructure.

Commercial contractors that compete in the aerospace industry will takes their place in this collaboration so I predict that we will see names such as Antrix, Bigelow, Boeing, EADS, Lockheed-Martin, Lovochkin, Space-X, and others as important actors. The necessity of a reliable and therefore a redundant supply chain to the Moon will make it important to have multi-sourced logistics requirements.

I would also predict an expansion of something like the ILN agreement for the development of additional coordinated precursor missions to survey and characterize and prepare potential human return sites, and to perhaps preposition supplies for extended stays or emergency use if needed by the first crews.

Perhaps crews will be launched with a back-up launch capacity, initially to insure early crew safety before a "secure beachhead" is established. An international lunar program supporting human return to the Moon can be simultaneously more careful, and more thorough in the establishment of human presence on the Moon, and can do so faster than in the old cold war nation-state style of space competition in human exploration. **DD**

Elsewhere in Asia

CHINA – CNSA

New Discoveries Learned from Chang'e-1 Data

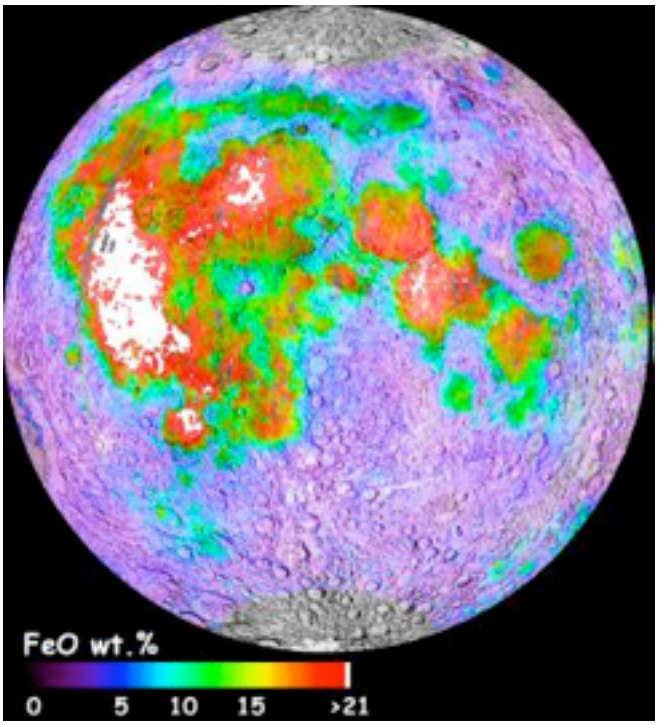
www.spacedaily.com/reports/Change_1_Has_Blazed_A_New_Trail_In_China_Deep_Space_Exploration_999.html

Shanghai, China (SPX) Dec 02, 2009

The Chang'e-1 lunar orbiter has accumulated an enormous amount of scientific data. Chinese scientists used laser altimeter data to create **an improved 3D lunar topographic map** that revealed **unsuspected impact basins** and volcanic deposits in highland areas.

[Note: older basins can be disguised by subsequent impacts that created new basins overlapping the older impact basin rim relics. A paper, C. J. Byrne; **Radial Profiles of Lunar Basins and Large Craters**, Lunar & Planetary Science Conference, 40, March 2009, Poster Session II, Abstract 1351, reached conclusions that fit the Chang'e-1 data.]

Aitken (SPA) basin is revealed to be the Moon's largest mascon as well as the deepest basin by far. Scientists put forward a fault structure hypothesis for the Apennine Mountain, significant for the study of the origin and evolution of the Moon. [Chandrayaan-2's lander and rovers may target the southern area of this farside basin, near the Moon's South Pole.]



Chang'e-1 data shows Moon's nearside maria to be iron-rich, with the white areas, portions of Oceanus Procellarum and Mare Imbrium over 21% iron

China to launch Chang'e-2 before end of 2010

http://www.chinadaily.com.cn/china/2009-12/28/content_9235695.htm

Chang'e-2 will test key soft landing technologies and provide high-resolution photo images of the landing area picked out Chang'e-3.

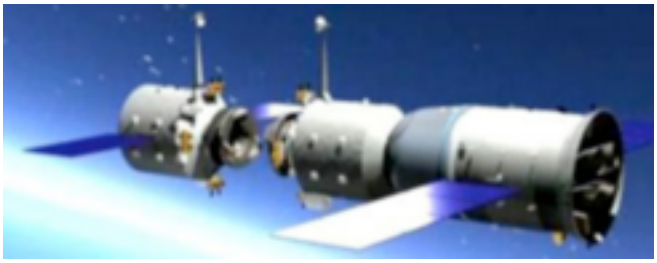
Progress is reported on six key technologies of Chang'e-2, including the lunar capture, orbit control and the research on high-resolution stereo camera.

Video on Chang'e-2 and Chang'e-3 missions

http://www.china.org.cn/video/2009-08/03/content_18256260.htm

Tiangong-1, China's 8.5 ton space laboratory module scheduled for launch in 'late 2010'

http://www.atimes.com/atimes/China/LA06Ad01.html



First rendezvous with manned **Shenzhou 8** is set for 2011

JAPAN - JAXA

Japanese Astronaut aboard ISS

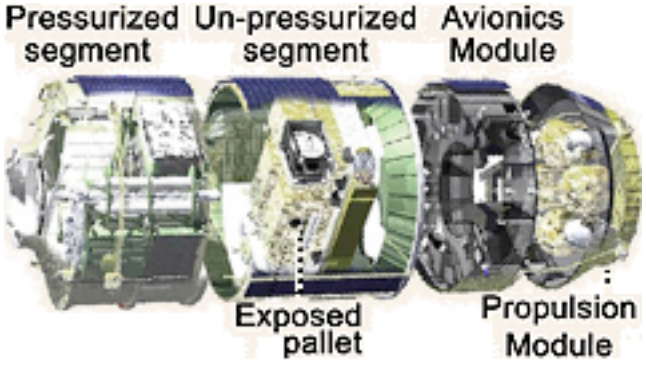
Soichi Noguchi rode on a Soyuz capsule to the International Space Station from Baikonur, Kazakhstan on December 23, 2009. He will be aboard for six monthes. This is his second visit. Noguchi previously served on STS-114 Discovery (July 26-August 9, 2005). He was trained by both NASA and Roscosmos.

Japan's Cargo Ship to ISS

Video of flight of Japan's new 10 ton cargo ship to ISS

http://news.bbc.co.uk/2/hi/science/nature/8248667.stm

The HTV was launched September 9, 2009 and is part of a plan to rely on cargo shipments by Europe' Jules Verne, Russia's Soyuz Japan's HTV, and Space-X Dragon to take over for the retiring US Space Shuttles.



The "Commonwealth"

"The **Commonwealth of Nations**, often referred to as the **Commonwealth** and previously as the *British Common-wealth*, is an intergovernmental organisation of fifty-four independent member states, all but two of which were formerly part of the British Empire. The member states co-operate within a framework of common values and goals as outlined in the Singapore Declaration (1971)"

"The Commonwealth is not a political union, but an intergovernmental organisation through which countries with diverse social, political and economic backgrounds are regarded as equal in status."

http://en.wikipedia.org/wiki/Commonwealth_of_Nations
http://en.wikipedia.org/wiki/Singapore_Declaration

(blue = present; orange = former: green = suspended)

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

The members have a combined population of 2.1 billion people, almost a third of the world population, of which 1.17 billion live in India ;94% live in Asia and Africa.

Commonwealth Space Agencies

Australia – CSIRO - http://www.csiro.au/
Canada – CSA / ASC –
http://www.asc-csa.gc.ca/eng/default.asp
http://www.asc-csa.gc.ca/fra/default.asp
East Africa (proposed: Kenya, Tanzania, Uganda)
India – ISRO - http://www.isro.org/
Malaysia – ANGKASA - http://angkasawan.gov.my/
Nigeria – NARSDA - http://worldofaerospace.googlepages.com/NASRDA-Nigeria-Space-Agency.htm
South Africa – SANSA - http://www.space.gov.za/
United Kingdom - BNSC - http://www.bnsc.gov.uk/

Capabilities

Launch Facilities:

Australia – Woomera (Sounding Rockets only)
India – Srikhota – Satish Dharwan Space Center (SDSC SHAR) - low earth orbit, polar orbit and geostationary transfer orbit capabilities

Operates Satellites:

Australia, Canada, India, Malaysia, Nigeria
Astronauts: Canada, India, Malaysia, United Kingdom

A Strategic Role for India in the Commonwealth

By David A. Dunlop

The commonwealth is a relic of the old British Empire on which the Sun Never Set. India was "the crown jewel" of that Empire. Now Britain, which was at the pinnacle of this empire just 100 year ago is now a secondary power with an economy substantially smaller than India's. Britain never recovered its dominating economic power in the aftermath of both the two world wars.

On the other hand India has since its independence pursued both a democratic political system and now a rapid growth of its enormous domestic economy. India has a unique position as the sole economically powerful commonwealth country to be a full fledged space faring power with its own launch facilities and launcher system. Its space program focus has served civil and peaceful environmental and economic objectives. Its own struggle against poverty and for social and economic development has shown a great measure of success and its population is both hopeful and working hard for more. Its role internationally is both respected and carefully watched as a major emerging economic power. Clearly India is on the way up and is also "on the make" in forging its future. It is the regional power in the Indian Ocean basin.

A Commonwealth Space Coalition?

What I am suggesting is that India's ISRO can serve the needs of commonwealth nations by providing a catalyst for the space ambitions of other commonwealth partners. Developed commonwealth countries such as Australia, Canada, and the United Kingdom have economies in excess of Trillion dollar economies and advanced technology scientific capabilities. These might be India's premium partners in that they have economies which could support collaborative efforts.

Australia with it $762B (5) economy is once again considering the creation of a national space agency. Those in support of this move see it as a key strategic commitment to maintaining scientific, technological, and economic competi-tiveness and to be more than a supplier of minerals and wool for the industrial needs of the world economy.

Canada's economy is $1.2T. (6) Its MDA supplies the robotic arms on the ISS and the US Space Shuttle. The Canadian' Space Agency has been a original partner in the International Space Station, conducts the Moon-Mars Analog Program on Devon Island in partnership with NASA, has established a Lunar Science Institute Node at the University of Western Ontario in London, Ontario, and is an associate member of the European Space Agency. The University of Toronto also has extensive capabilities in space engineering. Much of the Odyssey Moon company activities are centered in Canada.

The UK economy is $ 2.176T. (7) It has developed a strong small satellite expertise with Surrey Satellite LLC. (recently acquired by EADS). A recently conducted a strategic survey of the UK space program and interests indicated that it should ramp up it space activities in the interests of maintaining its economic position and not falling behind other advanced economies.

Yet Britain while a member of the European Union has been reluctant to abandon its independence or its habit of looking at its own role as a leader on the world stage even though its economy no longer supports the pretensions of the past. It has proposed a Moonlite mission to use penetrators to deploy a network of seismic instruments across the lunar surface. It also has a community of interest in further lunar exploration outside of the ESA framework. It is being forced to the conclusion that it must "pay to play" in making further investments in space. Its Isle of Mann has tax laws that have favored the establishment of both Odyssey Moon and Excalibur Almaz, two new firms with ambitions of creating a new space economy. Odyssey Moon wants to establish routine commercial access to the Moon and has ambitions to be the winner of the Google Lunar X-Prize competition. Excalibur Almaz is focused on orbital space tourism using the Russian Almaz vintage design for this purpose.

South Africa with its $ 492B economy **(8)** has recently established a space agency and is the strongest economic powerhouse of the continent. Its need for application of space based technologies into its economy for such purposes as precision agriculture, tele-medicine, and tele-education and resource protection are not dissimilar from India's own needs and its space program expertise.

Nigeria with it $ 315B economy (9) is also another potential partner with India. It has the advantages of oil revenues but the disadvantages of significant domestic discord between different tribal and religious groups and the need for educational, agricultural and medical satellite linked services. Again the needs for space applications to its social and economic needs are well aligned with Indian expertise and capabilities.

Kenya has a small economy $61B (10) with lots of economic and social challenges but also the potential to become a rich nation. Nairobi is also an International Center for the UN and its success in deploying space related technologies would be widely copied by those supporting economic development initiatives. It also sits on the equator and has an old marine launch platform that has been used for rocket launches. The threats from marine piracy, terrorism, and instability seem to limit the likelihood that this prime equatorial launch site on the Indian Ocean will soon be developed. A major strategic partnership might provide resources to open this door if the space economy expands and the Kenyan government is supportive.

Commonwealth County Space Budgets (12)		
Australia	(CIRO)	
Canada	(CSA)	$ 0.25 B I
India	(ISRO)	$ 0.86 B
Kenya		
Nigeria		$ .B
South Africa		$ B
UK	BNSC	$ 0.08 B

Now I have addressed in brief only those potential commonwealth partners that are economically powerful and that have national incomes which would permit them to be both investment and technological partners with India in space ventures. The great majority of commonwealth nations do not have the national incomes or capital resources to contribute much to India's space ventures or do they? Collectively they have a large population base that is poor but that represents a huge potential market for services and economic development. There is a crying strategic need for **"a space agency for the rest of us."**

This is another large potential opportunity for India to move into that "vacuum." But this might only be taken as empty rhetoric of little immediate relevance except for that other big advantage of India, it economic and population Diaspora. Indian entrepreneurs provide a ready-made vehicle for the movement of space age technologies to the markets in these countries.

That the space age can revolutionize societies has been shown by the phenomenon of micro-lending and the movement of cell phone technology into the village economies of the world. Indian IT expertise is a global presence and is also another powerful venue of international influence. The power and utility of the "I-phone" class hand held devices with innumerable practical applications which has swept the US market is a technology whose power remains to be unleashed in the poor nations of the commonwealth. Bandwidth from space is an opportunity that can touch millions of poor villages and that India can address with ISRO technology skills, and social-political experience.

Bollywood like Hollywood is also an institution and capability of global significance that reaches across the national borders and magnifies the cultural and political impact of India. The ability to craft compelling stories and images remains one of the most essential and fundamental powers especially when one is reaching across national boundaries, linguistic barriers, and cultural and religious differences by web and satellite.

. India has chosen to pursue a soft path to power" in the decades since it became independent of the UK. *My argument is **India still is the crown jewel** of the commonwealth and its many capabilities to be an economic leader and global superpower have hardly yet been grasped.* ISRO is in my opinion a keystone in this potential arch of economic and cultural capabilities that can provide a synergistic use of the many assets of the Indian social and economic diaspora.

India can manufacture sophisticated satellites and digital products that are directly relevant to the agricultural, educational, medical, and commercial needs of the most needful members of the commonwealth as well as the prosperous ones. India's potential partners in the commonwealth such as Australia, Canada, UK have capital and technological resources that compliment the space assets of India and share a long tradition of governmental, social, and economic ties, as well as the English language as an international vehicle for science, education, and commerce.

1. Space Based Communication Scenario

In the nearly 50 years since the inception of the communications satellite this commercial space industry has grown to approximately the $150B level. The use and impact of satellites delivered services has had a revolutionary impact on the 1 billion most economically advantaged citizens. They are the ones who use telecommunications, cell phones, laptops, web-enabled communications and information and these services have created vast new

wealth and vast social change. Yet over 2 billion people on Earth have no electricity. They remain hardly touched by these technologies except that they remain ever less competitive in a world where these tools are the enablers of economic participation.

One may properly argue that the best capital invest-ments that can be made are ones that use the new technologies to leverage human potential into the 21st century. As the impact of these devices and applications grow, so inevitably will the demand for bandwidth. This is an insatiable demand that is connected to GEO satellites. However there are a limited number of GEO orbital slots for these satellites and the right to these slots are largely allocated. This problem is one of the next great opportunities of Indian Space leadership. Like Solar Power Satellite the GEO platform is an invention that does not present any demand for basic technological breakthroughs. It is simply a matter of market demand and price curve. The standard GEO satellite is in the range of $400M to $500M. So a global spanning fleet of satellites with spare that can be rapidly brought on line if needed is about a $2B proposition.

A GEO platform, if it could be economically constructed and providing a location and space solar power for tens or even hundreds of transponders might make the unit transponder cost fall dramatically.

A GEO platform that also possessed a large dish antenna could technically listen to even weak cell phone signal and therefore provide truly global coverage.

The ISRO could, as in the previous suggestion on solar power satellites, take a leadership role in proposing and creating partnerships for the development of the advanced GEO platform.

ISS is the largest platform that has been assembled in space and its cost is in the neighborhood of $115B. At this price point the GEO platform concept will be stillborn. The ISS however has demonstrated that large international space construction projects are feasible, if heavily subsidized. The Space Shuttle always was unsustainable as a commercial tool. It is now a question as to how commercial space companies can bring down the price point for the construction of a GEO platform to the point where many transponders can share a large and powerful power source and large receiving antennas and can do so with high reliability from solar storms and space debris impacts. A demonstration GEO platform project is needed and this will require a partnership of spacefaring nations. ISS suffered from a long construction period and its further stretch out due to the loss of the Space Shuttle Columbia.

2. A Space Construction Supply Chain

Today, however, the conditions and the potential are quite different. The scale and the economic importance of the commercial space industry are much greater than at the beginning of the ISS era. At the moment the US, Russians, Europeans and the Japanese have the demonstrated ability to get to the ISS. The Chinese no doubt could also achieve this if invited to visit. The retirement of the US Space Shuttle will provide a brief interlude during which the US will lack the ability to get to the ISS. But this should be remedied within two to three years of the fleet's retirement (2012-2013) by the COTS contractors, Space-X and Orbital Sciences. India's Mark III and Mark IV launcher projects should have the capabilities to become a factor in the delivery of supplies to a space construction project. *The creation of a truly international supply chain for space construction projects is the first prerequisite.*

Giving the launch capacity of the world's space powers, a common purpose and destination would seem in and of itself a geopolitical objective worthy on its merits as a follow-on to the completion of the International Space Station. Like the ISS the project is an alternative to put large resources into a militarization of space race and a confidence builder for further international collaboration. India's political skills and leadership as a non-aligned power make it well positioned for such advocacy and the encouragement of an international GEO demonstration project as an example of the collaborative partnership.

Potential members of a GEO collaborative will ask "What in it for me? And what will it cost me? I suggest that at least some answers are as follows. There is the development of enabling technology as an economic reward. To enable a GEO platform construction industry we need various components deliverable a price point that enable an ultimate price advantage to space communications customers who include masses of very poor people, targeted as the ultimate mass consumers of these space structures.

1 We need a space tugs(s) to deliver construction supplies to LEO to GEO.

2 We need a construction module with advanced tele-robotic arm abilities of the old space shuttle that can move and grapple large objects. (Is anyone at Canada's MDA listening?)

3 We need a space refueling industry in LEO that can keep the space tugs going back and forth.

4 We need launch providers that can provide a high flight rate for refueling missions.

5 We need a program which can utilize tanks taken into LEO to create a refueling tank farm.

6 We need to determine if the best construction option is to assemble a GEO platform in LEO where access is easy and astronauts can assist and trouble shoot construction problems and then move it to a GEO locations or to build it in GEO. The LEO option must be balanced against the risks of damage in transit from orbital debris and the cost of subsequent repair

7 But these construction and repair replacement capabilities are at the heart of creating GEO platform as a cost feasible commercial project in the first place. This is expensive in fuel.

8 But both chemical and high Isp ion drive engines can be designed for these purposes. High Isp ion drive engines might provide a cost effective solution for both station keeping and efficient movement of large space structures

9 We may very well need a new space station that can accommodate such construction activities.

This is a significant laundry list of investment and development opportunities for all the space faring nations. The proposition of a GEO platform is an international

demon-stration project that can be the next big thing in space projects and that can gain wide public and economic support even as countries with poor populations see immediate benefits from transforming technologies.

3. Birthing a New Space Industry

It can be argued that the subsidy of a GEO platform by the space faring powers will establish an industry, because as experience is gained many additional GEO platforms will be constructed as the demands of the Earth economy and population consume ever larger volumes of communication services. In spite of the many capital investments and technology tools development listed above there is one great advantage from the times when the space station was planned. First there is a real and growing commercial industry to be served and which can provide elements of investment capital. Second there are more potential international partners that can be admitted to the partnership. The program partnership should be open ended so that as national economies grow they can join the partnership as investors in the communication infrastructure serving their home markets.

The consequences of such a proposal should be favorable to all of the partners.

First, a GEO platform demo will demand a much higher launch than is demanded by the commercial satellite industry today. There is much excess capacity in the launcher market so every country with launch capacity stands to see its own launch industry benefit. This will strengthen India's domestic space industry Antrix and other potential providers and provide increased employ-ment opportunities for India's technological workforce.

Second, like the ESA collaboration model there is a poten-tial for the allocation of various technological develop-ment tasks among the partners as a matter of mutual infrastructure development. This opens additional options for national infrastructure development and the establish-ment of India in the growing space construction industry.

Third, there are many synergies in the investment in the technologies and other space projects such as space solar power. A demo GEO platform might be a natural step for scaling up the ISS solar PVC technologies and the demands of power intensive commercial GEO platforms. This also ties in well with alternative energy initiatives and advocacy of Space Solar Satellites as the clean energy option. GEO platforms in essence buy down the risk of planning Solar Power Satellites by creating a supply chain, enabling infrastructure and a history of construction management of operations in the GEO realm with ever-larger scale.

4. Opening the Moon

The space tugs, construction facilities and refueling systems all have direct relevance to the ability to accomplish a permanent human presence on the Moon, accomplish major exploration objectives, and establish commercial markets for lunar sourced resources such as oxygen. If these investments and supply chain systems are provided for the GEO platform they will make for a much less expensive lunar exploration and development program. Ditto for more ambitious mission to near earth asteroid and Mars missions. A cheaper and more robust international space infrastructure will make India's human and science space program much more cost effective and robust.

5. Competing Strategic Visions

Today the parallel ambitions of several nations to return to the Moon seem to critics to be a return of the competitive politics of the "cold war" in the slighter warmer climate of geopolitical competition. The Moon society has proposed an International Lunar Research Park and Buzz Aldrin has recently also called for international collaboration in returning to the Moon. There is no doubt that this is another collaborative development option but one that lacks strong incentives for commercial investments and governmental and private partnerships of GEO platforms.

It may well be that a GEO platform demonstration project makes more sense as a major international effort than a collaborative Moon program as a first step. I believe that a GEO platform demonstration need not take 10 years for construction or if it did because the numerous parallel techno-logy developments, that many follow-on GEO platforms could be subsequently built and very cost effectively once the system infrastructure was in place. If the first GEO platform was built by 2020 for example then it might actually accelerate the rate at which a Moon Base and lunar exploration program could be achieved because an integrated supply chain and a high flight rate launch system and other infra-structure elements were well in hand. The stability of this path to space is also increased because people are looking for significant economic benefits in each of the partner countries and large commercial investments are being made and protected.

Summary

Although India's space program is far from the largest of the major space faring nations it is well positioned to assume a position of leadership by embracing the best strategic challenges of well chosen strategic partners within the commonwealth network, a program of collaboration on pragmatic commercial space structure such as GEO platforms and space based solar power, and applying its own expertise in social and economic development in India to many common-wealth countries. These steps could increase India's launch rate, investments in space technology infrastructure, and expand its leadership role internationally. In the process India can also evolve as another economic superpower carrying forward a development agenda of a truly Earth Moon economy.

References:

(1 thru 10) Note 2008 World Bank figures Gross Domestic Product 2008, Purchasing Power Parity

(11) http://www.8ak.in/8ak_india_defence_news/2009/12/backed-with-41-increased-budget-Isro-to-develop-semicryogenic-propulsion.html
This article cites R est. 4,959 cores (About US $1B)

(12) The Space Report 2009, p. 23 Exhibit 1o International Space Budgets 2008 Space Foundation

(13) The Space Report 2009, p. 15 Commercial Orbital Launches and Market share

What's New in the Commonwealth

Britain to Create its own Space Agency

December 17, 2009 - http://www.bnsc.gov.uk/13644.aspx

Science Minister announces new executive agency for UK space and satellite industry

"A new executive agency will be created to take the UK's recession-busting space and satellite sector into a new space age, Science and Innovation Minister Lord Drayson said today.

"This new bureaucracy busting agency will replace the British National Space Centre, and bring together for the first time the six Government departments, two research councils, the Technology Strategy Board and the Met Office that currently oversee the organisation of UK space activities to enhance efficiencies.

"The Government's ambitious plans to accelerate growth and jobs within our world-leading space industry were set out in Lord Drayson's speech at the Rutherford Appleton Space Conference."

UK to have dedicated Space Agency

Dec. 10, 2009 - http://news.bbc.co.uk/2/hi/8404213.stm

The UK acquired its first ESA astronaut - **Tim Peake** – in 2009.

Britain spends about £270m a year on space, most of it via its membership of the European Space Agency (ESA).

Russian Space Agency set to take-off in UK

December 17, 2009 - http://www.bnsc.gov.uk/13654.aspx

"Collaborations between UK and Russian space scientists and engineers could be on the horizon following a visit to the Science and Technology Facilities Council's (STFC's) Rutherford Appleton Laboratory, by the Russian Federal State Unitary Enterprise 'Centre for Ground-Based Space Infrastructure' (TsENKI) and representatives of the Russian Space Agency, Roscosmos.

"The seven strong delegation visited the Oxfordshire laboratory on Wednesday 9 December which helped to build relationships with some of the UK's leading research organisations. The visit was initiated under the scope of a 'Memorandum of Understanding' (MOU) signed by TsENKI and the STFC to enhance the capabilities of UK and Russian space research through the exchange and co-operation with 'centres of excellence'. It closely follows the announcement in July by Lord Drayson, the Minister of State for Science and Innovation that the European Space Agency (ESA) is to establish a facility at Harwell - a first for the UK. "

(British National Space Council (BNSC) on YouTube

http://www.youtube.com/user/TheBNSC

BNSC on Twitter - http://twitter.com/The_BNSC

Will Australia form a Space Agency?

There seems to be some support for this.

http://www.facebook.com/group.php?gid=29018979155

"Of the top 25 GDP Nations in the World, only Australia has no Space Agency. This lack of core government infrastructure has put Australia behind Bangladesh, Peru, Romania, Indonesia, Vietnam, & Malaysia.

"Our allies India, China and Japan are Advancing quickly in Space Science endeavours and instead of cooperating with them, we miss opportunities and suffer endemic Space Science brain drain."

Australia Building Large Telescope Array

http://www.atnf.csiro.au/projects/askap/

Australian Square Kilometre Array Pathfinder (ASKAP will be a next-generation radio telescope incorporating novel receiver technologies and leading-edge ICT systems. ASKAP will be a world-class telescope in its own right as well as being a pathfinder instrument for the full Square Kilometre Array (see below). It will comprise an array of 36 antennas each 12m in diameter, capable of high dynamic range imaging and using wide-field-of-view phased array feeds.

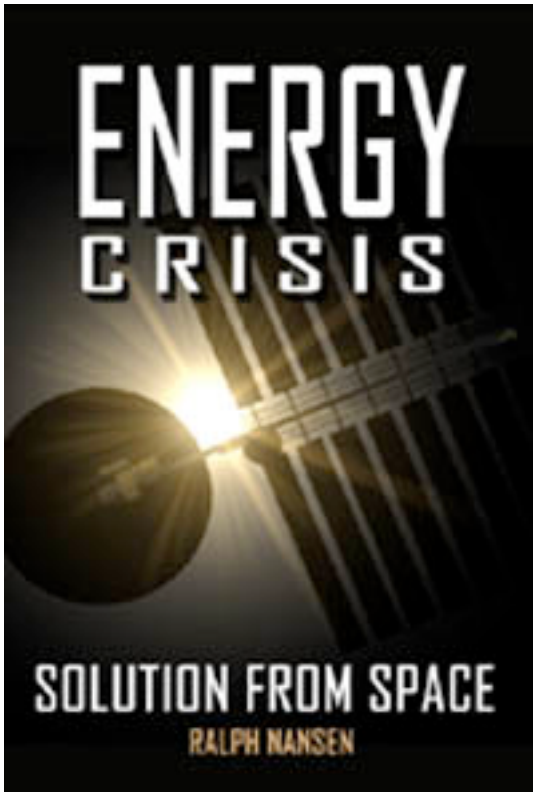
Canada's first study of how trees grow in space

http://www.asc-csa.gc.ca/eng/missions/sts-129/apex.asp

May 27 – November 30, 2009 (ISS Expedition 20/21) on board the International Space Station **Canadian Astronaut Bob Thirsk** conducted a study known as **APEX-Cambium** (Advanced Plant EXperiments on Orbit). Funded by the Canadian Space Agency.

APEX-Cambium will help determine the role gravity plays in trees forming different kinds of wood. [Cambium is the plant tissue that grows to form wood in trees; this tissue allows tree trunks and branches to increase in girth as the tree grows, so the tree has the strength to remain standing as it becomes more massive."] Why this experiment? "Parts of a tree that are not vertical typically grow one kind of wood on one side and another kind on the other.[snip] This is known as "reaction wood" and the mix of different kinds of this wood in trees influences their suitability for different uses, such as construction or paper. We believe reaction wood is a response to gravity, but could not prove it."

THE book WORM



Ralph Nansen is the founder and president of Solar Space Industries and was formerly Boeing Solar Power Satellite Program Manager. He is recognized as one of the key leaders in the world to promote, develop and manage the Solar Power Satellite program.

Energy Crisis: Solution From Space presents a bold solution for the problems we face today: dependence on oil as our primary energy source, global climate change caused by the proliferation of carbon dioxide, and the threat of wars over diminishing oil supplies. It explores how our energy situation is driving these major world problems, and how developing energy from space could bring unprecedented economic prosperity and opportunity to the world, just as Grand Coulee Dam did for the Pacific Northwest in the 1930s.

"When Grand Coulee Dam rose on the Columbia River during the Great Depression, it not only employed thousands of people but also provided an abundant source of cheap energy for the Pacific Northwest, ushering in a long era of economic prosperity for the region. As we now confront an economic crisis approaching the scope of the Great Depression, we are also forced to confront the severe consequences of our addiction to finite fossil fuel resources."

Order Information:

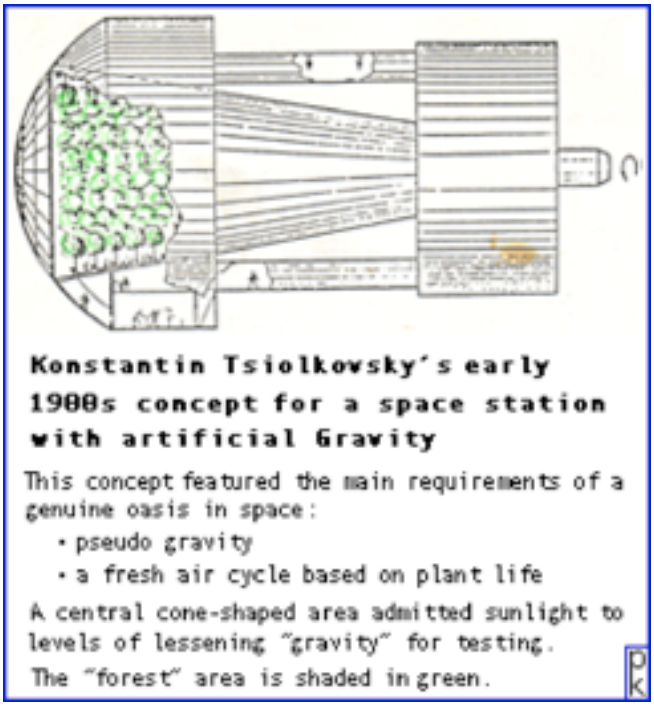
http://www.cgpublishing.com/Books/9781926592060.html

Newly Published Book on
The life of Russian Rocketry Pioneer,
Konstantin Tsiolkovsky,
An inspiration to us all

"The details of his life, as James Andrews explains in his new study of the man, are more complex and far more interesting than the legend."

Reviewed by Taylor Dineman

http://www.thespacereview.com/article/1508/1

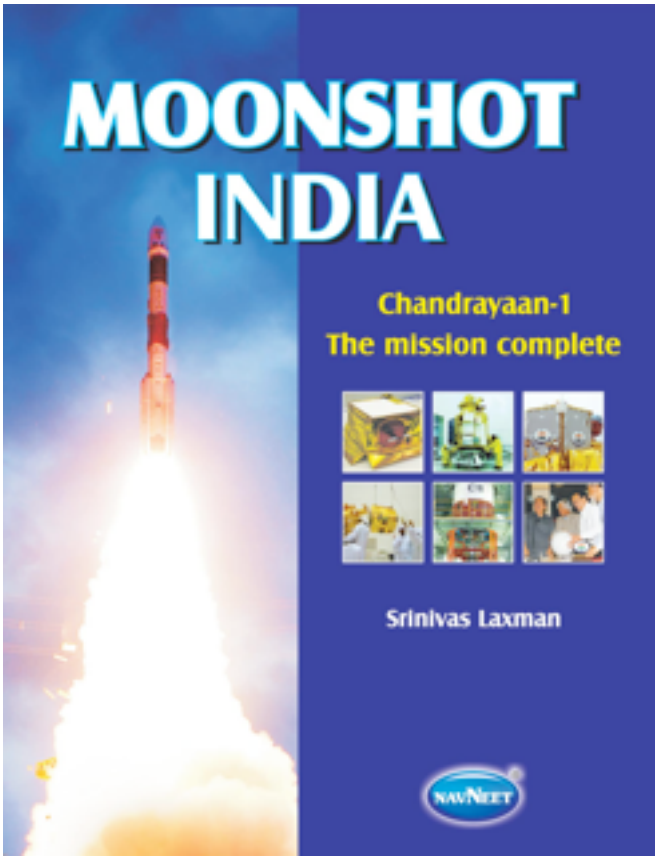


Konstantin Tsiolkovsky's early 1900s concept for a space station with artificial Gravity

This concept featured the main requirements of a genuine oasis in space:

- pseudo gravity
- a fresh air cycle based on plant life

A central cone-shaped area admitted sunlight to levels of lessening "gravity" for testing. The "forest" area is shaded in green.



[Book Review by Ken Murphy]

"Moonshot India - Chandrayaan-1: The mission complete"

By Srinivas Laxman

Published in 2009 by NavNeet Publications (India) Ltd., it weighs in at 111 pages, in English.

On November 14th of 2008, the Indian tricolour impacted the Moon near Shackleton crater near the Lunar South Pole, joining such prior achievements as the summit of Everest and Antarctica. The Moon Impact Probe (MIP) was released from the Chandrayaan-1 spacecraft, just one of many experiments carried from around the world to the Moon by Indian technology.

"Moonshot India" is the chronicle of that mission, written by Srinivas Laxman, a journalist who worked for The Times of India during the course of the mission. Its target audience appears to be the high school level student who wants to learn more about the Chandrayaan-1 mission, but is accessible to a larger audience curious about the Moon probe.

The story begins in May 1999 on National Technology Day, at the Ashok Hotel in New Delhi, where Dr. Krishnaswamy Kasturirangan, Chairman of the Space Commission, Secretary of the Indian Department of Space, and Head of ISRO, stunned his audience with the announcement that India was planning a mission to the Moon. It was an auda-cious challenge for the nation, an achievement that only a few nations have accomplished, but one that energized the best and brightest to do their utmost to ensure success.

India is not a newcomer to the space field, having launched its Aryabhata satellite in 1975 aboard a Russian launch vehicle, and Rohini in 1980 aboard the first Indian launcher. It is well known in international space circles for its work in tele-education and tele-communication, and has professors at International Space University. It has ratified all of the UN space treaties except for the Moon Treaty of 1979, to which it is a signatory.

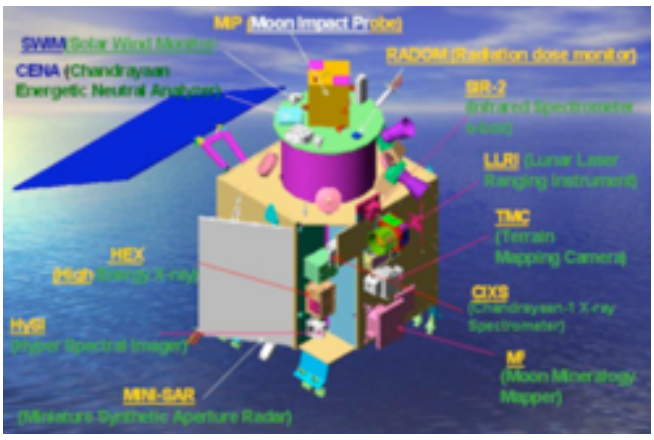
It also has many established space-related assets, and in the second chapter the author looks at how Dr. Kasturirangan started marshalling those resources to achieve the ends of the Moon mission. The effort wasn't without its opponents, but the scientists were increasingly enthralled by the scientific opportunity, and so high-level details were presented to the government for approval. That approval was announced on Independence Day in 2003, setting India on a course to the Moon.

The book then proceeds to look at the planning and implementation required to send such a mission to the Moon, India's history of space endeavours that had brought the country to the brink of such a historical achievement, the people leading the effort, other historical and recent Moon missions from around the world, and the many international payloads comprising the suite of instruments that would look at many different aspects of our Moon. Last up is the startling heads-up that Chandrayaan-1 gave the world that there is a lot more water and hydroxyls on the Moon than everyone had assumed, a finding confirmed by NASA's subsequent LCROSS mission.

The book wraps up with a glossary of space terms and acronyms. Overall, it offers a comprehensive look at the many interdisciplinary facets of the mission, chronicling it from start to finish. This makes it valuable for more than just students, and I can easily see it in many libraries.

The Lunar Library is proud to have this first addition from India.

Ken Murphy is a member of the Moon Society in the U.S., and runs the **Lunar Library** at:
www.outofthecradle.net/categories/lunar-library/
His extensive collection of non-fiction Moon-book reviews can be found at:
www.outofthecradle.net/categories/books/ while fiction stories are reviewed at:
www.outofthecradle.net/forums/viewtopic.php?t=88



Moon Society India

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

President's Message

"Astronomy is perhaps the science whose discoveries owe least to chance, in which human understanding appears in its whole magnitude and through which man can best learn how small he is"

"Three things cannot be long hidden: the sun, the moon, and the truth."- **Lord Buddha**

Moon: the word itself seems to be attractive and so does its surface as well. The nearest object and the only natural satellite of the Earth has captured the interests of the scientists and students once again after 40 years.

But this time we are going to create a mark in the history by establishing a permanent human colony on the lunar soil by 2020 which will also serve as a base for us to extend beyond, and reach other planets .So let's all be a part of it and make a big bang on the Lunar Sciences.

I'm extremely delighted by the launch of the Moon Society India Chapter. I'm also indeed honoured to be the first president of the society. The Moon Society mainly targets the young minds of India and wish to provide them with many opportunities in order to showcase their talent and invoke their interest in Lunar Research.

The Society aims at addressing all the issues related to the lunar exploration through education, projects and competitions and outreach program. The main objective of the society is to create awareness and educate the people about the Lunar Program. I think it's the duty of the students like us to motivate more students and invoke their passion towards the subject and get them all together for further discussion and experimentation. The Society will be very active in the future Lunar Programme of this country.

I would like to take this opportunity to thank Mr. Peter Kokh and Mr. David Dunlop from the Moon Society International for providing me this wonderful opportunity. I would also like to extend my gratitude to Mr. Srinivas Laxman and Mr. Pradeep Mohandas for their support and hard work.

"Life has no limitations, except the ones you make." - Les Brown

"Once you choose hope, anything is possible." - Christopher Reeve

Jayashree Sridhar, **President**
jayashreesridh@gmail.com
Moon Society India - January 7, 2010

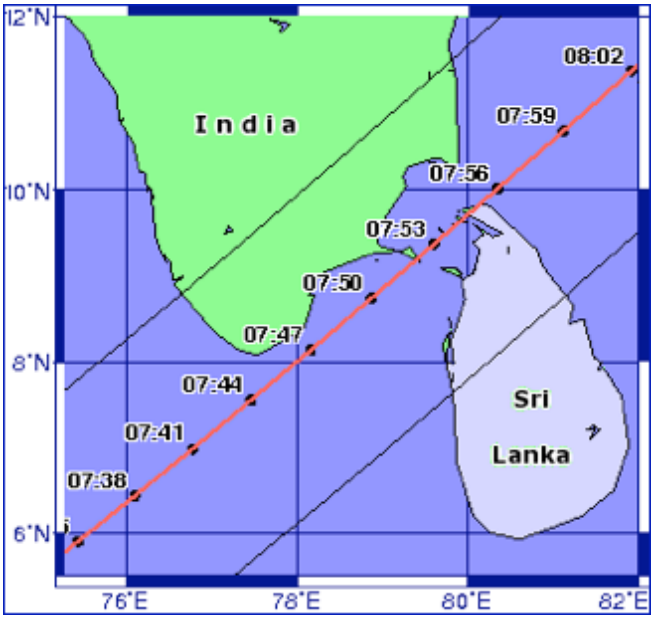
Moon Society India Report

By Pradeep Mohandas, Secretary

The Moon Society's India chapter was formally inaugurated in the Nehru Planetarium in Mumbai. Secretary, Moon Society India, Pradeep Mohandas in the Planetarium on the occasion of the first anniversary of Moon Impact Probe landing on the Moon, the first Indian object to do so on November 14, 2009, made the official announcement. The announcement also coincided with the celebration of Children's Day in India.

Since then Society has begun the first draft of the bylaws by looking at requirements under the registration laws in the city of Mumbai, Maharashtra and Moon Society bylaws in general. Society members have also contributed to the Moon Miners Manifesto India Quarterly number 4 and 5.

India was witness to the New Year's lunar eclipse and will be witness to the annular solar eclipse on January 15, 2010. The annular eclipse will be visible only to the southern most tip of India. The Eastern and western coasts of India will witness a partial solar eclipse. The eclipse is in the Saros 141 cycle with a duration of 11 min 8 seconds.



SEDS India National Conference 2010

Saturday-Sunday, March 6-7th, 2010

The annual national conference of the Students for the Exploration and Development of Space (SEDS)'s India chapter will be held in the Veltech University campus in the outskirts of Chennai.

Conference details and competition details will be uploaded on the SEDS India website in January.

http://india.seds.org

For details, one may also contact Sabyasachi Bhowmick, President, SEDS- India at:

bhowmick.sabyasachi89@gmail.com

Last years successful conference, SINC09, was held at Vellore Technical Institute, in Vellore, Tamil Nadu.

A report on this conference appeared in MMM-India Quarterly #2, page 18. This issue, and all M3IQ issues can be downloaded from this page:

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

M3IQ will provide a special e-mail announcement listing the details of the conference dates and program to its members when they are available. M3IQ will provide reports about the conference in the M3IQ Spring issue #6.

SEDS is an independent, Student-based organization promotingthe Exploration and Development of Space.

SEDS pursues this mission:

- by educating people about the benefits of space
- by supporting a network of interested students
- by providing an opportunity for members to develop their leadership skills, and
- by inspiring people through our involvement in space-related projects.

SEDS believes in a space-faring civilization, and that focusing the enthusiasm of young people is the key to our future in space.

SEDS believes in a space-faring civilization and that focusing the enthusiasm of young people is the key to our future in space.

One of its major objectives is to generate interest and help people in pursuing space oriented careers.

SEDS-India has expanded to 9 campuses!

SEDS VIT (Vellore)
SEDS Veltech (Chennai)
SEDS Savitha (Chennai)
SEDS Warangal (Warangal)
SEDS GGITM (Bhopal)
SEDS KCT (Coimbatore)
SEDS ISM (Dhanbad)
SEDS NIT Trichy (Trichy)
SEDS NIT(Nehru Institute of Tech, Coimbatore)

See map on last page of this issue

MMM-India Quarterly Editors:

Peter Kokh
kokhmmm@aol.com

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

Moon Society President
Editor:
Moon Miners' Manifesto

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

David A. Dunlop
dunlop712@yahoo.com

Moon Society Director of Project Development

Exec.Director of LUNAX (LUnar National Agricultural eXperiment)

University of Luna Project

We are proud to introduce our newest co-editors

Srinivas Laxman
moonmission.srinivas@gmail.com

Mumbai

Well known space writer

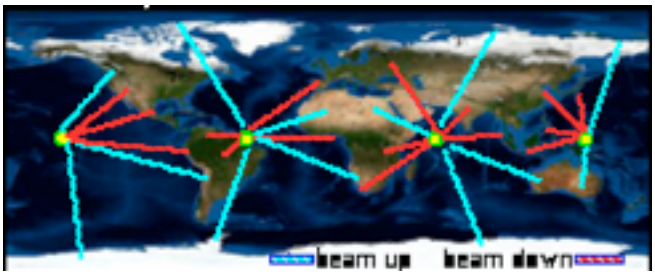
Pradeep Mohandas
pradeep.mohandas@gmail.com
http://pradx.org/ - blog

Mumbai

Formerly President of SEDS India

Electric Power to India via Space

By Peter Kokh



World Wide Orbital Grid: This proposal by the MMM-M3IQ Editor, would on the one hand, fall short of estab-lishing a Space Based Solar Power System, but on the other hand guarantee that SBSP is the only logical next step, while in the meantime, disarming all opposition from the current cartel of power brokers with a vested interest in the status quo. A **WWOG** would contain basic elements of the SBPS: power beaming and rectennas

WWOG - World Wide Orbital Grid
Space-Based Power Systems: Another Route

By Peter Kokh

Ground-Based Solar helps but can never be enough

Space-Based Solar Power, or Solar Power Satellites combine two technologies: solar collection in space, and power beaming. The advantages of collecting solar energy in space are clear to anyone who has looked at the numbers. Yes, we do also need to greatly multiply the use of ground-based photovoltaic and other solar energy collection systems. But we would have to quite literally pave over the state of Arizona and much of neighboring states with solar panels to supply the national power demands, and the real estate costs of that could be higher than the up front costs of space-based systems.

Yes, we need to continue to make homes and all other structures more reliant on a combination of energy-saving construction methods and architectures, and on site energy generation. The more individual home and building owners do their part, the better. But a plan that counts on widespread support by individuals facing their own micro-economic facts-of-life is not a plan at all for a national, let alone a global, approach to replacing dirty energy generation systems with clean ones.

The Long Lead Time Hurdle

The problem with space-based power generation schemes, however, is that as much sense as they make, they will decades to put in place. That long lead time may be enough to discourage many and send them looking for second best options that can be put in operation in shorter time spans. It would be tragic if the Space Based Power strategy that the National Space Security Office called for on October 10th, is not pursued because supporters want all the plan, when in fact there is a nearer term option that could be very attractive, cost far less, and yet guarantee that the full plan be eventually realized.

Divide and Conquer!

We suggest that we concentrate on the most basic half of the plan: power beaming, not just from space, but to space. This would require rectennas in both orbit and on the ground. It would require considerably less tonnage of material for construction, a threshold that could be met by launching all the components from the Earth's surface. Why?

Detractors of Space Based Power Generation Systems number not only Mars advocates who disingenu-ously want to dismiss and discredit anything that may legitimize a return to the Moon and lunar industrialization, but vested interests in terrestrial power generation systems: coal, oil, gas, even ethanol. But this same unholy alliance would be all in favor of the establishment of a single world wide power grid, where excess power from anywhere could be beamed to space and relayed to wherever it was needed.

In other words, let's concentrate on the creation of a space-based world power grid first of all. Oil people, tar sands people, coal people, hydroelectric people -- they will all see the sense of that. The effect would be to stabilize the world economies and greatly level the economic playing field, benefiting developed and developing nations alike.

At the same time, we will have put into place an orbital power relay system, that when the shortages that come from uneven distribution of fossil fuels and other fuels can no longer be managed by shifting loads because the total amount of terrestrial power generation is now insufficient, you just need to add solar arrays to these orbital relay stations to tap a bottomless supply of clean power. See the NSSO quote on page 2, column 2. That the orbital worldwide power grid is in place will easily derail any further opposition to "out-sour-cing" additional power generation to off-surface locations, made economically feasible by the use of lunar materials.

Wireless Power Transmission already Demonstrated

On June 5, 1975, NASA successfully beamed 34,000 watts (34 kw) of power from the Goldstone Dish over 1.5 kilometers (0.9 miles) to a JPL-built rectenna on the Goldstone collimator tower on a nearby ridge -- at more than 82% efficiency! Watch this 2 minute Video:

www.youtube.com/watch?v=jd47JXuz0g8

The WWOG could help now, in the interim, not only by shifting excess power, but by connecting to unused power sources.

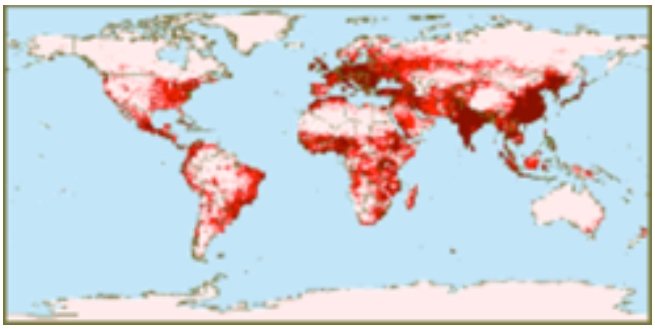
It is our belief that since it does not require compo-nents made on the Moon, a World Wide Orbital Grid could be put in place in less than half the time needed for realiza-tion of Space Based Solar Power systems, without detouring or delaying the latter. Quite to the contrary, this phased approach would speed up full realization of the SBSP plan by effectively disabling opposition by the powerful vested interests of Coal, Gas, and Oil producers. Here is how **WWOG would help:**

- Shift power loads globally rather than on the present subcontinental basis, with much greater flexibility of sourcing. Excess power from Hydro-Québec could be beamed to India as easily as to Arizona instead of just to the US northeast.

- Regions with chronic power shortages and no nearby sources of surplus power would find quick relief.
- Areas with fossil fuel reserves, instead of shipping those fuels (before or after refining) could derive added sales value by generating needed electrical power and exporting that by the WWOG instead of via pipelines and tankers which have environmental risks.
- Areas with little domestic power need but great capacity to produce power would now have a major export market to catapult the local economy into the new integrated world grid. Four examples:
  1. Underpopulated Desert areas without fossil fuel reserves but with abundant sunshine/wind.
  2. Antarctica: wind farms emplaced along it's 360° circling coast could beam power to power-hungry areas, without negatively impacting the Antarctic environment. Antarctica has the world's strongest, steadiest winds constantly blowing in the same direction, northward, away from the south pole. This power source is now untapped.
  3. There may be similar steady winds buffeting the arctic coasts of Alaska, Canada, Greenland, Scandinavia, and Russia-Siberia
  4. OTEC (Ocean Thermal Electric Conversion) units anchored off the US eastern seaboard in the Gulf Stream could supply abundant power to wherever needed. The Japan Current could be tapped also.

In short, not only would the WWOG even out power distribution globally, and with it level the economic playing ground, but it would tap considerable energy sources not now in play. This would help ease us through the period of two or more decades before a Space Based Solar Power Grid could be put in place, piggybacking on the already established WWOG. It is a win-win situation.

An orbiting solar array design currently highly favored. How well a proposed design lends itself to construction with lunar materials should be the deciding factor.



Global Population Density Map: With a World Wide Orbital Grid, power generated in unpopulated areas, including arctic regions, could be beamed anywhere.

Phasing in Space Based Solar Power with a WWOG

- If we can't have our cake with frosting, let's push the cake by itself. In time the frosting will be added. The alternative is that we get nothing, the world sinking into energy wars and general disorder and chaos.
- The WWOG builds on existing power generation systems, their present location, the needs of underdeveloped and developing areas, meshes well with world economics, will have the full support of power generation companies, and will create a new level (double entendre) of international cooperation.
- That's a plan that doesn't have to wait decades before results start justifying expenses.

How do we start?

There are several unanswered questions about power beaming through the atmosphere and to and from space. These questions concern efficiency and best choice of wavelength, safety for humans, wildlife, vegetation, and livestock. We need a step–by-step plan to investigate these uncertainties and zero in on the best options. Then we build an orbiting rectenna and power beaming relay demonstrator, and if it passes muster, put it in operation in an area of that includes regular power need/supply inequities, both deficiencies and surpluses. Then we ramp up to mass production of these units and their deployment to create the World Wide Orbital Grid.

Getting Everyone to "Buy In"

Along the way, we create a consortium of power generation companies and grid managers who want to be involved. Pair them up with developed and developing nations that see the WWOG as in their best interests and establish **a WWOG Authority** representing all these players and interests.

Finding investors is crucial. The members of the WWOGA (individual power generation companies) can place surcharges on their terrestrial power customers to help support expansion of the WWOG. Power generation companies with unsold excess capacity should be quick to invest as a way to maximize their profits and grow their power generation capacity.

No part of the inhabited or uninhabited world (not even the deep Arctic and deep Antarctic, from where orbiting relays may at times be too close to the horizon for effective beaming) will be too remote to benefit. Power will be avail-able not just to cities and manufacturing complexes but to agricultural and other areas: for irrigation and sea water desalinization, etc. Teleoperated nuclear plants could be established on remote uninhabited islands, to contribute to the grid. In general, establishment of a WWOG will lay economic grounds for would peace and prosperity. Widespread economic well-being,

Of course, it does not stop dirty power generation or start regreening the Earth, but by laying the natural founda-tions for SBSP while disarming all opposition, it will bring the day of a prosperous cleaner and greener Earth

that much closer, as well as make more inevitable the establishment of an Earth-Moon economy.

Meanwhile ...

There is much we can do in America, India, and elsewhere to slow the growth of dependence on fossil fuels for power generation. We can do much more in the way of on site solar power generation for home and building use -- and not just in the sunny southwest! "When you look at solar usage, the US is currently third behind Germany and Japan. Both of these countries currently have the solar footprint of Northern Michigan, but they are both able to make solar power work for them."

http://www.altenergystocks.com/ archives/2005/10/

By doing as much as we can with ground-based solar, we will not only be buying precious time, but we will be easing the public mentality towards a world view in which solar energy is King. That will help weaken the influence of the Vested Interest coalition of oil, gas, coal.

Dismissing this phased in approach in favor of going for the whole plan or nothing, involves the higher risk of failure. We need to avoid swimming upstream when there is this sure fire phased in plan that all interests involved will accept much more readily. And, though it is not much mentioned, a Space Based Solar Power system that does not aim at a World Wide Power Grid will only exacerbate the divisions in the world, which motivate unrest, conflict, and war as well as unacceptable inequities. We are all in this together. There is no *national solution*, only a global one.

Expanding on the Options for India

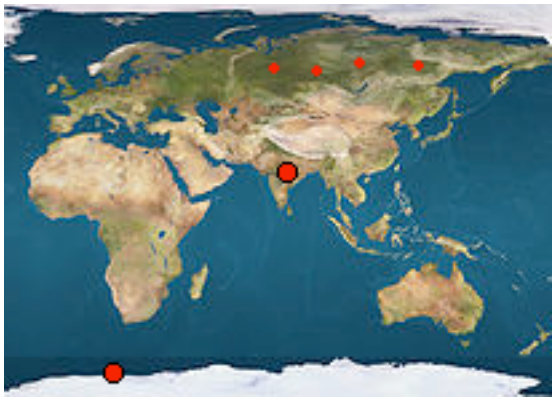
For originating power sources, there may be many options: new hydroelectric power plants in Siberia may be one. A map of current and proposed projects in Russia-Siberia: http://www.eng.rushydro.ru/

We do not pretend to know what the possibities are.

Another, we have already suggested. Wind power along the Antarctic coast.

A windmill farm on the all-weather ice free and rocky Schirmacher Oasis *(brown area on map below)* ***of Antarctica adjacent to india's Maitri Station would be perhaps the ideal place to start.***

Maitri lies south of South Africa, at 11° 44, 9" E
India lies between 67° and 97° E
A Satellite in Geosynchronous Orbit at c. 80° can "see" about 80° in all directions. Maitri is 70° S, within reach. Russia-Siberia below the latitude of Murmansk is also.



The suggested power sources above surely do not exhaust the possibilities. There will be many nations within reach of a Power Relay Satellite in GEO above the equator at the mid longitude of India that can generate more power by wind, hydroelectric, tidal and other green sources that they could sell. By developing ties with more than one supplier, India could insulate itself from politically minded threats of power beaming cut-offs.

India could use extra power for many reasons: its economy is growing at a rapid pace and can be expected to continue doing so for some time. Extra power could be for:

- Desalinization of sea water as India's demand for ever more clean drinking water continues to grow.
- "Clean Coal" – "**Clean coal technology** is an umbrella term used to describe technologies being developed that aim to reduce the environmental impact of coal energy generation.[1] These include chemically washing minerals and impurities from the coal, gasification (see also IGCC), treating the flue gases with steam to remove sulfur dioxide, carbon capture and storage technologies to capture the carbon dioxide from the flue gas and dewatering lower rank coals (brown coals) to improve the calorific value, and thus the efficiency of the conversion into electricity."

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

There is much heated dispute in the United States about the pros and cons of "Clean Coal" technologies, with some describing it as a "myth" or "deceptive lie." We do not pretend to know enough to judge, or to make recommendations. India must make her own decisions on, and we bring it up only as a possibility to be considered.

Dr. A. P. J. Abdul Kalam, Former President of India, believed that it will be essential for India's future to develop and deploy Solar Power Satellites. This would be a huge undertaking, and a considerable investment in India's future. Designing and deploying a Solar Power Relay Sateel-lite would be significantly less expensive than an SPS unit. Yet it is not a question of choosing. A Power Relay Satellite need just add Solar Power Arrays to become a full-fledged Solar Power Satellite. Furthermore, an Indian Power Relay Satellite could be the first of many, creating an orbital grid shifting excess power wherever needed around the globe. **PK**

Beyond Simple Rovers

ROBO-ANTS

Helpmates on the Space Frontier:

A Constructive Look at the "Bottom-Up" Approach to Artificial Intelligence, Taking it to its Logical Conclusion.

By Peter Kokh

Human labor on the Moon and elsewhere, is very expensive. We consume food, air, water, and produce wastes. We need periodic rest and recreation. To be sure, for some tasks, we are indispensable. But there are many tasks that perhaps can be done either by teleoperation, in the case of the Moon, where the communications time delay is less than three seconds.

Another option is to send robot vanguards with some sort of artificial intelligence or idiot-savant programming. We may think of robots as being of human scale. *But there is no reason not to miniaturize them,* especially where information gathering rather than construction, is the task at hand. Even for large tasks, "social" robots could cooperate to meet the challenge. They require energy, of course, but that is cheaper to provide than food.

I recently came across a video of just such a "robo-ant" system being tested for the British army by BAE, a company with a presence in the UK, India, and elsewhere.

www.eis.na.baesystems.com/media_resources/ast_mast1.htm - *watch it before reading on!*

More videos:

http://www.youtube.com/watch?v=0jyBiECoS3Q

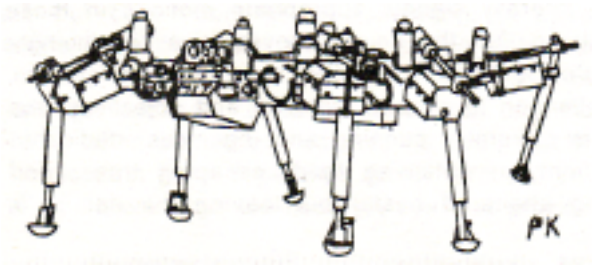
http://www.youtube.com/watch?v=qgoS_6lGsME&feature=player_embedded

Please watch these before reading further

Clearly, the technology is getting there. I was reminded of an article I had wrote for Moon Miners' Manifesto # 45, May 1991 – "Robo-Ants" - reprinted in part below

The Top-down Model of Intelligence

At Massachusetts Institute of Technology, MIT, researchers have pursued robotic artificial intelligence, and have abandoned the conventional forbiddingly centralized, computer- and software-heavy, "top-down" approach to artificial intelligence patterned after the human nervous system and various problematic theories of how we perceive, think, and decide. Instead, led by Australian-born Rodney Brooks, they took their cues and clues from the very different architecture of insect intelligence.



MIT's "Atilla"

Insects are highly successful at tackling complex feats on a routine basis despite their minimalist nervous systems and tiny brains. This is because, in bottom-up fashion, they operate by pyramiding more complex behaviors on simpler ones starting with simplest autonomous reflexes in individual legs and sense receptors. At each stage, there is no more coordination from above than there has to be to achieve a certain purpose such as walking or climbing or burrowing; and the animal's brain is called into play only when stimuli and the need for appropriate reaction spill over certain threshold levels. By terracing simple steps, activities that would otherwise seem dauntingly complex, are easily handled.

Brooks and his team built Genghis and a successor, Attila, both looking suggestively insect-like, and behaving in like fashion. They had multiple legs, each with its own autonomous microprocessor, segmented body, and stereo eyes. As each leg learned to coordinate with adjacent legs, the 'insect' gained skill in negotiating all sorts of terrain.

The robo-insect is meant to be an 'idiot savant.'

It should be quite stupid in general, *but extremely capable in a narrowly defined field of operation,* in a caricature of contemporary human horse-blindered occupational specialization. Unlike today's industrial robots which are designed to perform totally routine operations under identical circumstances over and over again, *robo-ants should be able to perform a related suite of operations under widely changing circumstances, be mobile over unprepared terrain, and self-contained.*

What's more, these robo-ants can be built relatively small. Given limited payload and cargo capacity, we can land more of the little critters on the moon (or wherever) and get back a lot more exploration data per buck, sampling more sites. *Yet the excitement these prototypes are causing in the space community seems too restrained, conservative, and unimaginative.*

Four main points, which we'll explore one by one:

1) **The insect is not the only**, nor necessarily the ideal, **model of bottom-up intelligence**.
2) We must give correlative attention to sensory apparatus.
3) We need not stop the behavioral pyramiding when we have perfected a functional individual robo-ant.
4) There are even more helpful chores these little beasties might be able to tackle eventually beyond just exploring and collecting samples, and they can be tailored to toil in settings other than the surfaces of Moon and Mars.

(1) Octopus: Another Model of Bottom-up Intelligence:

Insects are a poor model on which to pattern our "robo-ants." They do amazing things but are totally pre-programmed with no capacity to learn. They are virtually automatons. We can do better!

Our first advice for those researchers who want to explore the full range of possibilities that the bottom-up approach offers, and to become fluent in this 'language' and its idioms, is to consider the supreme culmination of individual intelligence in the invertebrate world: **the octopus**. [Greek *okta* + *pous* = eight-footed]

This curious creature carries some unfortunate and factitious evolutionary baggage that has kept it trapped at a level far below what its 'alien' *architecture should have allowed*. To give just two 'for instances',

- It has green copper-based blood (hemocyanin has only 1/20th the oxygen carrying capacity of iron-based hemoglobin, limiting its endurance), and
- The female octopus lays swarms of minute eggs, wherefore, lest it eat its own young while they are too small for it to relate to, the female has been naturally selected to die shortly after the eggs are laid.

[Trivia: "octopi" is out of favour as the plural of "octopus" and "octopuses" is more common in both USA and UK.]

Despite such handicaps, the octopus is far more capable of intelligently "manipulating" its natural benthic world than the more pelagic dolphin, the usual darling of popular esteem (*the sea bottom being a more structured and intelligence-challenging setting than the open sea*). In some still future time, it may be possible to correct some of the octopus's evolutionary missteps by genetic engineering (perhaps splicing in bits of genetic material from other mollusks with more desirable traits), and thereby set an altered cephalopod strain back on an upwards course with destiny ("sophopods" = the "wisefeet"?). But that's the subject for a Sci-Fi novel -- someday.

In the octopus, each tentacle explores rather autonomously, curiously picking up and examining by touch any food-sized object. The tentacle is good at sensing texture, but not shape, and can smell. Only when certain thresholds of stimulation are reached, does a signal go to the animal's brain. Similarly, each tentacle laterally signals appropriate motions in those adjacent, so that the animal moves in a convincingly coordinated fashion. Some naval and marine researchers have recognized the potential of modeling the octopus system:

http://www.robaid.com/bionics/robot-octopus-shows-great-potential-as-an-addition-to-mini-subs.htm - *includes* ***video***

http://www.israel21c.org/technology/forget-submarines-send-in-a-robotic-octopus-instead

The central brain is like a foreman, giving attention to general direction and objectives (the animal is extremely cunning and ingenious, dedicated and patient, in obtaining food, escaping traps, and preparing sheltered nests) but leaving the details of examination, handling, and locomotion to its tentacles.

Whereas, like 'intelligent' mammals in general, we have a "body image" by which we know where (orientation, direction, posture) our various body parts are (those subject to our discretionary control), the skeletonless octopus seems to have no "body image" at all. And, perhaps as a consequence, it has no 'hand'-eye coordination at all. (This somewhat 'protean' shapeless-ness gives it the advantage of being able to squeeze its great head through almost any hole or crack big enough to accommodate the thickest parts of its individual tentacles - an enormous strategic advantage.) While the octopus is quite different from the insect, A.I. researchers would do well to study its highly adaptable bottom-up terracing of behaviors and its much greater capacity to learn. ***On the other hand, the octopus is basically a loner, whereas some insects function as teams.***

(2) Refining Sensory Apparatus:

Attention has to be given not only to analogs of nervous systems, muscles, and bones, but to the sensory apparatus. Touch, for example, is a catch-all for separate but collocated abilities to sense shape, texture, hardness, wetness, temperature, and weight. If we can design robo-insect foot pads (or individual 'toes'?) with a set of receptors to do all of these, we will be getting off 'on a good foot' (pun intended). A sense of chemical taste should be included, designed to ignore the expected, and notice trace elements in unexpected concentrations. Rather than complex mass spectrometers, this might involve some suite of self-resetting litmus spots. On the other hand, a robo-ant need not have more sensory discrimination capacity than necessary to do the task for which it is designed.

Sight might be offered not only in a front-top-center stereo scanner on a stalk, but perhaps in a task-appropriate 'eyespot' on each foot, or forefoot, with the information not being called to the attention of the central processor and thus merit the gaze of the stereo-scanner, unless its content calls for organized response. In the octopus, the two eyes can cooperate or work separately when the situation allows divided attention. Two eyes are needed for range-finding (depth-perception) as one bobbing eye does just as well. We are currently at a juvenile level of playful fascination with a digital feast of irrelevant data completely overwhelming efforts at analysis.

An eye that can zoom

Researchers have to find a way to install data-filters that will ignore the non-significant and pick out the reaction-cuing patterns. Perhaps a good way to do this would be to give the eye "zoom" capacity, not just in magnification but in wealth of detail. In other words, a good eye for A.I. purposes, would sense only crude detail, but can "zoom in" in resolution, in spectral coverage (from black and white to special color filters, full colors, infrared, etc. as appropriate), and other vectors (polarization, shading contrasts, brightness, etc. etc.) when something "catches its eye", much like the comic strip hero Superman could "turn on" or "of" his X-ray vision. We need an eye that provides a basic rough view, yet capable of considerable real-time on the spot image enhancement, triggered by cues. What I would suggest is an under-lying wide field of view with low resolution with a scanning focus/zoom device triggered through a series of data filters to 'notice' the unusual and unexpected, stop scanning and fix its gaze, focus, and zoom in for an enhanced view as per above.

A properly designed robo-ant would have specialized legs, perhaps all capable of supporting locomotion, but

with some able to concentrate on examination of objects encountered, and others on transporting collectibles to a top-mounted bin or trailing wagon (which could empty its load when full, making piles for later pickup by a more capacious haywagon) or casting small 'obstacles' to the side.

(3) Co-operative Robo-Ants *(or "robo-pods*?**")**

At least two dozen separate times in the history of insect evolution, the pyramiding of behavioral functions has spilled over from the individual insect into inherited cooperative social behavior totally beyond the capacities of the isolated creature. The prime examples of this process are the social termites, ants, wasps, and bees.

In each of these cases, there is physical polymorphism within the species, that has gone beyond mere sexual differences and given rise to separate "castes" of workers, soldiers, drones, males, females, Queens etc. each of which have specialized built-in equipment and instincts, but together work cooperatively to achieve communal goals. Here there is no personal chain of downward command but rather a collective pyramid of upward input. Given these ample precedents, there is no reason why, once we've really mastered the business of terracing behaviors bottom-up style, that we cannot design our robo-ants in castes such that their specialized behaviors are pyramided to achieve really complex cooperative mission objectives.

POSSIBLE ROBO-ANT CLASSES

A Scout class that explores, reconnoiters, classifies and marks the terrain it moves over, would come first. This is what researchers are aiming at now.

Sargents could direct deployment, ensuring full coverage of a work area and act like sheepdogs, keeping units from straying. We can also have Harvesters whose job it is collect objects of interest noticed and tagged by the scouts or perhaps already placed in convenient 'hay bale' piles for later collection.

Refuellers or Rechargers could be on the lookout for stalled ants with an activated out-of-fuel or low-charge blinker. Retrievers could pick up disabled scouts and return them to the main staging area. Mechanics could affect simple repairs of disabled units, refresh their programming, or cannibalize them for parts.

Stragglers from other robo-insect collectives could be adopted and reprogrammed. Inspectors could accept or reject (undo?) work not up to their built-in standards.

A Queen or Mother unit, possibly atop a mobile hive-shelter to which individual ants could return at nightfall to conserve heat, to be recharged, to receive updated instructions etc. The queen unit need only recognize progress towards realization of the collective mission, that is, able to send out a deactivation signal when the job seemed finished, spur on lagging castes, etc.

Communications between units and castes can range from plug-in electronic and/or radio debriefing or reporting to visual clues like variously colored lights flashing in repetitive coded patterns.

(4) Complex Missions for Robo-Ant Collectives:

Once we have mastered the 'language' and idiom of bottom-up artificial smarts, extending it to intercommunicating polymorphic crews, to what use can we put this fluency? Exploration and sample retrieval are only openers, and unimaginative ones at that. Here are some more ambitious missions for our robo-ant teams:

Site preparation and pre-deployment tasks:

- Remove boulders from an area, grading and raking, for roads, skidways for craft landing horizontally, and pads for spacecraft landing on their retros.
- Excavate spaces for habitat modules, fuel tanks, etc.
- Collect regolith, load conveyors, and relay it as a shielding blanket over pre-deployed habitats etc.
- Identify desirable mineral and rock samples and pile them up for convenient later retrieval.
- Do pre-mining sortation, depositing richer concentrations of sought-after elements as 'leavings'.
- Sinter or gravelize 'porch' or airlock apron areas and approaches to minimize dust transport into habitat interiors.
- Set out tritium marker lights for roads, landing pads, and in lava tubes and other permashade areas etc.
- "Primage" lunar regolith for use as agricultural soil, sifting out ultra fine particles, and transforming glass spherules into zeolites to promote mineral ionization.
- Spin web mesh receiver antennas over suitably sized craters for radio astronomy and satellite solar power
- Survey/map lava tube complexes on the Moon/Mars.
- Harvest thin patchy water-ice deposits in lunar polar permashade not otherwise economically recoverable.
- Replace damaged panels in extensive solar arrays.
- Plug outguessing pores on comets in preparation for their shepherding to the Earth-Moon vicinity.
- Locate and map fissure escape routes for episodes of outgassing on the Moon that we notice as 'TLP' glows (Transient Lunar Phenomena) and mark those where the volume of flow may provide an economic resource

Within habitat-biosphere areas:

- Tend farms, trimming dead leaves and stems, tilling, spot-watering, spot-fertilizing, detecting early signs of infestation, picking ripe produce, etc.
- Sort consumer and industrial recyclables
- Clean streets and other pressurized passageways
- Change failed or failing light bulbs and tubes
- Detect and repair minor slow air and water leaks In service of a future Mars terraforming effort:
- Locate and pre-tap areas where water-ice perma-frost rises closest to the surface.
- Physically, and even chemically (where possible with non-consumed catalysts), condition raw soils, sands, and gravels for the introduction of microbial cultures
- Channelize potential canalways (identified by orbital altimetry mapping) from polar to equatorial areas; and channelize the 'saddles' between neighboring unlinked basins to accelerate development of a mature drainage system in expectation of future rains.

Out Among the Asteroids and Comets:

- Locate, map and presort and/or pre-treat surface-available mineral resources

- Pre-mine desired resources on small astrobergs so that only resource-poor tailings need be used as mass driver pellets in coaxing it into a handier orbit
- Locate intact remnants of impacting bodies
- Look for 'parent-body' tell-tale signatures
- Excavate pressurizable galleries for outposts
- Produce fuels from otherwise unpromising fields of volatile-rich materials
- Make and cache 'bricks' and other simple building materials in advance of crew arrival
- Locate outgasing pores or vents on comets during their dormant phase
- Tunnel to the comet core, analyzing the material all along the route

All of the above complex activities can be analyzed into a pyramid of simple tasks building on one another, and we should be able to design and program robo-ant teams to handle any of them with a minimum of human supervision or monitoring. In each case, given the higher cost of alternatives, the lower degree of accuracy, consistency, and coverage, and generally wider specification tolerances that bottom-up tasking can achieve may be acceptable. Surely, the above suggestions do not exhaust the possibilities.

There are a number of reasonably analogous sites on Earth where such robo-ant teams could be field-tested and given prior experience. Volcanic areas, cave areas too narrow for humans to negotiate, abandoned mines, Antarctica's Dry Valleys all come to mind.

"Social" robo-ant co-ops promise to become our indispensable helpmates in opening up the space frontier on the Moon and Mars, on asteroids and dormant comets, and even in free space construction sites, concentrating on tasks of limited complexity in life-hostile surroundings to relieve exploring pioneers and settlers of high-risk drudgery. As such, they could be the Army [Ant] Corps of Engineers of the future.

With a little imagination, there should be Earth-side applications aplenty for profits here and now, from robo-ants designed and engineered now. Some of our readers may be motivated to get in on the ground floor. We hope so!

NOTE: Rereading this article many years later, I still think that those doing research in this are ought to take a look at how the octopus functions, and try to replicate some of its extra abilities in their "robot-ant" systems.

With Chandrayaan-2 being prepared to land a pair of rovers on the Moon within two years, we think that this is a timely topic. We hope that student engineers in India may be inspired to pursue these ideas further. – *Peter Kokh*.

Using "Spin-up" to Pre-develop Robo-Ant Systems *for near-term down-to-Earth Uses*

By Peter Kokh

Spin-up is just the opposite of "spin-off."

In "**spin-off**," NASA (or any other national space agency) embarks on a crash research program at very high cost; and then ultimately turns over the resultant technology at no or low cost to commercial enterprises with the taxpayer footing the bill.

In "**spin-up**," a private enterprise, motivated by profit from near-term terrestrial applications, pre-develops the technology, with the consumer paying the bill.

As a result, when the technology is needed on the space frontier, it is already "on-the-shelf" and in need of only relatively inexpensive adaptations to unique off-Earth environments.

While "taxpayers" and "consumers" may be one and the same, in the first instance they are unwilling, in the second willing. When it comes to public support, this is an essential difference.

Here and now applications of Robo-Ant Systems

Military – *video of system already being tested*
www.eis.na.baesystems.com/media_resources/ast_mast1.htm

- Detection (possible removal or disarming) of mines and IEDs [improvised explosive devices]

Other Government (national, state, local)

- Detection (and eradication) of invasive plant and animal species that threaten indigenous species. *This is a big problem world wide* as species manage to "hitchhike" rides to new habitats by plane, or "stowaway" on ships, or smuggled in for personal reasons, and then "escaping."
- Assistance to fire-fighters in detecting persons needing rescue in smoke and/or fire filled rooms and spaces.

  A word of caution: if the military developed these technologies, it might not want to share them, even adapted for commercial or space use. A prior agreement with ISRO to share this military-developed technology adapted for space applications would be wiser. But development by Commercial enterprise for general use, with subsequent development for the above or other military uses, would be the optimal situation.

Commercial

- Searching trash dumps etc. for valuable salvage items. Even in jurisdictions where consumers are asked to "properly recycle" specific items, many do not.
- Removing toxic components from discarded computers in household trash dumps. In some areas of the world, children do this chore, and, as a result end up with serious lifelong health problems.

Now its your turn!

The above suggestions are those that occurred to me. There are undoubtedly many more possibilities: uses that would be helpful to the military, and to government agencies at various levels. And just as important, if not more so, uses that promise to produce commercial profits. **Send your suggestions** to **mmm-india@moonsociety.org**

Lunar Analog Stations
Without "Moonlike" Terrain

By Peter Kokh

Not every organization that would like to start its own lunar analog research station program, is going to be able to find an ideal "vegetation-free picturesque desert" location, especially one located to minimize the logistics costs of frequent visits and support. In such a case, what are the options?

Situation I: You want to build a lunar analog station but do not have any "logistically convenient" "moonlike" terrain nearby.

Situation 2: You want to do analog research on activities at a Moonbase that would we confined to the outpost complex interiors.

The two situations, of course, are match-mates made in heaven. One suggests the other. In this article we would like to suggest some options.

SITUATION 1: you definitely would like to do "outdoor" type activities such as experimenting with bulldozer and rover designs, teleoperations experiments, etc.

Look for an abandoned quarry: *there may be many!* The vegetated surroundings may well be out-of-sight from the quarry floor, and the floor may be vegetation free.

This is the active Hollister mine (NV?): imagine replacing the mine buildings and equipment with an analog station!

Or, an abandoned gravel pit

Gravel pits are frequently found in otherwise highly-vegetated areas. Any plant-rich surface soil has been removed to get at the underlying gravel. If you find such a pit that is large enough, and preferably out of the way of traffic and unwelcome visitors it may be an option to consider.

While remaining gravel may provide too rough a surface, a few loads of sand spread on top, but not hiding the gravel totally, may provide a suitable faux moonscape.

An abandoned sand/gravel pit

Option 2: an abandoned mine gallery, especially one that lies above the local water table and does not need constant pumping: better yet, one in a low rainfall area.

SITUATION 2: You have in mind experiments with life support systems; experimental agriculture under lunar dayspan/nightspan sunlight availability constrictions; you want to experiment with operations scheduling that tries to reserve energy-intensive chores for the two weeks of abundant lunar sunshine; with energy-light, manpower-intensive chores preferentially put off until the two-week long nightspan period when sunlight is not available.

This happens to be a dry, roomy, and spacious copper mine at El Salvador, Chile, near which the proposed Moon/Mars Atacama Research Station may be built. Another essential quality is that the mine gallery must be secure from cave in, roof or sidewall collapses.

Option 3: Build your own ideal environment!

Above: a small habitat module inside a much larger high ceiling warehouse or hangar, in which all interior "sky" surfaces are painted matte black; the floor a simulated

moonscape complete with mini-crater. During nightspan, fiber optic "stars" would brighten the sky. In dayspan, a spotlight "sun" with a fresnel lens to broaden its light cone, could brighten the surface. An Earth" globe (ideally of proper size, axial alignment, and face turned toward the "Moon" in proper lighting phase, would be idea.

While a domed or curved space would be ideal, if need be, a spacious pillar-free big box warehouse would do, or an abandoned sports dome of some kind. Perhaps the best bet would be an available aircraft hangar.

This one would be ideal, minus the UFO "flying saucer", of course! A hangar has the advantage of unobstructed clearspan and generally higher ceilings, especially in the middle. But you may have trouble finding one that is rent/lease free. In which case, this would be too expensive a solution. A hangar at an abandoned Air Force Base, or at one that is under-utilized, may provide a workable option.

Of course, there are vegetation-free areas in India. The Great Indian Desert in Rajasthan, for example, and the several "rain-shadow" Himalayan valleys mentioned in M3IQ #3 [Ladakh, Lahaul, Spiti, Kinnaur and Bharmour (H.P.); pockets of northern Uttaranchal; and Sikkim.] But if desert heat and shifting sands are a problem, or if the cold and/or logistics challenges of remote northern mountain valley sites pose too great a financial "tax", some of the ideas above may provide workable alternatives for a future LARS-India [Lunar Analog Research Station]

Obviously, finding the right site, of any of the types considered above, will require a lot of exploration. This is a burden best shifted to local enthusiasts. Feedback from those who have found a potential site and provided adequate photos and maps can produce a good "short list" for a Moon Society India site location team to visit and compare. For one or two volunteers to scour India for suitable location without this prior list of locally suggested sites would be a daunting task.

The ownership status and current use situation of each site must be considered. Would the Society have a free lease or right of use? The Mars Society solved this problem up front by only looking at government-controlled lands, specifically those under US Bureau of Land Management. MDRS has free usage of such a site, provided that it is returned to its natural state when no longer needed.

Privately owned and donated land may be an option – provided there are no annual "property taxes " to pay, or local "usage restrictions." So there are many options and choices. MSI will find a good site! **PK**

GREAT BROWSING

How the Moon produces its own water
www.astronomy.com/asy/default.aspx?c=a&id=8718

Significant Amount' of Water Found on Moon
http://www.space.com/scienceastronomy/091113-lcross-moon-crash-water-discovery.html

Water Discovery Fuels Hope to Colonize the Moon
http://www.space.com/scienceastronomy/091113-moon-water-colony.html

India Commits to Manned Mission to the Moon
http://www.ptinews.com/news/376698_Manned-mission-to-moon-soon--President

Planetary Society gives Solar Sailing 2nd Chance
http://www.thespacereview.com/article/1510/1

New Book on Life of Konstantin Tsiolkovsky
http://www.thespacereview.com/article/1508/1

Messenger sees changing seasons on Mercury
http://www.space.com/scienceastronomy/091103-mercury-new-images.html

Space Hotel Takes Reservations for 2012 Opening
www.space.com/news/091104-space-hotel.html

A Star Trek Like "Replicator" for the Moon & Mars?
http://www.colonyworlds.com/2009/11/almost-star-trek-ebf3-tech-could-help-replicate-tools-for-lunar-settlers.html

'Trash Can' Nuclear Reactors Could Power Human Outpost On Moon Or Mars
http://www.sciencedaily.com/releases/2009/10/091004020806.htm

Review: Krafft Ehricke's Extraterrestrial Imperative
http://www.thespacereview.com/article/1526/1

GREAT SPACE VIDEOS

MOON COLONY VIDEOS - The Moon Society

30 plus thought-provoking videos, produced for the Moon Society by Chip Proser (Celestial Mechanics, Inc.) can be found at.
http://www.moonsociety.org/video/ *or at:*
http://www.mooncolony.tv/
http://www.stickymedia.com/

ASSORTED SPACE VIDEO

Video of NASA's new Star Trek like "Replicator"
http://www.colonyworlds.com/2009/11/almost-star-trek-ebf3-tech-could-help-replicate-tools-for-lunar-settlers.html

Robotic rover that can drill on the Moon
http://www.sciencedaily.com/videos/2008/0309-moon_rover.htm

Earth's Magnetosphere charges Moon monthly
http://www.sciencedaily.com/videos/2008/1007-preparing_for_a_walk_on_the_moon.htm

India's Moon Mission
http://www.space.com/common/media/video/player.php?videoRef=SP_081015_chandrayaan

MMM - INDIA GALLERY

Energy Usage of India, Pakistan, Bangladesh and Sri Lankha is evident in this **night view from space**

A computer mosaic of India from space in daytime with clouds removed. The Himalayas form a natural boundary

The Indian Institute of Space Sciences & Technology at Valiyamala near Thiruvananthapuram, Kerala State.

Radio Astronomy Centre, Udhagamandalam, Ooty

Picture of New Delhi taken by an Indian satellite visualised using Bhuvan, a satellite images visualisation software. Bhuvan is Sanskrit for Earth: The new Bhuvan program has a resolution limit of 10 m vs. Google Earth's 200 m

ISRO Indian Deep Space Network (IDSN), Byalalu, Karnataka

A JAXA concept for Japan moon base

Moon Miners' Manifesto Resources

http://www.MoonMinersManifesto.com

MMM is published 10 times a year (except January and July. The December 2008 issue will begin its 23rd year of continuous publication.

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

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

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

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

MMM Classics: All the "non-time-sensitive editorials and articles from past issues of MMM have been re-edited and republished in pdf files, one per publication year. A 3-year plus lag is kept between the MMM Classic volumes and the current issue. **As of November 2009, the 1st twenty years of MMM, 200 issues, are preserved in this directory,** These issues are freely accessible to all, no username or password needed, at:

www.moonsocietyorg/publications/mmm_classics/

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

www.moonsociety.org/publications/mmm_themes/

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

www.moonsociety.org/publications/m3glossary.html

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

All of these resources are available online or as free access downloads to readers of MMM-India Quarterly

Help Wanted !

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

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

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

mmm-india@moonsociety.org

[This email address goes to the whole editorial team]

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

Guidelines for Submissions

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

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

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

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

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

Help Circulate *MMM-India Quarterly*

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

Readers are encouraged to share and to distribute these issues widely, either as email attachments, or via the direct download address (for all issues):

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

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

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

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

Student Space Organizations in India

The Planetary Society of Youth (TPSY)

http://www.youthplanetary.org/

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

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

======

Astronautical Soc. of India Student Chapter (ASISC)

http://www.indianspace.in/

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 - http://india.seds.org/

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

SEDS-India Chapters:
SEDS VIT (Vellore)
SEDS Veltech (Chennai)
SEDS Savitha (Chennai)
SEDS Warangal (Warangal)
SEDS GGITM (Bhopal)
SEDS KCT (Coimbatore)
SEDS ISM (Dhanbad)
SEDS NIT Trichy (Trichy)
SEDS NIT(Nehru Institute of Tech, Coimbatore)
See map on last page of this issue

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://www.nss-kolkata.org/
Dr. Satadal Das
drsatdas @ hotmail.com 91-33-24683336
76 Satyen Roy Road
Kolkata, , 700 034 India
Meetings: 547 Raja Rammohan Roy Road (1st Floor)

National Space Society Pune Chapter

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

Planetary Society of India

[Organisation for promotion of astronomy]
http://planetarysocietyindia.blogspot.com
http://planetarysocietyindia.blogspot.com/2008/08/space-camp-india-astrounaut-training.html
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 – India
http://www.vayuaerospace.in/

Moon Society India www.moonsociety.org/india/

President: Jayashree Sridhar (Chennai)
jayashreesridh@gmail.com

Secretary: Pradeep Mohandas (Mumbai)
moonsocietyindia@gmail.com
+91-996-932-4473

MMM-India Quarterly
mmm-india@moonsociety.org

Announcing a Moon Society Essay Contest

"Manned Space Exploration is Worth the Risk"

In celebration of the **40th Anniversary** of the successful return of the **Apollo 13** crew in the light of almost certain disaster. **Details**: http://www.moonsociety.org/reports/A13_contest_announce.html

MMM-India Quarterly #5 – Winter 2010 Index - Table of Contents

p. 2 About The Moon Society
About "Moon Miners' Manifesto"
About "MMM-India Quarterly"

p. 3 Water Politics on the Moon - *Srivinas Laxman*

p. 4 Interview of Shyam Bhaskara - *Srinivas Laxman*

p. 5 Discovery of Water: Promises and Concerns *Pradeep Mohandas*

p. 6 Major Omission in Chadrayaan-1 UTV Film *Srivinas Laxman*

p. 6 Predictions on the Impact of Discovery of Water on the Moon – *David Dunlop*

p. 9 Elsewhere in Asia

p. 10 Strategic Role for India in Commonwealth – *David Dunlop*

p. 14 What's New in the Commonwealth

p. 15 Book Reviews: Energy Crisis: Solution from Space; Life of Konstantin Tsiolkovsky

p.16 Moonshot India - Candrayaan-1: The mission complete

p. 17 Moon Society India

p. 18 SEDS India Conference 2010; M3IQ Editors

p. 19 Electric Power to India via Space – *Peter Kokh*

p. 22 Beyond Simple Rovers: Robo-Ants – *Peter Kokh*

p. 26 Lunar Analog Stations without "moonlike" terrain – *Peter Kokh*

p. 27 Browsing Links – Video Links

p. 28 MMM-India Photo Gallery

p. 29 MMM Resources; M3IQ Help Wanted

p. 30 Student/Other Space Organizations in India

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

and you would like to add your email address to our new-issue-ready announcement list,

Write **mmm-india@moonsociety.org**

Put "Subscribe" in the subject line of your email.

Include any comments you would like to make!

Feel free to send us email addresses of others Individuals and/or organizations or lists that you think would like to receive notice when each new future issue is published.

Homo Lunensis:

"We must develop the habit of dealing with anything and everything lunar in such a way that the Moon becomes a place where we will have learned to become truly native."

- Simon Cook

Key: ISRO Centres; Moon Society; SEDS; NSS

Engage! And Enjoy!