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Lunar Development Forum

http://server02.fb12. tu-berlin.de/ILR/koelle/lbq/
http://csxe.rutgers.edu/research/space/LBQ.html
http://www.irs.uni-stuttgart.de/institut/mitarbeiter/laufer/lbq.html

LUNAR BASE QUARTERLY
Vol.17, No.4 /October 2009

The *Lunar Development Forum* is an informal group of world citizens who are interested in the development of space travel. We observe and participate in the public discussion of current and future activities to return to the Moon and beyond. Readers are invited to raise pertinent questions and/or to assist in providing answers!
This is the fourth issue of the **LBQ 2009** in the 17th year of this publication! We hope that we will be able to continue next year discussing the new US Space Policy and other future National Programs with emphasis on lunar development.

As usual, we would like to thank following contributors for their responses and information received during the last 3 months: **H.Davis**, **H.Dittus**, **H.Heisig, D.Koelle**, **O.Liepack, H.Mertens**, **D.Stephenson, G.Vulpetti, G.Woodcock**.

The following INFO's are offered in this issue:

INFO 23/2009: Editorial
INFO 24/2009: EVENTS and NEWS
INFO 25/2009: Robotic Lunar Exploration
INFO 26/2009: Human Lunar Exploration
INFO 27/2009: Space Transportation Development
WP 5/2009: Space Program Objectives
WP 6/2009: Pros & Cons of reusable Space Vehicles

We would appreciate very much if you would participate in our deliberations designed to assist current efforts! You can send your contribution also by e-mail, pdf, WORD.doc format, or by "snail mail".

If you would like that your contribution is included in the evaluation of this LBQ, you should observe the deadline of January 4, 2010 on our desks or in our e- mail boxes!
sincerely,

Hermann Koelle, Haym Benaroya and Rene Laufer

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EDITORIAL

SPACE TRANSPORTATION

An Assessment of the first hundred years of space flight development 1950 to 2050

H.H.Koelle (July 2009; edited D. Stephenson)

Space Transportation is the fourth means of transporting goods and people invented by Mankind! It is the only transportation system capable to leave our home planet! Transportation history began many thousand years ago with land transportation, followed by water transportation, and eventually by air transportation just over a century ago. The transportation of Earth orbiting satellites and deep space probes began in October 1957 when SPUTNIK 1 circled this planet. The first human was sent to circumnavigate the Earth in 1961. The enabling technology of this new form of transportation was initially a rocket using the energy of chemical propellants to achieve the necessary velocities for overcoming the gravity of the planet Earth (1969).

The first vehicles used for space transportation were derived from military intercontinental rockets to meet priority political goals. These expendable vehicles demanded a new vehicle for each flight. They could not be individually tested, like bombs using them destroyed them! Instead expendable space launchers have to be type tested. One example of a particular launcher is made to work, and for subsequent operational launches copies are flown. A massive and expensive quality control bureaucracy ensures an acceptable level of reliability. Adapting this approach to space flight made space transportation – necessarily - a rather expensive enterprise!

The motivating force that drove the development of space transportation was the furtherance of national security and prestige! Space became the high ground competed for by the United States and the Soviet Union as a symbol of the superiority of their rival social systems. The USSR was the winner in the first decade of space flight but overtaken by the USA during the second decade demonstrated by the landing of the first American astronauts on the Moon!

Other nations and coalitions have since developed their own space transportation systems, within their own technical and economic capabilities. EUROPE, JAPAN, CHINA, INDIA became major space faring nations with fairly ambitious national programs enhancing their national stature. Some smaller countries such as CANADA, ISRAEL, KOREA, and IRAN have active, but more modest space programs. Currently only three Nations have the capability to send people into space: RUSSIA, USA and CHINA!

The result has been a plethora of expendable launch vehicle types constructed by many nations. This space fleet was and is serving no more than a 100 launches per annum. Each launcher type has therefore a low annual launch rate. Few vehicles types have achieved a launch rate of ten per year, or more than one hundred launches during their operational life period. The low production rate prevented the advantages of mass production reducing launch costs. Creeping design changes and operational requirements ensured productivity remained low. One exception to this rule has been the lower stages of the original SPUTNIK launcher.

Under these circumstances specific transportation cost per unit mass or per passenger has not improved significantly for several decades! This disappointing trend was acceptable for robotic missions, in case provided launch costs were in the same order of magnitude as the payload costs. The performance of robotic missions developed rapidly thanks to the extraordinary improvement of the reliability and performance of modern electronics.

In summary:
Current launcher technology could supply the demands of the limited market of the past but will not suffice in the future if space travel is to be extended into space beyond low earth orbit as envisioned and planned by the United States according to the updated space policy of 2004!

The current situation can be summarized by one word: **Stagnation!**
The conclusion: Mission reliability, crew safety, specific transportation cost, annual launch rates are nearly constant and limit the further development of space travel.
Expected near term trends:
- Earth satellites and robotic space probes financed by government agencies and selected commercial enterprises are likely to be transported at current rates.
- Robotic spacecraft will dominate the space scene and will explore the potential of space.
- The present destination of crewed space flights, the international space station (ISS) is a research facility that will probably only be available no longer than one decade. Single tourist flights of visitors to the ISS have been performed by Russia and will be the exception in coming years!
- Regular short ballistic tourist flights to altitudes above 100 kilometers, where space nominally begins, may begin during the coming decade.

This situation must be changed if human activities are to extend permanently beyond low earth orbit out into the solar system so that the vision of "**exploring the Moon, Mars and other celestial objects in our solar system" can be fulfilled!**

The political decision extending space travel development has been taken by the major space faring nations, suitable programs must now be planned, authorized, and realized!
The prerequisite to achieve this goal is lowering the cost of transporting people and freight into space by an order of magnitude must now be given priority in this process.

For decades decision makers have shied away from making major investments in innovative and efficient space transportation systems. The initial investment will not be small, and because of the long development cycle there will be no immediate return during the typical tenure of a democratic government or business cycle. The current market does not justify the expenditure, but that market will not expand significantly unless launch costs and availability are substantially improved. The result is a "chicken-and-egg" dilemma. We urgently need to design an Eagle!

The "return to the Moon" announced in 2004 by the President of the United States opened the door to new planning activities and the consideration of concepts of human activities beyond low earth orbit! These included a multi-months crash project by NASA to define a near-term space transportation concept that appeared to be affordable, and could support the next major step into space. NASA has an urgent need to replace the Space Shuttle and the new launcher has to be made available as quickly as possible and so was designed to use major elements of the Space Shuttle. NASA proposed the "ARES I/V, ALTAIR, ORION" space transportation concept which was approved by the US Congress in 2005. Development of these system elements is now underway or in preparation. After several years of detailed analysis, however, this concept now appears technically and financially marginal. This is not surprising and parallels past experience with the Space Shuttle. The proposed family of spacecraft and launchers by NASA may be capable of returning to the Moon, but certainly could not support the steps that must eventually follow, namely, establishing a lunar laboratory, supporting a permanent lunar base and enabling interplanetary expeditions that may culminate in - at least - a temporary human outpost on Mars!

The new US Administration has ordered a critical review of the current program. It appears that current plans would not achieve the objectives set by Congress (SPACE ACT of 1958 and the budget authority in FY 2005 and 2006) ! Also, the scope of the present program is questioned!

This review will probably lead to changes of the current program scope and schedule. Regardless, one goal is clear space travel can be realized only if the next generation of space transportation systems would be much safer, vastly more economical, and provide adequate performance in terms of payload capacity and travel time!
Let us not fool ourselves, if this hurdle is not overcome, mankind will not gain access to the vast extraterrestrial resources surrounding its home planet!

The ranked list below of weighted selection criteria illustrates the parameters that will have to be employed to compare various proposed program options to master space travel in this century. [The relative weights assigned to these criteria will change with time as circumstances develop.]

Space Transportation System attributes required:

1. Low risk of loosing human life	17.5%	
2. High return on investments	13.5	
3. Low technical risks	13.3	
4. Low total cumulative program investment	10.1	
5. High degree of program resilience	9.2	
6. High benefits to all stake holders	7.0	
7. Low public budget requirements during first program years	6.8	
8. Low financial risks	6.2	
9. High national and international prestige potential	5.9	
10. Low long term financial commitments	4.9	
11. High commercial potential	3.6	
12. Low average annual budget requirements by public investors	2.0	
Total		100%

In principle, it appears possible that a single nation could develop a space transportation system that would be in the performance class required for the logistic support of a permanent moon base and manned interplanetary expeditions (Model A).
If more than one nation decides to develop this capability then we have a competitive situation as experienced in the lunar landing program (Model B). Possibly two national coalitions will form and compete to exploit space. Space development would then mirror the Boeing-Airbus duopoly that dominates the construction of large airliners.
A further alternative is that several space faring nations cooperate under a program leader and “participate in the journey” as proposed by President Bush in 2004 (Model C).
Finally, an international body (such as the UN) assumes the global responsibility to open space for all nations desiring to participate (MODEL D).

In a multi-national effort program partners must satisfy certain criteria to qualify for participation (such as competence, stable governments, long-term motivation) and be willing to participate in a long-term cooperative effort. The fields of planetary environmental protection, energy supply and the regulation of the world economy are examples of nascent international cooperation. Negotiating a satisfactory international treaty would be time consuming and a transnational effort seems neither the most likely nor the preferable option. Thus, models A and C appear to be the prime candidates at this time for realizing a long-term space program to achieve the vision of “Earth, Moon, Mars and Beyond”.

If and when an investor is found, who has the goal of establishing a feasible and affordable long-term space program must first solve the problem of space transportation! The first step towards solving this problem will be to fund comprehensive studies of competing space transportation systems. Such study contracts will cost their sponsors several million dollars.

The proposed competition would narrow down the field of candidate space transportation systems and define their program specifications. This effort could also attract international interest and illustrate the importance of space travel for future development of mankind.

Sponsors (space agencies, foundations, commercial entities, private entrepreneurs) must define the scope of the program that could have following specifications:

Program goals:	**Lunar Base**	**Interplanetary Expeditions**
Target date	No later than 2031	No later than 2041
Program duration (decades)	2 to 3	1 to 3
Crews	10 to 100 persons	6 to 12 persons/mission
Missions per decade	50 to 100	5 to 10
Cargo delivered to destination	100 to 300 tons/year	100 to 200 tons/mission
Crew duty term in space	0.5 to 2 years	3 to 5 years

Assumptions:
Only chemical propulsion systems should be used for a program in this time frame.
Specific cost of direct man-year: $ 250,000.
Strategic cost reserve: 25 percent of direct manpower cost estimate.

Desired results of a respective systems analysis:
Define launch vehicle, spacecrafts and space infrastructure elements
Establish preliminary mass models
Determine annual cargo and passenger missions
Determine annual vehicle production rates
Estimate mission reliability from Earth to destination
Estimate mission reliability per roundtrip
Estimate annual workload and expenditures
Estimate specific transportation cost of cargo and passengers
Estimate of program effectiveness ($/work-year available in space)
Estimate of program effectiveness ($/work-year available at destinations)
Comparison with an all-expendable transportation system
Discuss growth potential of selected transportation system

Humanity faces a challenging present (preservation of the environment, feeding the population, elimination of disease, providing adequate energy supplies, fighting terrorism, etc) and these challenges will not diminish in the foreseeable future. The development of space travel may not seem to be one of our most pressing problems! We do know however that this planet is a sphere, and therefore its resources are limited, even though our demands continue to expand. We live in dynamic universe, and we cannot be certain what the future holds for us.

We have an obligation to future generations to stand ready to secure the long-term existence of our species. We must open the door to space and explore the use of extraterrestrial resources to enhance the quality-of-life on here and now on Earth while insuring the probably that humanity will survive and thrive. The investments needed to develop space travel are small (in the order of $ 10 billion/a) help to lay the foundations of future prosperity on Earth. Military expenditures, by comparison, exceed one trillion dollars per annum. The development of twenty first century space transportation systems is clearly affordably, especially if pursued jointly by several nations.

Future global programs of space exploitation can be initiated by a competition to find the best way to realize the safe and economic access to Earth-Moon Space and our neighboring planets beyond. The results of this competition will form an essential part of the map that will guide the development of the economy of a vibrant, far reaching space community during the rest of this century.

NEWS AND EVENTS

Retrospective - Lunar Base Symposium, 12-13 May 2009, DLR & Univ. Kaiserslautern, Germany

During the two day conference scientists, aerospace and civil engineers, architects, physicians as well as representatives of many other disciplines discussed various lunar base-related issues towards a permanent presence on the Moon.

After an introductory programmatic overview given by representatives of DLR, ESA and NASA more than 65 papers were presented within three parallel sessions themed "Geology, Resources and Constructions Materials", "Architecture, Structures and Transportation" and "Life Support Systems, Medical Science, Environmental Conditions and Infrastructure". The papers related to the first topic ranged from scientific knowledge and recent results about the geology of the lunar surface, properties of the lunar surface and lunar regolith utilization. This is of importance for construction experiments and upcoming demonstration and prototype projects. Within the second topic lightweight structures and designs for future lunar bases were addressed and necessary tools to design, develop and manage such upcoming complex projects as well as ideas and specific examples of surface transportation systems. The third session covered a wide range of papers starting with life science issues and development of necessary elements of life support systems for a permanent lunar base but also the lunar environment and the resulting challenges for human presence (and its safety) were presented.

The symposium demonstrated successfully the importance of interdisciplinary view and collaboration of representatives of different scientific and engineering disciplines. Discussions showed great interest of the non-space community in the challenges of developing and building a permanent lunar base - accompanied in the willingness to contribute to this area. Especially well-proven architectural and civil engineering knowledge would be useful to answer open questions and solve technical problems. The exchange of ideas, knowledge and visions could act as a starting point for further discussions as well as for projects and products as expected by DLR chairman J.-D. Woerner: "Similar to what happened with the Apollo program, a Moon base or a manned flight to Mars would lead to a huge wave of innovation on Earth. The exchange of ideas concerning building on the Moon is already providing impetus for innovations, for example in the area of materials research and folding lightweight structures."

Hopefully there will be follow-up events keeping the discussions and the exchange of ideas up and running. The Lunar Development Forum and the Lunar Base Quarterly were presented and offered as a communication forum and tool within the lunar base community and raised interest of participants (and hopefully future subscribers).

The program is still online at http://www.lunar-base.net/. Presentations are available for download at an FTP server at the Univ. Kaiserslautern - information are provided by the organizers.

Retrospective - Lunar Science Forum 2009, 21-23 July 2009, NASA Ames Research Center, USA

The second Lunar Science Forum hosted and organized by NASA Lunar Science Institute took place at NASA Ames Research Center during the celebrations of the 40th anniversary of the first human lunar landing. More than 600 participants followed the talks, presentations, panels and group meetings over three days.

The first day started with introductions on NASA plans and focused mainly on current ongoing missions: Lunar Reconnaissance Orbiter (LRO), LCROSS, Kaguya and Chandrayaan-1. Presentations were given by various LRO payload scientists showing impressive first results and representatives of JAXA and ISRO followed by talks on future topics like commercial activities and the Google Lunar X PRIZE.

After an introduction on scientific topics the second day was mainly covered by parallel sessions themed "On the Moon", "Of the Moon: Geosciences", "Of the Moon: Missions", "From the Moon" and "Non-Human Biology". The large number of very interesting presentations provided a good insight in ongoing and planned future research and offered an excellent overview of current knowledge in lunar science. The second day concluded with a very special event to celebrate the 40th anniversary of the Apollo 11 landing on the Moon: a panel with well-known and recognized Apollo scientists - P. Dyal, G. Lofgren, B. O'Brien, L. Silver and D. Wilhelms - moderated by author and historian A. Chaikin. This was a unique opportunity to see these researchers at such an event for the first time since Apollo sharing their experience and their views of future lunar exploration.

The third day saw presentations about Chang'e-1 results and planned Chang'e-2 as well as on the future missions International Lunar Network, LADEE and GRAIL followed by talks and discussions on the decadal survey and potential input from the lunar science community. The day was concluded by breakout sessions discussing topics like impact and bombardment history, astrobiology, dust and plasma and more.

Many scientific communities took advantage of this well organized and hosted event to discuss and possibly prepare input for the Augustine commission and the decadal survey. Abstracts as well as presentations of many talks are available online at http://lunarscience2009.arc.nasa.gov/ under Agenda/Presentations.

GLOBAL LUNAR CONFERENCE [PEKING 31 MAY-3 JUNE 2010]

Our desire to return to the Moon is irrefutable proof of the human need to constantly explore new and distant horizons. Such plans are an important element in encouraging nations to work together in the interests of peaceful cooperation in outer space.

Lunar missions will lead us to new understanding of the origin and the development of our Solar System. They will open new avenues towards a utilization of lunar resources that could be used in both the exploration of outer space and here on planet Earth.

In organizing this conference, the IAF promotes international cooperation, scientific investigation, technological development and helps to solve legal issues which will stimulate the peaceful use of the Moon.

Prof. Dr Berndt Feuerbacher□President□International Astronautical Federation

On behalf of the Chinese Society of Astronautics (CSA), I would like to extend a warm welcome to you to attend the Global Lunar Conference (GLUC) which is being co-organised by IAF and CSA in May 2010, in Beijing, China.

Since the beginning of the 21st century, many countries have made great advances in space exploration and applications. In September 2008, China’s manned Shenzhou-7 mission made an important contribution to space science and technology.

This century, lunar exploration will become more and more important to humankind. As the president of CSA, I feel greatly honoured to invite international experts to participate in the GLUC next year in Beijing, jointly sponsored with the IAF. We will spare no effort in providing excellent services and making this event successful.

I am sure the GLUC held during the late spring, with Beijing at its most picturesque, will stay in your memories for a long time.

Welcome to Beijing!

Prof. Ma Xingrui□President□Chinese Society of Astronautics

Opening of the call:
1 August 2009□Deadline for abstract submission: 15 December 2009
Registration process:□Registration will open on 25 January 2010□Registration fees will be soon available on this website
For questions related to the technical programme please contact the IAF secretariat:□Secretariat.iaf@iafastro.org□+33 1 45 67 42 60

ROBOTIC LUNAR EXPLORATION

Chandrayaan-1 lost

[Excerpt from WIKIPEDIA]

Chandrayaan-1 was India's first unmanned Lunar probe. It was launched by the Indian Space Research Organisation in October 2008, and operated until August 2009. The unmanned lunar exploration mission included a lunar orbiter and an impactor. India launched the spacecraft by a modified version of the PSLV, PSLV C11 on 22 October 2008 from Satish Dhawan Space Centre, Sriharikota, Nellore District, Andhra Pradesh, about 80 km north of Chennai, at 06:22 IST (00:52 UTC). The mission was a major boost to India's space program,[*citation needed*] as India competes with Asian nations China and Japan in exploring the Moon. The vehicle was successfully inserted into lunar orbit on 8 November 2008.

On 14 November 2008, the Moon Impact Probe separated from the Moon-orbiting Chandrayaan at 20:06 and impacted the lunar south pole in a controlled manner, making India the fourth country to place its flag on the Moon. The MIP impacted near the crater Shackleton, at the lunar south pole, at 20:31 on 14 November 2008 releasing subsurface debris that could be analysed for presence of water ice.

The estimated cost for the project was Rs. 386 crore (US$ 80 million).

The remote sensing lunar satellite had a mass of 1,380 kilograms (3,042 lb) at launch and 675 kilograms (1,488 lb) in lunar orbit. It carried high resolution remote sensing equipment for visible, near infrared, and soft and hard X-ray frequencies. Over a two-year period, it was intended to survey the lunar surface to produce a complete map of its chemical characteristics and 3-dimensional topography. The polar regions are of special interest, as they might contain ice. The lunar mission carries five ISRO payloads and six payloads from other space agencies including NASA, ESA, and the Bulgarian Aerospace Agency, which were carried free of cost.

Chandrayaan-1 suffered from a star sensor failure and overheating. At 20:00 UTC on 28 August 2009 (29 August 2009, 1:30 AM IST), Chandrayaan stopped sending all its signals. The ground control had lost total contact with the spacecraft and the mission was declared over. Chandrayaan operated for 312 days in lunar orbit, less than half as long as the intended two-year mission.

RELEASE : 09-215

NASA Lunar Satellite Begins Detailed Mapping of Moon's South Pole

GREENBELT, Md. -- NASA reported Thursday that its Lunar Reconnaissance Orbiter, or LRO, has successfully completed its testing and calibration phase and entered its mapping orbit of the moon. The spacecraft already has made significant progress toward creating the most detailed atlas of the moon's south pole to date. Scientists released preliminary images and data from LRO's seven instruments.

"The LRO mission already has begun to give us new data that will lead to a vastly improved atlas of the lunar south pole and advance our capability for human exploration and scientific benefit," said Richard Vondrak, LRO project scientist at NASA's Goddard Space Flight Center in Greenbelt, Md.

LRO is scheduled for a one-year exploration mission in a polar orbit of about 31 miles above the lunar surface, the closest any spacecraft has orbited the moon. During the next year, LRO will produce a complete map of the lunar surface in unprecedented detail, search for resources and safe landing sites for human explorers, and measure lunar temperatures and radiation levels.

"The LRO instruments, spacecraft, and ground systems continue to operate essentially flawlessly," said Craig Tooley, LRO project manager at Goddard "The team completed the planned commissioning and calibration activities on time and also got a significant head start collecting data even before we moved to the mission's mapping orbit."

The south pole of the moon is of great interest to explorers because potential resources such as water ice or hydrogen may exist there. Permanently shadowed polar craters that are bitterly cold at their bottoms may hold deposits of water ice or hydrogen from comet impacts or the solar wind. The deposits may have accumulated in these "cold-trap" regions over billions of years. If enough of these resources exist to make mining practical, future long-term human missions to the moon potentially could save the considerable expense of hauling water from Earth.

First results from LRO's Lunar Exploration Neutron Detector, or LEND, indicate that permanently shadowed and nearby regions may harbor water and hydrogen. Additional observations will be needed to confirm this. LEND relies on a decrease in neutron radiation from the lunar surface to indicate the presence of water or hydrogen.

"If these deposits are present, an analysis of them will help us understand the interaction of the moon with the rest of the solar system," Vondrak said.

Data from LRO's Lunar Orbiter Laser Altimeter, or LOLA, however, indicates that exploring these areas will be challenging because the terrain is very rough. The roughness is probably a result of the lack of atmosphere and absence of erosion from wind or water, according to David Smith, LOLA principal investigator at Goddard.

LRO's other instruments also are providing data to help map the moon's terrain and resources. According to the first measurements from the Diviner instrument, large areas in the permanently shadowed craters are about minus 400 degrees Fahrenheit (33 Kelvin), more than cold enough to store water ice or hydrogen for billions of years.

The Lunar Reconnaissance Orbiter Camera is providing high-resolution images of permanently shadowed regions while lighting conditions change as the moon's south pole enters lunar summer.

LRO's Lyman Alpha Mapping Project, or LAMP, also is preparing to search for surface ice and frost in the polar regions. The instrument provides images of permanently shadowed regions illuminated only by starlight and the glow of interplanetary hydrogen emission. LAMP has provided information to confirm the instrument is working well on both the lunar night and day sides.

The Mini RF Technology Demonstration on LRO has confirmed communications capability and produced detailed radar images of potential targets for LRO's companion mission, the Lunar Crater Observation and Sensing Satellite, which will impact the moon's south pole on Oct. 9.

Meanwhile, LRO's Cosmic Ray Telescope for the Effects of Radiation instrument is exploring the lunar radiation environment and its potential effects on humans during record high, "worst-case" cosmic ray intensities accompanying the extreme solar minimum conditions of this solar cycle.

Goddard built and manages LRO, a NASA mission with international participation from the Institute for Space Research in Moscow. Russia provides the neutron detector aboard the spacecraft.

For more information about LRO and to view the new images, visit:

http://www.nasa.gov/lro

MEDIA ADVISORY : 09-131AR

NASA Spacecraft Impacts Lunar Crater in Search for Water Ice

MOFFETT FIELD, Calif. -- NASA's Lunar Crater Observation and Sensing Satellite, or LCROSS, created twin impacts on the moon's surface early Friday, October 9/2009, in a search for water ice. Scientists will analyze data from the spacecraft's instruments to assess whether water ice is present.

The satellite traveled 5.6 million miles during an historic 113-day mission that ended in the Cabeus crater, a permanently shadowed region near the moon's south pole. The spacecraft was launched June 18 as a companion mission to the Lunar Reconnaissance Orbiter from NASA's Kennedy Space Center in Florida.

"The LCROSS science instruments worked exceedingly well and returned a wealth of data that will greatly improve our understanding of our closest celestial neighbor," said Anthony Colaprete, LCROSS principal investigator and project scientist at NASA's Ames Research Center in Moffett Field, Calif. "The team is excited to dive into data."

In preparation for impact, LCROSS and its spent Centaur upper stage rocket separated about 54,000 miles above the surface of the moon on Thursday at approximately 6:50 p.m. PDT.

Moving at a speed of more than 1.5 miles per second, the Centaur hit the lunar surface shortly after 4:31 a.m. Oct. 9, creating an impact that instruments aboard LCROSS observed for approximately four minutes. LCROSS then impacted the surface at approximately 4:36 a.m.

"This is a great day for science and exploration," said Doug Cooke, associate administrator for the Exploration Systems Mission Directorate at NASA Headquarters in Washington. "The LCROSS data should prove to be an impressive addition to the tremendous leaps in knowledge about the moon that have been achieved in recent weeks. I want to congratulate the LCROSS team for their tremendous achievement in development of this low cost spacecraft and for their perseverance through a number of difficult technical and operational challenges."

Other observatories reported capturing both impacts. The data will be shared with the LCROSS science team for analysis. The LCROSS team expects it to take several weeks of analysis before it can make a definitive assessment of the presence or absence of water ice.

"I am very proud of the success of this LCROSS mission team," said Daniel Andrews, LCROSS project manager at Ames. "Whenever this team would hit a roadblock, it conceived a clever work-around allowing us to push forward with a successful mission."

The images and video collected by the amateur astronomer community and the public also will be used to enhance our knowledge about the moon.

"One of the early goals of the mission was to get as many people to look at the LCROSS impacts in as many ways possible, and we succeeded," said Jennifer Heldmann, Ames' coordinator of the LCROSS observation campaign. "The amount of corroborated information that can be pulled out of this one event is fascinating."

"It has been an incredible journey since LCROSS was selected in April 2006," said Andrews. "The LCROSS Project faced a very ambitious schedule and an uncommonly small budget for a mission of this size. LCROSS could be a model for how small robotic missions are executed. This is truly big science on a small budget."

For more information about the LCROSS mission, including images and video, visit:

http://www.nasa.gov/lcross

HUMAN LUNAR EXPLORATION

Summary of the

SUMMARY REPORT of the
Review of U.S. Human Space Flight Plans Committee 9-09

http://www.nasa.gov/pdf/384767main_SUMMARY%20REPORT%20-%20FINAL.pdf

Key Questions to Guide the Plan for Human Spaceflight

The Committee identified the following questions that, if answered, would form the basis of a plan for U.S. human spaceflight:

1. What should be the future of the Space Shuttle?
2. What should be the future of the International Space Station (ISS)?
3. On what should the next heavy-lift launch vehicle be based?
4. How should crews be carried to low-Earth orbit?
5. What is the most practicable strategy for exploration *beyond* low-Earth orbit?

The Committee considers the framing and answering of these questions individually, and in a consistent way, to be at least as important as their combinations in the integrated options for a human spaceflight program.

The Committee's task was to review the U.S. plans for human spaceflight. In doing so, it assessed the programs within the current human spaceflight portfolio; considered capabilities and technologies a future program might require; and considered the roles of commercial industry and our international partners in this enterprise. From these deliberations, the Committee developed five integrated alternatives for the U.S. human spaceflight program. The considerations and the five alternatives are summarized in the pages that follow.

SUMMARY OF KEY FINDINGS

The Committee summarizes its key findings below. Additional findings are included in the body of the report.

The right mission and the right size: NASA's budget should match its mission and goals. Further, NASA should be given the ability to shape its organization and infrastructure accordingly, while maintaining facilities deemed to be of national importance.
International partnerships: The U.S. can lead a bold new international effort in the human exploration of space. If international partners are actively engaged, including on the "critical path" to success, there could be substantial benefits to foreign relations, and more resources overall could become available.
Short-term Space Shuttle planning: The current Shuttle manifest should be flown in a safe and prudent manner. The current manifest will likely extend to the second quarter of FY 2011. It is important to budget for this likelihood.
The human-spaceflight gap: Under current conditions, the gap in U.S. ability to launch astronauts into space will stretch to at least seven years. The Committee did not identify any credible approach employing new capabilities that could shorten the gap to less than six years. The only way to significantly close the gap is to extend the life of the Shuttle Program.
Extending the International Space Station: The return on investment to both the United States

and our international partners would be significantly enhanced by an extension of ISS life. *Not* to extend its operation would significantly impair U.S. ability to develop and lead future international spaceflight partnerships.

Heavy-lift: A heavy-lift launch capability to low-Earth orbit, combined with the ability to inject heavy payloads away from the Earth, is beneficial to exploration, and it also will be useful to the national security space and scientific communities. The Committee reviewed: the Ares family of launchers; more directly Shuttle-derived vehicles; and launchers derived from the EELV family. Each approach has advantages and disadvantages, trading capability, lifecycle costs, operational complexity and the "way of doing business" within the program and NASA.

Commercial crew launch to low-Earth orbit: Commercial services to deliver crew to low-Earth orbit are within reach. While this presents some risk, it could provide an earlier capability at lower initial and lifecycle costs than government could achieve. A new competition with adequate incentives should be open to all U.S. aerospace companies. This would allow NASA to focus on more challenging roles, including human exploration *beyond* low-Earth orbit, based on the continued development of the current or modified Orion spacecraft.

Technology development for exploration and commercial space: Investment in a well-designed and adequately funded space technology program is critical to enable progress in exploration. Exploration strategies can proceed more readily and economically if the requisite technology has been developed in advance. This investment will also benefit robotic exploration, the U.S. commercial space industry and other U.S. government users.

Pathways to Mars: Mars is the ultimate destination for human exploration; but it is not the best first destination. Both visiting the Moon First and following the Flexible Path are viable exploration strategies. The two are not necessarily mutually exclusive; before traveling to Mars, we might be well served to both extend our presence in free space and gain experience working on the lunar surface.

Options for the Human Spaceflight Program: The Committee developed five alternatives for the Human Spaceflight Program. It found:

- Human exploration beyond low-Earth orbit is not viable under the FY 2010 budget guideline.
- Meaningful human exploration is possible under a less constrained budget, ramping to approximately $3 billion per year above the FY 2010 guidance in total resources.
- Funding at the increased level would allow either an exploration program to explore Moon First or one that follows a Flexible Path of exploration. Either could produce results in a reasonable timeframe.

ORGANIZATIONAL AND PROGRAMMATIC ISSUES

How might NASA organize to explore? The NASA Administrator needs to be given the authority to manage NASA's resources, including its workforce and facilities. Even the best managed human spaceflight programs will encounter developmental problems. Such activities must be adequately funded, including reserves to account for the unforeseen and unforeseeable. Good management is especially difficult when funds cannot be moved from one human spaceflight budget line to another — and where new funds can ordinarily be obtained only after a two-year delay (if at all). NASA should be given the maximum flexibility possible under the law to establish and manage its systems.

Finally, significant space achievements require continuity of support over many years. One way to ensure that no successes are achieved is to continually pull up the flowers to see if the roots are healthy. (This Committee might be accused of being part of this pattern!) NASA and its human spaceflight program are in need of stability in both resources and direction.

Mike Griffin Responds in Congressional Testimony

Date Released: Tuesday, September 15, 2009

http://www.spaceref.com/news/viewsr.rss.html?pid=32378

We only quote his key points:

“The Commission notes that "Given the funding originally expected, the Constellation Program was a reasonable architecture for human exploration." In an earlier public statement, Commissioner Sally Ride noted that, "the program comes pretty close to performing as NASA advertised it would. ... NASA's planning and development phase of Constellation was actually pretty good." A veteran of the investigations of both the Challenger and Columbia accidents, Sally has seen her share of troubled programs, and so this comment was one I found telling. Thus, one wonders why the Commission failed to recommend as its favored option the simplest one possible -- providing the funding necessary to do the job. Of all the options considered, this is the most straightforward. Yet it was not recommended. Other options are possible, of course, and the Commission would have been remiss not to explore them as well. But not to include this one is, in my view, simply wrong.”

* * *

“Finally, there are a number of concerns as to the methodology by which the Commission reached some of its conclusions. When trying to assess the relative merits of multiple options for an engineering design - in this case the design of spaceflight architectures - the core requirement to allow meaningful comparisons is to fix the goals and constraints so that these "boundary conditions" are common for all. In the Commission's report, various options are presented which are not linked by common goals and constraints. Instead, differing options with different constraints are presented to reach disparate goals, rendering it impossible to develop meaningful cost/schedule/performance/risk comparisons across them. These options possess vastly differing levels of maturity, yet are offered as if all were on an equal footing in regard to their level of technical, cost, schedule, and risk assessment.”

* * *

Finally, the Commission did not do that which would have been most valuable - rendering a clear-eyed, independent assessment of the progress and status of Constellation with respect to its ability to meet the goals which have been established in two successive NASA Authorization Acts, followed by an assessment of what would be required to get and keep that program on track. Instead, the Commission sought to formulate new options for new programs, treating these options as if their level of maturity was comparable to that of the baseline upon which NASA has been working now for more than four years. This ignores the established body of law which has guided NASA's work for the last four years and which, until and unless that body of law is changed, must serve as the common standard for any proposed alternative to Constellation as the "program of record" for the nation's existing human spaceflight program. The Congress extended and improved upon the original "Vision" in passing that Act, and did so again in 2008. On both occasions Congressional support for NASA's direction was heavily bipartisan. Thus, when President OBAMA took office in January 2009, he inherited a civil space policy which had, in its essentials, survived six years of vigorous scrutiny, a space agency which had transformed itself to execute that policy, and could do so in a reasonable (if not very aggressive) timeframe on a constant-dollar budget as stipulated in 2005. The Commission itself speaks of the need for stability in direction and funding, if NASA is to make reasonable progress and to be accountable for so doing. In my view, then, the most important question that Congress could ask of the new Administration and its Commission is this: exactly why does the policy which we have established in law - twice! - need to be changed?

* * *

“I would like to close with a quote from the Commission's Summary Report: "Finally, significant space achievements require continuity of support over many years. One way to ensure that no successes are achieved is to continually pull up the flowers to see if the roots are healthy. (This Committee might be accused of being part of this pattern!)" I couldn't agree more. As I see it, the Commission didn't find anything wrong with the current program, didn't find anything safer, more reliable, cheaper or faster. The roots are healthy. So, why throw away four years and $8 billion pulling up the flowers? Let's apply some plant nutrient and watch them grow. This, to me, is our best option for re-affirming a stable civil space policy. Thank you.”

SPACE TRANSPORTATION DEVELOPMENT

Ares I-X first flight test of the Constellation program

The first flight test within the Constellation program is planned for end of October 2009 with a lift-off from famous launch complex 39B. The Ares I-X consists of a Space Shuttle derived 4-segment solid rocket booster with a simulated 5th segment as a first stage and with a simulated upper stage a simulated Orion spacecraft and a simulated launch abort system on top. The test should gain data from the first approx. two minutes up to around 40 km altitude simulating the future Ares I flight - the first stage will be recovered while the upper stage and spacecraft mock-ups will fall into the Atlantic ocean after separation.

In addition to test the flight control system and the parachute recovery system, gaining data on the flight environment the test should also provide experience in ground and flight operations as well as integration procedures. A second test flight Ares I-Y is planned for 2014 testing the five segment first stage and the cryogenic upper stage before the full launch system including the Orion spacecraft will be tested during the Orion 1 mission.

SPACESHIPS – A NEW GENERATION OF SPACE VEHICLES

H.H.Koelle (July 2009)

The first fifty years of space flight have seen a great number of different type rockets transporting satellites and space probes exploring the earth environment and celestial bodies of our solar system. Many countries participated and developed expendable launch vehicles that were derived mostly from military long-range missiles. In this period of the space age this approach was the fastest and cheapest way to participate in this competition.

Three Nations (RUSSIA, USA and CHINA) have developed the capability of sending people into space primarily for political reasons. Vehicles used were mostly derivatives of military rockets. There was one exception: the SPACE SHUTTLE of the UNITED STATES. It was supposed to be the backbone of the US space program for universal use transporting cargo and people into near earth orbits. It had also a capability of launching satellites into a geostationary orbit or to other planets. Here and there an attempt was made to recover some elements of the launch vehicle. Two of five SHUTTLES were lost, and after thirty years of operation this vehicle is obsolete and on the way to be retired. Being honest looking back, this was not a very successful project, launch rates were much lower than planned, performance was marginal and launch cost much too high.

At the turn of the century, an excess of launch vehicles in a declining market characterized the situation. The result was an operation at a fairly low level of annual launches, supported by an oversized and costly ground infrastructure. Specific transportation cost for cargo and people leveled off. This trend led to a stagnation of the market. It was a typical “Hen & Egg” dilemma!

In January of 2004 the President of the United States of America announced a new space policy. He initiated a new phase of space development with the objective of demonstrating the feasibility of permanent human presence in space beyond low earth orbit. The Moon and Mars were named as points of destination. Congress approved the goals of replacing the aging SPACE SHUTTLE as soon as possible, and a “return to the Moon by a human crew ” by the year 2020 as the first step of this program. This policy was selected observing the SPACE ACT goals of 1958!

Following this directive, in 2005 the NASA developed a concept for returning to the Moon on the basis of available technologies and hardware components, attempting to keep expenditures at a low level. The development of the ORION crew exploration vehicle to be transported into earth orbit by an ARES I launch vehicle was initiated. This combination was primarily conceived as a substitute for the SPACE SHUTTLE to be retired by 2010.

A new larger launch vehicle named ARES V, in connection with a lunar landing spacecraft ALTAIR, was planned to be developed beginning in 2011 to establish a capability of transporting astronauts and cargo to the lunar surface. The performance of this space transportation system (ARES I / V, ORION, ALTAIR) was limited to a maximum of 4 astronauts or 15 metric tons of cargo to the Moon. Stay times on the Moon were to begin with a week to grow to six months in due course with the intent of establishing a temporary human outpost in about five years. The expected cost of this sub-program was estimated to be in the order of about $ 106 billion through the year 2018.

Recently, the new US Administration has ordered a review of the status of this new program to be completed in fall of 2009. For several months it is uncertain if and how hat the preliminary program concept will be continued.

In fall of year 2009 we observe a development program, supported by the United States Congress that considers a return to the Moon by 2020. The cost per lunar mission is expected to be in the order of one billion $ per mission! Tentatively planned (but not yet authorized) are two to three excursions per year to the lunar surface with a crew of up to four with stay times of several weeks or possibly months. In this limited sub-program the logistic support is to be provided by **expendable** space vehicles that must be replaced after each mission! This is very expensive because it would lead to about specific costs of 1 billion $/lunar labor-year! This is too high and not sustainable over a longer period! We should not forget that one of the reasons the APOLLO program was discontinued after six successful missions in 1972 was a poor cost/benefit ratio!

This assessment indicates that the two envisioned space sub-programs identified

(1) a permanent lunar base of adequate size, and (2) interplanetary expeditions

require more efficient space transportation systems than presently authorized!

What must be done, what can be done?

Without a reduction of current transportation cost per person or per ton by one order of magnitude or more, space travel in the true sense will not be realized, and will remain a dream for a long time to come!

However, there is hope! The decision of the USA to enter a new phase in the development of space travel, with possible participation of other space faring nations, opens the door for an increase of the space market that would justify the development of a new generation of space vehicles! Concepts that did not look feasible or affordable in the past are back on the front burner! However, there is a limit with respect to available technologies! All past ideas on new propulsion systems other than the current engines using chemical propellants have not matured to a point that they promise more safety and economy! What we can do is to improve available engines with respect to reduced production cost and longer lifetime.

We can recognize at least are three ways to make a quantum jump in the development of future space transportation systems:

1. Apply the laws of scale, i.e. build bigger vehicles growing in size to “spaceships”.
2. Introduce reusability of space vehicle elements wherever possible and economical.
3. Make use of extraterrestrial propellant production for returning home.

Use of extraterrestrial production of propellants on the Moon and Mars or elsewhere would be extremely effective, but will take time! Such an activity requires equipment, energy and human labor that will not come for free. Ramping up production to the amount required by an adequately sized lunar base cannot be achieved without careful planning; particularly balancing cost and production rates.

Building bigger launch vehicles that have an initial mass that is twice of the famous SATURN V or the planned ARES V is possible and would be a big step on the road to achieve the goals. We have seen the growth of size in the past, building ships and airplanes, and can do it with the present state of technology. This experience must be utilized!

Re-using elements and sub-systems of the vehicles such as engines, heat shields and propellant tanks will require a special effort but can be realized. But as experience is gathered cost will come down and safety will be increased, as launch experience will accumulate with time. One can be optimistic or pessimistic as to how long and how much effort this learning process will take. But we can and should begin to enter this process soon and build on experiences resulting from other space vehicle programs in the USA and Russia.

How to get underway?

It cannot be expected that such a big step in developing space travel can be decided within a short time. It will take the courage of influential people such as the former President J.F.KENNEDY to initiate a quantum jump that would certainly be considered as too risky by some opponents. Thus, a modest beginning to make progress in the right direction would be a national or international competition for analyzing and designing a new class of space ships that would be capable of more effectively serving the potential space market at least through the middle of this century.

A set of ground rules, defining the scope of performance, and the program time frame required must be agreed upon to enable a fair comparison of the proposals resulting from an open competition.

All that is needed is a sponsor who is willing to spend about $ 10 million to move activities in this direction. The sponsor could be a national space agency, a foundation, a group of commercial entities or even a generous individual who has more money than he needs! It will than take about three years to come to a conclusion which concept is the best one “to deliver the goods”!

When done and the results of the competition are on the table, we should know the best road to take of realizing a balanced but courageous program to develop space travel in the next decades that will be commercially attractive and acceptable in the political circles of the space faring nations.

Space Program Objectives - Update of relative Importance as seen in 2009

Fifteen years ago we have made a major effort to compile the forces that support the objectives of extraterrestrial installations. An update was performed five years ago (see Annual Report of 2004) and by work papers this year as reported in LBQ 3_2009. The latest definitions in use are presented below.

We are now five years in a new phase of space development initiated by the EMMB vision of the United Sates in January 2004. A list of program objectives (such as this one) is needed for evaluation and comparison of potential benefits that can be expected of individual space programs, such as the "Earth, Moon, Mars and Beyond" visions of the United States. The latest check of the completeness of this list of objectives has motivated us to add objective 48. Including the latest changes of the US Program and the increasing influence of other space faring nations it appears desirable to take an other round of deriving relative priorities (weights).

THUS YOU ARE INVITED to participate in this group judgment. There are several options:
You have the choice of filling out just one or all columns, using two different methods and/or two different viewpoints.
Method A. You may prefer to assign a I to IV to the four **prime-objectives** and a number between 0 and 10 in columns 1 and 3 (indicating relative importance) to the **sub-objectives**, or
Method B. You may prefer to **rank** the **sub-objectives** beginning with rank # 1 to the one you feel to be the most important of the 24 sub-objectives listed and continue working your way through to the last one with lowest importance.
You have also the choice of taking the viewpoint of the space faring nations or the non-space faring nations, or both!

If you want to be particularly careful, you may want to compare the results of the two methods applied and make some adjustments when discovering discrepancies greater than expected, or you compare the results of only one method but comparing either the space-faring or the non-space faring nations and do the same!

We realize that the relative importance of the objectives will change with time due to geo-political developments and state-of-the-art. That is the reason why we need valuations as this one from time to time. To simplify the process we ask for your appraisal of the **average relative importance in the first 50 years of this century!**

Legend:

Column 1: Relative importance from viewpoint of space faring nations

using scale 0 (negligible) to 10 (extremely important)

Column 2: Relative importance using rank from viewpoint of space faring nations

Column 3: Relative importance from viewpoint of non- space faring nations

using scale 0 (negligible) to 10 (extremely important)

Column 4: Relative importance using rank from viewpoint of non- space faring nations

Evaluation Sheet

		1	2	3	4
1	**HUMANISTIC OBJECTIVES**		-		-
11	Enhance the evolution of the human culture beyond Earth				
12	Establish the first extraterrestrial human settlement as an initial step for expanding human activities in our solar system and learn to live in isolated, extreme environments				
13	Enhance the educational system and motivation to life-long learning				
14	Provide a survival shelter for artifacts, documents and some elements of the human race in case of a global catastrophe				
15	Assist in reducing tensions and conflicts, thus contributing to peace on Earth				
16	Provide opportunity for involvement of a broad spectrum of people in exciting frontier activities				
2	**POLITICAL OBJECTIVES**				
21	Demonstrate the potential growth existing beyond the limits of Earth				
22	Provide more opportunities for international cooperation among nations				
23	Extend the infrastructure and experience for commercial global enterprises				
24	Provide a peaceful outlet for national, competitive high technology urges and a useful employment of existing industrial-military capabilities				
25	Enhance the national pride and prestige of participating nations				
3	**SCIENTIFIC OBJECTIVES**				
31	Improve understanding and control of our own planet				
32	Improve knowledge of the Moon and its resources				
33	Improve understanding of the solar system beyond the Earth-Moon double planet				
34	Improve understanding of the universe beyond our own solar system				
35	Provide a science laboratory in a unique environment for experiments in physics, chemistry, biology, geology, physiology and sociology which can not be conducted on Earth				
4	**UTILITARIAN OBJECTIVES**				
41	Provide rewarding job opportunities and thus stimulate the economy on Earth				
42	Stimulate the development of advanced technology on Earth				
43	Produce marketable products in extraterrestrial facilities for extraterrestrial and/or for terrestrial use				
44	Contribute to the supply of space based energy to the Earth				
45	Provide an isolated extraterrestrial depository to store high level wastes in case of need				
46	Enhance the development of safe and economical space transportation systems providing access to other celestial bodies and space resources				
47	Provide thrust and focus for continued development of space technology other than in the area of space transportation systems				
48	Contribute to the protection of our home planet against extraterrestrial threats				
	Percent	100		100	

CONTRIBUTOR:

COMMENTS:

Assessment of PROS & CONS of Reusable Launch Vehicles

The space policy of the United States of 2004 has accepted the vision of developing space travel Enabling our species to expand into space "Earth, Moon, Mars and Beyond". The initial step of returning to the Moon has been initiated by the BUSH Administration.

This vision can be realized only if space transportation systems are developed that can offer adequate logistic support. These are not yet in sight. The ARES/ORION vehicle concept authorized, even if successfully developed, will not be compatible with the demands of a permanent lunar base and/or multiple interplanetary human expeditions. It is more and more recognized that only reusable space transportation systems will be able to deliver the performance, potential and economy to realize this vision of future public and commercial space travel.

However, the present political situation on our home planet require huge military expenditures to fight terrorism. This will last several more years and discourage extending efforts in space travel development. Consequently, the order is " go at the speed as limited resources permit"!
This was the reason restricting the development of space transportation systems to expendable vehicles using available hardware as much as possible. This cannot go on for long if the 2004 vision was a plan to be taken seriously.

In this situation it might be helpful to assess the PROS& CONS of reusable space transportation systems to find out what hurdles will have to be overcome to make the next big steps in developing space transportation systems:
- Building launch vehicles with higher payload mass and volume
- Increase the share of reusable hardware elements
- Make use of extraterrestrial propellant production as soon as possible and economical.

This is the reasoning of attempting to compile the pros & cons of the potential of further development steps and establish priorities for implementation. A preliminary road map might be the end-product of this effort.

Three steps are envisioned:
1. Define the pros & cons in detail. Attempt a first ranking based on relative importance.
2. After correction and complementation of definitions a refined ranking (using a scale of 0 to 10) will be performed.
3. Draft alternative road maps for developing next generation space transportation systems.

YOU are invited to participate in the first step of this effort by returning the next table to us. Please, review tentative list below, improve definitions, complement list and assign a tentative rank of relative importance to each argument.

Comments on the execution of this experiment are invited!

PROS & CONS of developing reusable space transportation systems (WP 6-2009)

Arguments in support of development of reusable space transportation systems	rank	Arguments against development of reusable space transportation systems	rank
Experience with X-15, SST and aircraft		Lack of relevant experience	
Higher crew safety		More complex operation on the ground	
Higher mission reliability		Higher space infrastructure requirements	
Higher program resilience		Higher engineering development effort	
Reduced production capacities		Higher dry mass of vehicle hardware	
Faster reliability growth rate		Higher propellant requirements/unit payload	
Higher program potential		Uncertain number of subsystem uses (engines, heat shields, landing gear)	
Faster development of new technologies		Uncertain vehicle design life	
Greater challenge & appeal for participants		Uncertain spare demands over and above scheduled replacements	
Lower specific transportation cost		Higher GSE requirements at launch site	
High potential for commercial users		Longer development time to 1st launch	

CONTRIBUTOR:

COMMENTS: