

The Role of the Lunar Exploration Analysis Group (LEAG) in Enabling a Sustainable Exploration Effort to the Moon, Mars, and Beyond*

Clive R. Neal¹

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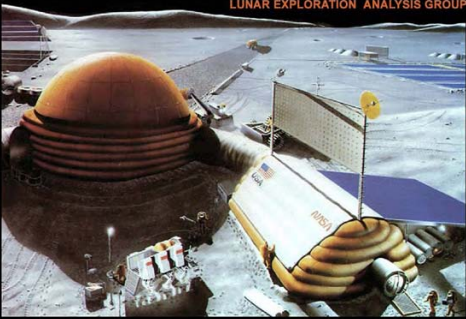
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Adapted from oral presentation at AAPG Annual Convention, San Antonio, Texas, April 20-23, 2008

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Abstract

The proposed return to the Moon in 2018 will occur approximately 45 years after the last human walked on the lunar surface during the Apollo program. Looking back, it is evident that the Apollo program (which visited different locations, took everything needed to survive on each mission, and was funded through a single government) was not sustainable. In this new era of lunar exploration, we must learn from history in order to establish a sustainable, long-term space exploration program. Emplacement of infrastructure (i.e., a lunar outpost) at one location sets the scene for initiating a long-term lunar exploration effort. Making this effort sustainable will require international cooperation, in situ resources utilization, and the involvement of the commercial sector, which in turn allows fascinating scientific investigations to be conducted. The Lunar Exploration Analysis Group (LEAG: <http://www.lpi.usra.edu/leag>) is at the center of integrating such efforts. The LEAG, established in 2004, is responsible for analyzing scientific, technical, commercial, and operational issues associated with lunar exploration in response to requests by NASA. It serves as a community-based, interdisciplinary forum for future exploration and provides analysis in support of lunar exploration objectives and their implications for lunar architecture planning and activity prioritization. The LEAG discharges its responsibilities through Specific Action Teams (SATs) and a focused annual meeting. For example, the 2007 meeting concentrated on avenues to involve the commercial sector, outpost site selection criteria, in situ resource utilization for outpost sustainment, sample return technologies, field exploration and astronaut training, robotic missions, and international partnerships. This meeting is also an avenue for NASA to brief the community on exploration developments.



The Lunar Exploration Analysis Group (LEAG)



<http://www.lpi.usra.edu/leag>

The Role of the Lunar Exploration Analysis Group (LEAG) in Enabling a Sustainable Exploration Effort to the Moon, Mars, and Beyond



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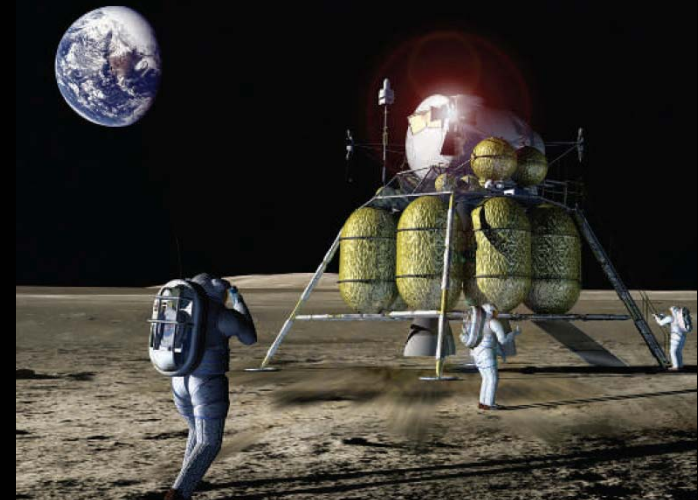


Footprints on the Moon in 2018-2020.

Learn from history - Apollo not sustainable.

Establishing a lunar base requires international collaboration, ISRU, and commercial sector involvement.

The Lunar Exploration Analysis Group is at the center of integrating such efforts. The LEAG serves as a community-based, interdisciplinary forum for future exploration.



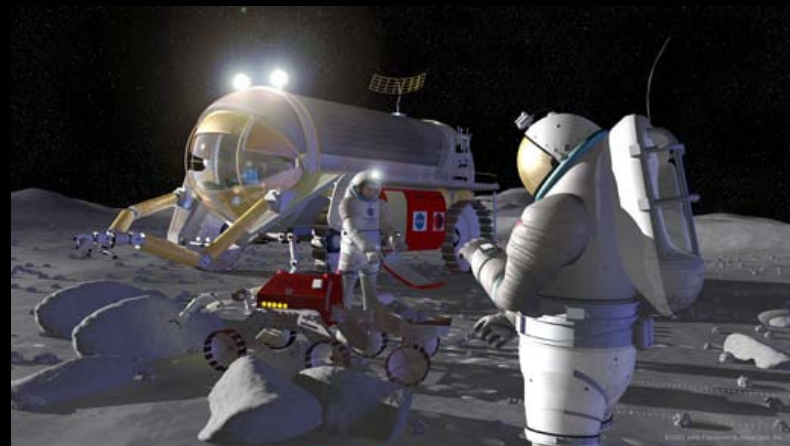
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Membership and participation in the LEAG:

lunar & planetary scientists; human systems specialists;
Engineers & Technologists; mission designers, managers;
and other participants in sustained lunar exploration drawn
from the broad community of:

Academia,
Industry,
Government,
Commercial sector.



M-1 MoonOne Lunar Lander

Payload Flight Opportunity – Request for Information



ODYSSEY
MOON

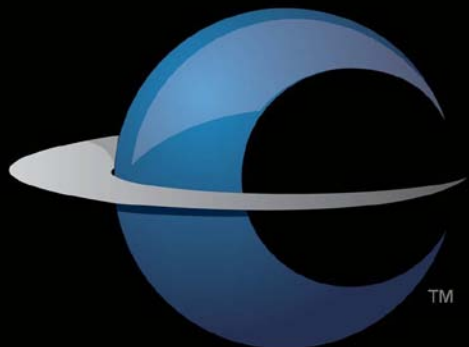
*A Commercial
Lunar Enterprise*

Specific Information Requested

1. Payload name and brief description;
2. PI name, contact information and resume detailing flight experience;
3. Other individuals and/or institutions associated with the payload;
4. General objective(s) of the payload (e.g., instrument type);
5. Engineering requirements (mass, volume, power, etc.).

M-1 MoonOne Lunar Lander

Payload Flight Opportunity – Request for Information



ODYSSEY
MOON

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Schedule:

- OML plans to release a detailed PFO by June 2008;
- Submissions of proposals by PIs due by September 2008;
- Payload selection in coordination with funding sponsor in early 2009;
- M-1 mission payload delivered for lander integration in mid-2010;
- Odyssey Moon M-1 mission targeted for launch by July 2011.

Full RFI available at:

<http://www.nd.edu/~cneal/Lunar-L>

LEAG Charter (TOR)

<http://www.lpi.usra.edu/leag/>

The Lunar Exploration Analysis Group (LEAG) is responsible for analyzing scientific, technical, commercial, and operational issues associated with lunar exploration in response to requests by NASA.

The LEAG serves as a community-based, interdisciplinary forum for future exploration and provides analysis in support of lunar exploration objectives and their implications for lunar architecture planning and activity prioritization.

It provides findings and analysis to NASA through the NASA Advisory Council (the Council) within which the LEAG Chair is a member of the Planetary Science Subcommittee (PSS).



LEAG Charter (TOR)

<http://www.lpi.usra.edu/leag/>

Executive Committee constituted to help with planning/execution of requests.

Ex-Comm: Chair; Vice-Chair; Previous Chair; ESMD Rep. (Executive Secretary); SMD Rep.; SOMD Rep.; Lunar Community Liaison (LPI Director of Appointee); Chair of ISRU sub-group; Chair of Commercialization sub-group.



LEAG Charter (TOR)

<http://www.lpi.usra.edu/leag/>

Tasking for LEAG activities may be initiated through the Council Chair from ESMD, SMD, SOMD, the Committees and Subcommittees of the Council, or the LEAG Chair.

The LEAG discharges its responsibilities through Specific Action Teams (SATs) and a focused annual meeting.



LEAG 2007 Annual Meeting

October 1-5, 2007

Houston Hobby Hilton Hotel

Theme:

“Enabling Exploration: The Lunar Outpost and Beyond.”

Meeting Goal: “Define pathways to offset cost and risk of achieving the next era of space exploration.”

Overarching question to be addressed by all sessions:

How can risk/cost be reduced through cooperation and partnerships in technological developments and demonstrations?

Meeting report available at:

<http://www.lpi.usra.edu/leag/meetings.html>



LEAG 2008 Annual Meeting

October 28-31, 2008

(coincide with LRO launch).

Joint with ILEWG and SRR.

Radisson Resort at the Port, in Cape Canaveral, Florida.

Theme: “Sustainable Moon”

Plenary and concurrent sessions - focused on questions pertinent to achieving the “vision” - similar to the last LEAG meeting.

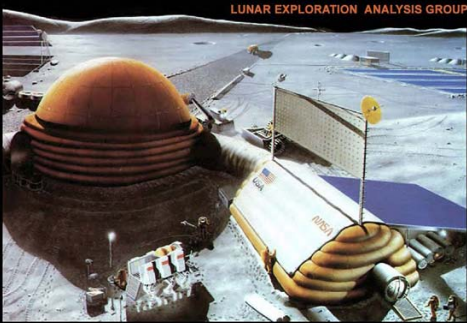
1st announcement is available at:

<http://www.lpi.usra.edu/meetings/leagilewg2008>



Lunar Exploration Roadmap

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LEAG

The Lunar Exploration Roadmap



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008

A Community Effort Coordinated by the
Lunar Exploration Analysis Group
(LEAG)



Lunar Exploration Roadmap

The Charge from the NAC

The Science Committee recommends that the Lunar Exploration Analysis Group (LEAG) be tasked to prepare a “Lunar Goals Roadmap” that maps science goals to objectives, and to observations and measurements. This roadmap should include an assessment of needed technology developments, areas of potential coordinated activities for commercial and international participation, and potential feed-forward activities for the exploration of Mars and beyond.



Lunar Exploration Roadmap



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008



A Community Effort Coordinated by the Lunar Exploration Analysis Group

Themes: Why are we going to the Moon?

Theme 1: Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them.

Theme 2: Use the Moon to prepare for future missions to Mars and other destinations.

Theme 3: Extend sustained human presence to the Moon to enable eventual settlement.



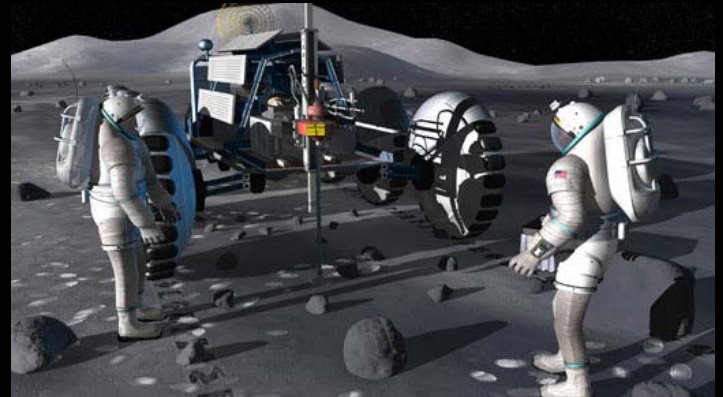
Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008

A Community Effort Coordinated by the Lunar Exploration Analysis Group



Crosscutting Themes:

- Learn to live and work successfully on another world.
- Expand Earth's economic sphere to encompass the Moon, and pursue lunar activities with direct benefits to life on Earth.
- Strengthen existing and create new global partnerships.
- Engage, inspire, and educate the public.



Lunar Exploration Roadmap



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008



Theme 1: Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them.

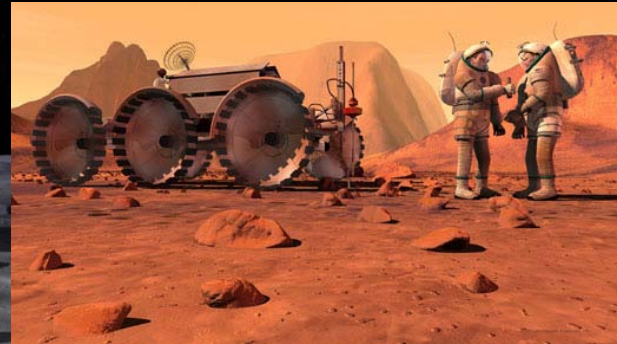
- a. Understand the formation, evolution and current state of the Moon.
- b. Use the Moon as a “witness plate” for solar system evolution.
- c. Use the Moon as a platform for astrophysical, heliophysical, and earth-observing studies.
- d. Use the unique lunar environment as a research tool.



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008

Theme 2: Use the Moon to prepare for future missions to Mars and other destinations.

- a. Identify and test technologies on the Moon to enable robotic and human solar system science and exploration.
- b. Use the Moon as a test-bed for systems, flight operations, and exploration techniques to reduce the risks and increase the productivity of future missions to Mars and beyond.



Lunar Exploration Roadmap

Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008

Theme 3: Extend sustained human presence to the Moon to enable eventual settlement.

- Identify, develop, and mature technologies and deploy initial infrastructure capabilities.
- Reduce the cost of re-supply and dependency on Earth.
- Keep humans healthy and safe off-planet.
- Facilitate development of self-sustaining economic activity.



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008



Themes and Goals on the web for public comment - 2-week window (e-mail notification).

URL: https://www.lpi.usra.edu/survey/LEAG_ThemesGoals/

Username: [leag](#)

Password: [moonorbust](#)



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008



Three SATs are being formed - reports by end of June. Public comment on the reports via the web.

Special session at the Lunar Science Conference at Ames in July 20-23 for further community input.

Unveil the Roadmap at the LEAG meeting, October 28-31.

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Lunar Exploration Roadmap



Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008

IMPORTANT: NASA needs a transition strategy from the Moon that allows it to get to Mars and beyond, but doesn't abandon the infrastructure it has built up, which can still be used for science purposes.

Commercial on-ramps are vital - these center around ISRU capabilities, which are also important for the "feed-forward" focus on Mars.