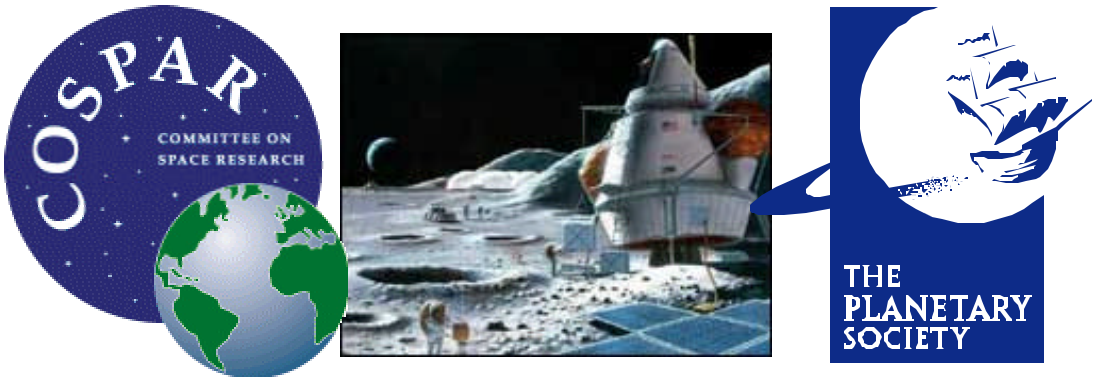

The International Lunar Decade: A Vision for Human Space Flight

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Introduction

The Moon is the first stop for any nation's enterprise in human space flight. Were we truly a global society then the whole world could be satisfied that we have "been there – done that," and found it a place only of "magnificent desolation."[1] But for any nation that does not yet have the means (including the U.S.), it is a necessary first step for travel beyond the Earth's gravity well. Europe is completing a lunar mission this year, Japan and China are planning launches to the Moon next year, India and the U.S. the year after. Human space exploration is being revitalized by American and European visions, Russians renewed support, and China's new capabilities. The moon is the next destination beyond Earth orbit.

The Political Value of Human Space Flight

While human space flight may be seen as a noble expansion of the human vision and part of our destiny as a species, the decisions to implement it are national political decisions with many constraints. Its cost and risk are high and only justified if the political value is also high.

In the United States the political value of human space flight has been low since Apollo and the program has therefore foundered.

In Russia the political value of human space flight has also been low since Mir and the program has become a service organization for other countries' national objectives.

In Europe and Japan the political value of human space flight has always been low and both are ambivalent about their ambitions, willing to be participants but not leaders in the venture – serving more limited domestic objectives and not broad political ones.

In China, conversely, since Shenzhou, the political value in China of human space flight has been high, establishing China as a modern technological power and a good bet for future leadership in Asia, if not the whole world. This value is the same that was sought and achieved by the U.S. with Apollo, and with Russia by Mir.

To implement a global vision for human space exploration one must integrate national political values into the enterprise. The establishment of permanent human presence in the Solar System is a global venture, not a national political objective for any single country.

While the U.S. *could* go to the Moon and Mars directly and alone, there is little political incentive to do so – especially as scientists and the public alike are thrilled with the ever-increasing robotic exploration that precedes humans. The political incentive lies in the global venture, and that will take global participation.

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[1] The phrase coined on the first human landing by Buzz Aldrin, now used as a title for a popular IMAX documentary.

Status of Lunar Mission Plans

The European Space Agency has a mission at the Moon right now. The SMART-1 was developed as a technology test flight for solar electric propulsion. After a successful 14-month flight, the spacecraft is now in lunar orbit imaging the surface making other scientific measurements. It is being directed for impact on the Moon on Sept 3 of this year. No follow-on mission is now planned, although lunar missions in the Aurora program (the European Space Agency's long-range plan for robotic and human exploration of the solar system) are being considered in support of its goal of sending humans to Mars. The Aurora "roadmap" places a human mission to the Moon by or involving ESA around the year 2024. Such missions are seen within the Aurora program explicitly as stepping-stones on the path to Mars.[2]

China, India, and Japan are all now developing lunar missions. China has described a 3-step lunar program, *Chang'E*, with the first step coming in 2007. *Chang'E-1* is a polar orbiter. C*hang'E-2* is a lander, probably including some type of rover. *Chang'E-3* is an automated lunar sample return (something hitherto only done by the Soviet Union). These three steps are being planned at approximate 5-year intervals. Lunar bases, and humans to the Moon are sometimes depicted in long-range planning documents, but no specific plans have been described.

Japan is scheduled to launch *Selene,* their large lunar polar orbiter, also in 2007. *Selene* includes two sub-satellites in addition to the main orbiter spacecraft. One is a backside relay orbiter, and the other is an interferometry satellite for lunar gravity measurements. A *Selene-2* has been vaguely discussed as a lunar lander in about the 2015 time frame. The long-term plan of the Japanese space agency specifically describes a lunar base goal for the 2020s decade. In a 2002 version of that plan it was described specifically as a robotic base, but recent presentations by the Japanese space agency have shown consideration of human exploration in that same time frame.

India has also said it will follow up its planned *Chandrayaan-1* polar orbiter mission, to be launched in 2008, with a lander mission, *Chandrayaan-2*. Like the Chinese, they say they are planning the lander mission some 4-5 years after the orbiter. *Chandrayaan-1* also includes an impactor.

Recently Italy has said it will conduct a series of "National Autonomous Projects" for lunar exploration. This program includes an orbiter, with a launch in 2010-11, and eventually a rover.

And the U.S. is planning lunar robotic missions as precursors to its human flight as part of its national *Vision for Space Exploration.*[3] Work has begun on the *Lunar Reconnaissance Orbite*r with a launch goal of October 2008. The LRO mission will include a lunar impactor. NASA recently revamped its plans for a lunar lander, with several options being considered for surface missions in after 2010. A human return to the moon before 2020 was stated as the Vision objective.[4]

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[2] It is noteworthy that Russia and Europe, the next two largest space powers after the U.S., do not have lunar goals, but have set their sights further on Mars. They have stated however their support for human missions to the Moon as precursors to those to Mars.

[3] Initially the Vision announcement said that human flights to the Moon were to be done with the purpose of preparing for human Mars exploration. The Exploration System Architecture defined by NASA to implement the Vision states additional objectives of permanent presence and facilities on the Moon.

[4] Recently, the NASA Administrator stated a goal of 2018.

A Global Venture?

It would seem that with all of the above missions that the foundation is being laid for a global venture to the Moon and then further into the solar system. In fact the viewgraphs of each nation's presentations show exactly that – a series of robotic missions to the Moon leading to international cooperation on human exploration of the Moon and Mars. Unfortunately, these plans are only viewgraphs, and almost no international planning has been done. The individual national missions are being planned with little, or only implied, consideration of the other national missions.

The national programs in China, India and Japan for a first mission to the Moon seem secure – their political value as a first step for each nation is clear. But the long-term support seems less clear, and in particular the growth required to sustain a human space flight venture is singularly uncertain. Public support seems soft for a human return to the Moon, not just in the U.S but also in the other space-faring countries.

The Bush Administration deserves credit for defining a *Vision for Space Exploration* that is worth the cost and risk of human space flight – extending human presence into the solar system. It is a noble vision and one that justifies the expense and danger. But we assert that it is not sustainable as a U.S. program alone; it must become a global, international enterprise.

What is needed is a popular vision to sustain political support in each of the space faring nations. To that end, we propose an *International Lunar Decade*.

Precedent

The *International Geophysical Year (IGY)* served as a vision to lead to both international Antarctic exploration and as a launching pad for the space age. The latter is its legacy more so than the former. It was modeled on the *International Polar Years* of 1882-1883 and 1932-1933 and was intended to allow scientists from around the world to take part in a series of coordinated observations of various geophysical phenomena. The IGY was developed by the International Council of Scientific Unions, and endorsed by national scientific establishments, such as the national Academies of Sciences. That led to political support for Antarctic exploration and scientific satellites at the beginning of the space age. The IGY was an 18-month "year" in 1957-58.

The earlier International Polar Years (IPYs) were similarly motivated by the need and value to coordinate observations from exploration of newly discovered areas on Earth. The "adoption" of the IPYs and the IGY came about through endorsement by international scientific groups, and acceptance of national agencies to support them as a rationale for program funding. Another International Polar Year 2007-2008 is now being planned.

An *International Space Year (ISY)* was observed in 1992-94 after being endorsed by the United Nations. [5] U.S. Senator Spark Matsunaga led the formation of the ISY as a 500th Anniversary celebration of exploration commemorating Columbus' voyage to the then "new world" of the

[5] A history of UN days, weeks, years can be found at http://www.unac.org/en/news_events/un_days/international_years.asp

Americas. Its purpose was to coordinate and encourage international activities in space science and exploration. The ISY served as great support and added rationale for the NASA's new *"Mission to Planet Earth"* program and the development of national Earth resources satellites. It also provided mechanisms for burgeoning relations between the U.S. and U.S.S.R. that led to the U.S.-Russian partnership on the *International Space Station*.

The *International Halley Watch (IHW)* was conceived to enhance and coordinate worldwide Earth- and space-based observations of the approximately once-per-lifetime apparition of Halley's Comet. Although never adopted by any international agency, it was adopted and funded by NASA and the European Space Agency, and formally integrated with the Russian, Japanese, and European missions to the comet. In addition to disseminating public information, and encouraging valuable supporting observations from Earth, the IHW is credited with assisting the space missions including navigation of ESA's probe enhanced by the earlier Russian encounters.

In all cases (IGY, IPY, ISY, IHW) there was a strong need for coordination and cooperation in missions.[6]

Could an International Lunar Decade serve the same purpose for current planned robotic lunar missions, and launching the global venture of humans to the Moon and Mars?[7]

The International Lunar Decade: 2007-2019[8]

The decade 2007-2019 could start with the national robotic orbiters, continue with many nations attempting to emplace cooperative and coordinated landers on the Moon, and end with a return to the Moon by humans – this time internationally, "…in peace for the benefit of all mankind." Starting the "decade" in 2007 would coincide with the 50th anniversary of Sputnik and advent of the space age.

An international goal like this should provide the missing political rationale that the U.S., Russia, Europe and Japan are lacking with their long-range objectives. It also would aid China with its objective of joining the world stage as a space power. It would provide a framework for space cooperation instead of a renewed space race, each nation doing the best and most possible within national objectives to be part of humanity's step outward.

Perhaps as important as the political rationale for space exploration missions an International Lunar Decade could enhance support for lunar science studies worldwide, even in non-spacefaring nations. Compelling science objectives in lunar science include both solar system studies and earth science subjects. Science objectives include:

- Searching for evidence of the origin of the Earth-Moon system
- Investigating the history of asteroid and comet impacts on Earth
- Obtaining evidence of the Sun's history and its effects on Earth through time

[6] A similar effort is currently underway with an International Heliophysical Year.

[7] We recently learned that an International Lunar Decade was endorsed by the U.S. National Research Council Space Studies Board and presented in an earlier proposal made by David Smith in 2004.

[8] The actual years bear some deeper consideration. But the precedents show a decade need not be exactly 10 years, no more than a "year" need be 365 days.

- Discovering samples from the earliest episodes in the history of the Eart
- Determining the form, amount, and origin of putative lunar ice

These would be enabled by lunar missions, but in an International Lunar Decade they could be pursued broadly among scientists from many countries.

Endorsement of an International Lunar Decade (ILD) should be sought in the scientific and space communities. To this end we should propose the ILD to:

1. Individual civil space agencies of space-faring countries, especially those planning lunar exploration.
2. COSPAR: the Committee on Space Research of the International Council of Scientific Unions, meeting now in Beijing (July 2006);
3. IAF: the International Astronautical Federation; next meeting in Valencia, Spain in September 2006;
4. COPUOS: the Committee on Peaceful Uses of Outer Space.

Acceptance by these bodies would be a great stimulus to lunar mission cooperation and coordination. The strongest argument for adoption of the ILD is the existence of current national plans, and the absence of strong coordination and international rationale among them.

Operating the International Lunar Decade

The Space Agencies Forum for the International Space Year (SAFISY) might serve as a guide for what would be needed for coordinating lunar missions. A similar SAFILD could be organized for mission operations and coordination, or the space agencies could decide that they have other coordinating mechanisms already in place, such as the Inter-Agency Consultative Group (IACG). SAFISY was organized at the international political level, while IACG originated and is operated at the inter-agency level.

In addition, public interest and support could be enhanced by a non-governmental organization (NGO) assisting in international communication and public relations. We would propose that an appropriate NGO set up a Communication Organization Forum for the ILD to work in partnership with the space agencies, as well as with private and other public organizations.

Possibilities for National Programs in the International Lunar Decade

Some ideas for national roles for international partners are offered in this section. Clearly this will be the province of the individual agencies that are developing their missions based on their own established mission objectives. It is hoped that some of those objectives may be more efficiently accomplished through international collaboration, perhaps permitting new objectives serving international exploration goals to be included. Some examples of possible national roles that could be adopted are:

- Adoption of communication standards both in-space between spacecraft, and between spacecraft and Earth
- Use of relay satellite(s) and cooperative gravity mapping
- Initiation of a Lunar Internet protocol
- Coordination of observations to enable jointly defined scientific objectives
- Development of a Lunar Way-Station with cooperative operations
    - Inspection function

- Navigation aids
- In-situ propellant manufacture and power transfer experiments
- Robotics experiments to support human operations
- Rovers; cooperative rover tasks
- Science and public involvement activities
- …

Conclusion

Many national missions to the Moon are being planned. To enhance their public interest and political value, greater international coordination and cooperation is needed, especially as part of the global reach extending human presence into the solar system. An International Lunar Decade is proposed as a framework for organizing synergistic national activities on the Moon that contribute to the global goal.