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Paper Session II-C - Policy Considerations for Lunar Development

Charles D. O'Dale

POLICY CONSIDERATIONS FOR LUNAR DEVELOPMENT

CHARLES D. O'DALE
1025 Grenon Ave., Suite 911, Ottawa, Ontario, Canada, K2B 8S5

1. INTRODUCTION

A Lunar Base project will not begin until early next century. However, the legal and strategic framework around which it will be planned are under construction today. Important questions such as the base's long-term purpose are being left unanswered while we plan its technical implementation, but if we are to see a lunar base become part of an effective and permanent space infrastructure of use to future projects, the goals towards which it will reach and the conflicts it will face must be addressed. This paper discusses some of the factors which will play a role in forming a lunar base project and considers some solutions to resolve the conflicts these factors create.

2. APPROACHES TO LUNAR DEVELOPMENT

The perspectives which will drive a lunar base project may be placed into three general categories: Scientific, Industrial and Social-Political.

A **Scientific** perspective is concerned with utilizing the Moon and its resources in the pursuit of knowledge. As outlined by the European Space Agency[1], scientific projects may be categorized into science *of* the Moon (gaining a greater understanding of the Moon and its origins), *on* the Moon (utilizing the properties of the lunar environment to study fields such as human physiology or materials science) and *from* the Moon (using the Moon as a platform for astronomy).

A lunar laboratory would strive to produce as small an environmental impact as possible since even minute contamination from sources such as propellant exhaust can spread throughout the entire Moon's atmosphere within a matter of hours[2], reducing the scientific yield from observations. Success would be measured by the scientific understanding lunar operations brought to humanity.

An **Industrial** approach is concerned with utilizing lunar resources to generate material benefits. These benefits may include energy projects utilizing solar power or He_3 fusion, the mining and refining of lunar materials for use in Earth orbit or, paralleling the goals of scientific study *on* the Moon, utilizing the lunar environment to pursue experiments which may yield commercially valuable results. Industrial work, as a result of its exploitive nature, will disrupt the lunar environment; However, as the focus of industrialization is on making the most effective use of lunar resources, the degree of this disruption is not a strong consideration.

Following a **Social-Political** perspective, the goals of the lunar base lie not with the project itself but with the "spin-off" effects derived from it. This perspective has been at the root of past space projects, such as the Apollo program's space race, and remains a strong influence today[3].

While Social-Political goals do not depend on the output of a project, they do influence design decisions which affect the achievement of scientific and industrial goals. In some cases, as with the decision to shift the International Space Station to the orbit of 51.6° to enable the participation of Russia and the resulting reduction of the Space Shuttle's launch window to 5 minutes[4], the logistic complications created by accommodating Social-Political goals can increase project costs and reduce the potential for scientific and industrial benefits.

Although the application of Social-Political considerations, such as the stimulation of employment, may reduce the effectiveness of a lunar project's implementation, the benefits to society created by these goals can be significant. For example, while international participation in a project tends to increase its cost and complexity[5], the communication networks and infrastructure built to accomplish it may be applied to other private or public sector joint-ventures; which in turn stimulate participating segments of the economy and enable the pursuit of related projects. The management lessons learned by facing the problems of international participation may also be applied to future technology programs[6] or day-to-day political negotiation. Social-Political factors of little long-term benefit, such as the nationalistic emotional satisfaction of the general public and the vicarious adventure felt by observing a space program should also be considered as it will be the general public, through government taxation, which will pay for the first stages of a return to the Moon.

3. RESOLVING THE DEVELOPMENT CONFLICTS OF AN EARLY LUNAR BASE

Should Social-Political concerns play a pivotal role in the development of a lunar base infrastructure -- for example, in accommodating space hardware from many nations to enable an international effort -- the program may be hindered from the start by attempting to be too many things for too many people. Infrastructure problems may also arise as the base expands if transportation and support services are designed with only a small scientific lunar outpost or short-term piloted missions in mind.

If a scientific perspective is allowed to dominate the lunar development planning process, the possibilities for industrialization may be restricted by legislation which curbs the degree of development in order to protect the lunar environment for observation. When considered at their extremes, the scientific and industrial perspectives cannot operate together on the Moon if they are each to reach their highest potential for success. As the basis of this conflict lies with the level of development required by each to reach their goals -- industry's ideal being unrestricted access to the Moon's resources, science's being the minimum disruption of the lunar environment -- we may assume that this problem will remain for many decades. As the costs and delays associated with resolving this conflict may be expected to rise as the lunar base project progresses and its complexity increases, it would be best to work out a solution now.

Since large-scale private sector industrialization will not be feasible for the first few decades of lunar development[7], industrial concerns could accommodate a ten or twenty year moratorium on large-scale resource exploitation. During the moratorium, the study of the Moon in its natural state could be pursued without interference. At the same time, small-scale demonstrator facilities for projects such as Oxygen fuel production or solar power collection could be operated with the intent of refining the technologies required for full-scale systems.

Establishing specific goals and a strong, uniform management structure to carry them out is essential if planning for the effective use of lunar resources is to be reconciled with our one chance to study the lunar environment in its undisturbed state. A ideal lunar administration would also have the capability to regulate Social-Political goals[8] which might otherwise overwhelm the project and dilute its scientific and industrial benefits. Although economic realities dictate that a rejuvenated Moon program will be an international effort, a distinct project leader must be present if the differences between development perspectives and the needs of international partners are to be balanced without frequently redesigning the project and changing its objectives.

4. RESOLVING THE DEVELOPMENT CONFLICTS OF A MATURE LUNAR BASE

As the moratorium ends, the emphasis on base planning will shift from lunar exploration to resource exploitation. The danger of this period will be the overwhelming of scientific interests by industrial concerns and the disruption of lunar regions of scientific value.

Since any activity will contaminate the Moon to some degree, after a few decades of human and machine presence at a scientific base the lunar environment will no longer be pristine. This disruption may be offset by setting aside areas of scientific interest as lunar "reservations" or, in later decades, limiting activities which disrupt large areas of the Moon. These limits should be compatible with activities such as lunar mining or O_2 extraction for fuel as they require a relatively small area of the Moon for operations. However, projects which cause a large environmental impact, such as the mining of lunar He_3 (which requires the annual dredging of many cubic kilometres of soil to obtain marketable quantities of fusion fuel[9]), may not be at all compatible with scientific interests. As much about the lunar environment and the technologies which will be used there remains unknown, a responsible decision as to how much exploitation is too much will have to wait. The data obtained from an early lunar research outpost will assist in setting reasonable limits to large-scale development.

For the creation of an administration to direct lunar development, the United Nations Moon Agreement -- even though ratified by only 9 minor or non-spacefaring nations -- may be expected to play a strong role[10]. One of the reasons that major spacefaring nations have not accepted the Moon Agreement lies with Article XI of the document, which puts forward the concept that the Moon and all other celestial bodies are of the Common Heritage of Mankind (CHM) and are not open to claim of ownership from any nation or private party. Since a nation accepting this agreement would forfeit major interests in future space industrialization while gaining nothing in return, there has been little incentive to sign. As a result, the legal position of would-be private interests on the Moon still remains unknown.

While the concept that "the Moon belongs to everyone" is just and does not interfere with the pursuit of scientific research, it does create difficulties when the activities of lunar industrialization are brought into play. Although scientific research may be performed commercially without securing the ownership of lunar real-estate, the inability to stake claim to areas of the Moon for purposes of mining, fuel production or the placement of energy collection stations leaves uncertainty and risk which private investors find unacceptable. As the direct participation of the private sector in a lunar program would provide management, technology and human resource experience refined by centuries of open market competition, it would be best to resolve the legal uncertainties surrounding lunar industrialization as early in the program as possible and encourage the participation of this group.

The Moon Agreement declares that an International Regime is to be established which will "... govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible" and ensure the equitable distribution of industrialization's benefits among humanity. As multi-national projects such as the International Space Station have shown however, the compromises necessary to satisfy even a handful of participating nations increases the cost and complexity of a project[11]. When faced with this reality, the prospect of directing a project with an all-inclusive global partnership becomes nightmarishly impractical.

Although an ideal International Lunar Regime would enable representation from all segments of Earth's population, the limitations of our present social and political systems must be recognized. While the international satellite administration organization INTELSAT grants decision making control on the basis of financial contributions of member nations, and thus limits the influence of poorer developing countries, it has proven to be an effective means of managing orbital space resources and provides a reference for the development of an International Lunar Regime[12].

However, unlike commercially oriented INTELSAT, a lunar base program will begin as a scientific venture, with the possibility of commercial activities occurring only a few decades after base inception. Since conflicts will change as the base shifts from an exploration to an exploitation perspective, and as many of the factors influencing development decisions will be understood only after the scientific lunar base has been established, the system chosen for lunar administration must remain flexible. One such reference model may be found in the Antarctic Treaty System[13], which has remained adaptable and cooperative in outlook through 30 years of activity. Although few commercial concerns have been dealt with in Antarctica[Ibid.], the experience gained in negotiating compromises with different parties over limited resources will still remain relevant to a lunar base. The lessons learned from the commercial model of INTELSAT, the scientific model applied to Antarctica and the attempt to mix both with Social-Political considerations on the International Space Station project should be considered when establishing an International Lunar Regime to balance the needs of science and industry.

5. RECONCILING INDUSTRY WITH THE "COMMON HERITAGE OF MANKIND"

When choosing systems of industrialization, the most effective remains the free-market capitalist system. However, capitalism is ethically neutral and does not contain within itself mechanisms to ensure that the exploitation of lunar resources remains within the spirit of CHM. This problem may be dealt with by combining the legal concept of usufruct with the International Regime discussed in the Moon Agreement. Usufruct, whose use dates back to the age of the Roman Empire[14], is the granting of exclusive rights to use and enjoy property held in common or owned by another party as if it were a person's own. Under a perfect usufruct the physical characteristics of property are left unchanged after use; for example, in building and using a structure on another person's land. An imperfect usufruct deals with consumable property which is unusable by the usufructuary, but which may be consumed for benefit by another party. Given that the Moon's resources are the common property of humanity, but are a useless asset if inaccessible, the concept of imperfect usufruct may be applied to lunar development with the International Regime acting in the interests of humanity.

One scenario would see a prospective lunar industrialist obtain a lease of a century duration from the International Regime. During the period of lease, any enhancements made to the lunar region would belong to the industrialist, who would be entitled to revenues derived from these facilities. At the time of lease expiry, the lunar region and all facilities constructed on it would once again come under the jurisdiction of the International Regime.

Before approval for use of a lunar region would be granted, projects would require certification by the International Regime, which would halt projects not in the best long-term interests of lunar development or which would infringe on the rights of other users of lunar territory. The Regime would also play an observer role to ensure compliance with lunar environmental standards and resolve disputes between lunar "tenants".

As an industrialist would be granted legal guarantees asserting their exclusive right to use a particular lunar region for a period of time sufficient to provide a large return on their investment, the risk of loss of assets or revenue due to ownership disputes would be reduced, removing many deterrents to investment. At the same time, the International Regime governing lunar affairs would retain control of the region, and receive any assets and infrastructure established on it at the time of the lease's expiry. These lunar facilities could provide substantial revenues to the International Regime if operations were continued under its supervision. Looking at one example, a mature lunar solar power system selling energy to Earth could provide a phenomenal $15,000 billion (1990) U.S. annual profit[15], making the lease period well worth the wait.

If the Common Heritage of Mankind concept is considered to extend also to future generations, lunar industrialization could be considered a violation of the concept's spirit. While the

International Regime would gain control of a lunar region at the end of a lease period, native materials would have been consumed to construct or maintain the operation and the area would not be left in the pristine and resource rich state from which it started.

However, with the exception of He_3, it is not the scarcity of lunar elements which makes them valuable, but their location. Compared with the monumental efforts required to transport materials from Earth to space, the Moon's 1/6 g and lack of atmosphere enables the shipping of native materials to Earth orbit with relative ease. As the use of lunar materials may be expected to enable humanity's large-scale development of space[16], an effective infrastructure capable of exploiting resource rich bodies such as near-Earth asteroids could be expected to follow lunar industry by a matter of decades. Given the infinite resources this would provide, the consumption of lunar materials over a few decades is a small and responsible price to pay; one in the best long-term interests of the lunar usufructuary, humanity.

6. CONCLUSION

If a lunar base is to become part of an effective space infrastructure, the driving forces of Science, Industry and Politics must be balanced. As the conflicts between these forces may be expected to change as the lunar base perspective shifts from a research outpost towards an industrial facility, the mechanism chosen to regulate them must remain flexible. Existing legislation demonstrates that the regulation of limited resources can be accomplished, and offers models which may be applied to a lunar administration.

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