

A NEW INSTITUTION IS PROPOSED TO MANAGE SPACE RESOURCES: THE METANATION IN SPACE

by

Declan J. O'Donnell

ABSTRACT

Space resources will be utilized in development of space as a place to live and work. The plan for space development must be anticipated, if not entirely decided, well in advance of settlers arriving in space. Because of the nature of the resources and the size of the territory and its accessibility from all points on Earth, a future space governance regime is proposed to assume jurisdiction in space as Trustee for all nations and all humankind. This may become a new nation in space: The Regency of United Societies In Space, a.k.a., "The Metanation".

INTRODUCTION

United Societies in Space, Inc. (USIS), a Colorado nonprofit corporation with USA Internal Revenue Service, Section 501(c) (3) status, as a public charity, (and not a private foundation), is sponsoring the Space Metanation. It is proposed that the Space Metanation be established as a Regency government *pro tem* for 100 years in

space. A constitutional convention will be held in Denver, Colorado, on August 4, 2000 AD, to establish the Space Metanation. Internet participation will begin early in the year 2000 AD. United Nations membership will be sought. Under the USIS plan, plenary and permanent space Governance will be delegated to a space based re-constitutional convention, August 4, 2100 AD.

An interim space governance system, the Metanation, is necessary for two principal reasons. First, the material and energy resources and some locations in space will become valuable and a governance system will become necessary to resolve disputes that arise between competitors for these resources. It is argued that establishing the governance system prior to the competition is an important step in enabling commercial investment in the opening of these resources. Secondly, the establishment of the Metanation allows the creation of a financial basis for funding space development through the issuance of Space Money, which can enable growth of activity and opportunity in space. It is also argued that the Space Metanation offers a mechanism for sharing benefits from the development of space resources among all nations on Earth, which might otherwise be very difficult to achieve.

The USIS plan includes the establishment of economic development authorities for various venues – Earth Orbit, the Moon, Mars, asteroids, etc. Each of these venues will have distinct issues, development schedules, and competitive forces. The Lunar Economic Development Authority was formed on August 4, 1997. It will deal with the future development of the Moon, including the establishment of infrastructure and municipal services and the enabling of commercial investment. LEDA will administer the LEDA bond Venture Capital Fund.

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The Mars Society was founded on August 15, 1998, in Boulder, Colorado as a Colorado nonprofit corporation with IRS 501 (c) (3) public charity status. A committee of the Mars Society is now forming as if it had municipal authority at Mars. Similar mechanisms are envisioned for space orbits, which could be occupied by cyeler vehicles and asteroid management.

Private citizens of the world will install the Metanation. It is viewed as a parallel paradigm to the largely exploration oriented space activities carried on by the space faring nations. It is not meant to replace any current activities. The advent of a space governance entity should be welcomed by space agencies because a synergy will result by concentrating governance focus, and organizing space resource management worldwide, and by offering a new source of money to help pay for space development.

THE HISTORY OF THE SPACE NATION CONCEPT

The L-5 Society. A comprehensive definition of a new nation in space was published by the L-5 society. It published a series of newsletters during the 1970's and early 1980's that extolled the virtues of a new nation in space. Mr. Arthur Dula authored most of these articles. A dozen or more references to this concept make the L-5 Society the originator of the concept as we know it.¹

The Federation. Prior to this there had been references to a Federation of Nations in space. This was worked out in some detail for the TV series, "Star Trek." It is clearly understood that the Federation has jurisdiction in space, was in fact a space governance authority, and it controlled the missions of all space ships under its aegis not only as to executive orders, but, also, as to legislative and judicial matters. The Federation may be identified now as the world's foremost image of how space governance should work in the future, for real.²

Russian Space Lore. Another repository of independent governance ideas for outer space is Russian Space lore. This goes back into the last century. It is known as "Our Host Nation in Space." One interpretive note to this ancient model is that the Host Nation was foreseen as springing up by itself rather than having any

substance by extension from the Russian government. Commentator Dr. Oleg Alifanov has made the point that National Space Infrastructure of Russia belongs to Russian people and may not be commandeered or borrowed by the New Host Nation in Space.³

This clarification could be applicable to all of the historical models. The Federation clearly had its own substance and was not presented as an extension of any one Earth nation into space. The Arthur Dula model clearly contemplated a new entity not dependent on transfers, assignments, or grants from other nations. It may be stated that the new and independent space nation model has been evolving for about a century.

The IARC Model. Sterns and Tennen introduced a United Nations dominated model that featured the issuance of a charter to space settlements. This would define and memorialize the independence of the settlement for space governance purposes by agreement. The IARC is an international agreement of recognition and capacity. It would be signed by the settlement representatives and by a UN agency called the International Organization for Sentient Space Activities, which could be created by amendment to the UN Charter or by UNGA resolution. This model represents the leading proposal for outer space governance having received broad recognition.⁴ A variation of the model is the proposal to treat an IARC as a Trusteeship Council Territorial Agreement for transition of areas not yet ready for the full measure of self-governance into an independent State.⁵

Congressional Models. Representative Newt Gingrich, (R-GA), advocated a new nation in space by Congressional vote during the 1970's. No consensus developed and the proposal died. In 1998, Mr. Alex Lightman, USIS Board Member, recommended a return to this model as a special U.S. Trusteed Authority to organize and develop space. (See, Space Governance Journal, V. 5:2, 1998). These proposals excluded the UN from their formulae and burdened one Nation, the USA, to serve all as Trustee. That burden may not justify the technical and time-line advantage.

The Regency Model. The Metanation was presented as a viable version of prior space nation concepts in 1994, and has been published

internationally and extensively.⁶ The adjustments made to the historical model included the concept of several entities (development authorities) becoming a constellation of Metanation authorities rather than one agency.

Metanation also adopted the trusteeship feature, in which it would act as the trustee for all nations on Earth and humankind. These beneficiaries were gleaned from the Outer Space Treaty (O. S. T.) of 1967. A Regency mechanism, in which persons on Earth, selected by election and/or appointment from every nation on Earth, would act in place of the permanent governing authority or authorities, is proposed. The actual settlers of space habitats will become the priority beneficiaries at the end of the 100 years Regency Period.⁷

The USIS Metanation also features the capacity to issue new money. As a governance entity, the Regency should be prepared to maintain a fiscal and a monetary policy. Space settlers will need a universal standard of money, one that does not fluctuate in response to Earth events, but, instead, can be managed to accommodate space governance objectives. A department called the Metabank, which will serve as the Central Bank for the Metanation Constellation, will run this feature.

The underlying substance to be effected by this new form of government will be the space development plan. This is a rising tide project to locate human settlements on the Moon, on Mars, and in the cyclo orbits during the next 100 years. The Metanation will sustain this project for a 100 year time period under its development authority subdivisions and with Metabank money. This development plan will take into consideration the exploration and development plans of all space agencies on Earth.⁸

United Societies in Space has reserved August 4, 2000 AD as Metanation Day. It will convene a constitutional convention in Denver, Colorado and proclaim an independent Regency in space that day. The White House has reserved the August 4th date for this convention as a Millennial event. Wide spread international participation is anticipated. The trusteeship will be expected to mature into a democracy of space settlers within 100 years. Another Space Convention for settlers in space is pre-set for

August 4, 2100 AD, when the Regency ends, winds up its affairs, and transfers *pro tem* infrastructure to a permanent regime.

THE LEGAL BASIS

Introduction. There are four parts to the legal basis for establishing a nation in space well before the territory is in fact settled. There are also two strategies that compel early action. These are stated as follows:

1. The International Space Treaties are Earthbound and silent on space bound jurisdiction, thus creating a political void in outer space as a legal venue.

2. The United Nations Charter, 1945 at Chapter XI, provides for the creation of new nations in any territory under a trusteeship system: Both substantive and procedural guidelines are published.

3. Metanation will follow the substantive guidelines in forming its new nation in space, a territory not yet ready for the full measure of self-governance.

4. Metanation will apply immediately for UN membership and waive the UN sponsorship procedures known as "Trustee Council."

5. The strategy for early establishment of Metanation includes creation of a space policy problem solving entity, which can work out a property, contract, and tort system and, under the label Astrolaw, an extension of Common Law into space, and,

6. It may create and maintain a fiscal and monetary system for the space territory and all of its political subdivisions, thus featuring a new source of money for the space development plan.

INTERNATIONAL SPACE LAW IS SILENT

International space law consists of five space treaties; several UNGA resolutions; and relevant custom and practice. There are no sanctions provided against the establishment of a space nation by any of these authorities and there is no requirement that such be established. Space law is silent on the subject.

The O.S.T. of 1967 is well known for the proposition that "Outer Space ... is not subject to national appropriation by claim of sovereignty, by means of use, or by any other means."⁹ This is thought to represent a principle of space policy against the extension of sovereignty of one nation into space at the expense of another sovereign nation. It is a Cold War product of UN diplomacy. Article VIII permits sovereignty to be transported into space inside a space ship so the sanction is not absolute. Also, the authorities commonly recognize the principle that space settlements can and will establish their own municipal government in space. The Article II O.S.T. proposition is therefore limited in scope and not a barrier to space governance as a Metanation for all.¹⁰

The UNGA resolutions have not addressed the issue. The 1997 resolution on benefit sharing stressed the importance of International Cooperation and that implies governmental activity. There seems to be a need for an agency that can assist this activity as a catalyst for all others.

The current UN Charter, 1945, Substantive Requirements will be followed. Section 76 provides the treaty guidelines for a new nation in a territory not yet ready for the full measure of self-governance. That Section recites these features as follows

"Article 76. The basic objectives of the trusteeship system in accordance with the purposes of the United Nations laid down in Article I of the present charter, shall be:

1. To further International peace and security,
2. To promote the political, economic, social, and educational advancement of the inhabitants of the trust territories, and their progressive development towards self-governance or independence as may be appropriate to the particular circumstances of each territory and its people and the freely expressed wishes of the peoples concerned, and as may be provided by the terms of each trusteeship agreement; To encourage respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion, and to

encourage recognition of the inter-dependence of the peoples of the world; and,

3. To ensure equal treatment in social, economic, and commercial matters for all members of the United Nations and their national, and, also, equal treatment for the latter in the administration of justice, without prejudice to the attainment of the foregoing objectives and subject to the provisions of Article 80, (relative to existing contracts are not be canceled or delayed because of trusteeship)".

The Regency of United Societies in Space Constitution is predetermined in large part, based on this list of requirements. In addition to these societal specifications, we may also expect to find a fiscal policy and a monetary policy; a budget for space development; a Metabank department as the central bank of the Metanation; and a provision for local government through the establishment of venue specific authorities.¹¹

As the territory of space is rather sparsely inhabited at any given time, a regency or trusteeship government will be asserted to govern the territory. This is traditional in history when a King is under age or incapacitated. The regency would be expected to maintain an executive, legislative, and a judicial department for those subject to its jurisdiction. The regency is invoked when it is anticipated that authority will be transferred to another entity at some future time.

The legislative department may consist of a large Council of Regents, presently planned for 2000 people worldwide. These people would be installed at the founding convention in Denver, Colorado. A reverse representation formula will be proposed so that those individuals who are suitable as delegates to the Denver Space Convention could also be assigned to represent relevant constituencies. In this way the Council of regents may hope to represent the world at large.

The executive branch may be fashioned after that of the USA with a President, a Vice President, a Cabinet, and select departments. Local governments could be represented in the executive branch, also. For example, the officers of the Lunar Economic Development Authority and the designees from the Mars Society should be in the cabinet and made part of the Metanation Federation of Space Governance entities.

One of the principal activities of the Metanation will be management of Space Resources. A Special Department of Resources is foreseen as the agency to exercise jurisdiction here.

The judicial branch will be authorized and empowered to conduct legal proceedings under Regency Law. That will be ordinances passed by the Council of Regents, plus Astrolaw. The founding convention will install Astrolaw as an extension of the English Common Law as adopted in the USA at a cutoff date of 1690 AD, and as modified by American Federal Law, and as extended to extraterritorial Courts at a cutoff date of 1850 AD, and, finally, as extended by the convention into Outer Space with Astrolaw modifications on August 4, 2000 AD. The specific plan for judges, court rooms, and precedent publications will be detailed by the convention.

The Metanation Federation will therefore be led by an entity that is purely public in function. Its authorities on the Moon and elsewhere will be quasi public and private, each having a venture capital fund made up of private money.

Finally, the constitution is projected to establish a trust relationship between the Metanation and humankind. This will dispense with the need for space citizenship because all of humanity, six billion people on Earth at 2000 AD, are citizen beneficiaries of this paradigm. They are now represented by nations to which they have committed citizenship: therefore those nations will stand as primary beneficiaries and their citizens as secondary beneficiaries.

These direct governance features would be a supplement to the space treaty system. They would fill up the void left by the Treaties. Indeed, the Regency would seek to join the U.N. and work with it and with the member Nations, its primary category of beneficiaries.

THE SPACE RESOURCE MANAGEMENT PLAN

Assuming that an agency is created (or adopted), for the purpose of managing space resources, its functional capacity must be styled in relation to the plan for those resources. For

example, if the plan is to convert space resources into usable minerals on earth, then the manager should have the capacity to sponsor Earth integration of space resources.

On the other hand, if the plan is to dedicate space resources to building out a space infrastructure, then the agency should be designed to integrate those resources in space into a space-sited-civilization. This threshold consideration is important because the latter type of agency would be required to assume plenary jurisdiction in space. The former would require commercial authority on Earth, a capacity that could intrude on the political and economic interests of many other entities.

Assuming that Earth already has adequate agencies to manage Earth based resources that can also manage space resources transported back to Earth, here we may concentrate on managing them off world. In the Outer Space venue there are obvious uses of a different nature in respect to (1) exploration, (2) preservation, and, (3) development.

1. For exploration uses there is a treaty standard to the effect that explorers should share information equally and engage in international cooperation. This standard is well defined and currently performed under the expert oversight of the UN office of Outer Space Affairs in conformity with provision of the O.S.T. 1967.

2. As to the activity known as preservation of space resources, we need to make another threshold decision: whether preservation should be passive or active. A passive or non-activity such as neglect and abandonment requires little capability. Active preservation, in the sense of museum management or the management of forests, oceans, and the atmosphere on Earth calls for a high degree of professional, scientific, and legal know how, complete with legislative authority including a police authority to enforce it. It calls for cataloguing, protecting, and preserving. It anticipates the making of decisions about what should be subjected to preservation. The ongoing decisions about what should be used and what should be preserved depends, in large part, on the plan for development of space resources. Without the plan for development, there are no criteria for preservation because no

development means total preservation. For this we need nothing and no agency is required.

3. Therefore, the bottom of it is contained in the solution to the inquiry "what is our space development plan?" There have been many proposals for the development of Outer Space, many of which utilize space resources in place as building blocks. There is no material and substantial movement in the aerospace science community to avoid all uses of all space resources. For example, current plans for Mars's exploration include the use of propellants derived from Mars' atmosphere.

The various plans for development of the Moon are generally conservative in the extent of resource disruption, but they may be equally substantial in the sense of selective exploitation of mineral resources. Many of the Moon's resources may be widespread and little competition could result from their development and use. However, NASA's recent Lunar Prospector mission has reported the existence of water ice in permanently shadowed craters at the poles. Thus, specific areas on the Moon may prove to be most economically valuable, raising the specter of intense competition for their resources.

Asteroid resources may similarly raise competitive urges. Although a large number of asteroids have orbits that bring them close to the Earth, only some of them will have resources of interest to space development. These include those with ready supplies of metals and of water. The value of Amun, 2 KM diameter metallic asteroid in orbit near Earth, is projected to be \$20,000 billion USD on earth.¹² It is easy to imagine that competition for the individual "best" asteroids may occur.

It is not clear that there will become a gold rush-like migration to space; however, competition may arise. The resource management agency will need far more than administrative competence. It will need to have a property regime that includes registration and protection of mining claims; a criminal law that is internationally understood and recognized; a police force that can exercise effective authority; and a municipal governance regime that can respond to the needs of the people.

All of this suggests that space resources should be managed by a space governance regime, one that is designed in advance of the gold rush and installed by consensus for the benefit of all. It will need an executive branch to execute our common plan, a legislative branch to define and refine how that plan is implemented, and a judicial branch to work out the governance problems on a day to day basis. Mechanisms to protect humanity and all participating nations from over reaching by the new nation in space are also needed. A check and balance structure for the 100-year Regency is essential to its trusteeship status, as well as its trustworthiness in general.

THE BENEFIT SHARING PROBLEM.

The United Nations defined and adopted the concept of benefit sharing in UNGA resolutions of 1962 and 1963, over 35 years ago.

This was adopted by the leading nations of the world as part of Article I of the O.S.T. in 1967. Although it may be called a principle of space policy, rather than a tenet of space law, the majority of nations certainly had a fair expectation of some real benefit sharing from the space faring nations during that long period of exploration of space. The 1997 UNGA resolution on benefit sharing appears to have converted the concept to a 2nd cousin of "International Cooperation" rather than maintain it as a separate treaty burden. Some have suggested that benefit sharing should be the subject of litigation so investors, developers, and third World nations can know whether or not it exists anymore.¹³

A new nation in space can override much of the failure on Earth by implementing benefit sharing into its long-term development plan for space. This activity is known as the "Municipal Model" for development. It requires that each and every space development project be designed to accommodate future generations of humankind. The analogy can be made to municipality development on Earth where building permits are conditioned on availability of water, open areas, parking spaces, parks, schools, churches, and, in Castle Rock, Colorado, landscaped parks with drinking fountains for residents, guests, and future generation of settlers.¹⁴

The original concept of benefit sharing may be called the Sea Bed Treaty Model, where all nations have a hand in development, a special

authority is created for each large project, and the net profits are actually distributed to each nation. This model may have been eliminated by the 1997 UNGA resolution on benefit sharing. However, a new nation in space could be designated to implement it as a traditional "equitable sharing" program, (consistent with the standard set forth in the Moon Treaty, 1979), limited to mining activities and administered as a landowner royalty program. Since mining will be a substantial off-world commercial industry, it may require space governance regulation anyway. The addition of a fair royalty in favor of the owner, i.e., all nations and humankind, could not be deemed unreasonable.

Mining can not be the only industry in space, if the products of that mining are intended for use in space. The extraction of material resources is a supporting industry on Earth and will likewise be so in space. The materials will be used for construction of habitats, factories, hotels, transportation systems, and so on that will be used by an increasing number of people in space

It is submitted that a space governance entity must be created to manage space resources. The space governance system must be one designed to accommodate what could become an exponential migration of industry and people into space. There will be a continuing need for balancing national, international, and space settlement interests between exploration, development, and preservation goals.

Only a new entity charged with plenary jurisdiction in space territory can bind that venue to its regulation, treat fairly with the competing interests by avoiding Earth grown conflicts; and decreeing its development allocations with relevance and a resulting claim of immunity attached to its core governance functions. Without the cover of immunity from litigation this management entity may never survive.

MINING SHOULD BE REGULATED IN SPACE.

Perhaps, the leading reason for a strong regime in space is that the economics will require it. The beef in this sandwich is in asteroids and these are found every where in the territory. Compared to all the space development commercial activities, mining asteroids appears to

feature the most mining wealth, the most net profit potential, and the most competition. The implications for government in space are critically important.

A very large profit potential could cause a gold rush of settlers in space. The 1849 AD experience in California and the western United States must not be forgotten. The lack of governance in that territory led to chaos and a suspension of civility. In Canada, a large force of Royal Canadian Mounted Police accompanied a similar gold rush and the territory was developed traditionally and peacefully. We should respect the better development plan as executed in Canada.

The force of space governance needs to be imprinted on space mining of asteroids to avoid chaos. A system of property right and mining rights, attended by a venue wide registration system, and complete with comity enforceability is obviously indicated. Only a space nation can do this. For example, comity can only be afforded one nation to another (or one state to another). If a property system is worked out in the territory known as space, other nations would tie into it by comity: i.e., affording mutual respect for national laws. Without comity the entire system would need to be memorialized by UN treaties that are circulated and recirculated every time a rule changed. Furthermore, without co-nation status and comity as a matter of course and custom, even the corporate shareholders on Earth could be exposed to tort liability at the mine site off-world: the corporate privilege of limited liability is entirely a matter of comity in International law.

Once the rules are set and industry commits capital to the mining activity, the workers need to be protected. The manager of the resources also needs to have jurisdiction and legal authority to deal with labor, management, welfare, health, and the social security of those who perform the day to day work for the benefit of all.

Lastly, asteroids are dangerous. Our colleague, Carl Sagan, and others developed the arguments that an errant asteroid could represent the death knell of our civilization on Earth. His Nuclear Winter was a graphic portrayal of such devastation. Only a venue wide, coordinated, and plenary system of government in space could hope to harness this peril.

LIABILITY EXPOSURE LIMITED

If the resource management agency was part of a new nation in space, grounds for limited liability could be constructed. The sovereignty feature of immunity from suit on core activities of that government could be extended to the primary enterprise of asteroid development, mining, milling, and management. This is critical because many asteroids are in orbit near Earth. If a mistake is made and an asteroid hits the Earth, the company that did it would be liable to all who are damaged, as would the nation on Earth that allowed or suffered that company to approach the asteroid.

In lieu of endless and open ended liability that marks the Earth governance paradigm since the O.S.T. 1967, the new nation in space provides a place to cut off that liability. Metanation would define space development as a space nation activity, and supplement its immunity with a fair insurance, workers compensation in space, for the workers, and by a nation well suited (because it has no other priority), to tend to these risks.

These risks of development are traditional and their management is traditional. Even the proposed fifty percent royalty on gross revenues is backed by precedent where public property is involved. The issue that our interplanetary commons should be mined for free

is not supportable. An equitable sharing of the resources and their profits with the space governance and resource management entity, for the benefit of all, is the traditional way to sustain governmental services in the territory. No space resource management plan could work unless the liability exposure is limited by law and a user fee, such as the benefit sharing royalty on mining supports the budget.

CONCLUSION

The Regency Government Model for space governance is asserted as the logical and traditional way to manage space resources. Anything less would be unworkable. Without effective governance regulation, the building of our off-world estate would be conducted in chaos, without standards and contrary to 35 years of space policy's promise of benefit sharing to humankind. Perhaps, the single most important aspect of management by government in space is that new money may result. The entity known as the Metanation could and will display the effects of its governance role, not only by maintaining a system of property rights, contract rights and tort law, but, also, by maintaining a monetary and fiscal system for outer space.

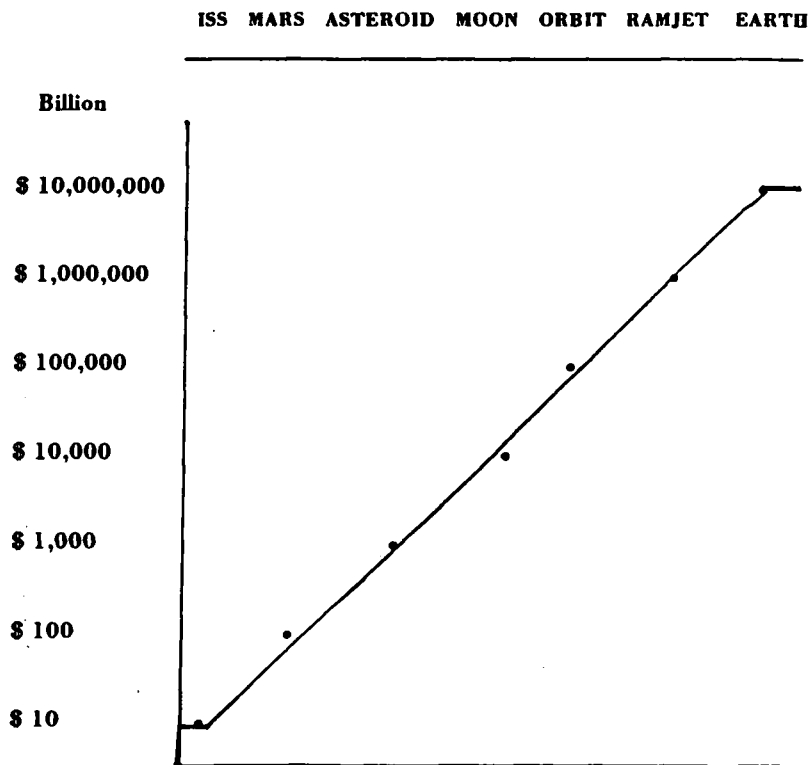
DECLAN JOSEPH O'DONNELL

(The author thanks Dr. Philip R. Harris and Dr. Mike Duke for editorial assistance)

1. The L-5 Society Newsletter was discontinued upon that Society's merger into the National Space Society. It is survived by Ad Astra.
2. Star Trek, the TV Series, was produced and directed by Mr. Gene Roddenbery who died in 1992, International Space Year.
3. Alifanov, Oleg, "Space is the Future of Humankind," Space Governance Journal, V2: 2, 1995, p. 26.
4. Sterns, P.M. and Tennen, L.R., "International Recognition of the Art of Living in Space: The Emergence of Settlement Competence," IISL 22, (1980).
5. Robinson, G. S. and White, H. M. , Envoy of Mankind, Smithsonian Institution Press, Wash. DC, 1986, p. 223.
6. WWW USISpace@aol.com; also, see: "Metanation and other Words" by O'Donnell DJ, and Harris, PA, AIAA, Beijing, 1996.
7. Space Governance Journal, 1994-1998, in passim.

8. NASA, SP. 509, 1995, referring to the Baseline Scenario.
9. The Outer Space Treaty (O.S.T.), 1967, Article II.
10. Fason, E., "Human Settlements on Planets: New Stations or New Nations?," *Journal of Space Law* V.22, 1994, p. 47; Cordell, B., "Interspace - A Design for an International Space Agency," *Space Policy*, V. 8N4, 1992, p. 287; O'Donnell, DJ, "Founding a Space Nation Utilizing Living System Theory," *Behavioral Science*, V. 39, 1994, p. 93.
11. The procedure for the formation of the Metanation is: (a) Global Essay Contest entries at 12/31/98, (b) will be published in *Space Governance Journal* in 1/31/99, (c) churned into a leading proposal for publication by 1/31/2000 AD, (d) referred to delegates and featured at the August 4, Space Convention, 2000 AD in Denver, Colorado, (e) where documents will be declared and (f) people will be elected to constitute the Metanation in Space for all humankind.
12. Lewis, James, Mining the Sky, University of Arizona State Press, 1998.
13. O'Donnell, DJ, "This Treaty Needs a Lawsuit," *IISL* (40), Turin, 1997.
14. O'Donnell, DJ, "Benefit Sharing: The Municipal Model" *IISL* (39), Beijing, 1996.

GROSS COSTS ESTIMATED

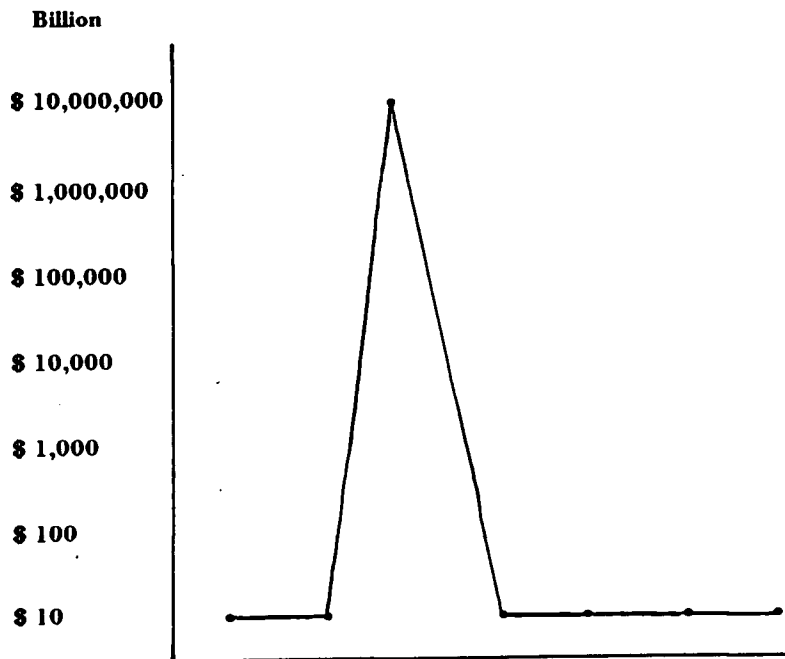


Exponential order of 10 magnitude starting at 10 billion US dollars equivalent and rising on a static scale not adjusted for time.

Approximate cost levels in US dollars complete the typical concepts of development at the stated locations suitable for sustaining human society not adjusted for time and based on relative cost differences.

EXPONENTIAL NET REVENUE ESTIMATED

ISS MARS ASTEROID MOON ORBIT RAMJET EARTH



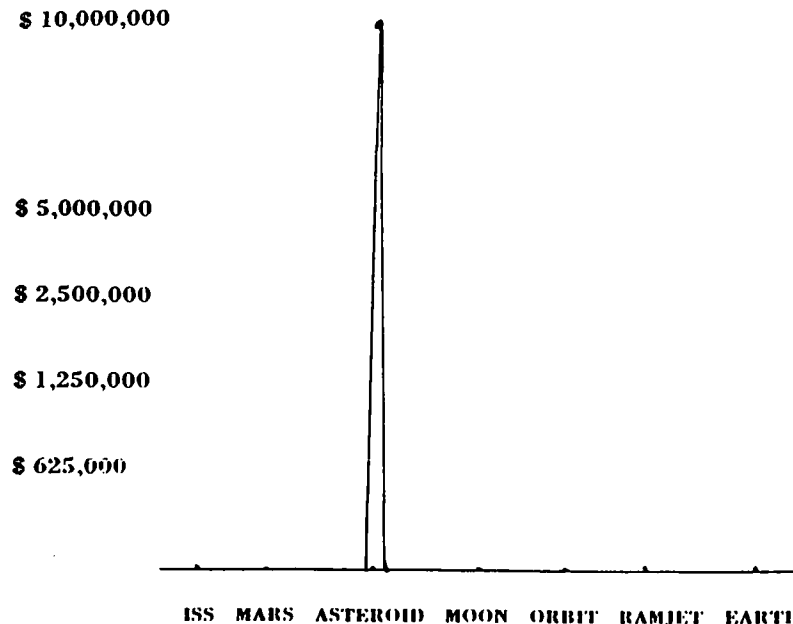
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Exponential order of 10 magnitude starting at 10 billion US dollars equivalent and rising on a static scale not adjusted for time.

Net revenues estimated from mining, refining, processing, and marketing minerals, metals, and water.

LINEAR REVENUE LESS COST

Billion



Linear (non-exponential) US dollars equivalent from zero to 10 quadrillion rising on a static scale not adjusted for time.

Approximate costs are taken from the estimated gross costs table and approximate revenues are taken from the estimated exponential net revenue table. Costs include 50% of revenues for benefit sharing.