L5 NEWS

November 1979

Lightsail Update - Eric Drexler

L-5 Sparks Moon Treaty Opposition

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 4 NUMBER 11 NOVEMBER 1979

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Cover: The Lightsail artwork by Carolyn Henson from a photograph by Steve Bell from a model by Keith Henson from a concept by Eric Drexler. How's that for teamwork?

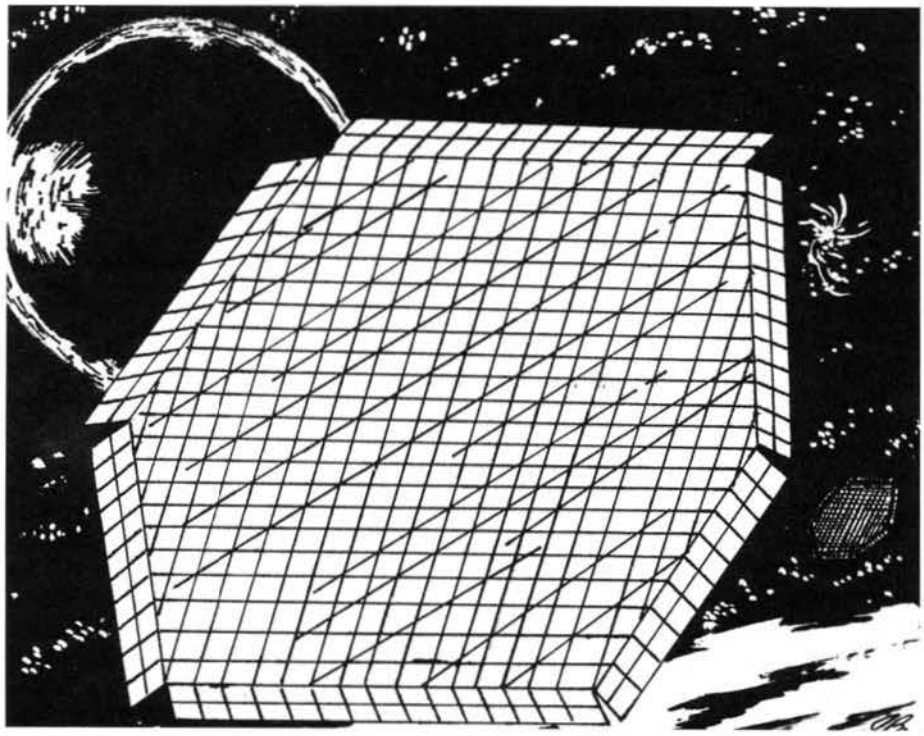
L-5 News (USPS 338-090) Publication office: the L-5 Society, 1060 E. Elm, Tucson, Arizona 85719. Published monthly. Subscription: $12.00 per year, included in dues ($20.00 per year, students $15.00 per year). Second class postage paid at Tucson, Arizona and additional offices.

Membership Services: L-5 Society, 1620 N. Park Avenue, Tucson, Arizona 85719. Telephone: 602/622-6351.

Change of address notices, undeliverable copies, orders for subscriptions, and other mail items are to be sent to:
L-5 Society
Membership Services
1620 N. Park
Tucson, AZ 85719

Lightsail Update

by Eric Drexler



Artwork by James Babcock

After almost three years of work, the lightsail (high performance solar sail) concept is beginning to receive widespread attention. In June, Dr. Arthur Kantrowitz invited me to give a presentation to a NASA innovation study group which included NASA Administrator Dr. Robert Frosch. It was well received and led to invitations to speak at the Aerospace Corporation and Jet Propulsion Laboratory (JPL). NASA now plans a formal review of the lightsail concept.

In these talks, and in further talks at RAND and Boeing, no threats to concept feasibility were uncovered. People were interested and took the concept seriously. (Having samples of the sail material to pass around the audience probably helped.) At JPL, people with experience in designing spacecraft (including deployable solar sails) expressed confidence that thin film materials were usable as sail materials. They felt that lightsail development costs would almost certainly fall below the one billion dollar level quoted on one of my slides.

This is less than 1/6 the cost of Shuttle development. An asteroid (or Deimos) dirt scooper should be pretty cheap. Since a few sails and a scooper could recover non-terrestrial materials, it seems that the cost barrier to space mining has dropped by a factor of ten or more. Further study seems called for.

Why "lightsails"?

The first English language reference to the use of light pressure for space propulsion (C. Wiley, **Astounding Science Fiction**, May 1951) referred to the device as "sail" and proposed using thin metal films, manufactured in space, for the reflector. Later, when spaceflight became a reality, attention shifted to deployable plastic film sails and the name "solar sail" was adopted.

There are a number of reasons for applying the name "lightsails" to space-manufactured, thin film sails. When compared to conventional sail concepts, they employ different structures and materials; they pose greater technical challenges, and they offer 20 to 80 times the acceleration. This alone would make the old name a little misleading. Further, the name "solar sail" leads to confusing conversations ("How efficient are these thin film solar cells?" or "I've got a cousin who works in solar sales"). Then of course solar *sails* use the solar wind...don't they? Finally, once it is made clear that the *sail* uses *light*, the adjective "solar" fails to suggest that sails can use infrared radiation and reflected light from planets, or that they can (someday) be boosted to interstellar speeds with huge lasers.

Since space-manufactured, thin film sails both use light and are light, "lightsail" seems appropriate. It is a distinctive name for a distinct concept, and it avoids the confusions of pronunciation and meaning that come with "solar sail." Finally, it sounds nice, and my mother likes it.

...lightsail development costs would almost certainly fall below the one billion dollar level...This is less than 1/6 the cost of Shuttle development.

Crawford Letter

The following letter from Dick Crawford raised some interesting questions:

"I have a few comments about the two solar sails articles in the May 1979 **L-5 News** ("Breakthrough" by Carolyn Henson and "High Performance Solar Sail Concept" by Eric Drexler):

"(1) The asteroid mining scheme depicted in Mrs. Henson's article looks great, except for one picky little detail. Tethering the sail to the asteroid as shown would be feasible only if the body is nonrotating (there aren't any such known) or if the point of attachment is somewhere near the axis of rotation on the night side. And that presents a problem for stays of more than a few months. Hence the loading phase should be as short as possible.

"(2) Mr. Drexler's idea of providing holes in the backing foil to permit the escape of gases from under the sail foil disturbs me. In the first place, any hole in the backing assures a hole in the sail foil (the evaporated film won't bridge gaps). I can't believe that a sail foil with holes in it would be stronger than one without holes.

"In the second place, I can't see the need for such holes. Their purpose seems to be to prevent any gas buildup between the two metallic foils that would rupture the thin sail foil. The easy way to control that is with temperature gradients. Just keep the whole sandwich cold enough to prevent sublimation until you want the foils to separate, and then apply heat (sunlight?) starting from one edge. The sublimed material (of which there need not be much, anyway) would escape gradually, under perfect control, and gently waft the sail foil away.

"(3) The idea of cutting the sail foil segments while they are still attached to the

backing foil seems to me needlessly complicated. I have trouble visualizing a blade that would cut through the one without marring the other. The easy way would be to deposit the sail foil segments to the right size and shape by masking, and eliminate the need for cutting.

"(4) I also worry about the strength of the sail foil. In my experience (admittedly limited and out of date) deposited metal films tend to be very brittle when detached from the backing. We solved this for our application by depositing reflective coatings on ultrathin plastic films. Might it not be possible to blow a big bubble of some low-vapor-pressure monomer that would be activated by sunlight to polymerize into a tough plastic? One could even imagine doing this inside a mesh of fine wires that would become part of the bubble, providing readymade attachment sites for the control and load-bearing lines.

"(5) Mr. Drexler's proposal calls for a vapor-deposition power supply. Making the sail in one unit of thin plastic allows us to do the vapor deposition all at once. For this we could consider a chemical source of aluminum vapor, the thermite reaction, which would be much lighter and more positive.

"Needless to say, there may be many hidden flaws in my ideas. I have invested almost no time in detailed calculations and engineering analysis. I would appreciate hearing from other L-5 members whether they can see any obvious booby traps I have overlooked, or whether they have any better ideas. Personally, I mistrust mechanical devices that must operate unattended for years and prefer simpler, one-shot processes. For one thing, they are usually cheap enough that if one of them doesn't work you can just send up another."

Dick Crawford
Walnut Creek, CA

Crawford response:

Mr. Crawford raises many interesting issues in solar sail design, fabrication, and use. Most have not been raised in print. At the risk of turning the **L-5 News** into a journal of lightsail technology, I would like to discuss them at some length.

New concepts like the lightsail generally benefit from a widespread exchange of ideas. The particular concept that I finally laid out is conservative in the sense of being comparatively easy to design with the information available to me. It is but one of many approaches to lightsail design and fabrication (you should see my heap of discarded ideas!).

(1) It is true that a tether from a sail to an asteroid must be attached to the asteroid at a point near the axis of rotation on the night side. However, if the tether is of reasonable length, the exact point of attachment isn't too critical. Still, as the seasons change on the asteroid, a tethered sail would run into trouble. However, since scoopers running at only 1/10 kg/sec can collect a 100 ton load in less than two weeks, this shouldn't pose a serious problem.

The tether can be eliminated if the sail can be brought by the asteroid repeatedly. The problem is that light pressure can't be completely shut off, so the sail always drifts with respect to a body in free fall. Gravity could keep a sail near a large asteroid or a moon of Mars. With patience (or an auxiliary propulsion system) a sail can make repeated flybys of any asteroid. In all these cases, the sail would drop off a scooper on one pass, let the scooper fill a bag with dirt and chuck it off into space, then fly back to perform an automatic docking with the bag (a la Progress).

The particular concept that I finally laid out...is but one of the many approaches to lightsail design and fabrication...

(2) Since the average stress in the film material is less than 1% of its fracture stress, strength is not of the essence. Tears, not fracture, are the real threat, and properly placed holes can block tears. For this reason (and to permit the escape of subliming vapor during fabrication) a pattern of cuts seems desirable.

The idea of peeling the film with a single wave of sublimation is interesting, and might work out. I selected a process involving many small pockets of sublimation to allow high production rates in a small device operating near thermodynamic equilibrium in the sublimation chamber. A potential problem with sublimation far from the equilibrium pressure is premature separation and blistering, causing damage to the film. Such problems might not arise, particularly if steep enough thermal gradients can be applied.

(3) Here's an idea for cutting the film without marring the backing foil. The film is less than 1/10 micron thick, and is supported on a micron or so of soft organic material. Plastic cutting blades should suffice to produce a line of damage when pressed firmly against the film. The backing foil is perhaps 25 microns thick. Make it of a hard alloy, or surface it with a hard alloy. Where it is pressed against the plastic blades, it can be supported by stretching it over a smooth steel roller. Such a well-supported, hard-surfaced foil should escape damage under these conditions. If not, there are other approaches to cutting the film.

Masking the substrate during film deposition can create holes, separation lines, or bands of thicker material in the film. This flexibility could prove very useful, particularly in squeezing the last bit of performance out of the sail. The masks would add to the number of moving parts in the device, however, and would require a subsystem to clean deposited metal from them.

(4 and 5) As was mentioned, the film's strength is high, but tears are a threat. My experience with handling aluminum films in the proposed thickness range makes me respect their fragility, but they seem rugged enough for the lightsail application (see the comments at JPL, cited above). Space-manufactured plastic films are worth examining, but face problems in achieving adequate strength, formability, and resistance to ultraviolet light all in the same material. Previous designers of plastic film sails have been forced to use fairly thick metal films to protect even thicker plastic films from ultraviolet light.

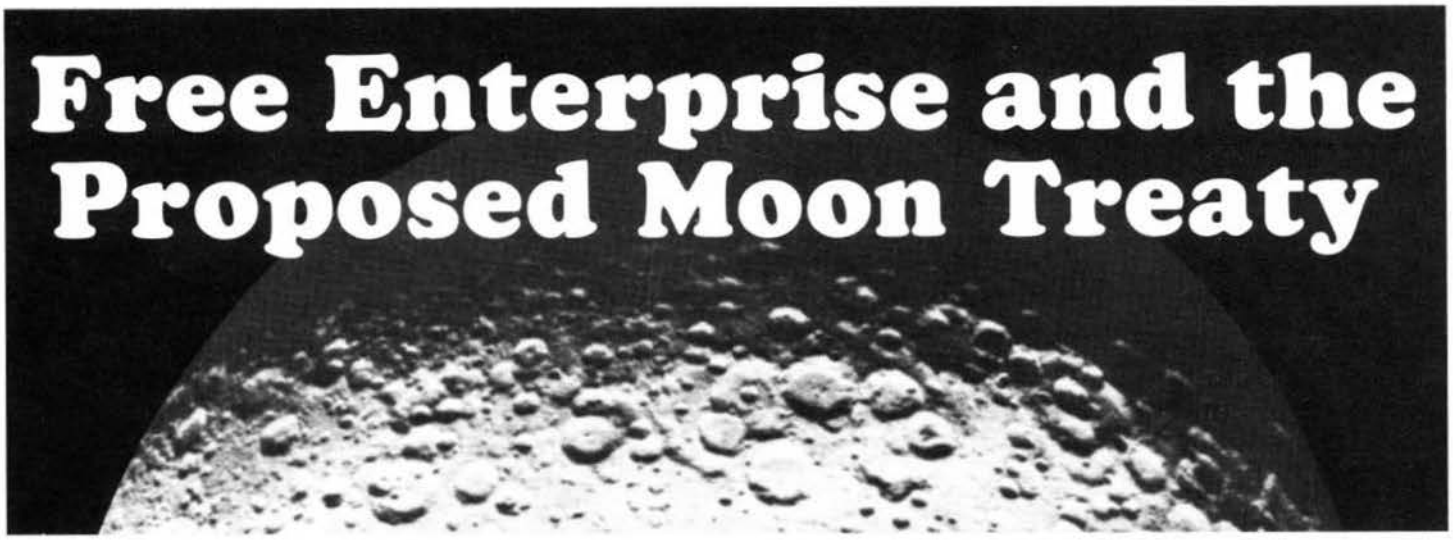
If a monolithic approach to lightsail fabrication proves feasible, a device using the thermite reaction would certainly heat a lot of aluminum in a hurry. While simpler than solar cell and electron beam vapor sources, it wouldn't be lighter for very long. The proposed film fabrication device could make its own mass in film in about a year, while a thermite reaction would leave a larger mass of waste aluminum oxide and metallic iron than of deposited aluminum. Although the mechanical system is more complicated, it is also more efficient, more controlled, and more flexible. Once the production bugs are worked out, this should lead to lower cost, higher performance, sails.

The mechanical system need not work unattended. If it is built from plug-in, replaceable pieces, a remotely operated manipulator could do regular maintenance. Once a high-orbit space station is in place, maintenance will be duck soup.

It will be many years before the last word is in on optimal lightsail design. In the meantime, a sensible development program would examine many options in more depth.

Eric Drexler is currently a graduate student at the Massachusetts Institute of Technology where he is developing the high performance solar sail as the key to inexpensive mining of the asteroids. He founded the MIT Space Habitation Study Group in January 1975. (It may be the oldest pro-space habitats citizen's group in existence.)

Free Enterprise and the Proposed Moon Treaty



Part II

by Art Dula, aerospace/patent lawyer in private practice.

Pro—The Moon Treaty as a Compromise that Allows Scientific Research

Proponents maintain that the Moon Treaty is a working compromise with the U.S.S.R. and the Third World. They stress that the Moon Treaty does not impose a moratorium on either space exploration or experimental use of space resources, pending establishment of an international legal regime to control exploitation of those resources.

This compromise is clearly a concession for the Soviet Union and the Third World, neither of which has the technical capability to exploit space resources, and both of which are immensely fearful of free enterprise. As late as 1974 a leading Soviet international space law expert, A.S. Piradov, used fear of free enterprise and "the intentions of big businessmen" to justify Soviet Moon Treaty provisions forbidding the establishment of any type of property rights in space resources.

"Such detailed enumeration of the legal and physical persons which could potentially claim establishment of a property right over the Moon, is, in our opinion, completely justified. The problem could be especially acute when the exploitation of natural resources has begun on the Moon or in its depths. *The intention of big businessmen in relation to the future use of the Earth's natural satellite is too well known not to take it into consideration.* (emphasis added)"

The compromise Moon Treaty specifically allows all states freedom to use space resources for purely academic purposes, such as the support of missions of scientific inquiry and research. If the U.S.S.R. and Third World are willing to accept U.S. unilateral statements interpreting the Moon Treaty as controlling the Treaty's meaning, then exploitation of space resources to support limited experimental and pilot plant operations may also be allowed prior to the time commercial exploitation of space resources becomes feasible and an international regime is established.

> ***"The intention of big businessmen in relation to the future use of the Earth's natural satellite is too well known not to take it into consideration."***
>
> ***—A.S. Piradov***

It may be suggested that investors could simply call whatever activities they decide to undertake in space or on the Moon "research and development," "experimentation," or "pilot plant operations." Unfortunately, this is not advisable because of differences in the legal consequences of experimental and commercial use. United States tax laws and regulations controlling investment in commercial operations differ greatly from the rules that apply to investment in experimental research or pilot plant operations. Generally, profits from the former are taxed and the latter deducted as expenses. The Internal Revenue Service and United States tax courts have proved themselves equal to the task of classifying investment as spending for legitimate research or commercial operations. If an operation consistently returns a *profit* to its owner, then it is "commercial" for the purpose of U.S. tax and investment law.

United States patent laws also differentiate between commercial and experimental purposes. Issuance of a valid U.S. patent is barred when an invention has been in public use or on sale within U.S. jurisdiction for over one year unless the use was for experimental purposes. Here again one of the touchstones distinguishing public use from experimental use is whether the owner of the invention makes a profit from its operation.

The Moon Treaty, if ratified, would be U.S. federal law and could be enforced by the federal courts. A group opposed to space industry, a foreign government, or even a foreign or domestic corporation that believed the U.S. or a U.S. company was violating the treaty could bring suit to obtain an injunction against the U.S. government, the company involved, or

both to halt the violation. Thus, it is unlikely that a prudent investor would believe that calling profit-making exploitation of space resources "scientific investigations," could be any substantial protection against the legal risks associated with such deception.

It may also be suggested that U.S. industry may be willing, with or without government assistance, to invest in space research and development without making a profit. Actually, it is not necessary, desirable or even rational to assume that the initial exploitation of space resources by free enterprise will be so experimental that it will not make a profit. Economic reality dictates that any lunar venture undertaken by U.S. companies will be designed to make a profit from its very beginning. The hundreds of pounds of lunar samples returned to Earth by the Apollo program have provided qualitative and quantitative data on minerals from several parts of the Moon. These samples are chemically similar to well known Earth minerals. In fact, several commercial processes developed on Earth have already been successfully tested using simulated lunar materials. Because the expense of research and development in space will be vastly greater than the cost of similar works done on Earth, it is virtually inconceivable that a profit-making business would not choose to develop any needed processes for exploiting space resources on Earth. Lunar working experience and bootstrapping will improve and expand space-based processes, but even the very first private endeavor that exploits space resources can be expected to seek an immediate profit from the sale of goods derived from space resources.

Con—The Moon Treaty as a Moratorium on Enterprise Space Activities

The Moon Treaty is very close in spirit and critical language to the 1970 U.N. resolutions on the deep seabed. The following arguments against the treaty are the view of Leigh Ratiner, an expert on the history of the 1970 seabed resolution.

If the United States becomes a party to the Moon Treaty, the opportunities and prospects for private enterprise development of the resources of the Moon and other celestial bodies will be negligible if not non-existent. Specifically, the draft treaty would:

1. create a moratorium on *commercial* exploitation of the resources of the Moon and other celestial bodies, until a second, much more comprehensive treaty for regulating resource activities is concluded;

2. establish guiding principles for the negotiation of this second treaty which are completely antithetical to the commercial development of outer space resources by private enterprise; and

3. thereby give the Soviets or Third World countries tremendous political control over the timing and direction of expanding commercial uses of outer space, as well as the question of whether to permit such uses.

The Administration, particularly the negotiators of this draft treaty, argue that United States public statements to the effect that the treaty does not establish a moratorium negate the implicit moratorium in the treaty. Unfortunately, such a moratorium is now contemplated in the treaty and *underscored* by the U.S. Delegation's statements on the record. However, even if it is conceded that the U.S.'s unilateral statements control the treaty's meaning, the fact remains that no private enterprise, or even a government, is going to invest billions of dollars in developing new commercial applications of space technology if most of the world disputes its legal right to deploy and profit from that technology.

. . . (the treaty) would give the Soviets or Third World countries tremendous political control over the timing and direction of expanding commercial uses of outer space.

It may be asserted that the guiding principles set out in the treaty for constructing the legal regime to control exploitation of outer space resources are empty phrases to be given later meaning. The Moon Treaty, however, must be considered in the context of international law and practice. These phrases all have a very well-defined meaning and have been exhaustively elaborated in other treaty negotiations. Since the Soviet Union first introduced a draft text on the Moon in 1971, the politics of resource development in areas beyond the territorial borders of nations have changed dramatically. The Law of the Sea Conference has moved to near-completion of a treaty establishing a deep seabed resource regime based on virtually identical guiding principles to those contained in the Moon Treaty—for example, that such resources are the "common heritage of mankind," that their development should be orderly and rationally managed, and that the benefits (both financial and technological) should be equitably distributed.

Regardless of whether the Law of the Sea Treaty ever enters into force, the Third World has now developed a very sophisticated position on the content of an international resource regime that best serves its interests. Many informed observers will support the view that this detailed elaboration of these revolutionary new ideas reflect the international custom, practice and consensus as to how so-called "common property" resources are to be regulated, managed and developed.

The draft law of the sea treaty requires the collectivization of resource development through a global monopoly under the political control of a Third World dominated, General Assembly-type body. It restricts the rights of states and private enterprise to carry out activities to that initial period required to fully transfer their technology to the monopoly and fund its operations with their profits. Finally, it provides for international regulation of production levels and prices in order to discriminate in favor of developing countries.

The Antarctic Treaty Parties have also been trying to hammer out an agreement on that continent's mineral resources before the United Nations intervenes. The difficulties experienced in this negotiation are partly caused by the Parties' reluctance to follow the law of the sea precedent and the lack of any other alternative that will satisfy developing country expectations and thus prevent Third World intervention through the U.N. Since private industry knows that the ultimate Antarctic minerals regime may practically deny it access to the resources, just like the deep seabed regime does, no investments are now being made in exploring the potentially attractive offshore hydrocarbon deposits of Antarctica.

In summary, adoption of the Moon Treaty as the basis for negotiating a future resource regime for the Moon and other celestial bodies would borrow from these precedents. There are many other imaginative approaches which would enable the nations of the world to cooperate peacefully in expanding the commercial applications of outer space technology to resource exploration and development. Good examples already exist for commercial utilization of outer space, and there is no reason why the United States should permit outer space resource development to be thrust into a quagmire of political principles derived from the rhetoric of the new international economic order.

In view of the enormous capital and technology requirements contemplated for the future industrialization of outer space,

political stability for investments will be absolutely critical. If this treaty is ratified by the United States, however, any commercial application of outer space technology which involves use of Moon or other celestial resources will be subject to the greatest insecurity imaginable. While the spillover effect for other commercial activities in outer space cannot be fully predicted, it may be very significant.

Specific Negative Implications of the Moon Treaty for Free Enterprise

Paragraph 5 of Article XI of the Moon Treaty obligates State Parties "to undertake to establish" a new regime for resource exploitation "as such exploitation is about to become feasible." One valid reading of this text is that the new regime *must* precede actual resource exploitation. The United States Delegation, however, has stated its interpretation that this provision "places no moratorium on the exploitation of the natural resources on celestial bodies." Yet Mr. Hosenball's statement goes on to explain that:

"This permits orderly attempts to establish that such exploitation is in fact feasible and practicable, by making possible *experimental beginnings, and, then, pilot operations*, a process by which we believe we can learn if it will be practicable and feasible to exploit the mineral resources of such celestial bodies. (emphasis added)"

The United States' effort to preserve its legal rights to engage in resource development under the treaty clearly stops short of full-scale exploitation. Moreover, there is a strong legal inference, arising under paragraph 2 of Article VI and paragraph 8 of Article XI, that *commercially-oriented* enterprises are even barred from engaging in the kind of experimental or pilot operations described in Mr. Hosenball's statement above. The treaty permits the use of resources in "scientific investigations." Thus the issue is the definition of "scientific investigations." To the extent that it excludes research and development activities undertaken by a commercial entity in the hope of future profit, paragraph 2 of Article VI would prohibit such an entity's using resource samples collected from the Moon and other celestial bodies—either for research and development or for the support of its missions. Paragraph 8 of Article XI reinforces this apparent prohibition on the conduct of interim resource activities by states and persons who are not pursuing scientific purposes.

. . . commercial application of outer space technology will be subject to the greatest insecurity imaginable.

It is highly doubtful that the Department of State would support authorization of U.S. nationals to engage in the commercial exploitation of Moon resources prior to agreement on a new international regime, even if it is possible to make the legal case that the treaty does not prohibit these activities. State authorization is required under paragraph 1 of Article XIV (as it is under Article VI of the 1967 Treaty of Principals). An affirmative act by the United States to permit commercial development of the Moon's resources by private entitites would probably require legislation and would be deemed by the State Department as interfering with the international negotiations.

Finally, the practical effect of an international commitment to negotiate a new, unknown legal regime covering Moon and other celestial resources will be to deter industrialists, and probably governments, from spending research and development dollars in related activities during the interim period. The precedent of the U.N. Conference on the Law of the Sea will convince them that Third World demands at the "Moon Conference" are going to be extreme, that existing investments may not be respected under the resulting treaty, and that the industrialized countries may not be very successful in negotiating a system of exploitation that permits commercial or industrial use of the resources under realistic terms and conditions.

Article XI of the Moon Treaty embodies the basic principles to be implemented in the future resource regime. Paragraph 1 established that the Moon and its resources are "the common heritage of mankind," a concept to be interpreted both in the context of the Moon Treaty and the future resource agreement. Yet the common heritage concept has already been the subject of protracted debate in the international community in relation to deep seabed resources and thus is deemed by many nations to have an independent meaning.

For developing countries, "common heritage" means common ownership of the resources and majoritarian control over their disposition. This translates into insistence that no single country, or entity under its control, has the independent right to use the commonly owned resource. Access to the resources must first be approved by the international community on the basis of one-nation, one-vote. As a result, the developing countries would collectively control who is allowed to exploit and use the resource. The concept of the "common heritage of mankind" does not, in the view of the Third World, recognize that industrialized countries with space technology should have a greater voice in regulating outer space resource development.

. . . the Moon Treaty must be clarified to protect our interests or it must be opposed.

Paragraph 7 of Article XI further compounds the future negotiating difficulties of the highly industrialized countries with space technology. First, it establishes the principles of "orderly and safe development" and "rational management" of the Moon and other celestial resources. Most nations of the world interpret these principles as mandating central planning of resource development and international controls over resource uses and or marketing. In short, these principles are the antithesis of a free market approach to the exploitation and use of resources on the Moon and other celestial bodies. Today, many believe that free market economics in the traditional sense will have only a small role to play in space industrialization. Yet it may be short-sighted to concede in a binding treaty that the political will of the majority of nations, rather than market-oriented forces, should dictate the pace and substance of outer space resource development.

Second, the principle of "expansion of opportunities in the use of those resources" will ultimately evolve into a Third World position that access to the Moon and other celestial resources must be limited for industrialized countries, so that developing countries have a chance to participate. (The Soviet bloc can also use the principle to insist that Western and Soviet activities using the Moon's resources be kept at the same level of intensity.) The clearest evolution of this concept is found in the draft law of the sea treaty which creates an international mining monopoly for half of the deep seabed's mineral resources, based on the argument that developing countries can only expand their opportunities to use the resource on a collective and subsidized basis.

Finally, the principle of "equitable sharing of benefits" could be interpreted to require a system of international taxation

of any profits made by commercial resource developers. Since the term "benefits" is not restricted to the financial realm, the principle also dictates mandatory transfer to all countries of the technology used to exploit the resources.

In conclusion, these are not benign or meaningless phrases upon which to found a new international law governing the use of the Moon's resources. Experience in other forums allows us to predict with confidence the implications for resource activities on the Moon and other celestial bodies:

. . . the Moon Treaty is a dangerous and unrealistic abandonment of basic legal rights that free enterprise will need to work effectively in space.

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1. No entity would be permitted to use the Moon's resources in a commercial operation without obtaining authorization from an international organization whose policies and decisions would be made by a U.N. General Assembly-type body.

2. To obtain that authorization, the entity would have to agree to submit a large share of any profits it makes to the international organization and to transfer to other countries on a subsidized basis any technology it uses.

3. Authorization would probably be withheld, if the entity was from a country that was already exploiting Moon resources.

4. Ultimately, no national entity would be permitted to exploit the Moon's resources; instead an international monopoly would be created.

Most of the technological alternatives being considered for the commercial use of outer space ultimately require use of the Moon, and probably use of its resources in one capacity or another. It is particularly important that the Moon Treaty does not attempt to define the term "natural resources." Therefore, it seems reasonable to conclude that, if there is ever to be *any* industrialization of outer space, it will involve commercial exploitation of some natural resource of the Moon or other celestial bodies.

Congressional Testimony on the Moon Treaty

On September 6, 1979 the Subcommittee on Space Science and Applications of the Committee on Science and Technology of the U.S. House of Representatives held hearings during which Congressman Breaux, NASA General Counsel Neil Hosenball, and Leigh Ratiner presented their views on the Lunar Treaty. Ratiner's opinions have been substantially set forth above.

Hosenball reviewed the background of COPUOS at the United Nations and recited a history of the negotiations that resulted in the present Moon Treaty. He discussed the comments that he and previous U.S. representatives placed on the record to represent the official U.S. interpretation of the Treaty.

Congressman Breaux, who was a U.S. congressional advisor to the law of the sea conference, analogized the law of space to the law of the sea. He pointed out that the Moon Treaty is only one of a broad array of evolving "north-south" accords between developed and undeveloped nations. Breaux described and listed numerous close parallels between the Moon Treaty and the 1970 U.N. Resolution on the deep seabeds.

Breaux especially pointed out that unilateral U.S. statements intended to interpret treaty language had not been effective in the past to protect U.S. interest.

"I'm deeply concerned that the Moon Treaty could contribute substantially to the futher erosion of the position of the United States and the other Western industrialized countries. I'm reassured neither by the fact that the development regime for celestial bodies will be negotiated later, nor by the argument that, in the meantime, the United States is protected by its unilateral statements on the record, which have apparently been uncontradicted thus far. I would like to point out that, in the Law of the Sea context, the United States in the mid to late 1960s felt comfortable with a similar situation, that subsequently found that what it perceived to be protections were not protections at all. I would also like to observe that the Moon Treaty contains ambiguities of the same sort that lead to serious difficulties to the United States with respect to the deep seabed.

If the Third World and the Soviet bloc could contend that universally applicable customary law, establishing a binding moratorium (on commercial development of deepsea resources), could spring from a General Assembly resolution, how much more easily could they argue that the same consequences derived from a treaty? Such a position taken by the Third World and Soviet bloc with respect to development of outer space resources could have a seriously adverse effect on a negotiating position on the future exploitation treaty. Investment uncertainties would result and, as this happened with respect to ocean mineral development, the exploitation of outer space resources would be seriously retarded."

Breaux concluded that acceptance of the Moon Treaty is not in the best interests of the United States:

"I believe, Mr. Chairman, that the long-term economic implications for the United States would be extremely adverse, if the United States were to repeat in the outer space context the mistakes committed with regard to the deep seabed . . . I believe that for the United States to accept a kind of situation presaged by the draft Moon Treaty is to invite a serious erosion of our material, legal and equitable position in the international community. Like the Law of the Sea Treaty and the Code of Conduct on the Transfer of Technology, the Moon Treaty must be clarified to protect our interests or it must be opposed."

Conclusions

International law allows sovereign states complete freedom to engage in any activity that is not expressly prohibited by law. Today the U.S. has a perfect right to exploit space resources for profit. The Moon Treaty does not give the U.S. new rights, it only limits existing U.S. rights to use space resources for scientific purposes and takes away the U.S.'s existing right to exploit such resources for profit. It must be stressed that the Moon Treaty does not create even a single new right beyond those the U.S. already enjoys under existing international law. Far from being a fair balance between the needs of free enterprise and the less developed countries, the Moon Treaty is a dangerous and unrealistic abandonment of basic legal rights that free enterprise will need to work effectively in space. The Moon treaty introduces substantial uncertainty and risk for private sector investment in space ventures that would exploit space resources for profit.

. . . the U.S.S.R. and its supporters in COPUOS . . . are executing a careful and deliberate program intended to limit the entry of free enterprise into space.

Space industrialization requires the establishment of realistic laws. To determine what law will be appropriate in space, it is necessary to examine why humanity is expanding into this new environment. Three principal forces, the

academic, military and commercial, interact to impel humanity into space. With the exception of communications, U.S. involvement in space is entirely academic or military. Present space law, including the Moon Treaty, has been forged almost entirely out of high academic ideals in *advance* of any practical commercial reality. True space law, if it allows free enterprise to operate at all, will evolve to meet the needs of practical commercial ventures. In this author's opinion, practical business space law would, if not preempted, evolve shortly after space-based exploitation of basic resources and energy begins to yield substantial profits. History teaches that the transition between academic and practical legal regimes can be gradual or traumatic, but that such transitions inevitably occur.

Ominously, the world now spends more for military purposes in space than for academic studies. The only remaining substantial possibility for free enterprise non-military development of space requires large scale commercial development of basic natural resources, i.e. raw materials and energy from space. Only basic raw materials and energy from space can return a profit commensurate with the capital expense and risk that will be required to start up space industry. Only large scale development of these basic space resources can provide sufficient economies of scale to permit development of space as an industrial frontier by free enterprise capitalism.

Such large capital investments cannot be made without clear legal guidelines that allow commercial operations to exploit space resources for profit. Free enterprise institutions simply cannot make significant investments in space while they are under the threat of suit over treaty terms or ex post facto appropriation of their investments by a nebulous future international regime.

Finally, it is clear beyond reasonable doubt that the U.S.S.R. and its supporters in COPUOS have and are executing a careful and deliberate program intended to limit the entry of free enterprise into space. Since the U.S.S.R.'s introduction of the draft Treaty of Principles in 1962, the Soviet Union and its allies have fought constant delaying actions to chill free enterprise investment in space as a new industrial environment. It is an unfortunate commentary on the will and vision of the United States and other Free World nations that the U.S.S.R.'s program has been so successful.

An annotated, updated version of this article will be published in the Winter 1979 **Houston Journal of International Law.**

L-5 Board of Directors member, Hon. Edward R. Finch Jr., speaks out in favor of the Moon Treaty:

As the L-5 NGO (non-governmental organization) delegate to the United Nations, I write to advise concerning the new Moon Treaty currently before the UN General Assembly. I have followed the draft treaty on the Moon and other celestial bodies (UN Doc. A/34/20) for the past seven years it has been under discussion in the UN Committee on Peaceful Uses of Outer Space (COPUOS). Careful review of the proposed Moon Treaty indicates the following:

1. As pointed out by US Delegate Hosenball in UN Doc. A/AC.105/PV.203, dated July 16, 1979:

"The draft treaty, as part of the compromise by many delegates, places no moratorium upon exploitation of the natural resources on celestial bodies pending establishment of an international regime. This permits orderly attempts to establish whether such exploitation is in fact feasible and practical by permitting experimental beginnings and then pilot operations, a process by which we will learn if it will ever be feasible to commercially exploit the mineral resources of celestial bodies. My Government will, when and if negotiations for such a regime are called for under Articles XI and XVIII, make every effort to see that such a regime is successfully negotiated."

Further, this in no way detracts from scientific research utilizing celestial bodies' resources by anyone.

2. It must be remembered that the general principles of the 1967 Outer Space Treaty, e.g., the freedom to explore and use outer space, including the Moon and other celestial bodies, remain applicable. The US has made this clear before COPUOS, UN Doc. A/AC.105/PV.203:

"In regard to the matter of the Moon Treaty's relation to the 1967 Outer Space Treaty, discussion in this Committee resulted in no statements to the effect that the Moon Treaty is intended to weaken in any way the provisions of the 1967 Treaty. In this light, and taking into account the last two paragraphs of the Moon Treaty, there was a feeling that a nonderogation provision in the Moon Treaty would be superfluous .... Our delegation accepted this view and joined in the consensus on the Moon Treaty with the understanding that it in no way derogates from or limits the provisions of the 1967 Outer Space Treaty."

3. The proposed treaty in Article VII contains important protection of the environment. To quote Mr. Hosenball again:

"The Committee agreed that Article VII is not intended to result in prohibiting the exploitation of natural resources which may be found on celestial bodies other than Earth, but rather that such exploitation will be carried out in such a manner as to minimize any disruption of or adverse effects to the existing balance of the environment."

The L-5 Society should encourage informed debate on the interpretations of the proposed treaty. To be avoided are hasty interpretations, inappropriate analogies and unwise political action tending to diminish L-5's role in advancing activities in outer space.

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4. Organizational models for the exploitation of space resources continue to be designed. The proposed treaty does not favor or prohibit any single set-up. An INTELSAT-type enterprise, for example, would be completely permissible under the terms and would provide the opportunity for an "equitable sharing of benefits." A system of international taxation of any profits is not required. Nor is a mandatory transfer of technology dictated by the terms of the proposed treaty.

Participation by US industry could be through a COMSAT-type organization. As is well known, COMSAT acts as manager for the INTELSAT global communications system. The opportunities and prospects for private enterprise, working through such organizations, are enhanced by mutual cooperation under the proposed treaty, not diminished. In addition, such arrangements would certainly include provisions for the recovery of costs.

5. No presumption should be made that an entity, such as the proposed International Seabed Authority, is desirable for the Moon. Quite the contrary, the model

for success in space enterprises is INTELSAT which by its business-like approach offers to all nations the benefits of (i) opportunities for participation and (ii) decreasing costs in domestic and international communications.

6. Further consultations as provided in the treaty are not anticipated for at least eight years as scientific research and pilot projects would have to continue for a considerable period before the possibility of commercialization arose. Commercialization should be discussed more appropriately when feasibility has been proven and solar power systems, space manufacturing facilities, and even small space habitats are more practical realities.

7. With regard to the "common heritage of all mankind" language is used in the treaty, three points need to be made. First, it is to be noted that the phrase is not "common province" as stated in the 1967 Outer Space Treaty. There is considerable consensus that the distinction is declaratory only and the subject is discussed at length in a recent article on semantics and decision-making in the **Journal of Space Law**, Spring 1979.

Second, no consensus has been reached on the meaning of "common heritage" and "common province" in the international law of outer space. And finally, recourse to law of the sea rhetoric should await conclusion of that treaty and successful development of seabed resources. Lessons on what to avoid are more likely from law of the sea experiences, rather than actions to be duplicated for the Moon and other celestial bodies.

Conclusion

The Committee on the Peaceful Uses of Outer Space has already produced by consensus five treaties which have been ratified by the US and which have made exemplary progress in the law of outer space. This treaty seems most appropriate, considering the rapidly advancing science for the use and development of resources from space for the benefit of all mankind.

The L-5 Society should encourage informed debate on the interpretations of the proposed treaty. To be avoided are hasty interpretations, inappropriate analogies and unwise political action tending to diminish L-5's role in advancing activities in outer space.

In particular, it is my feeling that there should not be "quick . . . political action in Washington" with regard to defeating this treaty before the US Senate as suggested by Leigh S. Ratiner in his letter of August 15, 1979.

The Soviet Union, by its Delegate Kolossov, indicated before COPUOS that his delegation would "make no hasty interpretation of the meaning behind each article of the draft agreements, its possible impact on further developments in international cooperation in outer space, or its potential impact on the further development of international space law." UN Doc. A/AC.105/PV.203. The writer supports this view as do many other outer space lawyers. Hasty analogies to the law of the sea can result in misleading presumptions and conclusions. Lawyers who have worked in *outer space* international law understand the dangers in attempting the application of analogies from elsewhere to the unique space environment.

The Senate may vote on the proposed Treaty as early as January. You can write to your Senator to express your views at the following address:

U.S. Senate
Washington, D.C. 20510

L-5 Speaks to DOE: There's an SPS in Our Future

by Annita Harlan

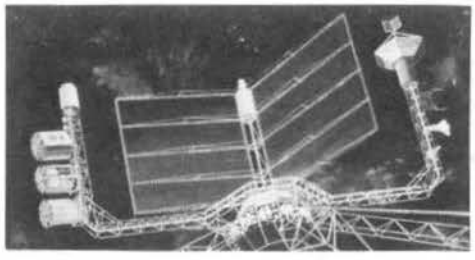
Your voice is being heard.

In October the Department of Energy received a report of last May's Solar Power Satellite questionnaire sent to L-5 members. The questionnaire asked members what they thought of the SPS concept, their opinion of the U.S. government's conduct of the SPS program, about the adequacy of designs and of impact studies already accomplished or underway, and for personal information intended to illuminate the nature of the SPS-interested public.

In all, 850 replies were received from the membership. This was considered a gratifyingly large response by PRC Systems Sciences Co. which is coordinating the public interaction program for DOE.

Carolyn Henson and Annita Harlan analyzed a random 10% of the responses, the whole of replies from women (only 72), and the detailed comments of especially knowledgeable members who had examined the background documents prepared by DOE.

The input of the participating public groups: L-5 Society, Forum for the Advancement of Students in Science and Technology, and Citizen's Energy Project, has been focussed into about 40 questions from the concerned public for DOE consideration. These will be sent by PRC to target experts within DOE for their detailed response. These questions, which showed the depth of information and interests of the memberships, will be reported in future **L-5 News** issues.



The message of L-5 to DOE:

— Solar power satellites look like a prime option for future energy needs.

— Private enterprise will be interested in SPS.

— The U.S. government should have a supportive and regulatory hand in the project.

— International involvement means complications for sure, but possible rewards for Earth as a whole.

— The new Moon Treaty could severely inhibit use of extraterrestrial materials.

— The Reference Design needs major revisions.

— There's going to be Big Trouble if environmental and social impacts are not calculated into the cost/benefit analysis for SPS development and deployment.

— If SPS is going to increase centralization of power, it better provide big rewards — like clean, cheap power.

— Earth resources should not be depleted.

— SPSs have military implications; that's good, and that's bad.

— SPS is a steppingstone to the stars.

Shuttle Express

How much will it cost to use the shuttle?

by Ed Bas

My first plane trip (and it wasn't terribly long ago—I led a sheltered life) came by way of a marvelous creation called the "student standby." I got from Michigan to California for less than $200, round trip, with the added adventure of not knowing for sure when I'd arrive. That made it all the more exciting. At least it did when I was 17 years old.

You can't fly standby anymore, but you can send a package that way aboard the Space Shuttle. You stand to save a bundle on the first shuttle flight if you're not particular about when you fly and have a small self-contained payload. The bargain basement rate: $50 per pound. Other U.S. agencies and participating foreign governments would pay $247, and "all others" would pay $292.

If you're in that latter category and in a hurry, you could pay up to $389 per pound.

The U.S. Department of Defense is guaranteed a lower rate ($187 per pound) not in the national interest but because D.O.D. has its own space launch system—in other words, competition is keener.

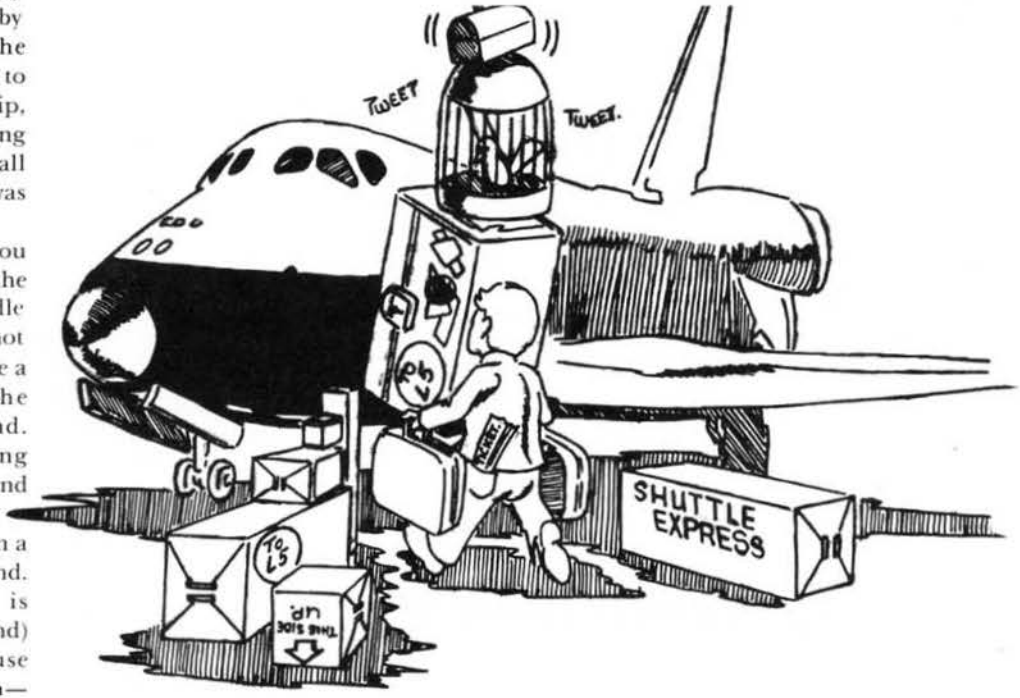
Why the differences? It's the old law of supply and demand. If you're in a hurry, you have to be willing to pay. If your package is larger or heavier than the minimum, you'll have to pay for that, too.

But William A. Jordan, of New York University, writing in the **Journal of Contemporary Business,** points out some possible flaws in the shuttle's pricing policy.

NASA, Jordan states, is in business to encourage fullest use of the shuttle, yet "as a matter of national policy, Space Transportation System (STS) operations must charge fees which cover the costs." Those two policies can be inconsistent and even contradictory, according to Jordan. One flaw is the lack of regulation by demand. If NASA reaps a windfall business, who pockets the profits—the public, or industry through lower future rates?

And if it takes in enough, does NASA get hit with even further budget cuts down the road?

NASA also may have made the mistake of holding the prices consistent, at least through 1983. Adopting the fixed price schedule for shuttle flights during the first few years could encourage potential users.



Artwork by James Babcock.

Of course, this naturally only applies to price increases—no customer is going to complain if the price is dropped, but it might raise a few eyebrows in the federal Office of Management and Budget.

Jordan suggests that NASA could have refrained from announcing any price schedule at all—"instead, negotiate separately with every potential user for each dedicated or shared-flight payload." This is known as perfect price discrimination, but could easily have political repercussions over who is charged what.

An even more complicated "multipart pricing" could be charged to more accurately reflect future demand. This would reduce the present 5% minimum load factor (the smallest percentage of the total shuttle payload capacity, outside of the "Getaway" that NASA is willing to sell) now required for shared flights. Instead of the huge financial leap between a "Getaway" and the present minimum $1 million charge for a standby payload, a 1% payload for "only $258,000" might be established.

The figure is Jordan's, but clearly shows an outlet for industry and yet incentive enough (a 25% savings) to go to the larger 5% load. Or the 5% could be contracted for initially by a large company and spread over several flights to get around that 5% one-shot figure.

Regulation of the monopolist might come later. The word has a sour connotation to most Americans, and with good reason. A monopolist controls its prices. A customer has nowhere else to turn. But if there's a justification, it's that NASA won't be twisting any arms. It will be the lure of profits that encourage use of the monopoly.

The other point is that NASA will hopefully have a short-lived monopoly Any changes in its present pricing policy could just make money but could also backfire by limiting future markets. Hopefully, competition is not far off—one sure way to break the monopoly. Until then and until we have a number of space-going firms to draw upon (Orion, Ltd., Luna Enterprises?), we have to give NASA the reins to get the most from its position.

NASA Vindicated

by Carolyn Henson

October 16 a Carter-appointed team investigating shuttle delays and cost overruns turned in their verdict: the shuttle program is healthy, faces no currently unsolvable problems, and is run by competent people.

So who's the villain behind shuttle problems? Carter's team fingered chronic underfunding caused by penny-pinching politicians which have kept NASA living hand-to-mouth, unable to tackle the problems they've seen looming on the horizon. The team found that shuttle delays were a consequence of having to stretch out development in order to remain within yearly budget constraints.

Space shuttle delays and cost overruns had inspired Carter to appoint a three-man team to investigate NASA management. The members of the team, retired Vice Admiral Levering Smith (former director of Strategic Systems Projects), William A. Anders (Apollo 8 astronaut and General Manager, Nuclear Energy Products Division, General Electric) and Dr. Robert A. Scarpie (President, Cabot Corp. and former President, Bell and Howell), each worked independently of the others. But they all arrived at essentially the same conclusions.

In testimony before the House Space Science and Applications Subcommittee the morning of October 18, NASA Administrator Robert Frosch reported on the shuttle: 10% chance of flying by next April, 50% chance by July, and 80-90% by September. That afternoon Carter's study team reported, recommending that NASA give more attention to the needs of shuttle users. In response, Frosch has already set up a new Office of Space Transportation Systems. He expects to appoint its head by mid-November.

This recommendation came as a relief to NASA-watchers who had been apprehensive about rumors that shuttle operations might be moved into the hands of the people who brought us Amtrack. Carter's team's recommendation to run shuttle operations within NASA is a vindication for a long-embattled agency which has, since 1971, had 40% of its employees forced out by budget cuts.

On November 5th, Frosch will report the findings of Smith, Anders and Scarpie — that NASA's problem is lack of money — to Jimmy Carter.

Studying Flares From Space

by Joseph Rothenberg

Reprinted with permission from Grumman Aerospace ***Horizons*** *Magazine, Volume 15, No. 2, 1979.*

A significant boost to the worldwide effort to probe solar energy processes during the present solar maximum will come from the Solar Maximum Mission (SMM) observatory satellite, or "Solar Max." In a program managed by the NASA-Goddard Space Flight Center, Solar Max is scheduled to be launched into Earth orbit on January 31, 1980.

The only space platform devoted to studying the physics of solar flares in the 1979-81 period, Solar Max will be operating cooperatively with other ground and space observatories during the International Solar Maximum Year.

In its 300-mile-high orbit, Solar Max will provide scientists with their primary vantage point. Its integrated package of seven different experiments . . . will operate in selected wavebands, letting us . . . focus in on flares.

The reason for our fascination with flares is that they represent an enormous, very rapid release of energies measured in ergs, approaching 10 to the 30th power *(or 100 times the total annual electric power demand of the U.S. today).* While SMM observations will aid solar-terrestrial studies, our project scientists will be primarily concerned with exploring such mysteries as: Where in the solar atmosphere do these bursts of energy originate? How is the energy built up or stored? What triggers its release and propagation out through the Sun's atmosphere to the region of the Earth and beyond?

In its 300-mile-high orbit, Solar Max will provide scientists with their primary vantage point. Its integrated package of seven different experiments—the specific strength of Solar Max—will operate in selected wavebands, letting us monitor active regions and focus in on flares.

Several theories attempt to explain the fundamental energy-release process of flares, and Solar Max is "open-minded" to all. Here's what many scientists tend to postulate: First, a buildup of a very intense magnetic field in an active region. Then, in time, more and more energy is built up until the field is *annihilated*—fieldlines break up and reconnect in different, less-energetic forms, creating transitory electric fields of great intensity.

Electrons accelerated by these fields rapidly heat up the normally hot and energetic solar atmosphere over the active region to enormous temperatures (10-20 million deg K). The atmosphere re-emits the energy as radiation in various wavebands in the gamma-ray-to-infrared range. But sometimes so much heat is built-up that radiation alone cannot release it fast enough. That's when the energy induces *mechanical movement* of the solar atmosphere. A shock front forms, plowing a hot, magnetized plasma of charged particles—electrons, protons, and atomic nuclei—ahead of it, accelerating them to nearly the speed of light.

Most significant to flare science are the X- and gamma-rays and light emitted in atomic lines of the electromagnetic spectrum, visible only to instruments such as those carried on Solar Max. It is through these "windows" that we will be looking into the various layers of the solar atmosphere for tell-tale changes that may at last reveal the mysteries of the solar flare.

Grumman's role in SMM is to plan and conduct the flight and ground operations required for the satellite to achieve its objectives. Our contract with NASA runs for one year after launch—the planned life of Solar Max.

Once Solar Max has been launched, all mission operations will be conducted from two buildings at Goddard: the Operations Control Center (OCC) and the Experiment Operations Facility (EOF). The OCC will house most of Grumman's 22-member team which will manage all the observatory's operations in orbit. It will be up to the Grumman controller to decide when and how to uplink new mission sequences to the satellite and when to command its tape recorders to "dump"

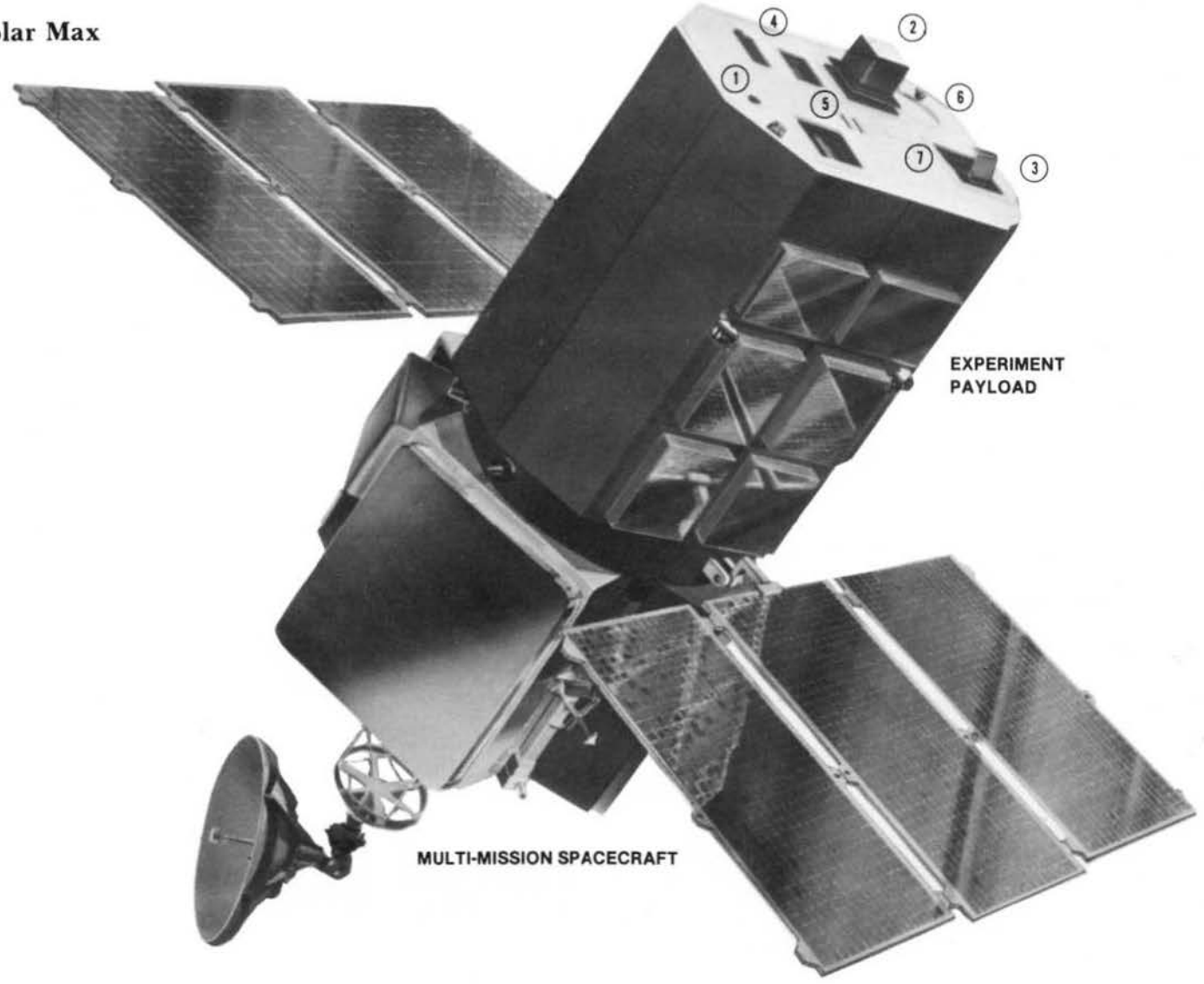
their data back to Earth.

Using SMM data and inputs from ground observatories worldwide, the seven principal investigators will jointly take part each day in 10 to 12 Solar Max orbits (90 min. each) of coordinated science. At their own computers in the EOF, they will receive both ground-based and satellite data in near-real time—the fastest response ever provided for this type of scientific mission. They will use the data to predict events on the Sun over the next 24 hours, adjusting the experiment program accordingly.

Grumman engineers in the EOF will help the experimenters plan the joint science program for each following day. We will control optimum pointing of the experiment payload, develop command sequences, and monitor the condition of the instruments during each contact with the satellite. Solar Max has a minicomputer brain of its own, but it needs a little prompting to know how to cope with the transitory explosive events that characterize the active Sun.

Some key Solar Max Mission firsts: first flight of the NASA-Goddard Multimission Spacecraft (MMS); first satellite to use NASA's Tracking Data Relay Satellite (TDRS) to be launched in 1980; and first spacecraft designed to be retrieved and returned to Earth by the Space Shuttle for refurbishment.

Solar Max



1. **Active Cavity Radiometer**—(R.C. Willson, Jet Propulsion Lab) Purpose: To measure Solar Constant with an accuracy of one-tenth of 1 percent. Spectral range: UV-IR.
2. **Coronograph/Polarimeter**—(R. MacQueen, High Altitude Observatory) Purpose: To study transient ejecta from Sun; relate coronal magnetic field and plasma density. Spectral range: 4435-6583A.
3. **UV Spectrometer/Polarimeter**—(E. Tandberg-Hanssen, MSFC/GSFC) Purpose: To study deposition of energy in lower temperature domain. Very-high resolution device monitors Sun's magnetic fields to detect any rapid changes in field where flare went off. Spectral range: 1100-3000A.
4. **X-Ray Polychromator**—(L.W. Acton, Lockheed Palo Alto Res. Lab; J.L. Culhane, Mullard Space Science Lab; and A.H. Gabriel, Appleton Lab) Purpose: To study energy-release processes in flare plasmas over 1.5 to 50 million deg C. Looks at many X-ray spectral lines and produces images representing how much energy is deposited in a specific line and what its temperature and density are. Spectral range: 1.4-22.4A.
5. **Hard X-Ray Imaging Spectrometer**—(C. de Jager, Utrecht) Purpose: To obtain high-resolution imagery of flare processes—determine where energy is deposited, at what height, and over what area—during flare's life. Also serves as an onboard flare finder. Spectral range: 3.5-30 KeV.
6. **Hard X-Ray Burst Spectrometer**—(K. Frost, Goddard Space Flight Center) Purpose: To provide first alert of a flare. Measures how much hard X-ray energy has burst out of Sun's magnetic field, which determines subsequent changes in flare plasma. Spectral range: 30-300 KeV.
7. **Gamma-Ray Spectrometer**—(E.C. Chupp, Univ. of New Hampshire) Purpose: To study gamma-ray-emitting accelerated particles in flare; determine presence and distribution of nuclides as an additional indicator of intensity of flare's energy. Spectral range: 0.3-17 MeV.

The L-What Society?

We recently received the following letter:

With reluctance I am renewing my L-5 membership. I have found the **L-5 News** uninspiring and as I stated in an unanswered letter to the editor most of the information printed can be found in **Popular Science**. Aside from the fever induced by the idea of space colonization nothing much else is emanating from the society's official organ. Nothing dynamic. No action. No fire. "Meanwhile Soviet cosmonaut trainees were growing cabbages as big as ..."

But who knows? This may be the year that L-5 advertises its existence. I can see it now! (fanfare with increase in tempo) Membership forms appear with ads in major magazines. Well known L-5 members appear on the Tonight Show. Bumper Stickers appear "Aerospace Needs L-5" "L-5 Means Jobs" etc. etc. etc. People stop asking "The L-What Society?" As membership forms come flooding in a new political force emerges in America. A force capable of influencing what is done with the space program. People coming to L-5 speaking engagements send money flooding into the society's coffers swelling those funds donated by big business! (crescendo) the L-5 Society becomes a power!

Will it happen? Huh? Will it? Huh? Huh? (Voce Belushian)

Noooooooo! The talents of famous members will go unused. The Society will remain obscure and people will continue to ask "The What Society?". Worst of all the **L-5 News** will continue to print "NASA Report on How to Cook Sausages in Space" instead of "How L-5 Pressured Congress Into Appropriating Funds for Earthport facilities in the Mohave."

M.A. Leptuch
Lakeview Terrace, CA

Perhaps the following report on recent L-5 activities will give M.A. Leptuch new hope:

L-5 Sparks Moon Treaty Opposition

by Carolyn Henson

Only 3 weeks before the now-controversial 1979 draft Moon treaty was scheduled for a Congressional oversight hearing on Sept. 6, the L-5 Society's Legislative Information Service swung into action.

We had learned that Rep. Don Fuqua's Science and Technology Committee planned to hear pro-treaty testimony only. Committee staffers seemed apathetic about portions of the treaty we saw as serious roadblocks to space development. So veteran Washington lobbyist and law of the sea expert Leigh Ratiner, whom the L-5 Society has retained for political advice, urged us to turn on the talents of Legislative Information Service participants. Within a few days of mailing an appeal to them we had enlisted a small army of grassroots lobbyists.

Bob Stern, a Gainesville lawyer, was one of the heroes of the "wake up Science and Technology Committee" campaign. He is strategically located in Committee Chairman Don Fuqua's district and is an active worker in Fuqua's Democratic Party. At Ratiner's advice Stern put together an alliance of other party stalwarts and began educating Fuqua and staff about the Moon treaty.

Dr. Larry Wolken, a researcher at Texas A&M University, is another example of an effective worker. While not located in the district of any Committee member, he was able to convince his Rep. Graham to urge Fuqua to allow the L-5 Society to testify on the treaty.

Robin Snelson, editor of **Future Life**, and Kathy Keeton, publisher of **OMNI**, both used their clout as media representatives to impress Fuqua's committee with the need to hear the L-5 testimony.

Leigh Ratiner played a major role with his legal research into the treaty and by advising L-5 people on how best to influence Congress. He also enlisted the support of an old ally from the law of the sea battle, Rep. John Breaux, Chairman of the Subcommittee on Fisheries, Wildlife Conservation and the Environment.

We made a team the Science and Technology Committee couldn't ignore. The Sept. 6 oversight hearing kicked off with Chief Negotiator Neil Hosenball's testimony. While he, as expected, supported the treaty, it was a case of "damning with faint praise." Then the L-5 opposition moved in. Leigh Ratiner took the witness stand, backed up by space researcher and former L-5 President H. Keith Henson, who was there to field technical questions. Ratiner was followed by Rep. John Breaux, who warned that "for the United States to accept the kind of situation presaged by the draft Moon treaty is to invite a serious erosion of our material, legal and equitable position in the international community."

The Sept. 6 hearing is having its repercussions. Shortly thereafter Committee Chairman Don Fuqua and ranking minority member Larry Winn sent a letter to the State Department demanding to know how the Moon treaty could be in the interests of the United States. Dozens of Senate staffers are now studying Ratiner's and Breaux's testimony and preparing for the real battle when Carter asks the Senators to ratify the treaty.

The September 6 hearing was a breakthrough for the L-5 Society. For the first time we fielded official representatives at a Congressional hearing. But this was just our first step. The Moon treaty must be either defeated or amended. If we fail, space will become the home of Big Brother. But if we succeed, we will demonstrate that those of us who plan to live and work in space are a people whose strength cannot be ignored.

What are the next steps?

U.S. citizens can alert their senators on the Moon treaty. Write to them c/o U.S. Senate, Washington DC 20510. Your senator can be especially helpful by complaining about the treaty to Foreign Relations Chairman Frank Church. And if the treaty goes to the floor of the Senate for ratification we will need 34 senators on our side in order to block it.

We would appreciate it if you would send copies of your letters and the senators' replies to both the L-5 Society and Leigh Ratiner, c/o Dickstein, Shapiro and Morin, Tenth Floor, 2101 L. St., Washington DC 20037. We need this information so we can keep track of the senators' positions on the treaty.

The L-5 Board of Directors has set up a study group to develop an alternate Moon treaty which will guarantee the rights and liberties of space settlers, protect and encourage developing nations in the use of space, and ensure the rapid development of the resources of space.

It falls to the L-5 Society, as the organization of the top researchers and space law experts of the world, to take the lead in the development of space. But in order to do that we need your help. If you wish to get further involved, write in to the L-5 office, 1620 N. Park, Tucson, AZ 85719 and ask to be added to the Legislative Information Service.

Do our children receive an Earthbound education? Teach them that space is in their future.

Space Colonization In The Classroom

by Lawrence C. Wolken

Artwork by Robert Cannon

Since the early part of this decade, public interest in space has seemed to decline. The major problem facing space enthusiasts is, "How can the general public be made aware of the potential benefits of space?"

Few people have turned their attention to the public schools as a solution to this problem. An ideal place for the study of the potential benefits of space is the American history classroom. This is a course that must be taken by every student in the country. This provides the broadest possible exposure for information about space. It utilizes an information distribution system which already exists, eliminating the problems of developing and implementing a new system. Since it is unlikely that American history will ever be dropped from the school curriculum, this approach, once begun, could continue indefinitely. Since the course lasts at least one semester (approximately 15 weeks), it allows for a relatively long period of exposure to space information. But the success of this program depends on showing history teachers how this approach will benefit them. Their enthusiastic support is essential.

History is one of the most difficult subjects to hold the student's interest. Supposedly, we study history so we will not repeat the mistakes of the past. However, it is often difficult to see how the problems of several hundreds of years ago relate to those we face today. Space can help bridge this gap between the past, present, and the future while at the same time keep students interested in their history class.

Some of the parallels between the past and the present should come to mind quickly. Columbus and other explorers were financed by governments. The same is true for the U.S. and Soviet space programs. The New World produced many resources and untold riches for the Old World. Will space, through solar power satellites, provide the world with the energy it so desperately needs? What other presently unknown riches does space have to offer us? The early colonies in America were financed through private investments by companies seeking to make a profit. Will the first space colonies be financed by private or public funds? This is a question being hotly debated in Congress today. These are just a few of the more obvious similarities between the past and the present. Many other parallels exist but are less well known.

An ideal place for the study of the potential benefits of space is the American history classroom.

Prince Henry of Portugal built a shipyard to develop new types of sailing ships which could sail in the open waters of the Atlantic Ocean. He also started a special school for navigators where they experimented with new methods of navigation, maps and instruments. How different is this from the NASA centers, the training of astronauts, and the development of the aerospace industry?

Beginning in the latter part of the fifteenth century, many European nations were interested in finding a new route to the riches of Asia. The ensuing period of exploration and discovery was dominated by two countries, Spain and Portugal. Spain concentrated its efforts in a westerly direction while Portugal sent its explorers around Africa. Also emerging during this time period were national rivalries as strong monarchs competed for national power and prestige.

A similar situation is occurring in the twentieth century. In this early stage of the exploration of space, the United States and Soviet Union are the dominant countries. The Cold War between the two world powers played an important role in the

race to the Moon during the 60's. Will America and Russia lose their world leadership positions just as Spain and Portugal did? Will Germany, Japan, and China, through efforts in space exploration and colonization, emerge as the dominant nations of the future?

During the American colonial period, England practiced a system called mercantilism. Colonies were viewed as a means of increasing England's power by increasing its wealth. The mother country developed manufacturing and established monopolies in foreign trade so it could accumulate gold and silver through a favorable balance of trade. The colonies were viewed as a readily available supply of natural resources and a market for manufactured goods. The resulting restrictions placed on the colonies eventually led to the American Revolution. When the United States establishes its first space colonies, will we repeat England's colonial policies? Will the United States be the "mother country" of the next American Revolution?

Today's generation of students may become the first inhabitants of space colonies. What type of government will be set up in the colonies? Will a constitution similar to that of the U.S. be adopted? Can future space colonists benefit from America's two hundred years of experience and draft a better constitution? Many of today's students may very well face this question during their lifetime.

Using space in American history classes has been the topic of several teacher workshops conducted in Texas this year. The participants have been very enthusiastic about the idea. Teachers need to be exposed to this approach and to the wide variety of materials available for classroom use. For further information about incorporating the exploration and colonization of space into history classes, contact:

Dr. Lawrence C. Wolken
Center for Education and Research
in Free Enterprise
Texas A&M University
College Station, Texas 77843
713-854-7722

For those who sincerely want to develop a greater public understanding of space and its potential benefits, the history classrooms of the nation offer a golden opportunity. This will not yield immediate results but its effects will be widespread and long lasting. Today's students will be tomorrow's voters and will help shape the nation's goals. Perhaps the most important decision they will face is whether humankind will venture into space or remain bound to the Earth's surface.

Book Review

Enterprise, Jerry Grey, William Morrow & Co., 1979
Reviewed by Carolyn Henson

At last—an insider's view of the people and events behind the space shuttle! Author Jerry Grey, Public Affairs Director of the American Institute of Aeronautics and Astronautics, has been either personally involved or close friends with nearly every who's who of the modern space era. He gives us the inside stories on space colonization pioneers Gerard K. O'Neill, Tom Heppenheimer, "Mother Earth" Henson and covers the formation of the L-5 Society. He details the politics and corporate warfare that gave birth to the space shuttle design and points the finger at the Senators and scientists who tried to kill the shuttle.

Political activists will be fascinated by Grey's blow by blow account of the creation of NASA and the ups and downs of the Apollo program. Besides crediting the obvious stars, Presidents Kennedy and Johnson, Jerry Grey's **Enterprise** brings to light previously unsung heroes such as committee staffers Glen Wilson, Jim Gerhig and Charles Lombard.

Those of you who are hardware fans will enjoy the detailed accounts, complete with diagrams and artist's conceptions, of how historically important design decisions were made. Why did Apollo use the lunar rendezvous? Why is the shuttle a delta-wing lifting body? Grey explains so clearly that even nonengineers can appreciate the design process.

Grey writes with a remarkable sense of humor and shows the people behind the space age as warm and genuinely human. You won't be able to put down his book until you've read it all, especially if you wonder if you're in it (hint: check the index).

I must make a confession before signing off on this review. Grey shows the L-5 Society and myself in a remarkably sympathetic light (he's one of the earliest L-5 members, by the way). So I'm clearly biased. But if you can find **Enterprise** at your local bookstore (raise heck with the manager if you can't!) just open it at random and start reading. You'll be hooked.

Enterprise, a hard cover book, can be ordered from the L-5 Society for $10.00 each plus $2.00 shipping and handling. Mail orders to L-5 Society, 1620 N. Park, Tucson, AZ 85719

Reading News

Apollo:
Ten Years Since Tranquility Base

Edited by Richard P. Hallion and Tom D. Crouch. Available from Smithsonian Institution Press, Box 1579, Washington, DC 20013, $6.95 paper, $17.50 cloth.

On the tenth anniversary of that historic voyage for all mankind the Smithsonian Institution's National Air and Space Museum has created this collection of essays about the Apollo program which attempts to put it in a historical perspective from the vantage point of a decade later. Written by experts in the fields of astronautics, history, art and public policy, the sixteen essays outline the mammoth effort required to reach the Moon. Even more important, is the discussion of the ultimate benefits of the mission: the scientific harvest reaped from Apollo 11 and the five subsequent Moon landings; the growth of human knowledge; and the general benefits to humanity.

Space Trek:

The Endless Migration

by Jerome Clayton Glenn and George S. Robinson. Warner Books, $2.50.

By 1992, there should be 10,000 people working and living in outer space — in an environment complete with trees, birds and rivers! We have the means, NASA's Space Shuttle Enterprise, and the ways, detailed here in photographs, drawings, charts and diagrams. All that remains to be settled are the debates (political, economic and philosophical) that continue to rage, before we can embark on the greatest adventure of the 20th century. **Space Trek** examines these provocative questions: Do we chance a real "Star Wars" in our race to outer space? Are there urgent reasons for us to undertake such a vast project? What are the risks to the pioneers? Who will be the first to go? The answers are here in this blueprint for a new era: **Space Trek**.

NEWS BRIEFS

Veteran space sciences foe, Rep. Boland (D-MA), is still trying to kill the Jupiter Orbiter Probe, now renamed Galileo. A combination of shrinkage in the weight the Shuttle is expected to be able to launch and growth in Galileo's expected weight have forced researchers to separate its experiments into two launches. Boland says that makes Galileo a new project, which would require a special approval from all four congressional subcommittees overseeing it- one of which Boland chairs.

NASA is expected to resubmit Galileo for approval shortly. In the interim, a House/Senate conference committee has authorized NASA to continue work on Galileo.

How bad are Shuttle thermal protection tile problems? Seven percent of all tiles failed the recent "pull test" which checked their bonding to the orbiter.

A better tile is under development for the next orbiter, 099.

The first flight of Ariane, the European Space Agency launcher, is scheduled for a date between Dec. 8-18. Ariane has been developed at a cost of $660 million, about 1/10 that of the space shuttle. Ariane, unlike the shuttle, will not carry people but will be capable of delivering 1.26 tons to geosynchronous orbit. This compares with 1.8 for the shuttle. Ariane is expected to offer slightly cheaper launch costs than the shuttle.

Ariane's first commercial payload will be Amsat, a satellite developed by and to be used by radio amateurs. Launch is scheduled for March 1980.

An improved Ariane, scheduled for 1983, will be able to loft 2.3 tons into geosynchronous orbit.

The Space Shuttle is expected to get the extra funding needed to fly by at least fall of 1980. The reason? Carter needs Shuttle capabilities for verification of Soviet military strength under Salt II.

How bad are Shuttle cost overruns? According to NASA, in 1971 FY dollars the project has expended $6.115 billion, 18½% over the original expectations.

Staunch R&D and space program defender, Sen. Adlai Stevenson (D-IL), has announced that he is "available" for the Democratic Presidential nomination. Recent Stevenson initiatives include a bill to make it easier for government contractors to retain patent rights, and a "peace-keeping" spy satellite system which any nation on Earth could use to ensure its security.

Earlier this year Stevenson lead an unsuccessful battle to save the Enterprise from being scrapped.

Debate on the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies opened in the United Nations Political Committee Oct. 29. The treaty is expected to be approved by an overwhelming majority of the U.N. General Assembly. The treaty, however, is facing mounting opposition within the United States.

The Salyut-6 radio telescope became tangled with other parts of the space station and had to be discarded by a spacesuited crew member shortly before the team returned to Earth August 19.

Announcements:

NASA to Select New Astronauts

If you have a bachelors degree in engineering, math, biological or physical science with three years experience in the field or three years of work toward an advanced degree you may be able to qualify as a mission specialist astronaut. Other requirements: you must be at least 5 ft. tall, but not over 6 ft. 4 inches.

If you were one of the over 10,000 people who applied in 1976 but failed to be one of the only 35 selected, don't be discouraged. Many current astronauts were originally turned down only to be selected for a later group.

This year's deadline for astronaut applications is Dec. 1, 1979. To apply, write to:

NASA Johnson Space Center
Astronaut Mission Specialist
Candidate Program
Code AHX
Houston, TX 77058

If you miss the deadline, or get turned down, don't despair. NASA plans to recruit a new batch of astronauts every year from now on, so you'll have plenty of opportunities.

Oops!

The October **L-5 News** contained the following errors:

Art Dula's Moon treaty article originally had a "fill-in" blank for the date the Moon treaty would be ratified by the United Nations. It was mistakenly changed to read that the treaty had passed the U.N. However, as of this date (mid October) the treaty has not yet passed but is expected to shortly. Peter Vajk's "Design for Success" article missed the credit line that it was a slightly condensed version of his testimony before the House Science and Technology Committee hearing on the Space Industrialization Act of 1979, held June 27, 1979.

Even the masthead got slightly scrambled. Carolyn Henson was listed under "membership services"! While she wrote, edited, aided in the research of, or solicited much of the material that appeared in the October **L-5 News**, she did *not* work in membership services.

We also received this correction from T.A. Heppenheimer:

"The article 'A Place in Space," on p. 17 of the October issue, was credited to T.A. Heppenheimer as the author. Dr. Heppenheimer states that he did not write this article; that it was pieced together by staff members from material he submitted to the **L-5 News** in 1975, taken together with other material by other writers; and that it reflects neither his current views nor his current understanding of the problems discussed therein."

Stanford Professor Wins Mitchell Prize

Paul R. Ehrlich of Stanford University, leading biologist and well-known author of the best-selling **Population Bomb** was selected as first-place winner in the $100,000 Mitchell Prize program (announced in the December 1978 **L-5 News**). This international awards series is designed to stimulate original thinking on growth-related issues.

Ehrlich, a professor of population studies in Stanford's biological sciences department, will receive $10,000 for his winning paper entitled "Diversity and the Steady State." In it, he discusses genetic, cultural, and technological factors affecting humanity's future.

Space Exhibition

In the tenth anniversary year of mankind's Giant Leap, Wildcliff Museum in New Rochelle, NY, is presenting a participatory exhibition on space travel and colonization, September through December. "Space: The Newest Frontier" is designed to give visitors a feeling for the challenge as well as the excitement of space exploration. It takes you to the frontier of the U.S. Space Program and beyond with a trip aboard a Space Shuttle and a sojourn on a lunar colony.

Beginning with a panoramic overview of aerospace efforts presented in diorama displays, your adventure quickly enters the realm of the future. You experience: a simulated flight to the Moon aboard the Space Shuttle; a lunarium that cradles your tactile and visual senses in the exotic textures of the Moon's surface and in a lunar rover; a lunar colony where you will meet Duna, the Wildcliff robot, who will introduce you to the command center of the colony. There you perform geological and biological experiments. You will exit the colony via space ship filled with aliens who sell gifts and souvenirs.

The exhibition will be open Sunday through Thursday from 1 to 4:30 p.m. Call (914) 636-2108 for further information.

High Frontier Trading Post

The High Frontier Trading Post is an L-5 member service; each noncommercial member is entitled to one free ad per year, not exceeding 40 words in length. Extra or longer ads will be charged at a rate of $.20 per word (or $4.30 per square inch). Please allow 3-4 months for your ad to appear. All ads are subject to editorial review.

Speaker: I am prepared to speak on several topics including astronaut opportunities, manned space flight, space budget options, the future space effort. In as much as L-5 groups support a common goal I would appear at such a group without fee or honorarium. However, if travel or an overnight stay is involved, I would ask that expenses only be covered. Paul M. Geyer, 230 E. Grand Ave., Rahway, NJ 07065.

For Sale: Space World '63-'79, **AW&ST** 2/65 to 1/77, many issues of **Wings, Airpower, Air Enthusiast, Aircraft in Profile** bound volumes. Send wants w/SASE. Jim Berry, 4529 SW Hamilton Terrace, Portland, OR 97201.

Inside the L-5 Society

Space Futures Searching for Volunteers

The Space Futures Society is taking another turn for the better! In addition to our normal activity such as publicity for the High Frontier movement in the Philadelphia, PA, area, we are opening up two new endeavors for L-5 volunteers living in the Delaware Valley and South Jersey area.

The two new projects are as follows:

The Space Futures Society is gathering volunteers with engineering backgrounds to work on a low cost space station comprised of discarded Space Shuttle tanks. Private industry, some NASA officials, and the Sabre Foundation have expressed interest in a finished proposal, that we are working on under the auspices of Ron Smolin. Those interested in joining a volunteer engineer group to finish this project write to him at International Ideas, 1627 Spruce St. Phila. PA 19103.

The Space Futures Society is also looking for volunteers to work closely with the Sabre Foundation on various volunteer projects. The projects will be as varied as will be the talents of the volunteers themselves. What we need the most are people who will finish a chosen project once they start. (Please send resumes to Richard W. Bowers, Space Futures Society, 3059 Cedar St., Phila. PA 19134.

Space Activists in Iowa

When the governor of Iowa proclaimed July 20th as "Space Day," it was the culmination of many efforts and the start of many more. The proclamation came into being due to a number of letters sent to the governor independently of one another. And at the signing ceremony a contingent of space activists from Iowa City and myself met for the first time. There we decided to organize a local space activist club which will hopefully be chartered by L-5. Anyone in Iowa who wishes to join us please write to me at the following address:

Matt Hickman
708 20th St.
West Des Moines, Iowa 50265

Discounts for L-5ers

The L-5 Society can now offer a 20% discount on car rentals and hotel rooms in several major hotel chains, including Hilton, Hyatt, Marriott, Fairmont, Omni, Radisson, and Town & Country Hotels, Rodeway Inns, Ramada Inns and Howard Johnsons. One phone call will reserve a room and a car, at a 20% discount.

For more details either write the L-5 Society, 1620 N. Park Ave., Tucson, Arizona, 85719, or call the Frequent Travelers Club (FTC) toll free number, 800-327-8388 (in Florida, 305-672-2200) and mention the L-5 Society. Your FTC membership card will be sent immediately. L-5 members only, please.

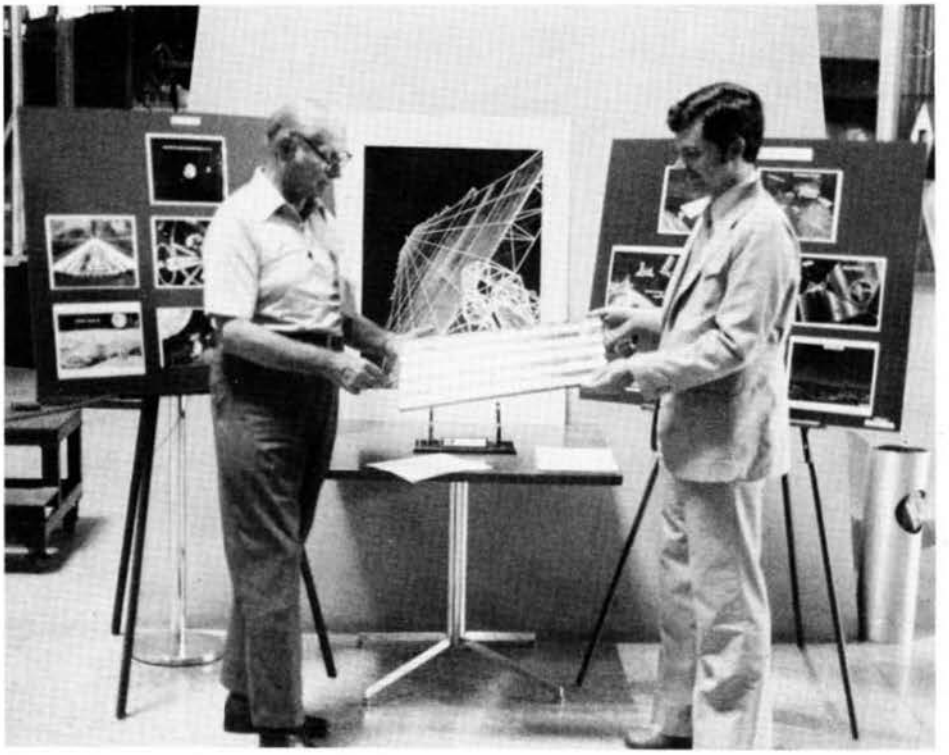
Huntsville's Display a Hit!

During the recent 10th Anniversary of the Apollo Lunar Landing, a series of exhibits were set up for special showing in the Alabama Space and Rocket Center. This opportunity was used by the Huntsville L-5 Society to explain the concepts of space habitation and solar power satellites.

The accompanying picture shows Dr. Konrad Dannenberg, L-5 Board Member, and member Carl Konkel holding a model of a gallium arsenide solar power satellite used in the display. Pictures of habitats, lunar colonies and SPS construction were set up, along with a stack of L-5 membership forms. Thousands of tourists go through the Center daily and I am glad to say the forms "sold out" in a matter of days.

It was evident that large-scale space activities *are* in the public's mind based **upon comments overheard near the display. The word is getting around!**

Carl R. Konkel
Huntsville, Alabama



Dr. Konrad Dannenberg (left) and Carl Konkel at the Huntsville Space Day exhibit.

L-5 Montreal

L-5 Montreal was formed at the beginning of May 1979. Its purpose is to act as a coordinating center for all chapters that will be formed in the greater Montreal area, including those organized at Montreal's four universities.

L-5 Montreal intends to fulfill the aims of the L-5 Society: promoting space industrialization and colonization by organizing conferences, meetings, etc.

L-5 Montréal
c/o François Coallier
1816 Ducharme
Outremont, Québec
Canada H2V 1H4

L-5 Montréal a été formé au mois de Mai 1979. Cette section de la société agira comme centre de coordination pour tous chapitres que seront formé dans la région métro politaine de Montréal, incluant ceux en voie de formation dan ses quatre universités.

L-5 Montréal entend poursuivre les buts de la société-mère, que est de promouvoir l'industrialisation et la colonisation de l'espace, par des conférences, seminaires, rencontres sociales, etc.

Dear Space Activist,

The 1980 presidential campaign is starting to roll. We have over a year before the election, and now is the time to make the New Space Program a national issue. It needn't be very hard to convince candidates to state their position. A number of preliminary, information-chocked letters followed by planted questioners at candidate talks might do the trick. After all, L-5 has chapters all over the country including key cities: Los Angeles, Houston, San Francisco, Seattle, Phoenix, Philadelphia, Boston, etc. Just imagine a candidate becoming aware that in every one of these cities (and more) there are people pushing for the New Space Program!

The United Nations New Moon Treaty will make the perfect vehicle for us. Criticizing the Carter Administration's foreign policy is all the rage among **Presidential hopefuls now, and if we can convince one to make a media splash by condemning the New Moon Treaty, we will have made an important step on the way to L-5!**

With the help of national directors Phil Chapman and Eric Drexler, a group of L-5ers in the Boston area have been brainstorming on what action to take to make the New Space Program an issue in the 1980 campaign. Two of our most definite ideas, letters to candidates and planted questions, have already been mentioned. Other possibilities include: press releases, Public Service Announcements, bumper stickers, buttons, short (two page) position papers, talk shows, posters, and working with other interested groups e.g. the AIAA. We are now gearing up for action.

But even if we do *all* of these things here, we will not succeed if they happen only in Boston. We need the help of other L-5ers, particularly the local chapters. It is crucial that candidates receive letters on space issues from *all over* the country. Equally crucial is that planted questions on space issues come up at Candidates Meetings in as many places as possible.

This could be the most exciting and important project L-5ers have ever worked on! We urge you to bring these ideas up at your next local L-5 meeting. Please look over our list of possible activities, add some of your own, and consider which ones your group can do. Write to us (c/o me at 518 Putnam Ave. #9, Cambridge MA 02139) and let us know of your plans. If we all pull together, this election will be a crucial one for the future of the New Space Program!

Reach for the Stars!

Christine Peterson

Help Needed for Ohio L-5

Due to time constraints and changes in my personal life, I have been unable to do any work on the organizing of OHIO L-5 since the beginning of Spring 1979. Nor do I see a lifting of those time constraints for at least another 2 years. Therefore, I am sorry to say, I cannot organize an OHIO L-5 chapter.

I do urge any Ohio L-5 members who have the time, to try and do what I was not able to. If I can help at all please contact me at the address below.

I would like to thank National L-5 for the help they gave me, and to the local chapters, especially Houston L-5, for sending me copies of their newsletters.

Ohio can be a driving force behind the humanization of space, as well we should be. After all, our state produced the first man on the Moon. We have a reputation to uphold!

Steven Stein
570 Fairhill Dr.
Akron, OH 44313

Letters

As a way to quickly promote the development of space, how about orbital fission power stations? Based on a proven technology, there would be no questions as to potential or unforeseen difficulties. With the exception of the actual mining of ore, or the extraction of small amounts of uranium and/or thorium from other ores, the entire processing and use cycle could be placed in orbit, removing all the various dangers of meltdowns, waste reprocessing and storage, etc., from the end users of energy on Earth. Processing facilities and power plants could be built using lunar or asteroidal resources; spent fuel rods could be reprocessed to extract uranium and plutonium; breeder reactors could be built, far from the hazards of terrorism, theft and accidental contamination (and of protestors), to extend the supply of usable fission fuels; the ultimate wastes could be disposed of in many directions (high orbit, solar escape trajectory, Earth-Moon or Sun-Earth Trojan points) or even be used in further power generation.

The total amount of uranium needed would be small at first; transport capability could be expanded as necessary. The well-known regulatory delays on Earth could be largely bypassed in an environment where there is no ecology to damage in any fashion or local residents to harm.

As a long-term solution to the energy problem, of course, this is by no means complete; fission is still a finite source. But it might provide a mid-term solution to public acceptance of both nuclear power and space colonization. And once the manufacturing capability is in place . . .

J.W. Braue, III
Rocky Hill, CT

I sputter in disbelief at the suggestion that material wealth from space will, by itself, end war and civil unrest ("Wealth: The Super Weapon," **L-5 News** July 1979). How does Micky McWilliams propose distributing that wealth to the world's poor? Wealthy nations are the ones that will acquire the tremendous wealth of space, and it's ludicrous to think they'd hand over anything more than a few token crumbs to the impoverished nations without a fight. It's not that people are "just perverse," but rather that they are *greedy*. Greed has had great survival value throughout history: it's nearly impossible to suppress one's ancestral heritage and say: "I have all the wealth I need — here you can have the rest."

To eliminate war will take a fundamental change in human nature itself, from a selfish attitude of "get" to a loving attitude of "give." Until that happens, all the wealth in the universe will not stop the fighting.

Reach for the stars anyway!

Michael A. Pelizzari
Northridge, CA