L5 NEWS

October 1979

LAWYER ART DULA REVIEWS U.N. MOON TREATY

L-5 DIRECTOR J. PETER VAJK DESIGNS FOR SUCCESS

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY

VOL. 4 NUMBER 10 OCTOBER 1979

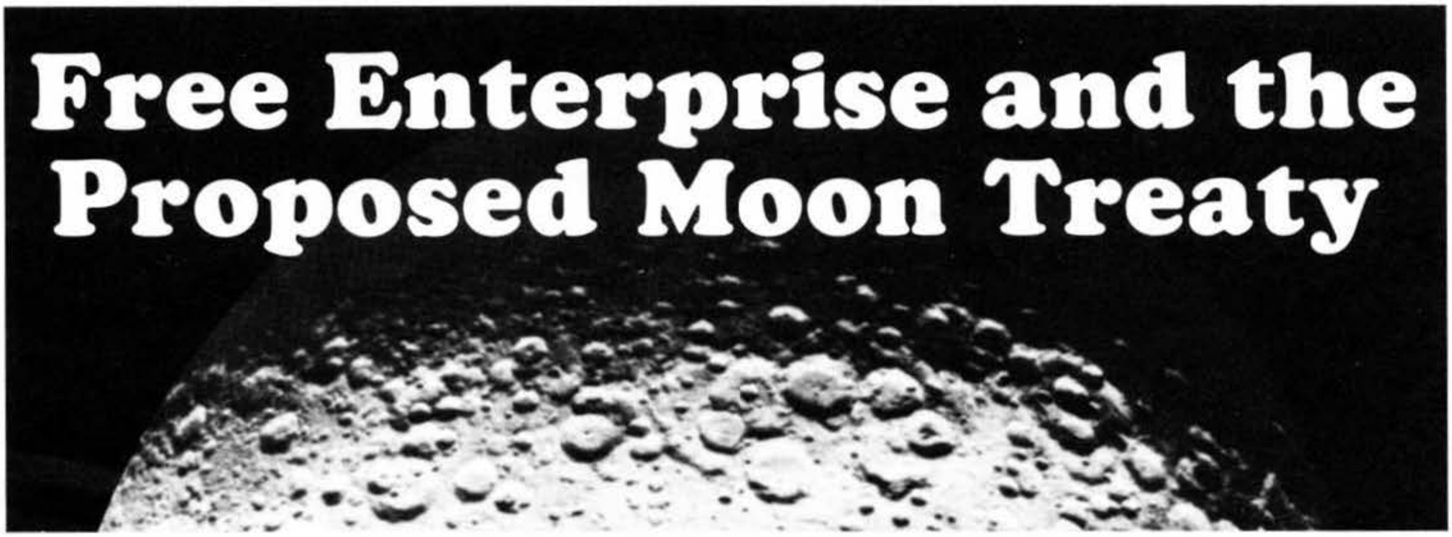
In this issue:

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

Cover: Will the Moon and other celestial bodies in the solar system be off-limits to private enterprise? See "Free Enterprise and the Proposed Moon Treaty" by Art Dula, page 1 of this issue. (Cover courtesy of Brian P. Sullivan)

Free Enterprise and the Proposed Moon Treaty



by Art Dula

Part I

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies ("Moon Treaty") was introduced in the United Nation Committee for the Peaceful Use of Outer Space ("COPUOS") by the U.S.S.R. in 1971. On July 3, 1979 a compromise draft comprising an introduction and 21 articles passed COPUOS by consensus and was sent to the General Assembly for adoption. The Moon Treaty is easily the most far reaching international agreement ever written. If ratified by the United States, the Moon Treaty's provisions will control the activities of the United States, as well as those of all U.S. citizens and organizations, not only on the Moon, but also on every celestial body in the solar system other than Earth and in the trajectories around and between them. It is hornbook law that any U.S. law or regulation contravening a ratified treaty is void. Thus planners who hope to exploit space resources commercially for profit through the free enterprise system would be well advised to study this Moon Treaty carefully and determine if its adoption would be in the best interests of the United States and the free world.

The Rescue and Return Agreement, the 1972 Liability Convention, the 1976 Registration Convention, and the Moon Treaty grew out of the "Treaty of Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies" ("Treaty of Principles"), which the U.S. ratified in 1967. By 1979 over 100 countries had bound themselves to abide by the "Treaty of Principles."

The history of the Treaty of Principles demonstrates the basic conflict that exists between the communist and capitalist philosophies concerning the exploitation of space resources. As introduced by the U.S.S.R. in 1962, the Treaty of Principles forbad free enterprise in space. The Soviet view was that only states should be permitted to engage in space activities. After the U.S. mooted this Soviet effort by chartering the Communications Satellite Corporation, a compromise resolution passed the U.N. and was ratified by the U.S. This compromise established significant barriers to the entry of free enterprise into space ventures. As ratified, the Treaty of Principles requires that all U.S. space activities, public or private, be authorized and continuingly supervised by the U.S. government and that the U.S. government bear unlimited international liability for damage caused by such ventures. Despite its drawbacks, the Treaty of Principles expressly mentions the Moon in several articles and thus clearly establishes a legal order for the Moon that is part of the positive federal law of the United States.

> ***If ratified by the United States, the Moon Treaty's provisions will control the activities of the United States, as well as those of all U.S. citizens and organizations, not only on the Moon, but also on every celestial body in the solar system other than Earth . . .***

Summary of the Moon Treaty

The Moon Treaty is vague, lengthy and complex. Many of its critical terms are not well defined. The language of its most important articles closely parallel similar language in the 1970 UN resolution on the deep seabed and the draft law of the sea treaty. The critical articles provide that:

1. The treaty applies to all celestial bodies in the solar system excluding the Earth.
2. All celestial bodies and their natural resources are the "common heritage of mankind."
3. No celestial body is subject to national appropriation by any claim of sovereignty, by means of use or occupation or by other means.
4. An international regime must be established to govern the exploitation of natural resources on or derived from celestial bodies before these resources are exploited for other than scientific purposes.
5. Neither the surface nor subsurface of any celestial body nor any part thereof can become the property of any state, corporation or private person.

Neither the Moon Treaty nor any other authority defines the terms "celestial body" and "natural resources" as they are used in the treaty.

"Exploitation" vs. "Use" of Natural Resources

One reason consensus was reached during the 1979 COPUOS session was that the Soviet Union accepted a Brazilian formulation of the treaty's "common heritage" language. This language is now in Article XI of the treaty:

"The Moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this article and in particular in paragraph 5 of this article."

Paragraph 5 of Article XI requires the establishment of an international regime, presumably via a second treaty, before exploitation of natural resources from space becomes feasible:

"States party to this agreement hereby undertake to establish an *international* *regime,* including appropriate procedures, *to govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible.* This provision shall be implemented in accord with Article XVIII of this agreement (which sets up a time table and mechanism for generating the regime)." (emphasis added)

Consensus was also encouraged in 1979 when a number of third world countries dropped their insistence upon imposing a total *moratorium* on all use of space natural resources pending establishment of an international regime to govern exploitation of such resources.

The United States, through Neil Hosenball, NASA's General Counsel and chief U.S. representative to COPUOS, made a number of unilateral statements defining the United States' interpretation of several parts of the Moon Treaty. Two of these statements seem intended to contradict the clear language of the treaty regarding exploitation of space natural resources:

1. "The draft agreement—and I am particularly pleased about this, as a member of the National Aeronautics and Space Administration (NASA)—as part of the compromises made by many delegations, places no moratorium upon the exploitation of the natural resources on celestial bodies, pending the establishment of an international regime. This permits orderly attempts to establish that such exploitation is in fact feasible and practicable, by making possible experimental beginnings, 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."

The Moon Treaty is vague, lengthy and complex. Many of its critical terms are not well defined.

2. "We also note with satisfaction that Article XI, paragraph 8, by referring to Article VI, paragraph 2, makes it clear that the right to collect samples of natural resources is not infringed upon and that there is no limit to the right of states' parties to utilize, in the course of scientific investigations, such quantities of those natural resources found on celestial bodies as are appropriate for support of their missions."

Mr. Hosenball's statements were not contradicted. They form a part of the treaty's history.

The clear language in Article VI of the Moon Treaty specifically permits scientific "use" of lunar resources. Conversely, equally clear language in Article XI states that before "exploitation" of those resources is feasible, a new international legal regime must be negotiated. The U.S. position contradicts this treaty language by stating that the Moon Treaty places "no moratorium on the exploitation of the natural resources of the Moon, pending establishment of an international regime."

While the meaning of the Treaty's terms

In addition to limiting the "use" and forbidding the "exploitation" of natural resources from space, the Moon Treaty goes to great lengths to deny any possible legal entity the capacity of owning any part of these resources.

could provide grist for the mills of the U.S. Federal Courts for years, it is clear that the Moon Treaty sets no moratorium on *scientific collection* or *experimental use* of lunar resources. The Treaty also specifically allows states to use lunar resources to support their missions in the course of "scientific investigations." The Moon Treaty does not specifically mention *"commercial"* use of lunar resources or *"use for profit"* except insofar as it requires that an international regime be established to control lunar resources prior to their exploitation." The difference between the "exploitation" and "use" of lunar resources is critical. According to **Black's Law Dictionary**, "Exploitation" is:

"The act or process of exploiting, making use of, or working up, utilization by, application of industry, argument, or *other means of turning to account*, as the exploitation of a mine or a forest." **State Finance Co. v. Hamacher**, 17 P. 2d 610, 613. (emphasis added);

while "Use" is:

"To make use of, of convert to one's services, to avail one's self of, to employ." **Hopkins v. Howard**, 99 S.W. 2d 810, 812.

Thus, exploitation is use "turned to account," i.e. commercial use that results in a *profit* accruing to the user. The framework of the legal regime to control exploitation of space resources would be laid out by a "Law of Outer Space" conference, which parallels several "Law of the Sea" conferences held over the past decade. The first such conference is set for 1982. The U.S.S.R. has offered to host the conference in Moscow.

Property Rights in Lunar Natural Resources

In addition to limiting the "use" and forbidding the "exploitation" of natural resources from space, the Moon Treaty goes to great length to deny any possible legal entity the capacity of owning any part of these resources.

Article XI, Section 3 states:

"Neither the surface nor the subsurface of the Moon *nor any part thereof* or natural resources *in place* shall become the property of any state, international, intergovernmental or nongovernmental organization, national organization or nongovernmental entity or of any natural person." (emphasis added)

On April 19, 1973 the U.S. representative to the COPUOS legal subcommittee unilaterally contradicted the clear meaning of the words "in place" appearing in an earlier working draft of the Moon Treaty:

"As is apparent from the text, this working paper excludes the concept of a pre-regime moratorium. References to the words "in place" in the first sentence of the paragraph . . . make this clear. More particularly, the words "in place" . . . are intended to indicate that the prohibition against ascertation of property rights would not apply to natural resources once reduced to possession through exploitation either in the pre-regime period or, subject to the rules and procedures that a regime would constitute, following establishment of the regime."

These statements by the United States drew no response, and this silence is a part of the history of the treaty.

Ratification

COPUOS agreed in July, by consensus, to send the Moon Treaty to the United Nations General Assembly, which convened in mid-September. The General Assembly has approved the Lunar Treaty and has opened it for signature by states. For the treaty to be legally effective in the United States, the U.S. must sign the treaty and the Senate must advise and consent to it by a two-thirds majority.

If the Senate fails to ratify the Moon Treaty, it does not become positive law in the United States. Despite this fact, signing the treaty signifies the administration's intent to accept, and presumably abide by, the Treaty's terms. This intent will influence governmental policy with regard to the government's authorization of space resource exploitation by U.S. industry. Because NASA has a monopoly on space transportation, the practical results of the U.S.'s signing the Moon Treaty could be just as far-reaching as the effects of the treaty's formal ratification.

To be continued.

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

Space Foxholes
or
Beetle Bailey in Orbit

by H. Keith Henson

Few people realize the extent of the military involvement in space. Besides the well-known spy satellites, military communication and navigation depend on satellites. At any given time, over a billion dollars worth of U.S. hardware is circling the Earth. The defense of this stuff which has become vital to the military has a lot of people worried. To date, very little has been done about these worries because there have been no really good ideas of how to defend anything in space. (An operational definition of "good" is a

Six feet of common dirt around the sensitive parts of a spy satellite would make it immensely harder to put out of action . . .

positive cost/benefit ratio, i.e. do we get more out of it than it cost. Military activities are as constrained by economics as anything else.)

Given the array of possible antisatellite weapons, shrapnel, lasers, particle beams, ordinary high explosives and nuclear bombs, what defense methods would work for all of them? The obvious method would be the space foxhole or bunker. Six feet of common dirt around the sensitive parts of a spy satellite would make it immensely harder to put out of action by any of these weapons. The problem is that a 6-foot shell of dirt around an object the size of a shuttle bay would weigh around 1000 tons. Boosting this much mass into orbit would require about 70 shuttle launches and would cost about 2 billion dollars.

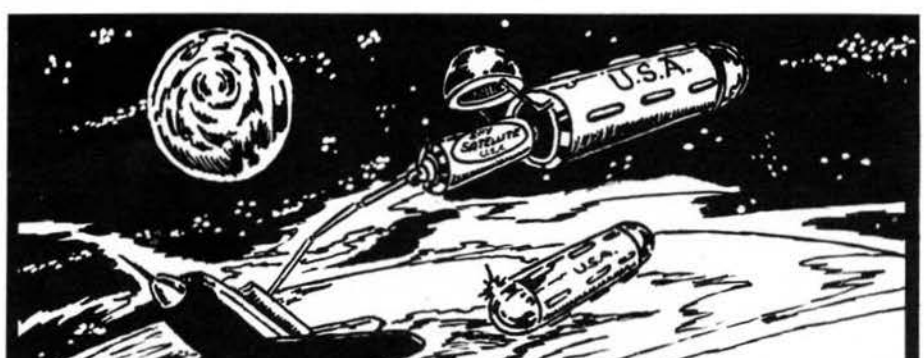
The advantages of armoring satellites are so great that it might be worthwhile even at this cost. Putting things in holes or under the sea where they are hard to knock out has a nonaggressive image. (Why bother if you are going to strike first?) The alternate response to antisatellite weapons is to threaten the other side's satellites with your own weapons. Those of you who read **Aviation Week** and **Space Technology** know that this is the path the U.S. is currently taking. This approach has little to recommend it, especially since the differences between the U.S. and U.S.S.R. spy satellites would make an exchange much more costly to the U.S. Our satellites are large, expensive, and long lived. The USSR tends to launch, on need, much smaller and shorter lived satellites and, unlike the U.S., keeps a ready reserve.

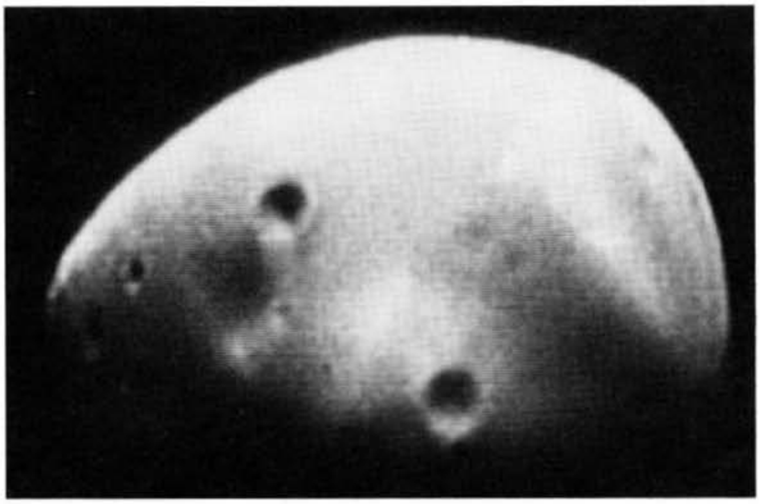
The use of extraterrestrial materials has not (to my knowledge anyway) been seriously considered for military applications. It is pretty obvious that if a method were available to get thousands of tons of dirt to the orbits used for spy satellites, a ready market would exist. As a guess, the military might be willing to pay 2 or 3 billion for 3-4 parking garages in orbit for its spy satellites, and perhaps half of that to armor its communication and navigation satellites. If this is a good guess,

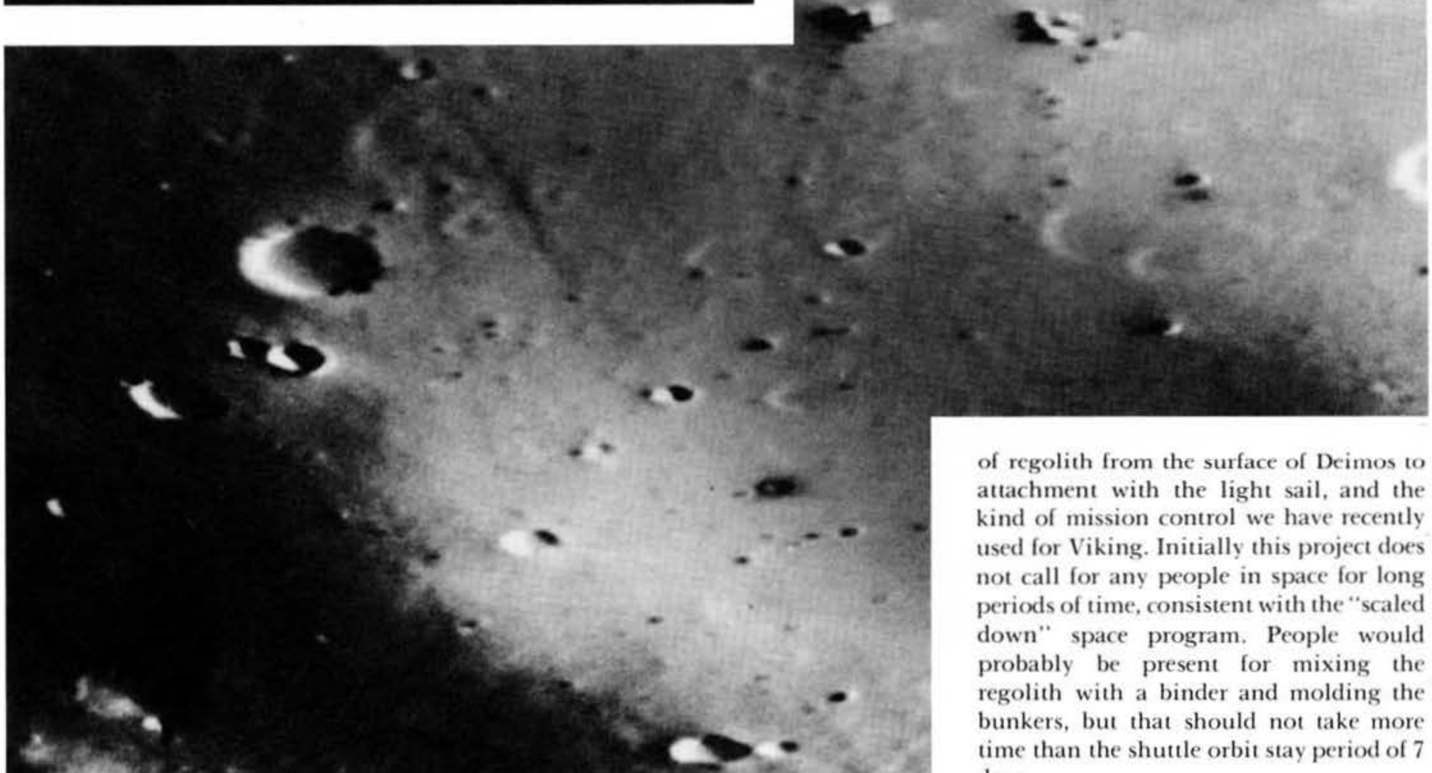
The Earth and the Moon are not the only sources of dirt in the solar system. We have run our remote fingers through the sands of Mars and photographed the regolith of Deimos.

then the military market is the next largest, after solar power satellites (SPS). Furthermore, the material needs little or no processing to be useful.

It's a long way from military space bunkers to what we are really interested in, the human habitation of space, but other than the SPS project, the space bunkers are the only other extraterrestrial resources project that might be economically justifiable. Extraterrestrial resources are, as we well know, *the* key to space







Above: The surface of Deimos photographed by Viking Orbitor 2. A layer of dust makes the surface appear smoother than the other Martian Moon Photos. Solar sails could transport regolith from Deimos at rates of 100-200 tons per month.
Insert: A computer-generated picture of Deimos from a pair of images taken by Viking Orbiter 1.

habitation.

A 3 or 4 billion market, large as this is, does not necessarily lead to an O'Neill-style space development (although it would help if,for example, an SPS project were in the works). The Moon base/mass driver cost estimates are in the range of three times the total market.

The Earth and the Moon are not the only known sources of dirt in the solar system. We have run our remote fingers through the sands of Mars and photographed the regolith of Deimos (the larger of the two Martian moons). In the context of solar sails, Deimos may be one of the most accessible objects in the solar system. Trip times for light sails would average four months on the outbound leg and a year on the inbound leg. Sail production rates of one per month would start returning material at a rate of 100 tons per month. As the sails begin to be reused, about a year and a half later, the rate would go up to 200 tons per month. This sort of thing could go on for a long time before we took a noticeable bite out of Deimos.

What would be needed for this project would be a solar sail production facility, remotely-operated carpet sweeper, a remote launch/docking tug to move bags of regolith from the surface of Deimos to attachment with the light sail, and the kind of mission control we have recently used for Viking. Initially this project does not call for any people in space for long periods of time, consistent with the "scaled down" space program. People would probably be present for mixing the regolith with a binder and molding the bunkers, but that should not take more time than the shuttle orbit stay period of 7 days.

There are numerous advantages to a program to mine Deimos by remote control. The existence of a transport system of light sails would make the wildest remote explorations of the outer planets feasible. A one and a half year flyby to Pluto would be one example. A Mars sample return could be tacked on to the program, probably at less cost than the Viking program. Sample returns from the asteroids would be easy as well.

The most significant advantage of this project is that it gives us a toehold in space. Once we have a steady supply line for extraterrestrial materials, we can build shielded habitats where people can live their lives without cosmic ray damage. We will possess the raw materials to build farms and factories. We will have made the step from being visitors in a hostile environment to being homesteaders in the promised land. L5

How to Be a Successful Inventor

"How? All it takes is skill, good advice, hard work and money"

by Carolyn Henson

Reprinted from Future Life Magazine, #13, September 1979.

Many frustrated inventors write to me because I'm president of the L-5 Society. And they're right, I do know how to help lone inventors. My husband is a full time inventor; his devices labor away in candy factories and tractor plants, monitor giant mine trucks and protect water pumps. His research shows up in the major space manufaturing technical works, as well.

I've had the pleasure of helping turn his schematics into hardware. How? All it takes is skill, good advice, hard work and money.

Let's work on skill first. Have you studied college level physics? I don't mean the creampuff courses they offer premed students; you have to take the stuff that requires calculus. Mechanics, electromagnetism, thermodynamics, optics and acoustics are essential. Beat it into your head until you can look at a scheme and immediately determine whether angular momentum is conserved or whether it obeys the second law of thermodynamics. Nine out of ten of the schemes people show me violate the laws of physics. They'll never fly.

Some kooks think the laws of physics are a conspiracy by evil scientists to keep reactionless drives and faster than light starships off the market. These people remind me of the Tucson gangster who bribed a building inspector to approve his bowling alley design. However, the law of gravity wasn't circumvented as easily as the laws of Tucson. The bowling alley collapsed.

Then there was the Arizona legislator who proposed the repeal of Carnot's law in order to save fuel.

Sharpen your skills with plenty of math. Learn to use Fourier and Laplace transforms, Bessel functions, Lagrangian interpolation and more. Study numerical analysis and how to get your computer to do the calculating for you. If you don't have something fancy on hand at least get a calculator with trig functions and a decent memory.

I remember when I independently thought up the idea of the tethered geosynchronous satellite — the "skyhook" concept. That is, I got an intuitive grasp of the idea. But I couldn't determine whether we had any materials strong enough to build the skyhook because the solution to the problem involves integrating over a diminishing gravity field, and I couldn't integrate. My husband found an article in **Science** for me where the math had been worked out. It was Greek to me. But I got the message: I spent the next four years buried in math books.

Yes, there are math kooks, too. I had to throw an old man out of my office because I tired of his demands that I join his crusade to declare pi equal to exactly 3.14. "There are no irrational numbers in nature," he declared.

Could you sign checks and write contracts when 9 months pregnant and in labor with contractions five minutes apart? If the answer . . . is yes, you're probably not **too** *lazy.*

You absolutely must have good advice. Many inventors go wrong because of obvious flaws in their concepts that a skilled friend could probably spot. One of the major reasons to attend technical conferences is that they are the perfect place to make friends who can help you turn that rough idea into real hardware someday.

Don't let pride trip you up. No matter how brilliant a researcher may be, he or she always looks to friends for advice.

Next comes the hard work. Could you do without your yearly vacation in the Bahamas? Do you mind working Saturdays? Can you survive on only six or seven hours of sleep a night? Do you mind scarfing down a cold taco and a warm soda pop with your left hand while you type data into the DEC-10 with your right? Could you sign checks and write contracts when 9 months pregnant and in labor with contractions five minutes apart? If the answer to all these is yes, you're probably not *too* lazy.

Last we tackle the money problem. People with sound, ingenious inventions write and call me with the same old sob story. "NASA won't give me a cent." "My wife left me because I spent our life savings on my invention." "The aerospace companies don't even answer my letters." So what else is new?

Peter Glaser, inventor of the solar power satellite, promoted it four years before getting a cent of NASA money. Gerard K. O'Neill, world famous space colony researcher, traveled around the country pushing his ideas for six years before getting his first grant.

How about Peter Vajk, the space industrialization pioneer? He lost his job at Lawrence Livermore because he spent too much time working on space colonies. T.A. Heppenheimer was fired by Rockwell for the same reason. But they didn't waste time feeling sorry for themselves. Heppenheimer is now working full time on space colonies as an independent consultant, has written a lucrative book, **Colonies in Space** and has another, **The Colonists**, about to hit the bookstands. Vajk was snapped up by Science Applications, Inc., which needed a space industries expert, and he wrote **Doomsday Has Been Cancelled** in his spare time.

I enjoy asking the authors of space industrialization research papers who funded their work. Often they reply "Oh, I did this research in my spare time. Hope the boss doesn't find out I swiped some computer time."

When my husband started his electronics company, Analog Precision, we had no money. But we needed a building and tens of thousands of dollars worth of test gear, circuit board facilities, machine tools . . . what a list of things! So we cut our living expenses way down — below the poverty line — remortgaged the house, borrowed up to our ears from the bank and all our friends, borrowed the equipment we couldn't buy, and hustled like crazy.

It worked!

It can work for you, too. Reach for the stars!

The Asteroid/Meteorite Connection

by Stewart Nozette

The concept of a relationship between asteroids, and the meteorites in our museums forms the basis for one of the most fascinating questions in contemporary planetary science. Where do meteorites come from? Answering this question may give us the basis for asteroidal utilization.

We all know that the cost of planetary exploration is extremely high. If the solar system is to be *thoroughly* explored, and if we are to make many direct observations of asteroids, an economic motivation must be present. The asteroids may provide an excellent resource base for future industrial activities in space. However, a gap in our knowledge exists concerning the physical and chemical nature of asteroids. The imagination of planetary scientists, along with the free samples residing in our museums, may help unravel the secrets of the asteroids, and provide the vital information useful in exploitation of extraterrestrial resources.

The imagination of planetary scientists along with the free samples residing in our museums may help unravel the secrets of the asteroids . . .

Meteroites may be divided into three catagories: stones, irons, and stony-irons. These categories have been recognized almost as long as people realized that rocks could indeed fall fromthe sky. Of the stony-type meteorites, the most abundant are the ordinary chondrites. These are made up primarily of silicate minerals with varying amounts of iron-nickel metal and iron sulphide. Chondrites are distinguished by the presence of millimeter-sized spherical bodies called chondrules. The origin of these chondrules is a highly debated subject, but impact and igneous processes may have been responsible. Some of the ordinary chondrites show evidence that they have been geologically processed, i.e. metamorphosed. The ordinary chondrites are thought to represent primitive planetary material which never experienced large amounts of remelting. Chondrites may be the building blocks of planets.

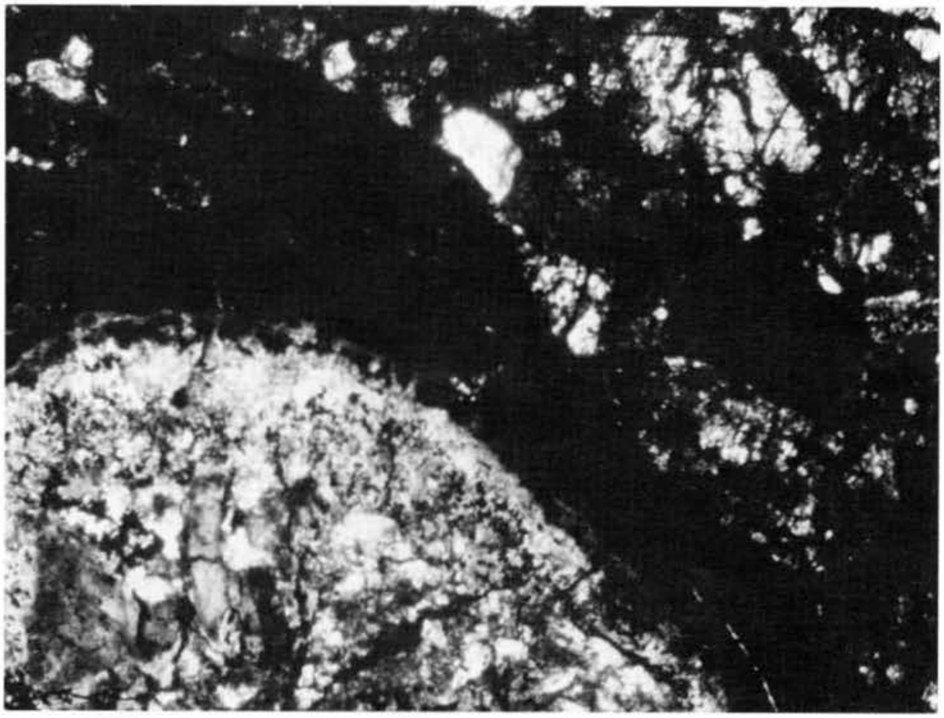
Other types of stony meteorites include the carbonaceous chondrites and the achondrites. Achondrites appear to have been produced by igneous processes similar to those found on the Earth and the Moon. One group of achondrites, the Eucrites, appear to be pieces of solidified magma produced on a small planet. This hypothetical planet is imaginatively called the Eucrite Parent Body. There is a continued debate on just exactly where the Eucrite Parent Body is, or whether it still exists at the present time. This mystery arouses intense fascination in the author. To think that we actually possess pieces from the surface of a distant planet! This planet may no longer exist, having possibly been destroyed in a primeval collision.

The carbonaceous chondrites often stimulate the highest level of interest in those interested in economic ventures in space. These meteorites appear to represent the most primitive solar system material we have seen. This is not to say that they do not have complex histories, but that they have never undergone extensive heating. The carbonaceous chondrites would provide an excellent source of volatiles for space activities. Some contain as much as 15% water by weight. This water may be converted into hydrogen for chemical propellent, and oxygen which may be used for life support and industry. One small carbonaceous asteroid could make space industry completely independent of terrestrial raw materials, except for special use items.

To think that we actually possess pieces from the surface of a distant planet!

The iron-rich meteorites also represent a

Figure 1 *A photomicrograph of a piece of carbonaceous chondrite in the Plainview ordinary chondrite. This might have formed on the surface of an asteroid.*



mother lode of raw materials. That huge hunk of iron which you may have seen in a museum is probably a piece of the core of a small planet which was shattered by collision millions of years ago. Civilization may never want for metal if we can utilize the source of iron meteorites.

The meteorites show evidence that they originate on large planetoids. We must now extract more subtile information from meteorites to tell us what the actual surfaces of these bodies are like.

When the first astronauts landed on the Moon, they found a surface composed of loose broken-up material known as regolith. The nature of the lunar environment, with its vacuum and exposure to the solar wind, produces distinct features in this regolith. These include evidence of impact, cosmic ray radiation damage, and high abundances of solar wind gases, i.e. helium. The regolith has been churned and broken over eons of bombardment. This bombardment produces special rock types called breccias, characterized by angular mineral grains cemented together with glass.

The surface environment of an asteroid will be similar to that of the lunar surface except for the asteroid's lower gravity. There are meteorites which show evidence that they formed in a regolith. This evidence includes brecciation, large amounts of trapped solar wind gases, and the presence of foreign fragments. Figure 1 shows a piece of carbonaceous chondrite found inside of an ordinary chondrite. The carbonaceous piece shows evidence of exposure of liquid water, produced possibly by heating during an impact.

Using the lunar example and evidence from meteorites, a model has been constructed for asteroid surfaces. This model gives clues to the type of surface which may be found on an asteroid of a

Civilization may never want for metal if we can utilize the sources of iron meteorites.

given size and age. The model suggests that large asteroids around 300km. in diameter will develop 2km. thick regolith blankets in the first 2 billion years of evolution. Later the surface will erode and eventually a collision will shatter the asteroid. A smaller body, about 100km. in diameter, accumulates much less regolith because less crater ejecta is retained in the weak gravity field. Smaller bodies lose nearly all their crater ejecta because of their tiny gravitational fields. Asteroids 1 to 10km in diameter are predicted to have very thin

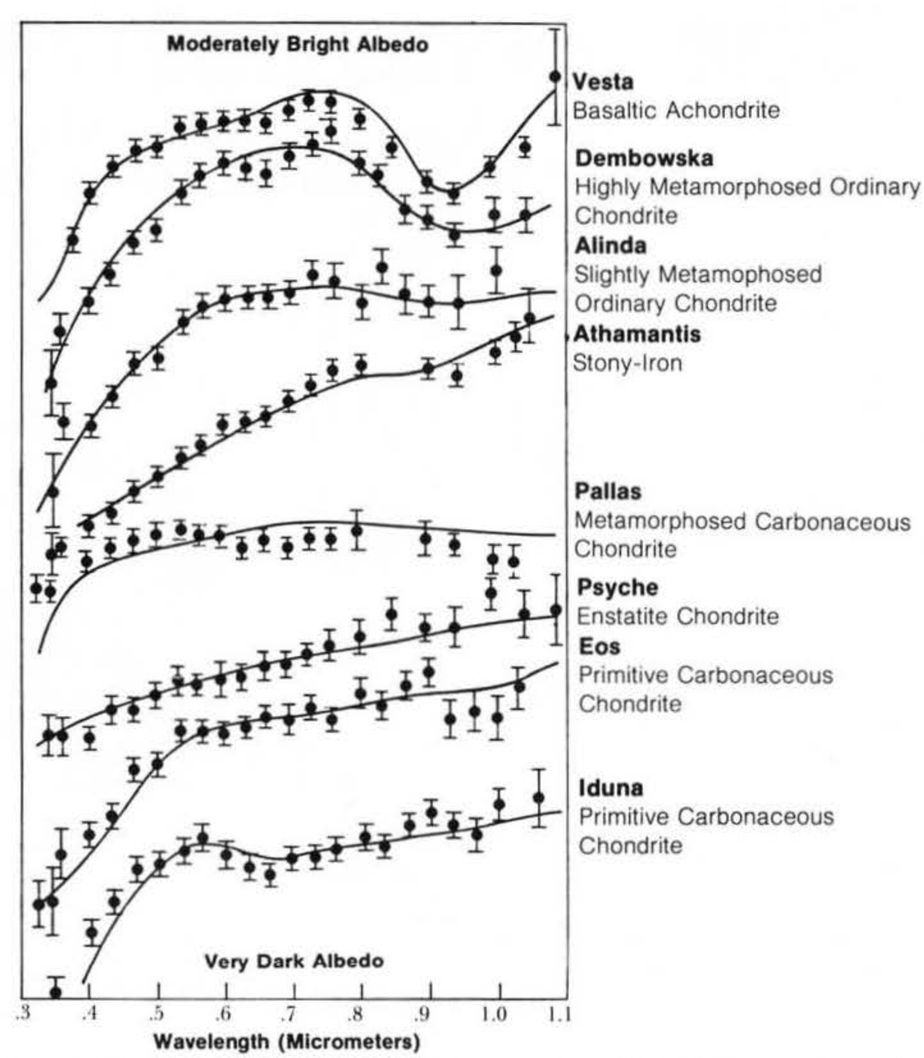


Figure 2 *Asteroid and meteorite reflectance spectra. The points are astronomical measurements; the lines are meteorite reflectance spectra.*

layers of regolith. A small body made up of weak material like carbonaceous chondrites will have more regolith. This model does a good job of predicting the astronomical properties of asteroids and the mode of formation of the brecciated gas-rich meteorites. A mining operation may simply be able to scoop up thin 2m. regolith layers. Thus, even a small body may have an easily exploitable surface.

We have discussed the physical properties of the asteroid surface inferred from meteorite evidence. What may we say about the chemical properties of these surfaces? Almost all of our current ideas concerning asteroid composition stem from spectro-photometric observations. These observations are carried out by Earth-based telescopes equipped with sensitive light-measuring equipment. The intensity of light reflected by the asteroids at different wavelengths is measured. The spectra obtained may be compared to laboratory spectra of meteorites. Figure 2 shows just such a comparison. The points represent astronomical measurements and the lines are meteorite spectra. These reflectance spectra are fingerprints which allow us to make educated guesses about what the surfaces are made of. By examining figure 1, we can see a fairly good match between asteroids and meteorites.

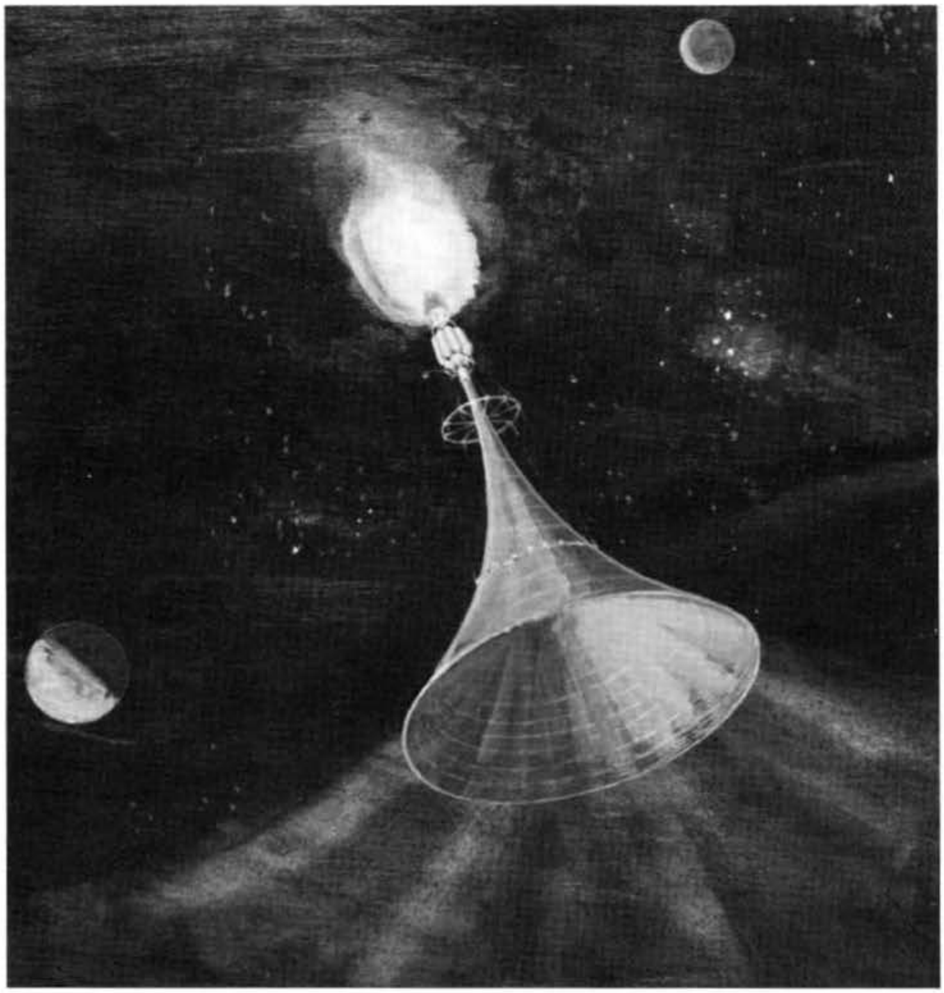
We still have a long way to go in understanding the asteroids. The evidence accumulated on the Earth will provide future asteroid prospectors with their basic information. The economic exploitation of these materials will provide an almost unlimited resource base for future generations and allow the scientific exploration of the solar system to proceed with fewer budgetary restrictions.

Chapman, Clark R. "The Nature of the Asteroids, "**Scientific American**, Vol 232 No. 1 (Jan. 1975).

Housen, Kevin R.; Wilkening, Laurel L.; Chapman, Clark R.; and Greenberg, Richard. "Asteroidal Regoliths," **Icarus** in press.

Stewart Nozette has recently received his bachelor's degree in planetary sciences from the University of Arizona and will begin graduate work at MIT in the fall.

On to the Stars!



The Bussard Interstellar Ramjet

This concept would provide a means for interstellar space travel. The large cone depicted would scoop up hydrogen from the interstellar medium for use as fuel for a thermo-nuclear fusion powered rocket engine.

Dr. Robert W. Bussard, pioneer in nuclear propulsion, proposes that the natural evolutionary drive that led humankind to dominate the planet Earth will lead us to the stars. In an inspirational talk prepared for the 15th Annual Propulsion Conference held in the Las Vegas Sahara Hotel on 18-20 June 1979, Dr. Bussard explored our past and opened up wide-ranging visions of our future destiny in space.

Three large professional engineering societies engaged in ground, air, and space propulsion: the American Institute of Aeronautics and Astronautics (AIAA), the American Society of Mechanical Engineers (ASME), and the Society of Automotive Engineers (SAE), jointly sponsored the propulsion conference. Dr. Bussard was one of the featured speakers at that conference's "Propulsion Concepts for Galactic Travel" session.

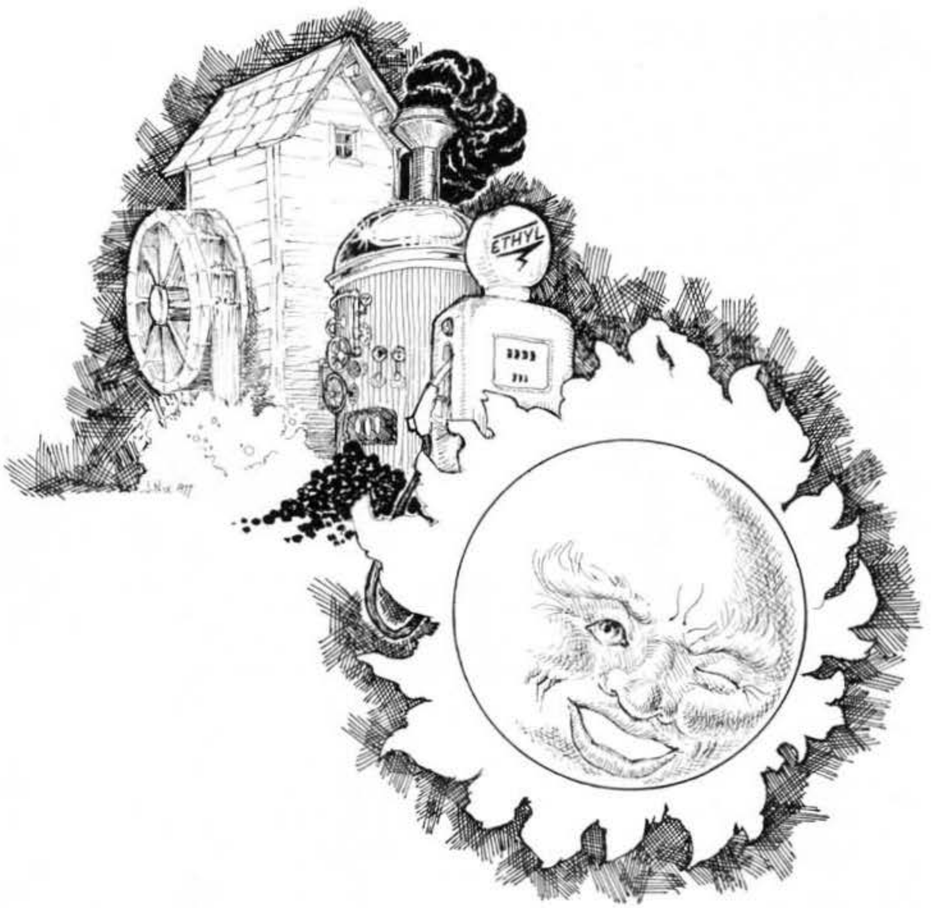
Bob Bussard pointed out that the rise of the human race as an intelligent toolmaking animal has occurred over a remarkably short time span. Billions of years were required for evolution that started in the primordial mud, passed through the mammals and the great apes, to yield homo sapiens (us). Yet it only took ten thousand years for our intelligence to control the resources of an entire planet.

Bussard feels that the same drive will lead us to the stars. It is only a matter of time, energy, and survival. If we do not destroy our civilization in a global war, then he sees us engaging in journeys through the vast reaches of interstellar space to build civilizations on other worlds.

Dr. Bussard is aware of the difficulties of interstellar travel. He is also aware of the great technological capabilities of the human race that will make such journeys possible. He points out that we already know the technical directions to follow which can lead to starships capable of carrying humans to other stars and eventually throughout the galaxy.

Dr. Bussard's talk also raised an interesting speculation on the uniqueness of the human race. Calculations show that if an intelligent species has a drive similar to humanity's, and starts to explore other stars, then within 1 to 10 million years (a very short time compared to the 10 billion year age of the galaxy), the descendents of those first explorers would have explored every habitable planet in the galaxy. This leads him to speculate that perhaps it may be that we are the first of the intelligent species, and it is our destiny to explore and populate the habitable planets in the galaxy.

Dr. Bussard has worked on nuclear propulsion for aircraft and spacecraft since 1952, and has published two textbooks on nuclear propulsion. In a seminal 1960 paper, he proposed the now-famous Bussard interstellar ramjet. Prior to founding his own company in 1974, he was Assistant Director of Development and Technology for the U.S. Atomic Energy Commission, where he created, directed, and managed all engineering research and development activities in the U.S. controlled thermonuclear fusion program. He is Founder and President of Energy Resources Group, Inc., which carries out technical analyses and design studies of nuclear, solar, and advanced energy systems, and is Founder and President of International Nuclear Energy Systems Company, Inc., which carries out research and development of novel fusion power systems. They are currently working on a "throwaway tokamak." This is a compact, low-cost, fusion reactor that uses the design philosophy of propulsion engineering rather than power plant engineering.



The Sunsat Energy Council's Letter to President Carter

July 13, 1979

The President
The White House
Washington, D.C. 20500

Mr. President

Encouraged by the positive findings of scientists and engineers throughout the world, the Board of Directors of the Sunsat Energy Council has authorized me to urge you to consider in your energy planning one of the most promising concepts yet developed for harnessing a safe, renewable source of electrical energy: the solar power satellite. In a number of respects, this advanced space technology affords the United States an extraordinary opportunity to accomplish several national goals with a minimum of economic or other risks.

Assuming the concept is as valid as many leaders of the world technical community believe, a single solar power satellite in space could beam to Earth usable electrical energy in amounts ranging from 1/10 to 10 times that which might be generated by existing individual fossil or nuclear power plants. There are, of course, certain unknowns which would have to be explored before any attempt to put in place such a satellite could or should be attempted. However, these unknowns are fewer and less hazardous potentially than those, for example, associated with our initial commitment to the Apollo program or those which still exist in connection with nuclear waste disposal or the carbon dioxide effects of burning fossil fuels.

A federal expenditure of between $200 and $300 million over the next five years would cover the research necessary to determine the safety and feasibility of constructing a solar power satellite. Although the Sunsat Energy Council is committed, by its charter, to foster the exploration of such a satellite, none of its members would be so rash as to propose—particularly in the light of the events of recent months—proceeding without a well-conceived research program which, for example, would cover conclusively the effects of microwave, laser or other power transmission means on communications and the Earth's ecology.

Although it would be unrealistic to expect to have a solar power satellite in effective operation much before the end of this century, your announcement now of our committment to move ahead with deliberate speed on this project would have immediate positive effects—on our nation and the world.

It would reaffirm United States technological leadership. As you know, high technology products are among our leading exports. Enhancing our prestige in that field could favorably affect our trading position. Based on the work being done by the Department of Energy and the National Aeronautics and Space Administration as part of the ongoing evaluation program which addressed the technical, economic, and societal issues raised by the solar power satellite, you can be assured that the known facts would back up your words.

Such a statement by you at this time also would restore to the people of this nation a sense that the United States will move actively and decisively to control its own destiny, and that it is capable of dramatic undertakings toward an objective which could be of benefit to all nations.

In addition, such a move could serve notice to oil producing nations that our dependency may not be everlasting and that oil kept in the ground may not necessarily remain as valuable as it is today.

Even assuming, as we frankly do not think possible, that the solar power satellite does not prove feasible in the projected time frame, the spinoffs resulting from the initial work would more than justify the relatively modest research expenditure required. For example, new materials could be developed in space with applications on Earth. Advanced solar cells developed for the solar power satellite could also be used in commercial and residential buildings. We could learn more about the capabilities of man to perform complex tasks in space and more about the problems of placing large payloads in space.

I would be happy to provide any additional information you may want about the solar power satellite. And, if you would like to discuss the subject, my colleagues and I would be honored to meet with you at your convenience.

Respectfully yours,

Peter E. Glaser
President
SUNSAT ENERGY COUNCIL

Space Industrialization: How to Design for Success

Current legislation reduces the risk of R&D by reducing the costs of failure. How could we turn the process around to reward success instead of failure and to stimulate entry into space manufacturing?

by J. Peter Vajk

Communications satellites are accepted today as a virtually "traditional" sector of the global economic system. It is difficult to recall the struggle of the early 1960's to encourage the development of a global communications satellite system in spite of the fact that we could see the technological feasibility and social desirability of deploying such a system. In 1963, Congress enacted the Communications Satellite Bill which created COMSAT, a private company to represent the United States in a worldwide communications satellite system. Two short years later, the first commercial satellite, Early Bird, was launched, initiating private sector improvement in outer space.

The post-war economic successes of countries such as Sweden and Japan have been predicated upon vigorous encouragement of technological innovation by deliberated government policy. For whatever reasons, the United States has not chosen to follow that path . . .

Today we are struggling with the next step in the economic use of outer space, as we stand on the verge of space shuttle operations and consider the possibilities of manufacturing products in orbit. From a technical point of view, we realize that the environment of low-Earth orbit offers some unique advantages, including weightlessness, ultrahigh vacuum, biological isolation, a wide range of temperatures, and a wide range of radiation environments. These can be exploited in new processes for converting a variety of raw materials into finished products of high intrinsic value per pound. Among the hundreds of possibilities considered thus far (and the thousands yet to be considered), we expect that some will prove to be commercially successful, providing new products, superior products, or less expensive products than we can manufacture here on the ground.

The key problem which the Space Industrialization Bill of 1979 (H.R. 2337) attempts to deal with is what kinds of new institutional arrangements can most rapidly and effectively bring the results of government-funded space research into commercial use? The post-war economic successes of countries such as Sweden and Japan have been predicated upon vigorous encouragement of technological innovation by deliberate government policy. For whatever reasons, the United States has not chosen to follow that path, and our leadership and economic advantage in a number of high-technologies has slipped so far that inflationary protective tariffs have been proposed to protect our domestic manufacturers from the reduced costs produced by vigorous innovation abroad.

I am an advocate of large-scale extension of human civilization and human affairs into outer space. My impression, from giving dozens of lectures to civic group, college, high school, and elementary school audiences over the last four years, is that the grassroots will vigorously support a space program geared to pragmatic, profitable ventures with visible and prompt benefits to people on Earth. Scientific exploration of the solar system and of the universe from space-based observatories are also of interest, but these would be far more acceptable in the presence of a vigorous program designed to exploit our capabilities, experience, and know-how. The Space Industrialization Bill of 1979 is a valuable step toward this goal and I sincerely hope that such a bill will be enacted into law in the near future.

However, I am offering some criticisms of the Bill as presently drafted in the hope that some modification will improve and accelerate the desired effects of the Bill.

In designing a new institutional arrangement, we must be very careful to design it for *success.* To do that, it is necessary to consider very carefully a long string of "What if . . . ?" cases to determine whether or not the proposed scheme will, in fact, discourage failures, inhibit cheating, and reward success.

(A beautiful example of this type of analysis is **The Federalist Papers** written by several of the architects of the United States Constitution. This type of analysis, which examined in detail how the self-serving interests of less-than-perfect politicians, judges, legislators, states, and factions could lead to various failures of the whole system, resulted in the exquisite system of checks-and-balances which have served this nation so well for so long.)

Let me give one brief example—perhaps controversial—of a system which appears to be designed for failure rather than success. Many critics, including such respected economists as Nobel laureate Milton Friedman, have described the present federal policy toward energy as just such a design for failure. In a nutshell, the *worse* the energy crisis gets, the *more successful* the Department of Energy (DOE) becomes. Its appropriations, staff, and regulatory power grow ever larger the further away DOE brings us from a viable solution to providing the energy we need and want. Should DOE somehow find a breakthrough solution to the problem, its survival as an entrenched bureaucracy would be severely threatened. Although all its employees may have the best of intentions and may strive sincerely to solve the energy problem, the system is designed to reward failure, not success.

. . . the worse the energy crisis gets, the more successful the Department of Energy . . . becomes.

It is my concern here that the Space Industrialization Corporation as proposed by the present draft of H.R. 2337 may in part be designed for failure rather than success. At the present time, space manufacturing is generally perceived by U.S.

industry to be "too risky" and it is the legitimate aim of the present bill to reduce that risk and thus to stimulate entry of the private sector into this new field of commercial activity. As in gambling, risk assessment in the business community must consider two factors: (1) How much can we afford to lose? (2) On a probabilistic basis, what is our *expected* gain or loss from this particular investment option? If I wager $1 on some particular number in a roulette game in which the wheel carries the numbers one through thirty-six, zero, and double-zero, I have one chance in thirty-eight that my number will win, and thirty-seven chances in thirty-eight that

[If] a . . . corporation did invest the necessary funds to bring a space product to commercialization . . . the economic returns would be modest because of present tax laws. Thus the returns would be no higher than those of conventional, tested, Earth-made goods.

my number will lose. If the payoff for winning is thirty-eight to one, then my expected winnings are exactly zero, and the game is balanced evenly between the bettor and the house. I have a 37/38 chance of losing my $1, and the house has 1/38 chance of losing $37. The bet is "fair," but I dare not bet more money than I can afford to lose completely, *no matter how fair the bet may be.*

Now consider the opportunity for a company to invest in R&D to develop a new technology to the point of commercial profitability. Suppose market research shows that the company could earn $50 million if the venture succeeds. Suppose the chances of success are estimated (strictly on an intuitive or "hunch" basis) to be one chance in five. On that basis, the company would still break even on an expected winnings basis if it had invested $10 million in the R&D program. (I am deliberately ignoring such subtleties as interest costs and taxes to keep the basic argument simple.) A prudent investor would require that the R&D budget be somewhat less than $10 million or that the prospective earnings be somewhat greater than $50 million before making the investment in order to end up *better* than event, that is, to end up with a profit, a positive return on investment. He or she would also check the overall financial condition of the company to determine whether or not the company could afford to lose completely the funds invested.

If we now contemplate an investment in a new, untried process for the manufacture in orbit of a new or improved or reduced-cost product, we must ask the same questions. How much can we afford to lose completely? What do we expect to gain from the investment, weighing the chances of success against the chances of failure? In the present environment, space manufacturing is generally perceived as "too risky." The common perception in business and industry today is that the development costs for space manufacturing would necessarily involve millions of dollars of investment before any chance of economic returns, and this sum is in many cases more than medium-sized corporations are willing to lose, no matter how large the payoff may be. Yet a series of well-conceived experiments to develop and test some space manufacturing processes would necessarily involve millions of dollars of investment before any chance of economic returns, and this sum is in many cases more than medium-sized corporations are willing to lose, no matter how large the payoff may be. Yet a series of well-conceived experiments to develop and test some space manufacturing processes for products of high intrinsic value could be carried through for as little as $500,000 to $1 million, particularly if the red tape requirements of NASA could be reduced.

Suppose, however, that a medium- to large-size corporation did invest the necessary funds to bring a space product to commercialization. Unless the product were totally new (implying much higher risks of market acceptance as well as of technical development), the economic returns would be modest because of present tax laws. Thus the returns would be no higher than those of conventional, tested, Earth-made goods. In this context, given the higher uncertainties of the R&D phase, any prudent investor would rather put his or her money into a more conventional investment.

The proposed legislation under discussion here today approaches the problem of risk strictly from the viewpoint of reducing the costs of failure, by forgiving the full amount of a "loan" from the Space Industrialization Corporation. I believe this is a serious flaw; it rewards failure of the R&D program by removing the pain of failure, but provides no rewards, over and above those modest returns of any conventional manufacturing enterprise, for a successful effort.

Moreover, this approach encourages cheating, especially by smaller companies. Suppose a small company were formed for the primary purpose of carrying out some space manufacturing activities on a commercially profitable basis, and suppose this company received a loan from S.I.C. in the amount of several million dollars. Suppose that halfway through the planned R&D phase this company realized that the project would result in a fantastic new product which will earn millions and millions of dollars within just a few years.

The temptation would be very strong to begin at this point to maintain two sets of books on the progress of the work, especially with respect to flight experiments. In one set, the true results and progress of the work would be recorded, analyzed, and elaborated. In the other set, forged results would show (during the next 40% of the total funding available) ambiguous results gradually dwindling down to a dead-end failure. Under the terms of the loan from S.I.C., the remainder of the funding would be cancelled, and the company's only obligation would be to document the "failure," and the loan would be forgiven. Soon thereafter, the company could dissolve completely, and the principals in the company, possessing highly valuable trade secrets, could form a new company which completes the necessary R&D from entirely private funding to go into business manufacturing the end product in space, without the inconvenience of sharing their secrets with anyone else or the inconvenience of repaying a loan of several million dollars.

This is not to suggest that the private sector is dishonest; but I think it is most unwise to create an institutional arrangement which rewards failure and provides incentives for cheating.

How could we turn the process around to reward success instead of failure and to stimulate entry into space manufacturing? First we should note that small companies characteristically are more willing to

. . . it is most unwise to create an institutional arrangement which . . . provides incentives for cheating.

invest in risky ventures than are giant corporations. If a small company makes unwise investments, it can always file for bankruptcy; a large corporation which loses several tens of millions of dollars will survive and have to face its irate stockholders at the next annual meeting. If the Space Industrialization Corporation has an annual budget of $50 million initially, it would be reasonable to expect that most of its grants will fall between $0.5 and $5 million. On this scale, most of the awards would go to small- or medium-sized companies; a few might go to the giants of industry, but these are unlikely to be interested unless the prospective earnings in the event of success are much greater than for conventional alternative investments.

Profits and jobs resulting from successful space ventures would be additions to the economic base; to refrain from taxing these . . . would not take away tax revenues since there would otherwise be no profits to tax.

Suppose, then, that S.I.C. loans were required to be repaid in all cases, preserving some of the pain of failure. (That pain could be reduced somewhat by providing the loans at low interest rates with long periods allowed for repayment.) Large companies would find such financing of the R&D costs appealing; small investors would be sheltered from total failure by the bankruptcy laws just as effectively as if the S.I.C. totally forgave the debt. Yet the incentives for cheating would be largely eliminated.

To encourage success, suppose all revenues from space manufacturing operations were granted tax-free status for, say, ten years beginning from the date of the first operational Space Shuttle flight, and 75% exemption for the next five years, etc. The profitability of space ventures would immediately be more than doubled in view of the 46% corporate profits tax, encouraging participation by all sizes of companies. The limitation of ten years, say, before the extent of tax forgiveness were reduced would encourage early entry into the market in order to maximize gains before taxation is phased in.

Some might argue that exempting profits from space ventures provides an indirect subsidy to industry at the expense of other taxpayers. I would suggest that this is not the case at all, because if no incentives were provided for space manufacturing, no profits or jobs in this field would materialize either. Profits and jobs resulting from successful space ventures would be *additions* to the economic base; to refrain from taxing these (at least in the early stages) would not take away tax revenues since there would otherwise be no profits to tax.

What should the role of the Space Industrialization Corporation be if we reward success as I have suggested above? S.I.C. should still, I believe, provide "seed money" for the development of space manufacturing processes, with low interest rates in the event of failure and normal interest rates in the event of success. Besides financing the technological R&D effort, however, S.I.C. can contribute to risk reduction by funding careful market surveys to determine the scale of earnings to be expected if the R&D effort succeeds. Uncertainty about the anticipated revenues in the event of success is a major factor in the present assessment of space manufacturing as "too risky."

I believe that S.I.C. would be most effective in carrying out the purpose of the Bill if it were required to award 90% of its funding to private companies, with no more than 10% spent in-house for administrative costs, project review and coordination, and R&D. In order to improve the efficiency of the organization, its employees should not be included in the Civil Service system, especially in view of the intent to move the Corporation out of the federal government and into the private sector after a few years. In order to minimize the problems of entrenched bureaucracies, a "sunset" clause should be added to the Bill, terminating the Space Industrialization Corporation not more than twenty years after its formation.

In order to allow space industrialization to grow as rapidly as it can, without ceilings imposed by politically determined appropriations and impoundments, I believe it would be most desirable to authorize the Space Industrialization Corporation to issue long-term "space bonds"

Uncertainty about the anticipated revenues in the event of success is a major factor in the present assessment of space manufacturing as "too risky."

backed by the full faith and credit of the U.S. Treasury. Given the requirement of full repayment of S.I.C. loans, and given reasonable judgment by S.I.C. in the selection of its investments, the actual subsidy involved in the form of loan defaults would be quite modest. Once S.I.C. has moved over into the private sector, it could continue to obtain funding by selling corporate bonds in the same manner, albeit without federal subsidy.

I hope these suggestions will prove helpful. I am most concerned that, whatever institutional arrangement results from these considerations, it should be designed for success from the very start. I further hope that increasing the benefits of success will be considered a more desirable way to reduce risks than merely decreasing the pain of failure. Pain is valuable, and should not always be anesthetized. Positive incentives, I believe, will insure the success of space industrialization. L5

Announcements:

Air and Space Museum Marks 40 Years of Jet Aviation

Famous pioneers of the jet age will meet for the first time at a day-long symposium on Oct. 26 at the Smithsonian's National Air and Space Museum.

The symposium will mark 40 years of jet aviation. Participants include:

- Brigadier General Charles "Chuck" Yeager, the first person to fly faster than the speed of sound;
- Air Commodore Sir Frank Whittle, first to successfully operate a turbojet engine;
- Hans J.P. von Ohain, developer of the engine for the first jet aircraft;
- Najeeb E. Halaby, former head of the Federal Aviation Administration and Pan American World Airways; and
- John E. Steiner, "father of the Boeing 727."

Forty years ago, the first aircraft powered by the jet thrust of a gas turbine engine, the Heinkel He. 178, lifted off the ground at Marienehe Airfield in Germany. That historic flight ushered in a new era—the jet age. Each speaker at the symposium played a significant role in the development, production and expansion of jet aviation.

A well-illustrated book containing the lectures and five additional articles will be published Oct. 26 by the Smithsonian Institution press. Edited by Walter J. Boyne and Donald S. Lopez of the National Air and Space Museum, the book spans the history of the jet age as recorded by the people who made it happen. Other articles are by Anselm Frantz, who first developed the axial flow jet engine, and Gerhard Neuman, who was responsible for many important engine developments.

The book also contains a significant collection of historical photographs, many never before published, as well as a comprehensive guide to bibliographic sources.

"Forty Years of Jet Aviation: A Symposium" will be held in the Museum's theater from 9:00 a.m.-4 p.m. Friday, Oct. 26. All lectures are free and open to the public.

Included in the collection of the National Air and Space Museum are the Bell XS-1 ("Glamorous Glennie"), the plane in which Yeager flew faster than the speed of sound; the Messerschmitt Me 262, the first operational jet fighter; and the Bell XP-59A, the first American turbojet airplane to fly.

Beginning Sept. 4, the Air and Space Museum is open seven days a week from 10:00 a.m.-5:30 p.m.

Antioch Lecture Series

A lecture series on space exploration and space colonies is being held this Fall at Antioch College in Yellow Springs, Ohio. The lecture series features Princeton Professor of Physics Gerard K. O'Neill (author of **The High Frontier—Human Colonies in Space**), Timothy Leary, and Peter Vajk (pronounced "vike"), scientist and author of **Doomsday Has Been Canceled**. Other speakers include Barbara Marx Hubbard, co-founder of the Committee for the Future; Dr. Stephen Cheston, president of the Institute for the Social Science Study of Space in Washington, DC, and publisher of the journal "The Space Humanization Series," the Honorable Edward Finch, Jr., chairman, Aerospace Law Committee of the American Bar Association and former Special Ambassador to the United Nations; and Michael Michaud, author, lecturer, and an employee of the Department of State.

Antioch College is the school that pioneered the work/study program, coed dormitory living, social activist studies and written evaluations in place of letter grades. Fall 1979 marks the first time in its long history that Antioch will offer a course and lecture series on the social, political and scientific implications of space exploration.

Already with a place on the space shuttle reserved for experiments, Antioch is developing an interdisciplinary program in space studies geared especially for students of the social sciences and humanities. Faculty from all academic disciplines will be participating in the class.

Antioch College is also developing for its students space-related jobs with companies and institutions around the country. The work/study program of Antioch requires students to work as well as study in order to graduate. These space related jobs will supplement the hundreds of existing employment opportunities already open to Antioch students.

For further information contact Harrell Graham, Antioch College, Yellow Springs, Ohio 45387 (513) 767-7177.

Errata

No Moon Glass Workshop Summaries—In the August 1979 **L-5 News**, an article entitled "Moon Glass" appeared in the announcements section erroneously advertising a workshop summary. There are **no** summaries available for the "Glass and Ceramics Industry in Space Based on Lunar Materials" workshop held at the Lunar and Planetary Institute.

New Button Available

Jon Alexandr, designer of the "Conserve Earth—Colonize Space" bumper sticker, has now produced a button with a similar message designed to prod people out of their normal mode of thinking.

The buttons may be purchased by mail in quantities of 15 (for $5.00) or 33 (for $10.00) from the Bay Area Chapter of the L-5 Society. Orders are particularly invited from other L-5 Chapters and should be sent to:

Bay Area Chapter L-5
3144 Henderson Drive
Richmond, CA 94806

LIS

If you voted in the LIS election but didn't get the mailing of July 20, please write in to the L-5 Society and let us know. We will reinstate you on the LIS mailing list.

Government Publications

The following books are issued by:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Skylab, Our First Space Station

The vast accomplishments of Skylab are almost too profound to grasp. This publication, through its many color photographs, follows the three piloted Skylab missions from launch to reentry, providing key insights into the human as well as the technical side of the program's triumphs.

Skylab established a broad base of factual data on which to base the design of future space systems and the planning of future operations in space. This volume narrates that episode of America's history. 1977. 164 p. il. $7.00. To order, write to:
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

"Careers in Space" Conference Planned

"Where do I sign up?" is a favorite question of would-be space pioneers. Today, however there's no place where you can just walk in and sign up for a job in space. But there's hope on the horizon. With the US space shuttle about to begin regular Earth-to-orbit service, with the Soviet Salyut-6 space station's cosmonauts conducting space manufacturing experiments, the European Space Agency Spacelab nearly completed and a Japanese space shuttle on the drawing boards, experts are predicting hundreds to thousands of jobs in space will open up in the next 10-20 years, with many more space-related jobs on the ground.

What will these jobs be and how do we get in line for them? The L-5 Society and the American Astronautical Society are organizing a three day conference, "Careers in Space" to be held in San

Francisco in late June 1980 to help answer that question.

Topics to be covered will include what careers will be opening up, how and where to train for these careers, and — most important — what we can do to push the New Space Program which is going to create these jobs in orbit.

This conference will provide low cost housing and food, so you won't have to be a fancy executive in order to attend. We plan tutorial sessions to provide you with a basic background in several career areas so you can better choose your occupation of the future. Evenings will be reserved for fun!

Let us know what you'd like to get out of this conference. Please send the questionnaire below and any additional comments to:
Careers in Space
c/o L-5 Society
1620 N. Park
Tucson, AZ 85719

The careers in space which interest me are:

________ space transportation
________ space station/habitat design and construction
________ power satellites
________ communications satellites
________ remote sensing
________ entertainment
________ food preparation
________ agriculture
________ other life support
________ materials processing
________ mining of Moon and asteroids
________ computers
________ law
________ management
________ mental health
________ medicine
________ business
________ other (please list) ________________________________

I would like to enjoy the following evening conference activities:

________ music (what kind?) ________________________________
________ dance (what kind?) ________________________________
________ exciting lecturers (who?) ________________________________
________ other (please list) ________________________________

I want to push the New Space Program by learning how to:

________ organize a local L-5 chapter
________ conduct community education programs with displays, information booths, lectures, film festivals, etc.
________ influence the media
________ influence politicians
________ develop private enterprise space activities
________ initiate a space education program at my local college or high school
________ other (please list) ________________________________

My major areas of interest are ________________________________

My occupation is ________________________________

My level of education is ________________________________

Inside the L-5 Society

The 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.

Call for Papers: If you presented a paper at AIAA, ASCE, SPS or other student chapter meetings and would like to be included in Space Colonies: An Annotated Bibliography, send an abstract to Loompanics, PO Box 264, Mason, MI 48854.

Cascadia Futuria: A New Chapter

Futurists in Portland, Oregon, met September 8 to form Cascadia Futuria, an "Umbrella Organization" to promote thought of the future and futurist activities. The first activity was to form a local L-5 Society chapter and elect officers. Future meetings will be held in Room "E" at the Multnomah County Central Library, Portland, Oregon, 14:00 on October 6, November 3, and December 1. Also being organized is an L-5 display for the ORYCON Science Fiction Convention to be held in Portland, November 9-11.

Persons wishing further information can contact Bryce Walden, 13933 SE Mall, Portland, OR 97236, or call the LightLine (503) 761-8768 and leave a message, or contact the local L-5 chapter president, Susan A. Word, 7144 SW Oleson Road #75, Portland, OR 97223, (503) 246-4432.

Jody Rawley: We would like to send you complimentary copies of the September **News** and thanks for your article. But we have no record of your address! Please write in to the main office.—JA

Georgia L-5 Cosponsoring "Issues for Tomorrow"

The Georgia affiliation of the L-5 Society is kicking off Fall with cosponsoring "Issues for Tomorrow," the southeastern regional conference of the World Future Society, being held at the Georgia State University Urban Life Center in Atlanta (announced in August **L-5 News**).

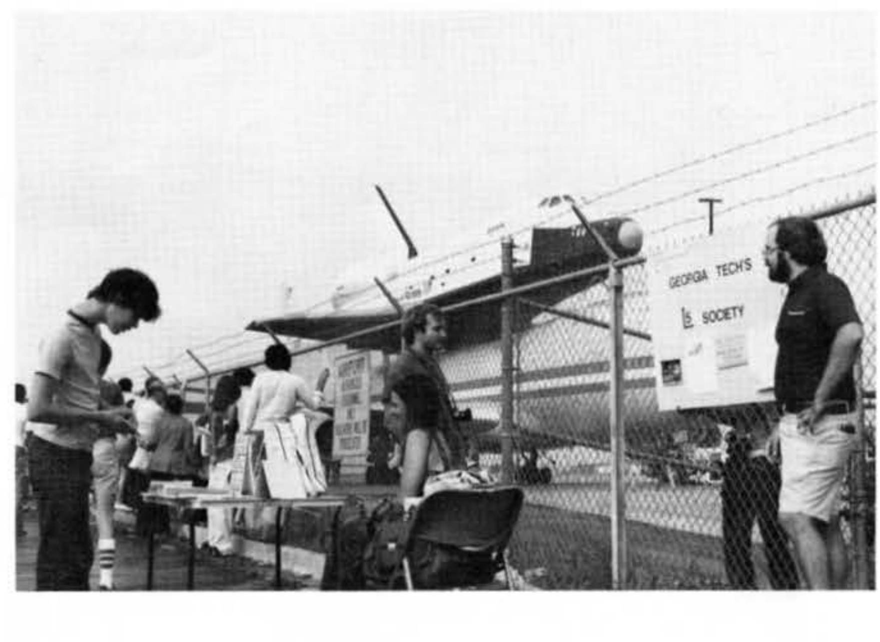
Barbara Marx Hubbard, L-5 Board of Directors member, will give a plenary address on Friday morning, October 12, the first day of the two-day conference. Konrad Dannenberg, L-5 Board member, will lead an afternoon panel shared by Richard Brown of NASA-MFSC in Huntsville, Gerald Driggers of the Southern Research Institute and Jesco Von Puttkamer of NASA Headquarters Advanced Planning. They will discuss "Space in the Eighties—and Beyond: The NASA Program and Space Industrialization" and will describe the latest program of research development, and applications of the space shuttle to the extent of NASA's planning horizon.

Bill Gardiner, President of the Georgia Tech Chapter L-5, will lead a panel shared by Jack Spurlock and John Carder, Associate Director and Senior Research Scientist respectively of Georgia Tech's Applied Sciences Laboratory; Garry Noyes, of the Environmental Engineering Sciences Department of the University of Florida; and Ina Jane Wundram, of the Anthropology Department of Georgia State University. They will discuss "Space Settlements: Reconstruction Spaceship Earth," putting a current focus on the prospects and problems of constructing and maintaining closed ecological life support systems (CELSS) in the space environment.

Although the standard conference fee increased on September 13 to $40, L-5 Society members registering after September 13 may still pay the conference fee of $30, spouse fee of $15, and student fee of $5 by mentioning **L-5 News** with their remittance to:

Division of Public Service
Registration Office
Georgia State University
University Plaza
Atlanta, Ga. 30303

For more information contact Bill Gardiner at (404) 873-6159 or 762-1986.



Georgia Tech Chapter members promote L-5 alongside the doomed space shuttle Enterprise. The Enterprise was at a stop-off in Atlanta on its way to California to be scrapped.

To L-5 Members:

Some questions have been raised about the functions and overall effectiveness of the L-5 Society local chapters. It seems that after the initial steps of organizing a local chapter have been overcome, the members are at a loss as to what to do next. Many chapters seem to be content to have meetings among themselves to discuss their individual views concerning space humanization. Does this really serve the purposes of the society?

The L-5 Society is right now at a turning point. In order to attract more members, the quality of the **L-5 News** needs to be upgraded. In order to fund upgrading the **L-5 News**, L-5 membership must increase. This is where the help of local chapters is needed most. L-5 members tend to assume that the general public is not lacking knowledge of the space program, but merely the support of it. Having been a member of the general public in the not too distant past, I cannot agree.

The logistics are simple. One cannot support that of which one has no knowledge. This is something L-5 local chapters can do. First, arm yourselves! Read up on space colonies so you can answer questions. Organize yourselves; have headquarters send you some promotional materials, then set up an information booth in a conspicuous spot (a shopping mall, etc.). Your presence will arouse the curiosity of passers-by. Tell them what you and L-5 are all about.

The present circulation of the **L-5 News** is close to 3600 copies per month. If the number of our members were raised to 4600 (that's one new member for every three current members), the **L-5 News** could start a program to promote newsstand sales. Each issue sold on the newsstands from that point would convert to a reduction of production costs. Once circulation is over 10,000 per month, production costs would drop considerably. (This means the money could be better spent elsewhere.)

One of the major complaints about the **L-5 News** is the habitual lateness of delivery to certain parts of the country. An increase in circulation would help alleviate this problem also. If there are ten or more members who receive their **L-5 News** at the same Post Office, the magazines can be bundled together and sent directly to that office. If, on the other hand, there are only a few members in the region, the mail is sent through normal sorting procedures, and we all know how long that can take.

Humanization is the key word, for people will colonize space. The L-5 Society needs people for its support. L-5 national is constantly seeking ways to better serve its members. In order to provide more services, more members are needed. In order to prosper, in order to be more effective in not only promoting but reaching the goal of the humanization of space, the L-5 Society must grow.

Randy Clamons,
Administrator

L-5 Society Revenue and Expense Statement
July 1, 1979 - August 31, 1979

Revenue		Expenses	
Memberships	14,908.42	General Office	5,879.20
Donations - LIS	493.50	**L-5 News**	7,108.58
Donations - General	422.65	Legislative Information	982.30
Merchandise Sales	1,180.26	Contract Services	1,263.14
Contract Services	1,963.39	Promotion	3,772.32
Miscellaneous	374.70	Merchandise Expense	191.53
Total Revenue	19,342.92	Total Expenses	19, 197.07
	Excess Revenue Over Expense	145.85	

Give this membership form to a friend!

L-5 Society Membership Form (please type or print)

NAME: ______________________________

ADDRESS: ______________________________

CITY/STATE/ZIP: ______________________________

AFFILIATION/TITLE OR POSITION ______________________________
(OPTIONAL)

I am____ am not ____ interested in being active locally. Phone (optional) ______________

_____ Please enroll me as a member of L-5 Society ($20 per year regular, $15 per year for students). A check or money order is enclosed. (Membership includes the **L-5 News**, the monthly magazine of the L-5 Society. Subscription of $12/year included in membership dues).

L-5 Society members who sign up for the Space Legislation Hot Line option receive frequent first class mailings on the actions of Congress and the President which affect the space shuttle, space colonies, solar power satellites, space exploration and other space projects.

_____ Sign me up for the Space Legislation Hot Line.

L-5: A Place in Space

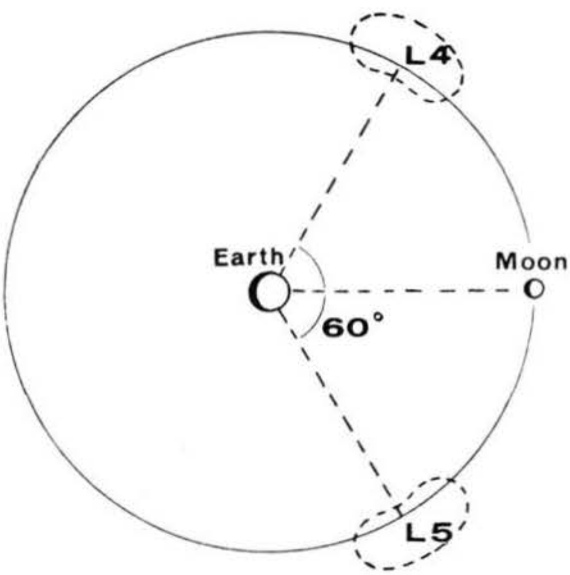
by T.A. Heppenheimer

L-5 is the fifth Lagrangian Libration point. But what are libration points? They are locations where a spacecraft may be placed so as always to remain in the same position with respect to the Earth and the Moon.

The French mathematician, Lagrange, in 1772, showed that there are five such points. Three of them lie on a line connecting the Earth and Moon; these are L-1, L-2, and L-3. They are unstable; a body placed there and moved slightly will tend to move away, though it will not usually crash directly into the Earth or Moon. The other two are L-4 and L-5. They lie at equal distance from Earth and Moon, in the Moon's orbit, thus forming equilateral triangles with Earth and Moon. These points are stable. It is a curious fact that they are stable because the Moon is only 0.01215 times the total mass of Earth and Moon together. If the Moon were greater that 0.03852 times the total mass, L-4 and L-5 would be unstable.

The situation, however, is even more complex than this. The Sun is in the picture and it disturbs the orbits of spacecraft and colonies. It turns out (from an extremely messy calculation done only in 1968) that with the Sun in the picture, a colony should be placed not directly at L-4 or L-5, but rather in an orbit around one of these points. The orbit keeps the colony about 90,000 miles from its central libration point.

In the colonization project, the colonies may be located in the vicinity of L-4 or L-5. L-2, located behind the Moon, is the site of a catcher vehicle, which collects mass shot up from the Moon by the mass-driver. The "2:1 resonant orbit" is also a solution of the restricted four-body problem (Earth, Moon, Sun and satellite), as are the kidney-shaped orbits around L-4 and L-5. The orbit is roseate-like, and can be thought of as an elliptical orbit which precesses around the Earth very rapidly, with a satellite in such an orbit returning to the same location relative to the Earth and the Moon every two months. Such an orbit is relatively stable, requiring nominal station-keeping, and has the advantage of a relatively small "delta-vee" to transfer completed power satellites from a space manufacturing facility to geosynchronous or lower orbits. For this reason some researchers believe that the 2:1 resonant orbit will be the site of the first space manufacturing cities, rather than L-4 or L-5.



But the issue that has people excited is not what orbit will be chosen but what could be done there. Space industries in one of these orbits could manufacture solar power satellites (SPS) from lunar or asteroidal resources. Each SPS could deliver twice as much low cost, environmentally safe energy to Earth, via microwaves, as the Grand Coulee Dam, and forty-five of them could meet the total present electrical power needs of the U.S.

This activity would create tens of thousands of jobs in space and on Earth within as short a time as 15 years.

The **L-5 News** once proposed that we disband in a mass meeting at L-5, but we're not particular — the 2:1 resonant orbit would do as well. Getting tens of thousands of us living and working somewhere in space is our goal.

Spread the Word

We of the L-5 Society of New Bern have found a very effective method for spreading the news of L-5. This method involves only L-5 buttons and membership flyers.

The idea is to wear your L-5 button no matter where you go and carry along some membership flyers (the ones which tell what L-5 is) in your car. Wearing the button is an automatic attention-getter. The first thing people will ask is what is L-5? Explain briefly and ask if they would like some literature on the subject; that you just happen to have some in your car. If they want to see the literature, give them one of the membership flyers. Even if they don't, they have at least heard of L-5. Some may even become interested enough to attend one of your meetings.

The beautiful thing about this method is that it does not force your ideas on someone else. We have sometimes faced open criticism and hostility when trying to volunteer information. When they pop the question and then differ from your opinion, they tend to be more polite. We are not trying to discourage other ways of achieving L-5 goals, but rather encouraging a way which requires no planning, costs almost nill and brings a large amount of people in contact with the L-5 dream.

Danny Hill
L-5 Society of New Bern

Letters

By innuendo, not worthy of a scholarly publication, the "News Brief" appearing on page 15 of the September L-5 edition, must logically conjure up in the minds of your readership some imaginary point counterpoint of opposing views on the draft Moon Treaty between myself and S. Neil Hosenball, the NASA General Counsel. In his federal capacity, Mr. Hosenball is depicted as "countering" concerns about the Moon Treaty registered by Leigh Ratiner, while I am portrayed, in my capacity as the NASA-Ames Chief Counsel, as "retorting" against, and dissenting from, the views of my agency supervisor.

Let me clear the air at the outset by stating that as a lawyer, as a private individual, and as an independent researcher, I consider the draft Moon Treaty unsound as a legal instrument. But the disagreements which I have expressed, and continue to express, about the draft Moon Treaty and its possible future adverse impact upon human rights and fundamental freedoms in space arise from conclusions set forth in prior research of mine published by U.C. Berkeley and Columbia University, long before any consensus existed at the U.N. Space Committee on a single draft Moon Treaty text.

In defending my published works as a legal scholar—and not as a federal official espousing a position—I have always taken measures to exclude the superfluous fact of my federal employment when responding to questions. Consequently, when Carolyn Henson phoned me a few weeks ago and asked whether the views and conclusions emanating from my research were for attribution, I indicated then, as I always will, that they certainly are. I did not entertain the notion, however, that the **L-5 News** would rework my comments to appear as if they emanated from some imaginary policy debate with my NASA supervisor. For the record, I have never, at any time, had discussions with Mr. Hosenball concerning the Moon Treaty, nor do I have any involvement, in my NASA employment, with any matter before the United Nations Space Committee.

In the course of our conversation, and in all of our prior contacts, there was ample notice that my views and conclusions of law were offered entirely in my private capacity and not as a federal official. The Columbia article that I sent in, as a result of our conversation, makes no reference to my NASA employment. All letters written by me to the L-5 Society appear on individual stationery. Moreover, specific views of mine registered in the past and published in the **L-5 News**, do not in any way advert to the fact of my federal employment (see June 1978 edition, pp. 12-14). So I think that my sentiments on this point had to be clearly known.

In closing, there remains nothing further to be done except for you to print this letter to allay any misimpressions entertained by your readers, and for me to apologize to Neil Hosenball—not because he is my NASA supervisor but rather because he has been a trusted colleague and friend of many years—for the "cheap shot" appearing in your September edition.

J. Henry Glazer, J.S.D.
San Francisco, CA

In response to Ken McCormick's article "High Frontier Politics" in the June issue of the **L-5 News**, I would like to state that while SPS construction is certainly the most attractive plan that will lead to the permanent human habitation of space, it is important not to depend on power satellites exclusively as a justification for this goal. In terms of services and industries that can be conducted in space, SPS is one of many. It is true that SPS does have the greatest potential for getting humanity into space on a large scale, however the concept also has the highest risk. While virtually all people agree that SPS is technically feasible, many SPS supporters state that there are questions of economic practicality still to be answered. This is why a vigorous program of research, development and evaluation, which Congressman Ronnie Flippo and AIAA advocate, must be conducted before any commitment to SPS can be made. The L-5 Society should take an active role to ensure that the power satellite concept gets the research funds that it deserves, but I would be disappointed to see L-5 close its doors if continued SPS research results in negative conclusions.

In order to maximize the probability of achieving human independence from Earth, it is necessary to promote and encourage the development of all profitable space activities. In other words: don't put all of your eggs in the SPS basket. Although orbital manufacturing may have from 1/4 to 1/10 the profit potential of SPS, it is still an attractive option in the event that SPS proves to be impractical.

With regards to other large-scale space industries possibly comparable to SPS, Brian O'Leary of Princeton University has stated that large orbital agricultural facilities could become a major space industry in the near future. And there is always the possibility of lunar and asteroidal mining and orbital refining as a profitable venture in itself.

William C. Rudow
Rockport, MA

Who is working on the obvious relationship between offshore oil-field construction work and space work?

The day-to-day work of a saturation diving team is very nearly the equivalent of the work of a space work crew. A sat team lives in a chamber complex for a period of some weeks. The team remains pressurized at the working depth pressure. Teams of two divers at a time are ferried to the work at depth in a bell. These divers lock out of the bell, one at a time, and work about 4 to 5 hours apiece.

Their shift completed, they are ferried back to the surface. The bell is mated to the chamber complex. The first two divers return to the chamber, two more enter the bell. These two divers now go to work their shift.

Work continues in shifts in this manner 24 hours a day until the job is complete. Generally a team living in the sat complex consists of three two-person teams of working divers, a "sat tender" to care for equipment, and possibly a medic. Sat technicians work outside on deck, monitoring life-support, serving meals, etc.

When large-scale projects are constructed in space, the work will probably very much resemble the activity of a sat job.

If you know of other people who are interested in or are working on this connection, please write to me.

Charles S. Upp
SR Box 11385
La Quinta, CA 92253

Last February or so, I renewed my membership with L-5 until next April (1980). I also included a rather lengthy note in which I made some comments and suggestions concerning the Society. The only response I received was simply a membership card in an envelope. If you don't feel that my comments are appropriate, fine; but I think that I deserve at least an acknowledgement of my letter. A simple letter to me would not require much effort on your part, and it might retain a few memberships; no one likes to be snubbed.

Richard Schultz
Seabrook, TX

L-5 members, help! People such as this often write in—heaps of these letters every day. Any volunteers to help answer mail?—CH

I must express my concern over the fact that certain L-5 members seem to be jumping on the anti-nuclear bandwagon. Nuclear fission is still the safest and cheapest large-scale energy conversion system, Harrisburg notwithstanding, and those technical problems it undoubtedly has are likely to be far more tractable than those we will run into with solar power satellites (SPS). As to social constraints . . . well, SPS is as vulnerable to phony statistics and scare headlines as nuclear fission. Our emphasis should be in developing SPS as a *cheaper* energy source than any competing one: technically better, not just socially more acceptable. Besides, an energy-rich society is far more likely to invest in space than an artificially energy poor one.

John R. Aynesworth
Sherman, TX