L5 NEWS

July 1979

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Ed Bas asks, "What's holding up the show?"
"Wealth: The Super Weapon," by Carolyn Henson

L-5 NEWS

A PUBLICATION OF THE L-5 SOCIETY
VOL. 4 NUMBER 5 JULY 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: What's there to do on a Saturday night if you're a solar power satellite construction worker stationed at geosynchronous orbit? Pictured here are two workers loosening up with free fall acrobatics in the recreation room. The woman's weighted belt helps to balance the center of gravity where her hands clasp her partner's. Outside the window North America and a 10 GW power satellite 100 km² are visible. (Artwork by Carolyn Henson.)

Wealth: The Super Weapon

by Carolyn Henson

Artwork by James Babcock

" 'The evidence shows a strong correlation between economic deprivation and violent social action.' . . . wealth . . . may someday silence all the guns and bombs and nukes."

Space colonization may give us the leverage to put an end to war. How? Ask Micky McWilliams. He's a tall, red-bearded sociology instructor at the University of Mississippi and President of the Ole Miss L-5 chapter.

This modern day Viking isn't exactly one of your detached ivory tower types. In the fall of 1977 he was invited to present his ideas to a Congressional seminar on space colonization. So he and two friends hopped into his car, which carried a dayglo "L-5 Sex at Zero Gravity" bumper sticker, and tooled off for Washington.

Maybe that sticker was bad luck, because 2½ hours out they were broadsided by a truck. A nearby hospital sewed them back together and a friend drove them home to Oxford. Micky's car was totaled.

As they reached city limits the unlucky trio decided they couldn't bear to miss their chance to bend the course of history. Declaring, "I regret that I have but one car to give to the movement," Micky borrowed an old rattletrap and they drove off, stitches and headaches and bruises, day and night, and just barely staggered into the Rayburn Building in time to meet with members of Congress.

McWilliams' message? "We're talking about opening up our environment." According to him—and many other researchers—the colonization of space will generate enormous wealth. Take unlimited energy, trillions of tons of asteroids full of nickel, iron, platinum, water, oil, every known element, and a bunch of adventurous people and we'll create an economic boom as big as the galaxy.

How about civil unrest in our country? . . . people who have hi-fis and cars and scuba gear don't want to lose them.

How will this wealth end war? "The evidence shows a strong correlation between economic deprivation and violent social action," Micky explains. "Of the 27 countries classified by the World Bank as rich, only one suffered a major internal upheaval on its own territory between 1958 through 1966. On the other hand, during this same period 32 of the 38 nations classified as very poor experienced significant conflicts."

Yes, wealth is the super weapon that may someday silence all the guns and bombs and nukes.

But—it all sounds too simple, doesn't it? Didn't the U.S. send troops to Vietnam and bomb Hanoi? Yes, but would we have done it if Hanoi could have bombed Los Angeles? It would have killed people, damaged real estate and tied up traffic on the freeways! Ralph Nader would have forced the government to recall the war because it was unsafe for the consumers.

How about civil unrest in our country? The Weathermen mostly blew up themselves. The Symbionese Liberation Army never gathered more than a handful of warriors. The reason is that people who have hi-fis and cars and scuba gear don't want to lose them.

In New Delhi, on the other hand, when people get mad at the government they go bananas. I remember the time—it was late November 1966—when some Indians were protesting their government's refusal to ban the butchering of cattle. It was perfectly legal for the local butcher to go out in the middle of the night and call "here cow, here cow" until he found a nice healthy stray hunk of hamburger. He'd lure it into his house and butcher it. The next morning he'd stuff a chunk of the carcass in a gunny sack and go from door to door, selling to Moslems and Christians. "Psst! Wanna buy some beef?"

I must admit, sacred cow steak was a mouthwatering delight. Anyhow, one day this huge procession of cow-sympathizers came marching down the street. It was a real sight. At least a quarter of these protestors were sadhus — holy men and women who go naked with ashes and cow dung plastered in their hair. I got bad vibes from the crowd so I nonchalantly faded back and got inside just before the first volley of bricks hit the windows.

Having never seen honest to gosh violence I ran to a second story window for a good view — more time to duck the bricks up there! People lay bleeding on the street. Police with staves were beating up everyone they could catch and rioters were now running around turning over buses and torching them. Columns of smoke towered everywhere. I started to get nervous when a character with a torch started running my way.

I dashed for the bedroom and stuffed opals and star rubies in my bra — I didn't have any rupees on hand and figured a bribe or two could come in handy. I pulled the end of my sari over my head and looked at myself in the mirror. Would the rioters believe that I was a six foot tall blue-eyed vegetarian?

Then I heard a holler — the cavalry had come through, or at least a jeep from the American Embassy. As we roared off to their fortified compound I noticed one bloody body had lain in the street for a long time.

The plain fact is that people who couldn't even dream of owning a bicycle, who fear they'll be a casualty of the next famine, have a lot to gripe about. They may at times seem to have quixotic goals: the right to force women to wear veils, the right to put the Sikh butcher out of business. But they have little to lose and much to gain.

The same goes for wars. When Idi Amin got afraid that Ugandans were about to kick his ass, he distracted his angry countrypeople by provoking a war with Tanzania. It's an age old trick, but it doesn't seem to work on a prosperous people.

Of course, it could be people are just perverse. In spite of Micky McWilliams' observations, even the unlimited wealth of space may not bring an end to riots, war and bloody revolt. But it's such a pleasant sounding cure that it's surely worth a try.

You can do your bit to end war the fun way by getting your dayglo orange "L-5 Sex at Zero Gravity" bumper sticker from Micky McWilliams, L-5 Ole Miss, Box 891, Oxford, MS 38655. They cost 50¢ each, three for $1.25. And remember to stay out of the way of trucks!

Inhibitors: What's Holding Up the L-5 Show?

"Our power monopolies had Edison, Ford had Ford. Who will sell space?"

by Ed Bas

"The crowd had pushed to the west end of the platform as the ship swarmed up the mountain. Harriman had stayed where he was, nor had Dixon and Strong followed the crowd. The three were alone, Harriman most alone for he did not seem aware that the others were near him. He was watching the sky.

"Strong was watching him. Presently Strong barely whispered to Dixon, 'Do you read the Bible?'

" 'Some.'

" 'He looks as Moses must have looked, as he gazed out over the promised land.'

"Harriman dropped his eyes from the sky and saw them. 'You guys still here?' he said. 'Come on — there's work to be done.' "

—Robert Heinlein
The Man Who Sold the Moon

Where are you, Delos D. Harriman, now that we need you? Our power monopolies had Edison, Ford had Ford. Who will sell space? Heinlein wrote the blueprint for him in his 1940 story — wanted: a pioneering spirit, a mover and a shaker. But where is his real-life counterpart? Who will make outer space the greatest thing since sliced bread?

For all the good intentions, there are still major stumbling blocks to the industrialization of outer space by American industry. Art Dula, a Houston corporate attorney specializing in technical and patent law, believes he has indentified the "most important inhibitors affecting the potential commercial materials processors/NASA business relationship."

Yes, "inhibitors."

For the most part, they point the finger at a general lack of knowledge on the part of the private, nonaerospace contractors of what space (read: NASA) has to offer. What's more, they don't know *how* to deal with the government (again, read: NASA) and are uncertain or downright uneasy over working within government constraints. And first, probably most important, Dula notes a lack of an "obvious mandate from within NASA to promote commercial materials processing."

Mandate as in "an authoritative command" — Webster.

NASA would like private industry to commit funds early to research and development aboard the space shuttle. But private industry is in a trend of shying away from pure R&D, and the more they demonstrate this the more reluctant NASA seems to "sell themselves."

It has to do with traditional "laissez-faire" of government in industry — hands off or the next step is socialism. Or maybe, like most government agencies, NASA has a problem in selling themselves because they simply don't know how to go about it.

Dula suggests large amounts of personal contact, and willingness to involve all nonaerospace industry.

Two points: one of congratulations, one just a question mark or rather several.

Representatives of North American Rockwell showed up at Oakland University (Rochester, Mich.) to sell the shuttle. They huckstered it just like you'd sell soap flakes — and they did it before a general assembly of the local chapter of the Society of Automotive Engineers (SAE). Is it beneath NASA dignity to stand on a street corner? Does it smack of socialism for a government agency to try to turn a profit?

Along the same lines, the September '78 issue of **Business Week** had a special pull-out section on the space shuttle — put there by *advertisers*, not editorial writers. Wonder of wonders, there was even a postcard enclosed to send in for more information on products and services available through the shuttle. Everyone I requested information from responded, and it wasn't just Boeing and Rockwell.

The other point has to do with the risks incurred by business in outer space ventures. Depending on who you believe, Skylab will impact (read: crash) the Earth this year, either scattering flaming debris over much of the inhabited portion of the planet, or plop harmlessly into the ocean.

Is private industry ready to take such a risk for a launch they sponsor? And, more importantly, do they carry such risk?

As Dula points out, space law is unclear—as is all law where there are no precedents. But a 1972 United Nations treaty gives clear and absolute liability to the launching *state* in the event of an accident. This is the Liability Convention, a sort of corollary to the 1967 Treaty of Principles.

If there were a question of liability, what would stop the United States from financing a catch-all umbrella insurance policy, such as it did with the nuclear power industry in the Price-Anderson act?

There is also some confusion over whether patent and data rights can be retained by nonaerospace users of the shuttle. No one industry is going to bridge new frontiers if it can't be sure of hanging onto new knowledge. Dula said that this goes back to the Kennedy era of "full light of disclosure" to contrast the Soviet Union's secret space program. And Dula calls the policy "an open invitation to a third party suit seeking to force NASA to disclose publicly the results of research done on the space transportation system by nonaerospace industrial users."

NASA could remedy this easily and immediately, by waiving any requirements that industry information be made public.

Looking beyond the shuttle, who owns the Moon? A 1971 International Lunar Treaty states that "the surface and depth of the Moon cannot be the property of states . . . or not as well as the property of physical persons."

Is it beneath NASA dignity to stand on a street corner? Does it smack of socialism for a government agency to try to turn a profit?

Could international space law prevent the movement of lunar materials once a mass-driver is established, or even for L-5 mass-shielding? Do we have the right to go in and kick things around before Zambia and Botswana can build rockets and have the thrill of a national "first" Moon landing?

Can a government entity ever successfully interact with American industry? Or are the two forever distinctly separate breeds?

Is American industry really settling into complacency, afraid of speculation? Are we sure how liability, patent laws and government contracts will fare in the future? The West Germans seem to have overcome these problems, if we can believe in Orbital Transport-und Raketen-Aktiengesellschaft (OTRAG). They are out to scoop the world on delivering the cheapest (CHEAP!!!) launch vehicle to orbit international payloads. Henry Ford may have put our nation on wheels, but Datsun and Toyota are helping keep it there. In fact, OTRAG has whimsically been dubbed "Volks-Rocket."

For every step, there seems to be another question left unanswered, to say nothing of those that haven't been asked yet. But making money isn't supposed to be easy, or without committment, or risk.

As D.D. Harriman said, "You ask me to show figures on a brand-new type of enterprise, knowing I can't. It's like asking the Wright brothers at Kitty Hawk to estimate how much money Curtiss-Wright Corporation would someday make out of building airplanes."

L-5's National Anthem?

Home, Home on Lagrange

The following crazy space song was written by Bill Higgins, an engineering physicist, and Barry Gehm who is doing PhD work on the biochemistry of vision at MSU. The song was first published in the Summer, 1978 issue of **The Co-Evolution Quarterly.** Bill Higgins writes:

> Since we introduced it at the Worldcon in Miami Beach in 1977, the song has become quite popular among science fiction fans and in L-5 circles. This summer it will be published by Ace in Jerry Pournelle's anthology **The Endless Frontier**. We've sung it (usually to the accompaniment of my ukelele) all over America, in cars, on merry-go-rounds, in hotel rooms, and even once knee-deep in a wading pool filled with dry ice, illuminatd by laser beams.
>
> Barry's fond hope is that large space colonies will indeed be built, and that their citizens will choose "Home on Lagrange" as their national anthem. Why not? It's just the thing to sing before settling down to a ball game . . .

by Bill Higgins & Barry Gehm

Oh, give me a locus where the gravitons focus
Where the three-body problem is solved.
Where the microwaves play, down at three degrees K,
and the cold virus never evolved.

Chorus:

Home, Home on LaGrange,
Where the space debris always collects.
We possess, so it seems, two of man's greatest dreams,
Solar power and zero-gee sex.

We eat algae pie, our vacuum is high,
Our ball-bearings are perfectly round.
Our horizon is curved, our warheads are MIRVed
And a kilogram weighs half a pound.

Chorus

You don't need no oil, nor a tokamak coil
Solar stations provide Earth with juice.
Power beams are sublime; so nobody will mind
If we cook an occasional goose.

Chorus

I've been feeling quite blue since the crystals I grew
Became too big to fit through the door.
But from slices I sold, Hewlett-Packard, I'm told,
Made a chip that was seven foot four.

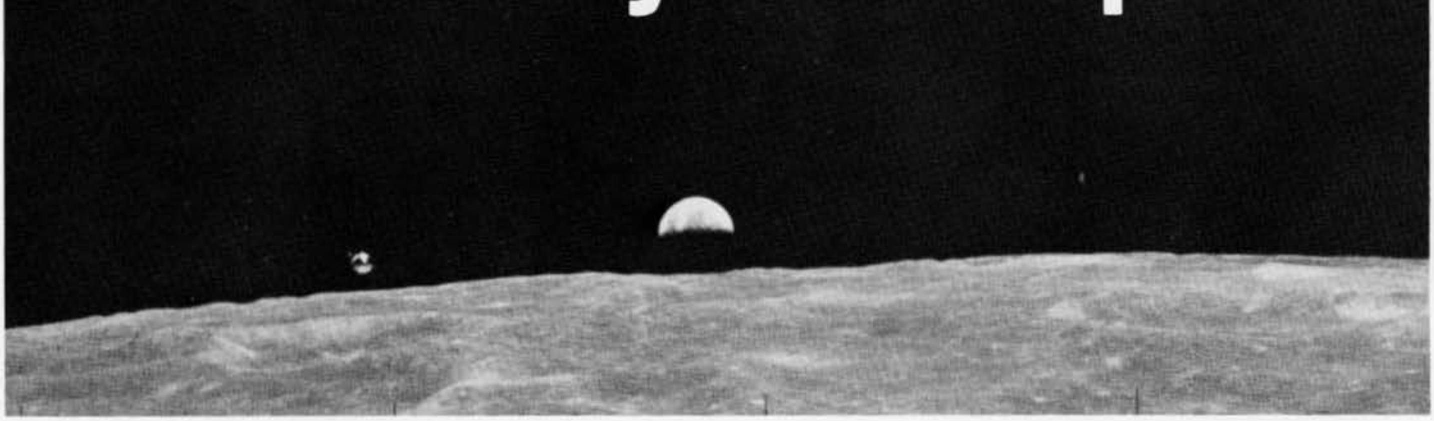
Chorus

If we run out of space for our burgeoning race,
No more Lebensraum left for the Mensch,
When we're ready to start we can take Mars apart,
If we just find a big enough wrench.

Chorus

I'm sick of this place, it's just McDonald's in space,
And living up here is a bore.
Tell the shiggies "Don't cry," they can kiss me goodbye,
'Cause I'm moving next week to L4.

Astronomy from Space



Apollo 16 viewed from the Lunar Module at Earthrise.

by Ed Bas

L5 enthusiasts have made a valid point that the fruition of a space colony will open the "last frontier" to more people, this time the non-astronauts—the manufacturers, the engineers, the entrepreneurs.

But let's not forget that it will also open up space to the group that has held it for so long, yet never grasped it—the astronomers.

Already, a revolution in astronomy is occurring that will shake the foundations of that science more than any discovery since the telescope. The revolution is multi-faceted and multi-fascinating.

Astronomy off the Earth's surface will have the impact that a Renaissance interest in anatomy had on the art world. In a few decades we'll wonder how we ever even developed the science while Earthbound.

Viking to Mars, Voyager to the outer solar system and beyond, Pioneer Venus with its multiprobes and the High Energy Astronomical Observatories (HEAO I and II) are building by leaps and bounds our knowledge of the universe.

No astronomer has yet flown in space. That's not as surprising as it might seem at first when you consider the six piloted Moon landings did not transport any scientists at all until the last, Apollo XVII, landed a geologist there.

Most astronomers would agree that we are nearing the end of our rope in useful observing from Earth. The new discoveries from Earth will be more esoteric, studies in cosmology rather than observation.

Mount Palomar is a prime example of our limitations. If built today, it would cost about $10 million to duplicate the 200-inch reflector, about one-third the cost of a nuclear submarine. It is the world's second largest (the largest is in the USSR). When it was built, it was a scientific marvel for its tremendous light-gathering power. Yet encroaching civilization will one day render it no more than a curiosity, something busloads of school children will look at and point to much as they do the mock-ups of blue whales and Tyrannosaurus Rex.

Astronomy off the Earth's surface will have the impact that a Renaissance interest in anatomy had on the art world. In a few decades we'll wonder how we ever developed the science while Earthbound.

Lights, the bane of astronomers, are everywhere. Our power monopolies are every year giving us higher output for less energy—incandescents, fluorescents, mercury vapor, high pressure sodium. Already, in ever-increasing radii of our metropolitan centers, there is no darkness—ever.

Anyone who has ever gotten completely away from cities, and gasped as I did at the splendor of the Milky Way, will have a hard time returning home and taking urban observing seriously.

The great discoveries of the next century will be made from space itself, which by that time might be no less accessible than the high mountains of Chile.

It took actual fly-bys of Mars in the '60's to finally, once and for all, disprove the myth of the Martian canals. Until then, all was speculation. Percival Lowell was as right as Edgar Rice Burroughs. And Mars is one of our closest neighbors. The same for Venus, which was not revealed until Pioneer.

How many moons does Jupiter have? Galileo guessed four, and the count is 13 or 14 today. It took a satellite photo to find Uranus' ring, and Voyager to find Jupiter's. Is there a tenth planet to justify the "missing mass" and Neptune's planetary wobble? Does Barnard's Star have planets?

Radio telescopes face the same threat as optic telescopes. Just as our skies are no longer dark, neither are they "quiet."

A return of samples from Mars is being contemplated. Where better than space to study them, and thus avoid possible contamination?

L5 will open up space to the nurses, plumbers, farmers, barbers, dentists and welders. But many of them will be claiming telescopes as part of their personal baggage allotment. The journalists will have them along with their typewriters. Sure, we'll exploit space, but let's not forget that we're also going there to marvel at it, and catch a glimpse of a universe long denied us—a glimpse Galileo would have longed for.

Gas Entrained Solids—A Heat Transfer Fluid For Use In Space ©

Part I of a two-part article.

by

H. Keith Henson
Analog Precision, Inc.

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The high cost of low temperature radiators could be reduced by the use of extraterrestrial materials.

The rate of expansion of human activities into space will depend at least in part on the relative advantages and disadvantages that space offers to industry compared to those offered by planetary surfaces. In spite of the authors' well known bias in favor of moving industry and people into space, it may be too early to tell how soon and on what scale it will happen.

The obvious advantages of space for industry, such as energy availability, control of acceleration, and the low structural mass of large objects have been widely noted. However, planetary surfaces also have significant advantages for industry. Ours, at least, possesses concentrated deposits of useful elements, some, like tin, of very low cosmic abundance. A planetary surface like ours is also extremely useful for disposing of large quantities of the inevitable industrial waste product—heat.

Nothing beats a planet covered by liquids and gases for a low cost heat sink. Waste heat on our planet is carried away from concentrated sources such as power plant condensers by water or air and eventually radiated from the Earth into the cold (three degree Kelvin) universe.

Getting rid of massive amounts of waste heat without a planet is not difficult, just expensive. Designers of space habitats, space industrial facilities, and thermal cycle power satellites all need economical ways to dispose of immense amounts of waste heat. Radiators for these applications will use vast quantities of materials and will be very, very large. Hopefully, a method discussed below will keep them from being correspondingly expensive.

Not surprisingly, humans and their machines function best around "room temperature," 293° Kelvin plus or minus a few degrees. Due to temperature drops in the heat exchangers, the above mentioned radiators would have to operate at least twenty degrees below this, about 273° Kelvin or near zero Celsius. The radiation rate of a perfect "blackbody" in watts per square meter is the Stefan-Boltzman constant (5.67×10^{-8} meter^2 T^{-4}) times the temperature in degrees Kelvin raised to the fourth power. For ordinary surfaces, the equation is modified by multiplying the blackbody radiation by a emissivity factor e. Surface emissivities of 0.9 are not too difficult to produce. These numbers imply a requirement of about four square meters of radiator surface area for each kilowatt of waste heat. For these two applications, it seems probable that reducing the radiator area by using heat pumps to raise the radiator temperature will be counterproductive due to the cost of equipment, energy, and the additional radiator area required to dump the heat pump energy.*

Getting rid of massive amounts of waste heat without a planet is not difficult, just expensive.

Given this radiation rate and assuming sunlight filtered to one kW per meter^2, habitats in thermal balance will require about four times as much radiator area as they have sunlight collectors. For 10,000 people in a habitat growing most of their food, the projected radiator area (both sides radiate) is close to a square kilometer.

Space industrial facilities vary in their waste heat output, but the energy trapped in finished products like aluminum is likely to be small compared to overall use. Five hundred megawatts of waste heat from a medium sized material processing plant will require two square kilometers of radiator surface. This will be the reference size radiator discussed below.

Thermal cycle solar power satellite (SPS) designs are driven to a considerable extent by the radiator requirements. Radiator size is minimized by using the highest possible temperature. Potassium Rankine cycle radiators seem to optimize at very high temperatures, 928 degrees Kelvin

**This is not true at lower temperatures. For constant heat flux, the radiator area (proportional to $1/T^4$) goes up by a factor of 16 for each drop of temperature by 1/2 in absolute degrees. At liquid oxygen temperatures, a kilowatt of heat radiation would require over 300 square meters of area.*

(1210 deg. F). At this temperature, they would radiate close to 100 times as much waste heat per square meter as habitat or industrial radiators. Brayton cycle SPS radiator designs were proposed to operate above 530 degrees Kelvin, where they radiate between four and five kilowatts per square meter. Even at this rate, a 10 GW SPS would have about 6 square kilometers of radiator surface area.

It would seem enough of a burden that waste heat radiators need to be so large, but, worse yet, they exhibit diseconomies of scale. The radiation rate (R) is proportional to the square of the linear dimensions, and mass (M) is proportional to the cube of the linear dimensions.

$$M :: L^3 \qquad (1)$$

$$R :: L^2 \qquad (2)$$

Therefore M/R (in units of kg/kw) $:: L^3/L^2$ or L

by (2) $\qquad L :: \sqrt{R}$

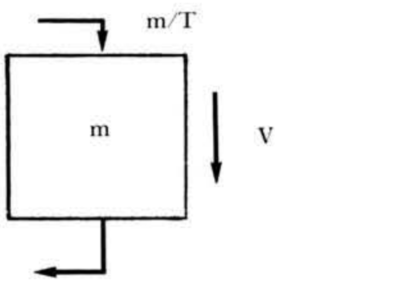
or $\qquad M/R :: \sqrt{R}$

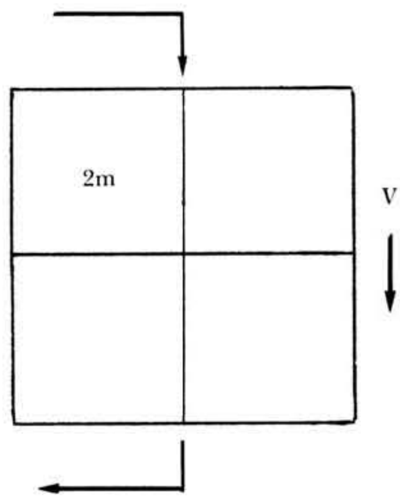
For radiators, small, if not beautiful, is at least less expensive. (See box)

In the Boeing Brayton cycle SPS design, the radiators would be twice as heavy for the same dissipation if the four modules were combined into a single unit. As it is, radiators, fluid and the piping system for the heat transfer fluid contribute about 45% of the mass of a thermal SPS.[1] Later work on the potassium Rankine cycle both raised the radiator temperature (at the expense of thermodynamic efficiency) and reduced the radiator module size by increasing the number of power modules to 16.[2]

There are other discouraging factors about radiators. In large single phase (i.e. non-condensing) radiators, where the fluid mass is dominant, it seems impossible to design the piping system to have less mass than the radiator itself. Fluids, especially liquids, are limited in the maximum velocity of flow. For water in commercial air conditioning systems, this limit is about eight feet per second. Higher velocity will cause pipe damage due to cavitation. Minimum system mass requires maximum velocity everywhere in the closed loop. If the velocity (and density) is constant, the cross section area of the loop must be constant also. It follows, therefore, that the mass of a piping system will be proportional to its length.

Because the pipe mass is proportional to its length, simple geometry of planar shapes and closed loops will define the best shapes for radiators. One example is a radiator of unit area, aspect ratio x, and mass (if in a square shape) of m. The aspect ratio is the width (across flow) to length (with flow) ratio. As each of the tapered headers that distributes the fluid to the radiator has a diameter weighted length of 1/2x, the two headers will have a mass of





This may not be obvious, but consider two identically-shaped radiators at the same operating conditions, one four times as large and twice as long as the other. The small one will contain a fluid mass of m, which passes through in a unit of time (l/V). The small one has a radiation rate of R and the large one, 4R. The velocity of flow (V) will be limited by the fluid. Now consider the left half of the large radiator which radiates 2R. To carry twice as much heat, a mass of 2m per unit time (l/V) must flow into the radiator. Since the velocity is the same, the fluid density per unit area of the radiator must be doubled. Therefore the larger radiator must have twice as much fluid mass per unit area as the smaller radiator.

mx. The radiator and the return pipe will each have a mass of m/x. System mass is the sum of these three or $M=m(x+(2/x))$. The minimum (about 3.4 times the radiator mass) for this function occurs at an aspect ratio of the square root of 2. Since $w/l=\sqrt{2}$ and $wl=1$, $w=\sqrt[4]{2}$ and $l=1/\sqrt[4]{2}$ (1.19 by .84). The return pipe is not needed if the fluid is reheated by passing it through a heat exchanger and on to an adjacent radiator. In this case, system mass is minimized (at twice radiator mass) by using square radiators. A glance at current space habitat models indicates that the radiators may miss being optimized by a factor of 4 or 5.

Another possibly sub-optimised geometric characteristic is the "self-viewing" noted in some radiator designs. A radiator which faces part of itself or another radiator of the same temperature has reduced effective radiation over what it would have with an unobstructed view of the sky.

A small amount of self-viewing may be permissable if it allows the radiator to be broken into smaller blocks. The tradeoffs between smaller radiator segments and the ideal of a radiator looking only at the stars is somewhat complex. Radiator self viewing can sometimes be avoided by using thin reflector sheets to block the view from one radiator to another. The reflector sheets should not reflect a radiator upon itself.

A planar array of tubes provides an example of the potential improvement reflector sheets can provide. Figure (A) shows the effective loss of surface area of an array of tubes as a function of their spacing to diameter ratio. Touching tubes provide an

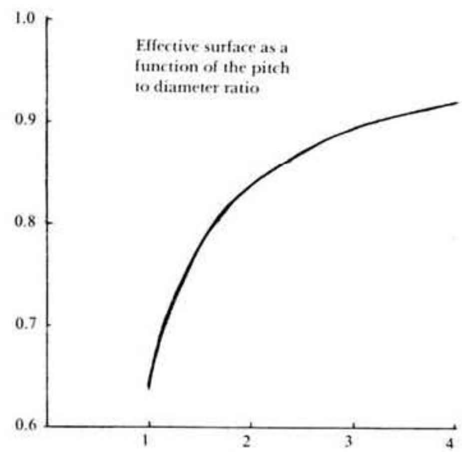


Fig. A

effective area per unit length of only 2d instead of πd. Tubes spaced far apart radiate better but require long and therefore massive headers to connect them. Figure (B) and Figure (C) give examples of reflectors which improve the radiation performance to about that of an isolated tube. In Figure (B) the tubes are spaced about 4.8 radii apart, providing 65% of the area a flat surface between them would provide. In Figure (C) the spacing is 3.65 radii giving a performance of 85% of a flat surface between them would provide. At this spacing the reflectors provide a 17% improvement in the radiation by preventing the tubes from seeing each other. An "air mattress" design (essentially a number of overlapping tubes with common walls) is better at space filling, but for the same amount of material gives only 72% of the radiation of an isolated tube. Fabrication

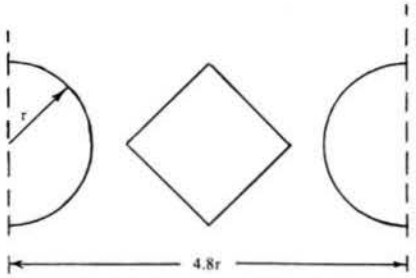


Fig. B

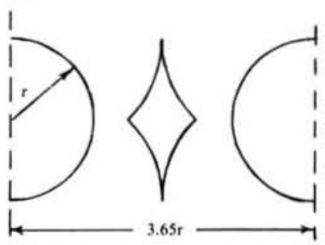


Fig. C

of the "air mattress" shape, while simple, would be more difficult than plain tubes. It also makes blocking off and depressurizing a tube for repairs difficult.

Micrometeors make ease of repairs a consideration in radiator design. The size of the radiators will be so large that micrometeoroid impacts, some causing holes, will be commonplace. A square kilometer radiator using 0.008 inch thick walls would experience about 20 punctures per hour. Each increase of wall thickness by a little over 2 (cube roots of 10) would decrease the puncture rate by a factor of 10.[3]

Another serious source of trouble posed by punctures is that substantial amounts of the gas or liquid heat transfer fluid circulated within the radiator could be lost. Leaks can have serious economic consequences especially if the heat transfer fluid must be imported from Earth. They would be less significant if extraterrestrial resources of lower cost could be used. There are also potential problems with the leaking fluid damaging nearby objects. The inhabitants of a space colony might be somewhat upset if the windows were suddenly plated over with sodium.

Leak prevention favors thick walls, but thick walls over large areas will be heavy and therefore costly. A wall thickness of one millimeter of aluminum on a square kilometer of radiator area would weigh 2.7 million kilograms. Imported from Earth at $200/kg, the walls alone for the reference design would cost $540 million. Several times this weight (and cost) would be required to fill the radiator with a heat transfer fluid. Of course, the normal response when things get ridiculously expensive is to consider extraterrestrial resources.

A serious problem in extraterrestrial resource utilization is the lack of an obvious heat transfer fluid in well known (i.e. lunar) extraterrestrial materials. The only fluid known to be available in quantity from the Moon for use at these temperatures is oxygen gas. In 1977 one of us (Henson) explored the possibilities of oxygen filled habitat radiators in a short article.[4] The amount of heat a gas stream can carry away is proportional to its mass. Reasonable mass flows require fairly high pressure (a substantial fraction of an atmosphere), leading once again to the problems of thick and costly radiator walls and the possibility of high loss rates through punctures.

Now let us consider the ideal heat transfer fluid for use in space. It would have high specific heat, very low vapor pressure (which keeps down the leak rate as well as reducing the wall thickness required) and low viscosity (to keep pumping losses down). For SPS use, compatability with high voltage power conductors and insulators, and the power transmission antenna is a concern. Unpublished Boeing studies have noted the potential compatability problems of sodium and potassium with these subsystems. In addition, the heat transfer fluid should not freeze (removing water from consideration even if it were available), should be available from the Moon or asteroids and require minimal processing. It turns out that space may be full of just what is needed.

Shortly after the Princeton Space Manufacturing Conference of 1977, the other author (Drexler) thought of using gas entrained solids for heat transfer in zero gravity. The idea is quite simple. Use a low pressure gas on the order of 1% of an atmosphere to move finely divided solids over the heat transfer surfaces.

In this kind of heat transfer fluid most of the heat would be moved from the heat exchanger to the radiator surface by the solids at no cost in structural mass. In the microgravity environment of space, there should be no tendency for the solids to settle out. The solids could be screened or finely ground lunar soil or slag from processing operations. The immediately obvious problems such as abrasive wear seemed to be controllable. Wear, for example, can be reduced to a tolerable problem by controlling the shape of the particles, avoiding sharp bends in the manifolds, using hardened or replaceable parts where necessary, and keeping the flow rate below a few tens of meters per second.

Like most of the industrial processes considered for use in space, there are more or less related Earth-based experiences to draw upon; the two that come to mind are fluidized beds and pneumatic transport. Fluidized beds are widely used for heat treating, combustion, and chemical reactors. Heat flow rates determined for heat treating may be useful in designing gas entrained solids heat exchangers.

There is also substantial literature on the subject of moving, separating, and even cooling dust mixed with air. Most of the cement, flour, and other bulk substances in this country are loaded and unloaded from shipping containers by pneumatic conveying. Unfortunately, due to the dominance of gravitational effects, this information will be of little use for designing zero gravity systems. Research on the zero gravity movement of solids in gas streams and separators for gases and solids should have a high priority as hard engineering data will be needed for zero gravity process design.

To be continued in the August **L-5 News.**

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L-5 Saves the Day

by Ken McCormick

When representative Don Fuqua's campaign to obtain the necessary 220 co-sponsors for a bill to proclaim a "United States Space Observance" this year showed signs of fizzling out, members of the L-5 Society responded in the 11th hour with mailgrams and telephone calls to their own representatives, pushing the count of co-sponsors over the 220 mark by the June 7 deadline. When members of Mr. Fuqua's staff finally asked for our (L-5) help, we telephoned contact persons in some of the larger L-5 groups in areas with congressmen who had not yet agreed to co-sponsor the legislation. Space Watch and the National Action Committee for Space were also alerted. Responses to Mr. Fuqua's "dear colleague" appeals had slowed to a rate of one or two per day; during the next 48 hours 32 congressmen responded. To all L-5 Society members who contacted their own representatives: thank you and congratulations.

L-5 members who wish to be added to the Legislative Information Service mailing list can request this service by writing to the L-5 headquarters.

NEWS BRIEFS

"REACH FOR THE STARS" TO BE AIRED

On or near July 20th, the tenth anniversary of the Apollo Moon landing, "Reach for the Stars" will be aired on at least 60 television stations in the United States.

"Reach for the Stars" compares the settling of the American West with the future promised by space industries, solar power satellites and space colonies. Film footage covers Salyut 6 space station activities and the private OTRAG launch base in Zaire.

If you want to guarantee that your local TV station will air "Reach for the Stars," ask them to arrange it with Telecast International, (213)846-9527.

The Soviets have pressed the U.S. to suspend testing of the space shuttle as part of the Strategic Arms Limitations Talks. The Soviets fear the shuttle may be used as a satellite killer, scooping up targeted space vehicles and either destroying them or hauling them to Vandenberg Air Force Base for inspection. The shuttle cargo bay is big enough to capture the entire Salyut space station.

The European Space Agency and China have begun negotiations on possible cooperative space projects.

June 6 the Soviets launched an unpiloted Soyuz 34 craft. It will conduct two days of propulsion system tests in order to better determine if the thruster failure which aborted the Soyuz 33 mission to the Salyut 6 space station has been solved. After completion of tests it will dock at Salyut's rear port.

Speculation has it that the Soviets don't want the Salyut crew to return to ground in the Soyuz 32 craft, which has been docked with the Salyut for over 100 days. The Soviets have never tried using a Soyuz after more than 100 days in orbit and, especially after the Soyuz 33 near-tragedy, may prefer to keep the recently-tested Soyuz 34 available at the Salyut in case of an emergency evacuation.

NASA's recently completed Lunar Resources Study concluded that the use of lunar materials for power satellite construction probably will become cost effective if more than three 5GW plants are built. Taking uncertainty factors into account, they calculated a 92% probability that lunar resources would become cost effective for a program of 30 power satellites.

The lunar resources scenario studied would require a 36 person space base in low Earth orbit, 1,365 people in a space manufacturing complex, probably in a higher orbit, and 48 working on the Moon.

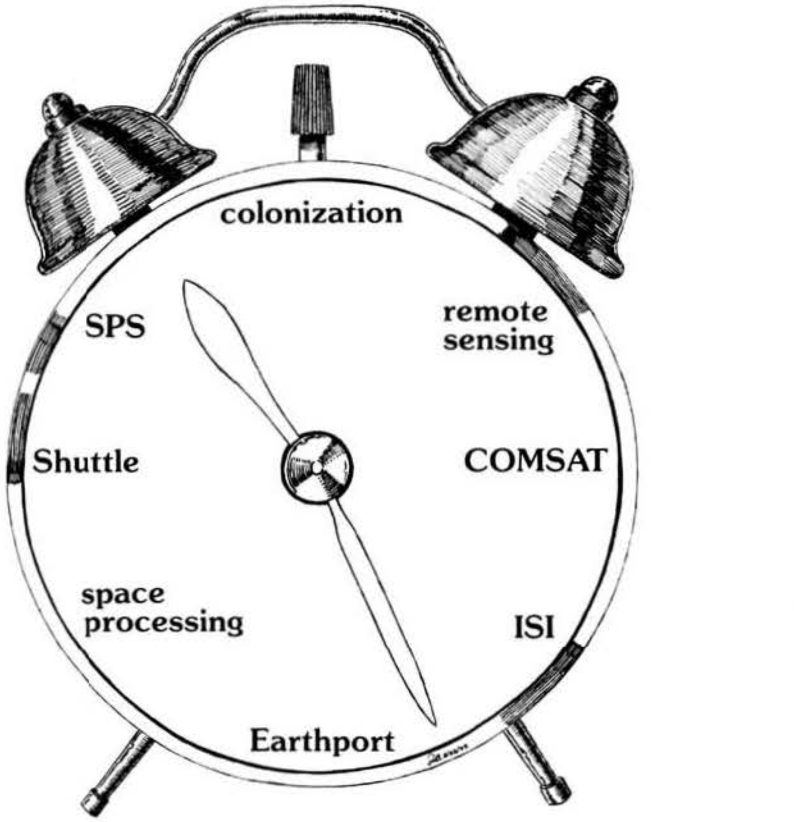
Carter's Office of Management and Budget has released plans for the next four years of NASA activities. The FY'80 request is $4.7 billion, to be followed by $4.6 billion in '81, $4.3 billion in '82, $4.0 billion in '83, and $3.7 billion in '84. The message is clear: four more years of Carter means a 22% cut (not counting inflation) in the NASA budget.

The National Academy of Sciences Environmental Board has begun a study of the solar power satellite concept. The use of extraterrestrial materials will be evaluated. The study is being funded by the "High Frontier Feasibility Study" appropriation in last year's National Science Foundation bill.

What time is it?

The 1979 Goddard Memorial Symposium discussed ISI, Earthport, SPS and more.

by Amy S. Bouska



Artwork by James Babcock

The "official" answer from the 1979 Goddard Memorial Symposium in Washington, D.C. last March was: time to organize and cooperate. However, with the first flight of the Shuttle in the near future (we hope), it is also time to get going again.

The first response was hardly a surprise from a conference which was organized around the theme "Space: New Opportunities for International Ventures" and which included as speakers Mr. Roy Gibson, the Director-General of the European Space Agency (ESA), and Mr. Peter Jankowitsch, the Chairman of the UN Committee on the Peaceful Uses of Outer Space.

Dr. Robert Frosch, giving the first keynote address, set the tone for the symposium when he noted that those space opportunities could be either competitive or cooperative and, in their proper places, both would be desirable.

Cooperation in space *can* be relatively easy, for instance in the purely scientific areas or in projects of clear and widespread benefit. On the other hand, it can be beset with difficulties. As Mr. Jankowitsch remarked, it is a form of international cooperation that has evolved remarkably rapidly (as opposed to agreements on use of the sea, for example).

Serious questions which must be settled include the allocation of geostationary orbit stations and frequencies, the use of nuclear power sources in satellites, and space arms control. Solutions to these problems will demand continuing interaction between lawyers, legislators and scientists, combined with broad public support.

The problem of luring private money into orbit appears to be self-solving as space research continues.

The field of remote sensing was the object of considerable discussion, especially in answer to the last question of the three-day meeting, when Dr. Charles Sheffield, President of the American Astronautical Society, asked the panelists to speculate on the next step in the use of space. The panelists were almost unanimous in their certainty that the development of a world-wide remote sensing network, with a common data base and extensive real-time capability, is both necessary and inevitable.

Competition in the high vacuum is as old as the almost forgotten(?) US-USSR Space Race, but real economic and technological competition is only now beginning to emerge from the earlier government monopolies. Of course COMSAT and INTELSAT are the prototypical profit ventures in space, and telecommunication is firmly established as a business, with 1977 revenues of approximately one billion dollars. According to Mr. John Disher, the Director of Advanced Programs in the NASA Office of Space Transportation Systems, this is the field where solid, nonspeculative growth is almost guaranteed.

What about space processing? Where is the industrial demand? As Mr. E.F. Branahl, Vice President and General Manager of McDonnell-Douglas Astronautics, explained, the private sector must *know* that a product will have high value and a stable market and that development will be possible and affordable. To these ends, the government should support proof-of-concept work. McDonnell-Douglas has identified pharmaceuticals, including the isolation of beta cells (a possible single-injection *cure* for diabetes), as the most promising initial field for space processing. The problem of luring private money into orbit appears to be self-solving as space research continues.

The great majority of the discussion at the conference was either historical or descriptive, dealing with more or less nonspeculative topics. Against this background, three topics of special interest to L-5ers stood out: International Satellite Industries, Inc. (ISI), Earthport, and solar power satellite (SPS) work. Mr. Christian Basler was at the symposium with copies of the ISI preliminary prospectus. In spite of Dr. Frosch's rather cool answer to a question about ISI, copies of the prospectus were being picked up from the ISI table. The Earthport project, represented by Dr. Larry Smarr, seemed to be received with somewhat more warmth and interest, and its emphasis on the development of a Remote Sensing Institute was very much in line with the widespread importance attached to this topic.

Whatever time it is now, the symposium consensus was clearly that it is a long time to SPS-time. According to one NASA representative, it is "way out there . . . well beyond the state-of-the art." There are technical problems, legal problems, financing problems, military problems (possible susceptibility to sabotage), and environmental problems. Surprisingly, however, the situation "between the lines" was very upbeat, with speakers frequently going to pains to point out that much work on other projects could be directly applied to SPS development; bigger, more complex satellites will require more power from bigger solar panels and both work in low Earth orbit and crowding in the geostationary orbit will soon require the construction of large space platforms. In fact, about forty million dollars of NASA's budget could be relevant to future SPS work.

Overseas, ESA has created a special SPS task force and West Germany, France, Japan, and the USSR are all studying the topic. Especially interesting and encouraging was an unscheduled talk by Mr. Raymond Munday of the British Aerospace Corporation on "Europe's Developing Interests in the SPS." "Aerospace & Energy," with the SPS as a central item, was the theme of a recent display in the halls of Parliament, and the members reacted quite favorably after the shock wore off. By Mr. Munday's report, Prince Charles is very interested in the SPS concept!

And where in all of this is L-5? About where it always has been—far out. Space colonization penetrated as far as three slides in the "Space Art Show" but the silence on the idea otherwise was deafening. One pro-SPS participant, when asked privately if this represented some institutionalized resistance to the idea replied "No, not at all." As he preceived the situation, the silence is mostly based on economics, with the enormous up-front costs working badly against both large-scale space processing and colonization. According to the studies which he quoted, space processing of lunar materials would become profitable somewhere between the fifth and the tenth SPS.

So the scenario is: first, the Shuttle; then the small-scale space processing; then one SPS; then more SPS construction; then, someday, maybe, colonization. Does this prospect sound gloomy? From the depths of the pre-Shuttle blahs, I would say that, on the contrary, it looks slow but hopeful. It is definitely time to look up to space again.

Announcements:

James Oberg has requested that the **L-5 News** run the following:

"References made to Jim Oberg's rationale for leaving the Air Force were based on my personal speculations fuelled by private conversations, and cannot be construed to definitively describe Oberg's true motivations. Readers should disregard my remarks and ask Oberg directly if they wish to know about this subject.

C.M. Henson"

NASA Info

In the May issue of the **L-5 News**, there was an invitation to readers to be put on NASA's mailing list for free NASA news releases. Apparently this has posed a problem; we have received a letter from William Pomeroy of NASA Public Information Services informing us that NASA is not in a position to accommodate such requests except to "professional representatives of news media and established free lance writers."

As an alternative, Pomeroy suggests a subscription to the monthly **NASA Activities** ($11.55 domestic per year, $14.45 foreign). Interested persons should mail their subscriptions to:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

WE and ESPO at Seacon

A Space Settlement Information Room is being organized for Seacon, the World Science Fiction Convention to be held in Brighton, England this year (August 23–27). The project will be a joint effort of the L-5 West European Branch and the European Space Promotion Organization (ESPO) (formerly the European Space Association — ESA).

Copies of the **L-5 News** and the new ESPO paper, **TNT — Tomorrow's News Today**, will be distributed in addition to a whole plethora of pamphlets now being written by WE and ESPO members, covering almost every aspect of space settlements. Other plans for the exhibit are brewing, including a possible computer-simulated Moon landing and Earth Ferry Rocket docking.

The exhibitors plan to include a map indicating the locations of all L-5 chapters. Chapters are requested to send a one-page write-up of their chapter and its activities to post around this map. Chapter write-ups can be sent to, and all L-5ers coming to Brighton are encouraged to write to:

Andy Nimmo
Ingleneuk
Waterside Road, Kirkintilloch
Glasgow, G66 3HB, Scotland

Voyager Photographs

Prints and slides of the dramatic color and black-and-white views of Jupiter, its moons and ring, sent back by the Voyager space probe, are now available from the Astronomical Society of the Pacific (A.S.P.). A world-wide nonprofit educational organization, the A.S.P. works to increase public understanding of astronomy through its publications, resource materials and activities.

Two sets of ten slides and two sets of five prints are available. For an information sheet and price list, please send a stamped, self-addressed envelope to:

Voyager Dept.
A.S.P.
1290 24th Ave.
San Francisco, CA 94122

Models Sought

Daring L-5 photographer Chuck Divine is planning a photographic interpretation of the humanization of space. He is looking for models, both professional and non-professional, to pose in these photographs. If you are interested in helping, please contact Chuck at 214 Park Lane, Trenton, New Jersey 08609 (phone: 609-587-0921). Profits from the sale of these photographs will be donated to prospace efforts (L-5 Society, Space Studies Institute, etc.).

Strategies For Feeding Humanity

World Game was conceived by architect/philosopher R. Buckminster Fuller as an alternative approach to global problem solving. Strategies will be formulated during a one month planning session in Philadelphia, June 11-July 11. These strategies will be presented at the symposium at New York University on July 14-21. At this symposium, leading food experts, representatives of national and international hunger and agricultural development organizations, and innovative thinkers including Buckminster Fuller, John Todd and Rene Dubos will make presentations. Also present will be Secretary of Agriculture Robert Bergland. The cost of the lab, including room and board, is $361.00. The cost of the symposium is $155.00.

For further information and applications, contact Steve Mosenson, World Game 1979, 21 Washngton Place, N.Y., N.Y. 10003. Phone 212-598-2036.

Space Movie

A quality 25 minute movie on space industrialization is available from John Guthrie at Laseradio. The film contains interviews with Carolyn Henson, Timothy Leary, Peter Vajk, and others. Called "A Void Home," it is being offered to comercial stations for a nominal fee and free to PBS affiliates. L-5ers can obtain a Betamax cassette of the film for $90 from:

John Guthrie
Box 77821
L.A., Cal. 90007
(213) 666-6874

Lunar Landing Anniversary

July 20 marks the tenth anniversary of the first landing on the Moon. To help celebrate the event, the Smithsonian's National Air and Space Museum is sponsoring a free public ceremony, a commemorative book and special exhibits.

A public ceremony, co-sponsored by the National Aeronautics and Space Administration (NASA), will be held Friday, July 20, from 11:00-11:45 a.m. on the Mall side of the Museum. Participants will include the three astronauts from the Apollo 11 mission (Neil Armstrong, Edwin J. "Buzz" Aldrin, Jr., and Michael Collins), representatives from the Smithsonian Institution and NASA and other dignitaries.

Also on July 20, a commemorative book entitled **Apollo: Ten Years Since Tranquillity Base** will be issued by the Smithsonian Institution Press. Edited by Richard P. Hallion and Tom D. Crouch, curator-historians of the National Air and Space Museum, the book is a series of essays ranging from the Apollo concept and its technological evolution to its impact on science, technology and society. Contributors include Rocco Petrone, Roger Bilstein, John Logsdon, Farouk El-Baz and James Dean. Also contained are a comprehensive photo essay and a guide to bibliographical sources.

A special exhibit located in the Milestones of Flight gallery will open in early July. The commemorative exhibit will include a videotape of the first walk on the Moon, photographs and items from the mission.

Visitors to the Museum from July 16-24 (the nine days during which Apollo 11 made its voyage in 1969) will be able to view day-by-day actual coverage of the mission as it was televised 10 years ago on special closed-circuit television sets.

In addition to the Apollo 11 command module, "Columbia," which returned the three astronauts from the Moon, the National Air and Space Museum contains the world's only "touchable" Moon rock, a lunar landing module identical to the one used by the Apollo 11 team, and the Skylab Orbital Workshop which visitors may enter.

The Museum's Apollo to the Moon gallery contains the space-suits worn by the Apollo 11 astronauts, a lunar roving vehicle and various personal and flight equipment.

The National Air and Space Museum is open free to the public seven days a week from 10:00 a.m. to 9:00 p.m. through Labor Day. Admission is free.

Remember the Future—The Apollo Story

The San Francisco section of the AAS and AIAA will sponsor this two day conference on July 20 and 21 along with sponsors, the Bay Area L-5, **Space Age Review** and FASST. A number of broad-ranging topics will be covered: intersteller travel, space industrialization, military in space, the Soviet Space Program, SETI (search for extraterrestrial intelligence), planetary exploration, advanced rocketry and space settlements. Speakers will include: Peter Vajk, Mark Frazier, B.J. Bluth, Robert Edelson, and Christian O. Basler. The banquet will feature Poul Anderson, science fiction writer, and Robert Bussard, intersteller ramjet inventer. The conference will be held at the San Francisco Airport Hilton. L-5 members' cost will be $30 including the banquet; the student rate is $20 including the banquet. Write to:

SF Bay Area Section of AAS
P.O. Box 7205
Menlo Park, CA 94025
(408) 737-1394

"Giant Leap" for Space Day

To commemorate the tenth anniversary of the "giant leap for mankind" the Visitor's Center at NASA/Langley Research Center, Hampton, Virginia, will feature a special program of lectures. This program, to last the entire month of July, will include a showing of the Apollo 11 films. For schedule information call 804/827-2855.

To accommodate visitors during the month of July, NASA/Lewis Research Center will be open extra hours: Monday through Friday from 9:00 A.M. to 9:00 P.M., Saturday from 10:00 A.M. to 4:00 P.M. and Sunday from 1:00 P.M. to 6:00 P.M. Special displays will include commemoration of the Apollo 11 and lunar discoveries and large (20'x24') photographs taken by Voyager spacecraft of Jupiter and its satellites. For more information call 216/433-4000, ext. 415.

Tenth Anniversary activities at NASA/Johnson Space Center, beginning at 9:00 A.M. July 20 at the Visitor's Center, will include dedication of the new Lunar Sample Facility (Building 31A), the Saturn V Rocket and the Rocket Park. Site maps will be available showing buildings open to the public, among which will be the Sample Processing Facility (Building 31A) and the Space Shuttle Orbiter Mockup Laboratory (Building 14). Visitors may sign up for tours as they arrive at the Building 2 Information Desk.

Inside the L-5 Society

Keeping Your Chapter Active

by David R. Jones, Jr.
Virginia Tech Chapter
L-5 Society

So you've decided to form an L-5 chapter. You'll put up a few signs—maybe write your local paper. No sweat. Get together and have a good time. Easy? Only it doesn't work that way.

To have a good chapter you must be active. To keep active you need "planned" events that will keep your members' interests. These events should be a wide variety of things—such as discussions, movies, guest speakers, trips, projects, contests—you name it. Just so long as you take time to plan it out and keep it interesting.

Involve your group in lively discussions. The more controversial the better. Announce the subject at the preceeding meeting so your members can come prepared. And be prepared yourself. You must start it off—usually with your own opinion. A few subjects that have worked well for our chapter are:

Who should be allowed to go.
How should we live (culture).
Interior designs for living.
Military vs civilian control.

Or you could base your discussions around movies. Movies are available for free or for return postage from many sources. NASA has many on a wide range of subjects. Most libraries have movies or access to them—ask to see their lists. Also, many large businesses make movies that might interest your chapter (such as Bell Telephone). Write and ask.

Don't limit your group to just space movies. Be diversified. Look for related topics like agriculture, communications, environment. And not just movies. Look for various speakers.

Speakers can be found at local universities, industries, through libraries, other clubs (such as astronomy, AIAA chapters, ham radio satellite users, etc). Look for a variety of topics: power generation, waste disposal, international and space law, the environment. Many subjects relate to space colonies.

If the speaker can't come to you, go to him. Take trips to museums, observatories, NASA facilities, etc.

Plan projects. See what your members would like to do. You could put together slide/lectures on such subjects as space colony design history or solar power satellites. Offer them to local schools, clubs, even church groups. Put out a newsletter. Be it fancy or small, it keeps your members informed.

Have contests. Use space colonies books as prizes. Have contests to name chapters, to design chapter patches, for posters, for space poems, to name colonies. (How about an entertainment colony?)

Put up displays. Libraries love for someone to fill their display boards. Set up tables at science fiction conventions, Sun Day activities, college registrations, public events. L-5 has some nice membership forms and handouts or make your own. Sell bumper stickers or L-5 post cards (they're hot items).

And along with displays goes publicity. Many local newspapers are more than glad to run notices of your meetings—and are hungry for stories. Just don't get too technical for the local Earth-based folks. And keep national L-5 informed of your activities.

Most important, find out what your chapter members are interested in. Start working from there and expand outwards. There is a universe of events and topics awaiting you.

Members Beware!

by Keith Henson

Events over the past few months prompt a reiteration of a long-standing policy of the Board of Directors of the L-5 Society.

"Representatives of the L-5 Society consist of the officers and those authorized by the Board for specific purposes. Unauthorized representation is grounds for revocation of membership."

L-5 is a young organization largely made up of young people who in many cases do not know the conventions of power and personal deportment for dealing with the world of powerful people. If we are serious about our long range goal of getting large numbers of people into space, we are going to have to understand and use the rules of the game which have been worked out over so many years.

Among these rules is never misrepresent yourself. Being a member of any corporately organized society gives a person no more right to represent the society than a holder of a share of General Motors has to represent GM. If this abstraction of honesty doesn't appeal, consider the potential embarrassment.

Two recent examples of the embarrassment this kind of behavior can cause come to mind. One was a L-5 local chapter president who, by droping the qualifiers, made it appear to an important group of people in Washington that he was the L-5 Society president. Since a substantial number of these people personally knew the Society's president, a considerable amount of amusement was expressed at his expense.

A much more serious example was a person who lost a job for "unprofessional conduct." While there were other factors at work, an apparently precipitating event was the unauthorized implication of representing one of the technical societies in giving a paper.

On the other hand, don't hesitate to ask if you can represent the L-5 Society in some worthy endeavor. For example, Norrie Huddle, Magoroh Maruyama, Peter Vajk, and others represented the Society at the UN Habitats conference in 1976. Edward Finch, Amanda Moore and Frank Vernuccio currently represent the Society as a nongovernmental organization at the UN. Ken McCormick represents the Society (and even gets paid for it) as our Congressional liaison in Washington.

Of course, be sure to ask in advance. Some while ago, an L-5 member requested that the Society vouch for him being an L-5 member to a radio station. This sounded a little strange, so one of the office staff called the station and found that the misguided member was desirous of giving an award on behalf of the L-5 Society to a commentator for a UFO program.* The station personnel, wise to this sort of thing, wanted verification of the member's authority to make the award. No such authority existed, and the staff had to say so.

We should all remember that the people in power are fairly sharp. They didn't get where they are by being taken by phoneys very often. They are not impressed by puffed-up titles in organizations with typed letterheads. So be what you are, work hard with what you have, and earn people's trust. And when you are a rung or two up the ladder to respectability, you too can write little essays on manners like this one.

*UFOs have nothing to do with space colonies. Once they become IFOs (*identified* flying objects), that will be a different matter.

Annual Election

Here's your chance to impact the leadership of the L-5 Society by electing the L-5 Board of Directors.

The L-5 Board authorizes expenditures, sets policy and chooses the officers of the Society. It also recognizes L-5 chapters.

Beyond these duties, Board members are hard workers who assist the Society in many ways.

For example, L-5 Director Edward R. Finch, Jr. (who is also Chairman of the American Bar Association Aerospace Law Committee) is the L-5 Society's representative to the United Nations. He arranged the necessary letters of recommendation and met in person with U.N. officials to arrange the L-5 Society's acceptance as a U.N. Non-Governmental Organization. He supervises Amanda Moore, a graduate student working on her doctorate in international law, and Frank Vernuccio, a young lawyer, in their work covering U.N. activities. They make frequent written and telephone reports to the L-5 President. Much of the **L-5 News** coverage of U.N. activities depends on their work.

Senator Barry Goldwater, Robert A. Heinlein and Philip K. Chapman have been working on methods to increase our membership. They have written promotional pieces for direct mail and advertising efforts. In addition, Mr. Heinlein located a free ad space and paid for another out of his own pocket. One of Senator Goldwater's staff located a reputable direct mail firm for us.

Barbara Marx Hubbard is one of the largest financial supporters of the L-5 Society. She uses her considerable influence in Washington circles on behalf of the cause of the settlement of space. She has also contributed articles to the **L-5 News**.

Norrie Huddle is our "token environmentalist," as she likes to joke. She organized the L-5 Society's presentation at the United Nations Habitat Conference. She currently is working as a free lance writer in Washington, D.C. We find her contacts with the environmentalist and anti-war movements invaluable. She has also been an excellent fund-raiser for L-5.

Gordon R. Woodcock has obtained large amounts of artwork, information and a number of well thought-out technical articles for the **L-5 News**.

Konrad K. Dannenberg, J. Peter Vajk, Jack D. Salmon, Mark Hopkins, Arthur Kantrowitz, Harlan Smith, and Philip Chapman have provided assistance to their local L-5 groups.

Konrad Dannenberg is organizing a L-5 Society session on space habitats for a conference planned for Atlanta next year.

H. Keith Henson works with L-5 President Carolyn Henson, Secretary Jack Salmon and Treasurer William Weigle in the day to day management of the Society. His activities have ranged from setting up a revolving credit line to chairing the Nominating Committee. He occasionally writes for the **L-5 News**; his article, "Bound for Glory" (March '79 **L-5 News**), has set the L-5 record for the most reprint requests.

L-5 President Carolyn Henson is currently working closely with the American Astronautical Society President Charles Sheffield on a pair of joint L-5/AAS conferences on how to get jobs in or related to space. The organizing committee for the one to be held in late June 1980 in San Francisco has already been set up. We plan to hold our 1980 Annual Meeting at that conference, so for once we'll have a real crowd on hand to cheer the announcement of the election results!

Ms. Henson also is conducting a study on behalf of the U.S. Department of Energy to solicit feedback on their solar power satellite program from L-5 Society members and space policy makers in Third World Nations.

Bylaws and Board Elections

As some of you are aware, our bylaws call for an annual meeting at which additional nominations to the Board may be made by members. (The bylaws are deficient in that there isn't even provision to decline a floor nomination if you are not present.) These features of the bylaws are not really too appropriate for an organization as geographically spread-out as ours. The bylaws were originally adapted from a local organization where most members could come to the annual meeting.

The bylaws also call for the election of a new Board by the end of June. Last year's annual meeting was combined with ballot counting and only four L-5 members showed up.

Because of some disagreements on the election format this year, we considered calling an annual meeting to accept additional nominations per the bylaws. However, since time is short, several of the people who would be at the annual meeting proposed the following: the entire L-5 membership be nominated from the floor; this includes all possible nominees. The nominating committee has endorsed this idea. Keep in mind when voting (circle names) that many of these people would decline Board membership, and a few would be utterly unacceptable to the regular Board. Use the write-in space for members too recent to be listed.

On the ballot proposed by the nominating committee, vote for each person that you support for the Board. Those with more than 50% of the number of ballots cast will be on next year's Board. We sincerely thank the out-going Board members for their efforts on behalf of the Society.

Annual Meeting

The results of the election will be announced at the L-5 Annual Meeting. This year the meeting will be held July 22, 2:00 p.m. at the Kinsey Auditorium, 7000 State Dr., Exposition Park, Los Angeles, CA 90037. For further information, contact: Charles Carr, (213) 749-0101, Ext. 228.

Dr. Jerry Pournelle, famed space researcher, science writer and best selling novelist, will open the L-5 Annual Meeting with a speech on how we can get the space program back into high gear. Dr. Pournelle is a dynamic, fascinating speaker—don't miss this opportunity to hear him!

The following pages include the approved candidates ballot and the ballot for candidates nominated from the floor. A copy of the ballot may be used if you don't want to cut up your **L-5 News**, *however, only those in the official envelope will be counted.*

Ballot

You may vote for as many of the candidates for the Board of Directors as you wish. All candidates who receive a majority of the ballots cast will be elected.

Approved Candidates

________ **Senator Barry Goldwater, Sr.** He was one of the first people in the U.S. Congress to support both solar power satellites and space colonies.

________ **Freeman Dyson** He originated the theory of quantum electrodynamics, which unifies quantum mechanics and Einstein's special relativity. He is a professor at Princeton's Institute for Advanced Studies. He has been a long term advocate of the use of asteroids and comets for the colonization of space. His book, **Disturbing the Universe** (Harper and Rowe) to be released this August, carries a detailed account of past human migrations and considers how we can accomplish the next migration when we will spread throughout the universe.

________ **Barbara Marx Hubbard** She chairs the International Committee for the Future. She was one of the earliest financial supporters of space settlements research, and was responsible for framing House Concurrent Resolution 451 which called for the United States Office of Technology Assessment to study the feasibility and value of space settlements and the use of extraterrestrial materials. She is currently touring as the star of the Theatre of the Future.

________ **Robert A. Heinlein** He is a science fiction writer; his books such as **The Man Who Sold the Moon** and **The Moon Is a Harsh Mistress** foresaw many of the issues which are now a matter of serious international debate.

________ **Hon. Edward R. Finch Jr.** He is Chairman of the American Bar Association Aerospace Law Committee.

________ **Arthur Kantrowitz** He is one of the world's foremost experts on lasers.

________ **Philip K. Chapman** A scientist/astronaut, he was responsible for crew training and coordination for the Apollo 14 mission in 1970. He is an advisor to the Earthport project and currently works for Arthur D. Little, Inc. on solar power satellites.

________ **K. Eric Drexler** He was an organizer of the Princeton Conference on Space Colonies in 1974, and Prof. G. K. O'Neill's research assistant from 1974–77. He 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.) In August 1975 he came to Tucson for several weeks and assisted Keith and Carolyn Henson and William Weigle in forming the L-5 Society.

________ **Jerry Pournelle** He is the former Chief of Human Factors at Boeing. He has worked on the Mercury, Gemini, and Apollo projects. Dr. Pournelle was Willey Ley's successor as science editor for **Galaxy** magazine and currently covers science developments for **Destinies**. He edited **The Endless Frontier**, an anthology of factual articles and fictional speculation on space settlements. It will be released this September by Grosset and Dunlap (hardback) and Ace Books (paperback).

________ **Gordon R. Woodcock** He is Boeing's solar power satellite study manager.

________ **Norrie Huddle** She is an environmentalist and author of **Island of Dreams**, a chronicle of the environmental crisis in Japan.

________ **Harlan Smith** He is head of the Astronomy Department at the University of Texas in Austin and Director of McDonald Observatory.

________ **Konrad K. Dannenberg** He is a veteran of Peenemunde, former project director of the Jupiter missile system and deputy manager of the Saturn Program.

________ **J. Peter Vajk** He is a space industrialization researcher for Science Applications, Inc.

________ **Mark Hopkins** He is a researcher with Rand Corporation.

________ **Carolyn Meinel Henson** She is President of the L-5 Society and one of its founders. Her papers on space activities have been published in **Science** and **Space Manufacturing Facilities I.**

________ **H. Keith Henson** He is a founder of the L-5 Society and its first President. His technical papers have appeared in every volume of the American Institute of Astronautics and Aeronautics series **Space Manufacturing.**

________ **William Weigle** He is a founder of the L-5 Society and the current Treasurer.

Nominated From the Floor

EDWARD H BOCK
WALKER CROFT
T. STEPHEN CHESTON
DOUGLAS DENHOLM
GERALD W. DRIGGERS
STEWART NOZETTE
EDWARD F. HOGGE
JAMES J. HARFORD
JAY S. HUEBNER
JOHN AND NANCY MARTIN
PROF. JOHN F. MCCARTHY, JR.
CAROL J. MOTTS
PHILIP PUGLIESE
GRANT T. CALL
ALLAN M. SCHWARTZ
WILLIAM A. WHEATON
J. PETER VAJK
GORDON R. WOODCOCK
ROBERT SALKELD
JAMES E. OBERG
MARK DUNCAN
JOEY SOOD
MICHELE KLEIN
STANLEY C. DORR
GERARD K. O'NEILL
JAMES P. KUJAWA
RICHARD H. NOLTE
BILL GARDINER
CHARLES CHAFER
JUSTIN J. MILLIUN
CLAUDIA ELLQUIST
STEPHEN A LAWRENCE
DICK H. FREDERICKSEN
ALLY D. HING
DAVID ROCHE MURPHY
BARBARA MARX HUBBARD
LESTER L. SACKETT
TERRY NIELSEN
HUGH MCLARTY
BRUCE W. HANSON
JAMES & MELISSA WADE
TERRY C. SAVAGE
SIGURD H. PETERSON III
JONAH L. GARBUS
FRANKLIN H. MEAD, JR.
RALPH H. CONDIT
PATRICK GREALY
NEIL FREER
LAWRENCE C. PAULSON
ANDRE KOERNER
GARY JEMOFSKY
MICHAEL D. ALLISON
NELSON BRADY
CHARLES HIXSON
IRENE BERMAN
TIMOTHY GALE HART
HANS MORAVEC
JOHN R. PLATT
ENGINEERING LIBRARY
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WILLIAM BOGEN
NICHOLAS SCOTT CARDELL
ERIC HUSHEBEC
DAVID MICHAEL DRYDEN
BILL WEIGLE
HON. EDWARD R. FINCH, JR
JOE W. AND GAY HALDEMAN
JACK L. HOPKINS
HENRY JENSEN
MAGOROH MARUYAMA
MICHAEL A.G. MICHAUD
CHERYL PELTZ
RANDAL LINN RICHEY
BRADFORD SHAHEEN
JOHN K. SHRYOCK
BILL VERPLANK
RICK GORE
NANCY WOOD
DONALD C. FLINT
JERRY GREY
ROBERT B. DUFFIELD
SAM M. SANSONE
TIM SULLIVAN
PEOPLES COMP CO
RICHARD P. WILLING
ERIC STEINBERG
ANN ELIZABETH ROBINSON
NICHOLAS ELBAUM
RICHARD ARNDT
DAVID CAULKINS
JOHN PHILIP PARKER,AFB,AMOPM
RAY SPERBER
TOM GLASS
ALAN R. KATZ
JAMES A. LOUDIN
SYDNEY B. INGRAM
BRUCE MON
ALAN MORGAN KIDD
PROF. KENNETH BRAKKE
WILLIAM R. SNOW
EDWARD T. GROGAN
ROGER ABLAHAT
WILLIAM N. AGOSTO
RAFAEL L. PEREZ
JOEL R. GLUCK
MAITLAND MCLARIN
CLIFFORD SWARTZ
DAN HERRICK
SAUL KENT
ALEXANDER H. SCHILLING
CONOR D. FITZGERALD
GARY GUTT
ADELBERT FRANK GIGUERE
HARLAN J. SMITH
BRUCE FRIEDMAN
M. RUTH MINYARD
STEVEN BRODY
ROBERT M PURCELL
JEFF G COX
DAVID W KLEMP
STEWART BRAND
JULIE YODER
DAVID C. HALLEY
KONRAD K. DANNENBERG
WM. RANDOLPH FRANKLIN
LARRY FRIESEN
ANNITA HARLAN
ROBERT B. TOPPEL
RICHARD & CAROL KESTLER
MICHAEL MAUTNER
ROGER H. MILES
STEPHEN T. BARIAK
DENNIS RIGGIN
DR. RALPH C. SKLAREW
CHARLES "ED" TANDY
JOHN C. VOGEL
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LT J G JAMES K GRUETZNER, US
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ROBERT HAMEL
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RICHARD A DALY, JR
MMC (SS) ROBERT PICKETT, USN
JOHN L HUBISZ
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CHARLES S UPP
DAVID M WILNER
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BRAD WRIGHT
GEORGE KOOPMAN
MICHAEL L. WARDEN
DNIS JOSEPH WHITMAN JR
L S WOLFE
MICHAEL SESTAK
RICHARD W. BOWERS
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COLE K. LOVETT
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DALE DEUTSCHER
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ALFRED SCHICKENTANZ
NEIL MCALEER
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GERALD KRAULFIDIS
RANDY ANKENY
DAVID HARRIS
FREDRICK WILLIAM MANZO
BRENDA C GATES SPIELMAN
G M HANNAMAKER
JULIE A PETERS
D SCOTT JONES
CHRIS HARRISON
TIM LOMAS
WILLIAM PHILLIPS
EDWARD SWEET
RONALD HARTZELL
MS JANE HILLEMANN
PAUL STINCHFIELD
JAMES RANSOM
SHELTON SWEI
G DUNCAN BLACK
DENNIS KOCHER
MS MARGARET J LYELL
ALBERT A KURLAND
P T RICHARDSON
DAVID E HOSTETTER
GEORGE DAVID KROUSE
JOSEPH E TORNABENE
HOLLIS RODNEY WILLIAMS
JON MILLER
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JOSEPH STEGER
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KENNETH MCCORMICK
JOSEPH A HOVEY
FRANCESCA K FLYNN
KAREN L METCHIS
JASON ELLIS
MART HILLARD
CLIFFORD COSMAN
LISA WHITE
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