

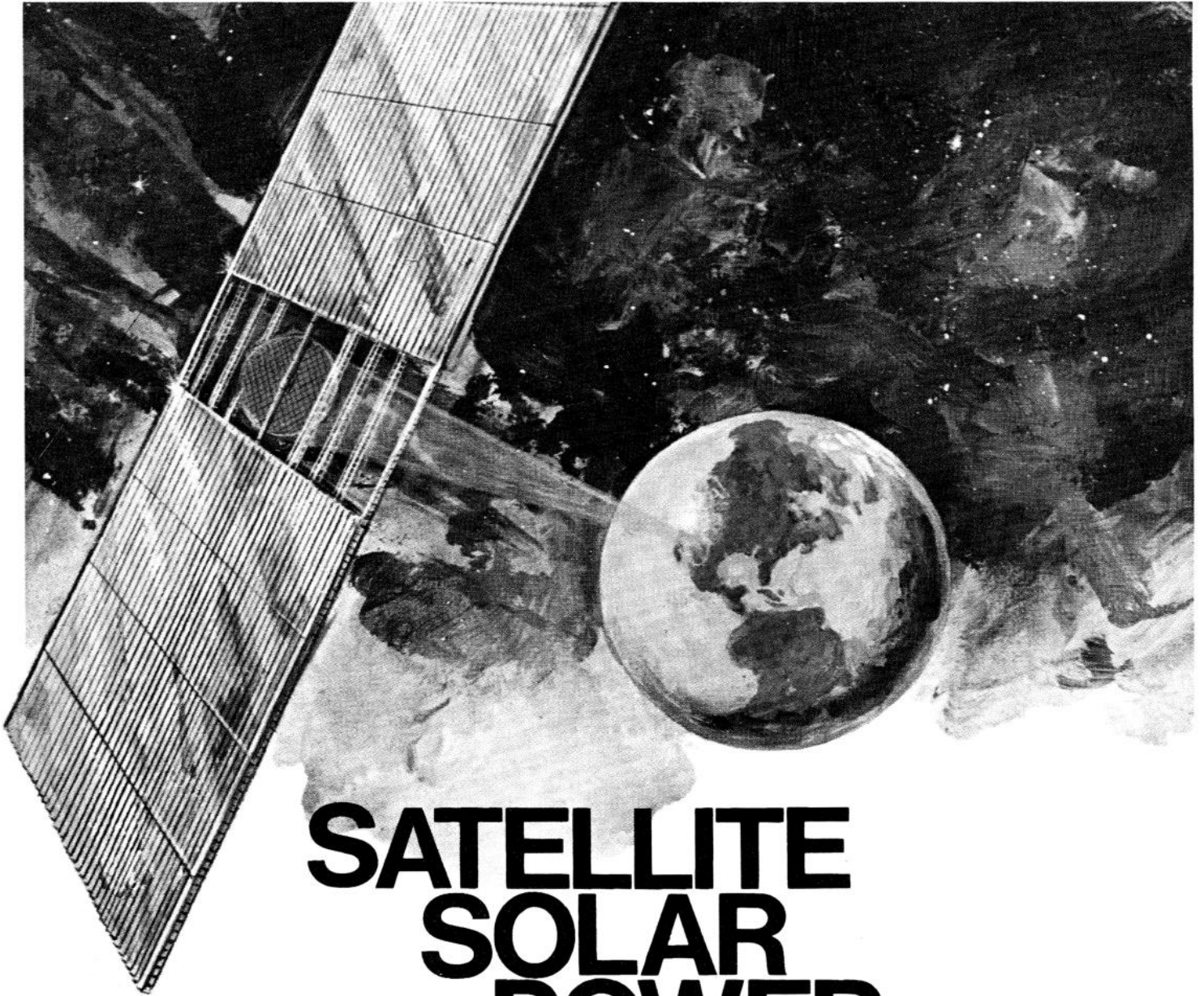
LATEST DEVELOPMENTS IN SPACE INDUSTRIALIZATION, SATELLITE SOLAR POWER, AND SPACE HABITATS

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SATELLITE SOLAR POWER STATIONS

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SPACE SOLAR POWER

Excerpted from Grumman Aerospace Horizons.

Investigations performed by Grumman Aerospace Company and its associates -- Arthur D. Little, Raytheon, and Spectrolab -- over the past five years indicate that space solar power is feasible and economically practical. The collection of solar energy in Space at the preferred synchronous orbit (22,000 miles above the equator) is essentially continuous. No storage systems are required, in contrast to ground-based collector systems.

The Satellite Solar Power Station (SSPS) design calls for a large space solar power collector, assembled in space, to be stationed in a geosynchronous orbit (one that makes the SSPS virtually fixed over a given point along the equator). From this orbital position it would transmit the collected solar power via a microwave beam to a six-mile-diameter receiving antenna, or rectenna, on the Earth. There the microwave energy would be converted to electricity and fed directly into the power grid.

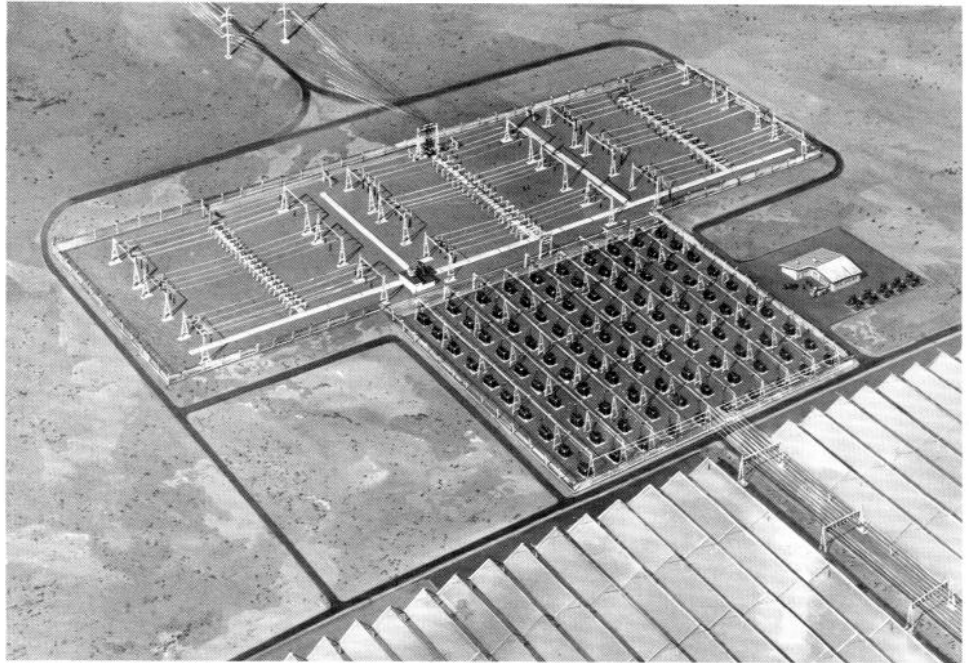
The station itself consists of two large rectangular solar panels, each measuring approximately $3\frac{1}{2}$ miles long by $2\frac{3}{4}$ miles wide by 200 yards deep, interconnected by a single large mast. Centered between these solar panels is a microwave antenna some 900 yards in diameter.

Mounted on the huge panels are vast arrays of solar cells, making these solar panels very much the same in every respect but size as those used to power nearly every spacecraft and satellite to date.

The solar cells are laid out in vast arrays along the bottom surface of each depression in the solar panel structure. To concentrate additional sunlight on a solar array, the immediately adjacent sides of the structure are covered with a reflectively coated sheet of lightweight Kapton plastic. Thus, as the panel is bathed in the Sun's rays, the solar cells receive both the direct radiant energy and that reflected from the Kapton-lined sidewalls, effectively doubling the amount of solar energy absorbed by the cells.

Each solar cell, through a photovoltaic process, converts the Sun's radiant energy to direct-current electricity which flows along the conducting panel structure and mast to the microwave antenna. The rotatable antenna transmits a beam of microwave energy to the receiving station on the ground, where it is converted to usable electricity.

There is relatively little energy loss in this transmission, and the power can readily be generated at frequencies that preclude interference with other bands. Microwave energy can also be transmitted through clouds and heavy rain with less than a five percent loss. It is also safe.



Rectenna array over farmland (lower right) receives microwave transmission, and inverters (center) convert it to usable electricity which is distributed over conventional power transmission lines.

Siting studies indicate that the rectenna is best located on low-value land or offshore near large metropolitan areas. Actually, a key advantage of space solar power derives from locating the rectenna near the power users, thereby minimizing the transmission costs. Of course, with solar power you also avoid the need for mining equipment, delivery trucks, and other costly elements.

The heart of the SSPS system concept is the solar cell and the microwave link. Solar cells today can deliver electric power with an efficiency of 13 percent; in the future we can reasonably expect to get 16 to 17 percent.

Silicon, the basic material used in solar cells, is quite plentiful. The technology has a sound base of experience as a result of the many solar devices produced for spacecraft that have been successfully orbited.

Solar cells today are relatively expensive, but the key to a drastic reduction in their cost is high-quantity production. A single solar power satellite will require many times the amount of solar cells that have been produced for all previous solar cell applications combined. This tremendous boost in production is expected to drop the cost of a solar cell to one-fiftieth of today's cost.

Microwave transmission in Space does not require the use of a vacuum-tube type of amplifier such as a *klystron*, since Space itself is a vacuum. Instead, we can use a more efficient device, the *ampliflon*, to transmit the microwave energy. Such devices have demonstrated very high efficiency, reliability, and long life, and are extremely lightweight.

In terms of efficiency, the entire transmission chain--from the distribution of power to the space-borne microwave antenna, to the beaming of MW energy to Earth, and finally to the conversion of the microwave to DC power--is expected to achieve a level of better than 65 percent. Recent tests at NASA's Goldstone, California, facility have confirmed the microwave link's efficiency.

While the theoretical efficiency of the solar-to-electric power transfer between Space and Earth appears to meet the requirements, there is still the matter of determining the best way to get this huge satellite solar power station into orbit.

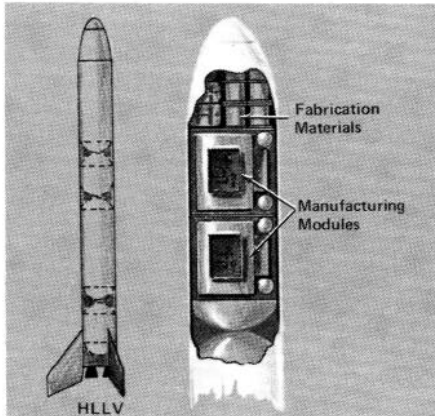
In terms of mass alone the task is staggering -- a 5,000-megawatt SSPS might weigh as much as 40 million pounds. But there have been developed a number of ways in which this might reasonably be accomplished. One promising method involves a system whose principal stages are shown on pages 8-9.

The Space Shuttle, slated to become operational in the early 1980s, offers the basis for beginning the total space solar power enterprise with certain key experiments and also provides a means for transporting elements of a Solar Power Development Lab into orbit.

Of course, the Shuttle Orbiter's payload (65,000 lb) and cargo bay volume were not designed for transporting so large a mass into Space. Were the satellite structure built -- primarily of truss-work -- on the ground and put into the Orbiter's bay, there would be much wasted space. An

alternative is to build the structure in Space and to use another payload vehicle with a larger, more efficient, cargo capacity. Such a vehicle might take the form of a large cylindrical can with a payload of 160,000 lb which would replace the piggy-back Orbiter on the Space Shuttle.

Looking further ahead to the need for transporting SSPS elements in meaningful quantity within a reasonable build-up schedule, plans are made for a Heavy Lift Launch Vehicle (H.L.L.V.) that can carry 400,000 lb in a single launch into a near-Earth orbit.



Once the mass of basic construction material is brought by the H.L.L.V. into low Earth orbit (below, and therefore unaffected by, the Van Allen Radiation Belts), manufacturing of the SSPS structure can be started in Space.

By using spools of material, either aluminum or composite strip, small structural elements would be made in the form of triangular cross-sections and then built up into complete beams. Continuing this process, all the structure needed could be produced.

In general, manufacturing the SSPS in Space would require little human power. Work vehicles fitted with articulated manipulators, operating from space stations also used to house a small work crew, could assemble the entire satellite structure.

Once the huge structure is assembled, the next step is to move it from low Earth orbit to the high, or synchronous, orbit. To do this will mean traversing the Van Allen Belts whose intense radiation could seriously damage the exposed solar cells. The idea for avoiding this exposure is to mount the solar cells on blankets of material that are rolled up like window shades during the orbit-changing phase, thereby shielding them from the radiation. Once the SSPS attains the desired orbit, the blankets of solar cells would be rolled out and available to receive the Sun's energy.

The abundant solar energy in Space should be further used to move the SSPS into its high orbit. The design calls for a

Solar Electric Propulsion System, or SEPS, in which the Sun's energy is used to drive an ion engine. Applying a low-level but continuous acceleration, the SEPS would propel the entire satellite solar power station up to synchronous orbit.

There, an attitude-control system comprised of jet thrusters similar to the ones used on our Lunar Module, would be used to nudge the huge satellite into its operating position, with antenna pointed toward the Earth-based rectenna and solar arrays broadside to the Sun. Because the satellite's orbital path will be affected by various forces in Space -- including gravity gradient, solar pressure, the interactive pull of the Sun and Moon, and motion due to the Earth's ellipticity -- it will require periodic adjustments to keep its proper station and orientation with respect to the rectenna. Estimates are that about 100,000 lbs of fuel per year would be sufficient to keep the SSPS in proper position.

Some human maintenance of the space facility will be required, but it is expected to be minimal over the projected 30-year life of the system. While it is quite clear that placing an SSPS in orbit would be a great undertaking, it would result in the continuous delivery, over a 30-year period, of 5000 MW of power--roughly enough to power a city the size of New York. The design in fact calls for putting up enough stations in orbit to meet 10 percent of the annual incremental electric power requirements of the U.S.

Despite its enormous scale, complexity, and technological challenges, the SSPS provides a great many advantages. Among these are: rapid pay-back (estimated at two years) of the net cost of the energy to build the system; delivery of environmentally "clean" power into the regular power grid; and production of a significant volume of power (one SSPS would provide the equivalent of 200,000 barrels of oil per day or, over a 30-year period, \$36 billion worth of electricity).

INTERVIEW WITH PETER GLASER

Carolyn Henson

Peter Glaser is a Vice President of Arthur D. Little, Inc., and the originator of the solar power satellite (SPS) Concept.

I'd like to know what's happening with the Grumman study on space industrialization.

The space station study which Grumman Aerospace and myself have been carrying out on behalf of Marshall Space Flight Center has looked very hard at the kinds of problems one might encounter in constructing the satellite solar power station in orbit. It has included considerations of construction bases. Also, attention is being paid to space processing -- what can one do in space which would be of real interest.

I've read some interesting things about vapor deposition of silicon solar power cells. Is that being considered as a possibility?

This possibility is an example of such kinds of processes. Whether or not a specific one would be the way to go is probably too early to tell, because, as far as I understand, studies of this particular approach are still in the very early stages of investigation.

How many people does the Grumman study estimate will be needed on site to assemble a power satellite?

I really don't have the number. Remember, the first steps are not really to make the whole satellite but rather to make the first small-scale test object, which may be just a few hundred kilowatts or a few megawatts. And the question is, how would you go about assembling these small test objects, learn from them, and then apply the learning to the bigger ones? So it's really hard to go from where we are today to a full scale satellite without a lot of learning on the way.

So you are planning an evolutionary approach, then?

I think it is the reasonable approach, because there are some very tough problems. It isn't just a matter of assembly, but what kinds of components you would be willing to produce in space and, as you know, there are studies along these lines. Can we produce girders and other structural components to be used to produce satellites from rolled aluminum coils? I think these are of great interest.

Another one is: should we attempt to, for example, produce silicon solar cells in a space station or construction base, or should we carry the material from Earth? All of these involve not just technology but a lot of economics.

There have been studies on the use of lunar resources to produce oxygen to propel solar power satellites from low Earth orbit to geosynchronous orbit. Is your study group considering the use of lunar materials?

Our study is much too near term for those considerations. You really have to learn to crawl before you can walk.

You're basically concentrating on assembly, then?

At this moment it is too early to consider whether you'd like to use lunar materials. I'm sure that will be a very important topic, however, once we've done some of this earlier work.

Are you familiar with the solar power satellite proposals of James E. and Ronald N. Drummond? (see L-5 News, August, 1976, p. 8.)

I believe they certainly are interesting and should be studied further. The particular Sun-synchronous orbit certainly has some advantages,

although it does involve a much shorter time for the microwave beam to reach receiving antennas. The multiplexing that could be involved may introduce some additional complexity.

Whether this is the right orbit or geosynchronous is the right orbit is a matter one will really have to understand and study-and I think this approach, especially his suggestion of using dielectric power conversion, indicates that the more people start to think about satellite solar power, we can look forward to novel ideas, and out of that eventually will come what I hope is the optimum solution.

It's only by doing the work and trying various approaches we will develop the optimum solution.

WIRELESS POWER-TRANSMISSION TEST AIMS AT HARNESSING SUN

John F. Mason, reprinted with permission from Electronic Design, Dec. 6, 1975.

For 75 years, engineers have tried to transmit power through the air without benefit of wires or other man-made conduits. Now a group of engineers in the Mojave Desert are doing it every few weeks via microwave signals.

They are from the California Institute of Technology's Jet Propulsion Laboratory, in Pasadena, and Raytheon's Microwave and Power Tube Division, Waltham, Massachusetts. Their work is being sponsored by the National Aeronautics and Space Administration's Office of Applications and Office of Energy Programs.

The distance covered and the power transmitted in the Mojave experiments are both small (a little over 30 kW. of d.c. output over 1.54 km.), but the techniques for improving both are being defined.

The ultimate goal is to develop equipment capable of efficiently transmitting power captured by a solar-energy collector in space to a receiving station on earth. Such a proposal was first made in 1968 by a team consisting of Arthur D. Little, Raytheon, Grumman and Textron.

A more earthly application might be to beam power to a high-altitude, stationary, electrically powered, unpowered helicopter -- say, at 50,000 feet -- that would relay television signals for weeks or months at a time without having to land.

Point-to-point transmissions on Earth are, of course, possible applications, but highly improbably, according to Raytheon's consulting scientist William C. Brown, who developed the rectifying antennas used in the current experiments.

"The attenuation and scattering through many miles of rain would be a problem," he says. "To replace high-power transmission lines, the power density in the beam would be far above safe exposure limits. The economics

might also be questioned."

There could be isolated applications, Brown continues, that might be practical -- for example, where power could be profitably transmitted over deep canyons or bodies of water. But the main goal is to capture clean, nonpolluting energy from the Sun. Earth-orbiting stations would collect solar energy, convert it to microwave radiation and beam it to receiving stations on Earth.

"A typical satellite using a microwave beam at a 10-cm. wavelength could provide 10,000 MW.," says Peter E. Glaser, vice president of Arthur D. Little, Inc., Cambridge, Massachusetts. "A network of such satellites could generate enough power to meet a significant portion of the foreseeable U.S. energy demands."

The space station would require an energy-collecting area of at least 70 Sq. km. of solar photovoltaic cells, according to Raytheon's Brown. "The area needed for ground-based 'rectenna' arrays, as the antenna elements are called, measures some 40 to 59 km.," he says.

The immediate goal of the current experiments is to test the high-power performance of a reception-conversion array rather than an over-all system. Existing transmitting equipment is being used, consisting of a klystron with a maximum output of 450 kW. at 2.388 GHz., a 26-m. diameter (85 ft.) parabolic reflector antenna, and a 30.5-m. tall (100 ft.) collimation tower located approximately 1.54 km. (1 mile) from the antenna. The equipment is part of the Venus station, a research and development facility of NASA's Deep Space Network at Goldstone near Barstow, California.

Thus far the Mojave Desert tests have shown, JPL says, that the present rectenna array concept should be adequate for a somewhat weather-

dependent, yet highly efficient, receiving mechanization for a high-power microwave power transmission link. To improve the system, a number of innovations are needed, JPL says: diodes with higher conversion-efficiency, a better array impedance match and simplified techniques for mass manufacturing and assembly.

Collecting the Power

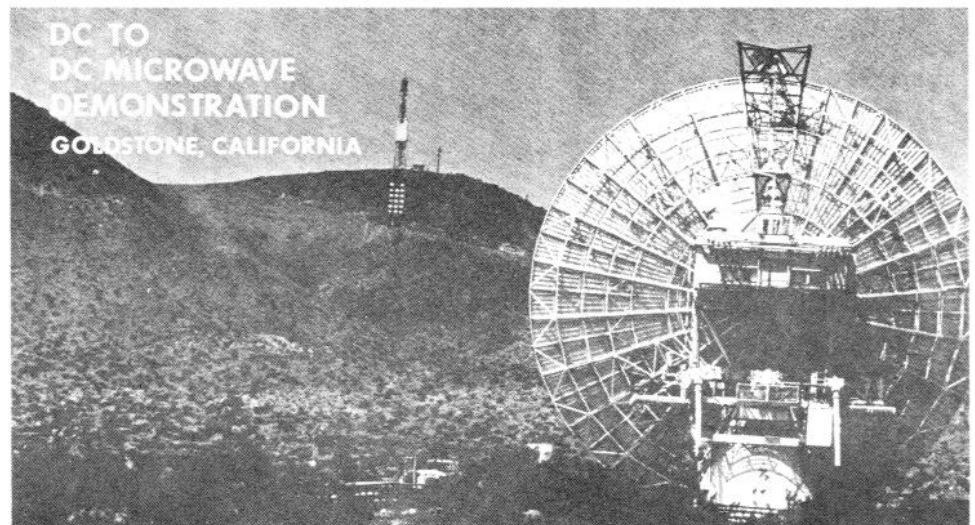
The transmission of power via microwave differs from transmission of communication signals, in that a greater percentage of the power must be received. You can amplify weak communication signals but not power.

In the space station, a series of microwave generators would be combined in a subarray about 15 meters square, and the latter would form part of the transmitting antenna, according to Peter E. Glaser.

The generator design, Glaser says, is based on use of a crossed-field device such as an Amplatron, which has the potential of high efficiency, high reliability and very long life. Each generator subarray must be provided with an automatic phasing system, so that the individual radiating elements of the antenna are in phase. These subarrays would be assembled into a slotted-waveguide phased-array transmitting antenna, about one km. in diameter, to obtain a microwave beam. The distribution within the beam could be designed to range from uniform to Gaussian.

In the ground experiment microwave power is being received and rectified with a Schottky barrier diode detector. However, the diode operates at a power level of +39 dBm., and the output is d.c. Although other power output forms, such as pulsating d.c. or even low-frequency a.c. (60 Hz.), can be obtained,

POWER TRANSMISSION SYSTEM



- TRANSMITTER DIAMETER - 26 m
- RANGE (TRANSMITTER TO RECEIVER) - 1.5 km
- MICROWAVE FREQUENCY - 2388 MHz
- SYSTEM EFFICIENCY - 82.5%

d.c. was selected for system simplicity at this time.

The function of the receiving system is to collect the incident RF and convert it to d.c. This is done by building the receiving antenna in the form of a planar array of half-wave dipole rectenna elements over a ground plane facing the transmitter incident beam. Each dipole has an integral low-pass filter, diode rectifier and RF-bypass capacitor.

The dipoles are d.c.-insulated from the ground plane and appear as RF absorbers in parallel to the incoming RF wave. Their d.c. outputs are in a parallel and series combination to produce the desired output voltage and current levels.

The size of the dipoles and their configurations are adjusted so that when they are in combination with the transformed d.c. load impedance the array provides a match for the incoming RF wave. The dipoles are 0.74 h long; they are spaced 0.6 h apart in a triangular lattice and are 0.2 h from a ground plane.

The low-pass filter design represents a compromise between insertion loss at the fundamental and the proper rejection at the harmonics. The harmonics must be trapped and phased properly to result in maximum RF-to-d.c. conversion (inverse Fourier Transform).

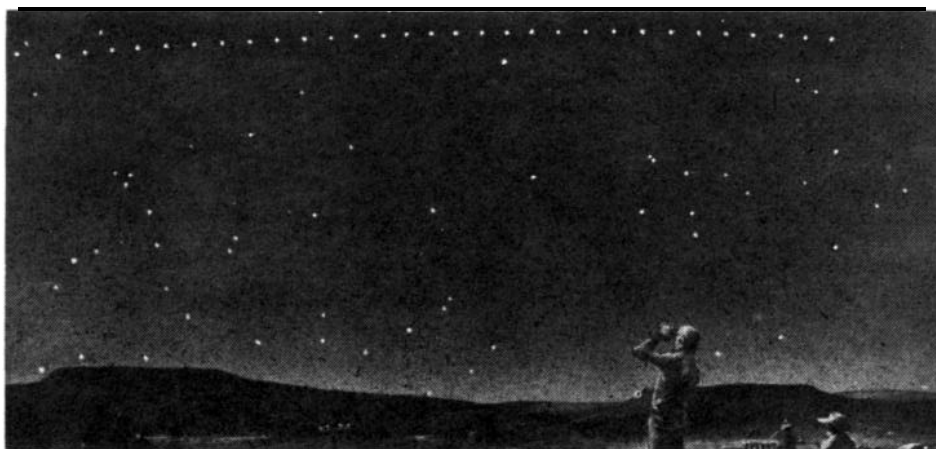
The RF-bypass capacitor in the rectenna performs the dual function of a smoothing filter for removing RF and harmonic ripple from the d.c. output and resonating the diode capacitance so that the proper impedance match between the diode and the low-pass filter is obtained.

Collection efficiency approaching 90 per cent in the 3-GHz. region is expected ultimately for the rectenna, Brown says. The present efficiency of the rectennas at Goldstone is 82 per cent. A principal reason for this optimism is the very high potential rectification efficiency of the GaAs Schottky barrier diode when its depletion layer is optimally designed for this application and when rectifier circuits using such improved diodes are also optimally designed.

The physical capture area of the array, including the interstices between subarrays, is 24.5 m² (263.5 ft.²). Each of the seventeen subarrays is positioned normal to the beam from the Venus station antenna. All subarrays lie in the same plane. The seventeen separate d.c. load and instrumentation wires from each subarray are routed to a central load and instrumentation complex, located in and near the collimation tower support building.

Additional tests of the ground system are planned to determine performance vs. frequency, incident polarization, treatment of the interstices and the effects of various environmental conditions, including rain, snow and angle-of-incidence variations.

SOMETHING NEW IN THE STELLAR LINEUP



Strung across the sky like a string of pearls, thirty power satellites in geosynchronous orbit could be added to the stellar scene if a BAC study should lead to building of the space-based power units

BOEING GIVEN CONTRACT FOR STUDY OF SPACE-BASED SOLAR POWER

Bill Rice, Boeing News

A study of space-based solar power concepts designed to determine which may be worthy of further technology studies and, possibly, systems demonstration, has been assigned to Boeing Aerospace Company by the National Aeronautics and Space Administration.

The contract, awarded by NASA's Johnson Space Center and valued at approximately \$970,000, is in two study phases. The first, of five months duration, will address itself to the selection of viable solar energy conversion candidates and to the location of their construction in space.

The second phase, to run seven months, will be aimed at refining cost estimates and at the reduction of satellite mass.

Over the past several years, Boeing and other aerospace firms have developed a number of concepts for the gathering of the Sun's energy in space and for the beaming of this energy to Earth for use here as electricity. These concepts include:

- The orbiting of a series of huge reflectors measuring miles in length and width which would reflect the Sun's rays into central furnaces, or solar cavities. These furnaces would heat gases which, in turn, would drive generators which produce electricity.

- The orbiting of huge fields of solar cells-again measured in miles-which would transform solar rays into electricity.

Equal to Coulee Dam

In both concepts -- and there are several candidates proposed for each approach -- the satellites would beam the electrical power to Earth as microwaves which would be received by large antenna arrays. The microwaves would be

reconverted to electrical energy and fed into the nation's power system. These satellites each would have the capacity to produce power on the order of that produced by Grand Coulee Dam or several nuclear plants.

The power satellites would be stationed in geosynchronous orbit some 23,000 miles (37,000 kilometers) above the Earth. At this height, the satellite, as viewed from the ground, would appear stationary.

Weighing thousands of tons and covering many square miles in area, these satellites will be too massive to be constructed on Earth and launched into orbit. Boeing, under its new contract, will attempt to determine whether it will be better to assemble these large space structures in low Earth orbit and then transfer them to geosynchronous orbit or whether it would be better to assemble them in geosynchronous orbit.

The study is part of a systematic NASA investigation into the feasibility of the solar power satellite concept and of those systems needed to support it.

Nondepletable Source

The overall concept offers the hope of tapping an alternate energy source which, unlike fossil fuels and nuclear fission, is nondepletable. However, for it to be viable, it must be capable of producing large amounts of energy at a price competitive with other energy sources.

In addition to the Johnson solar power satellite concept, Boeing presently is conducting power-satellite-related studies in the areas of:

- Low-Earth-orbit transportation of a sort which would carry massive amounts of material into space at low cost.

- Orbital transfer systems which would be used to ferry men and material into space at low cost.

- Fabrication and assembly of large space structures.

- Development of advanced-technology solar cells.

MOVEMENT INTO SPACE: A VIEW FROM

Part 1 of Interviews with Dr. Timothy Leary and Captain Robert Freitag

Elizabeth Robinson

In October 1976, the well-known consciousness proponent of the 1960's, Dr. Timothy Leary, and Captain Robert F. Freitag, Deputy Director, Advanced Programs, National Aeronautics and Space Administration (NASA), presented their views in separate interviews, on the movement into space-by citizens, free enterprise and government.

These interviews addressed several aspects of the movement into space: (1) space migration and evolutionary philosophy; (2) citizens' space migration; (3) the urgency of space migration; (4) the concept of cooperation and control in space; and (5) the effects of space migration on the future of humanity. Part I of these interviews will focus on the philosophy of the space movement and citizens' participation in it.

Dr. Leary was released from prison in the spring of 1976. A Harvard psychology professor who engaged in early experimentation with the effects of "psychedelic" drugs, Dr. Leary found himself a popular leader of the consciousness movement in the sixties. To some, he was a hero; to others, a threat. He became ward of the prison when a half ounce of marijuana was found in his car as he crossed the border from Mexico to the United States. With another relatively minor drug charge, Leary spent several years in prison. While there, he developed an interest in space.

Since his release, Dr. Leary has been lecturing around the country to thousands of college students and other audiences about his threefold cause -- "S.M.I.²L.E." "S.M.I.²L.E." is an acronym for Space Migration, Intelligence Increase, and Lifespan Extension.

Evolution and Space Migration

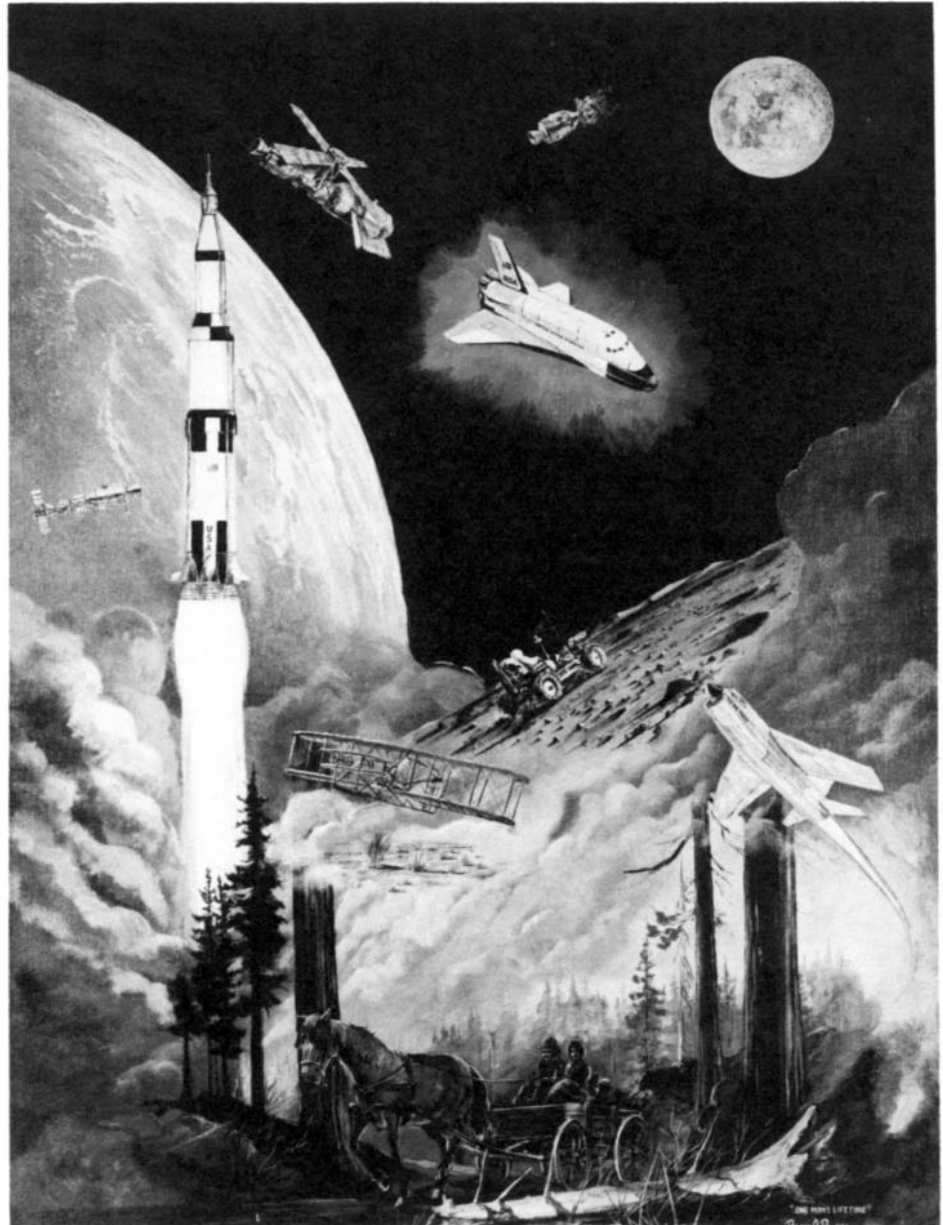
"The movement from Earth to Space. . . is a genetic imperative . . ."

Tucked away from the crowds he had come to address in Washington, D.C., Dr. Leary settled into a chair and began to explain his concept of space migration.

I have no concept of it [of my own]. The work of O'Neill and the Ames conferences, the L5 Society, and the anthropologists and the sociologists who have been working on these matters are very convincing to me. . . I'm simply broadcasting their messages.

In your lectures, you have linked new frontiers with new ideas and new philosophies. Would you elaborate on your concept of migration in terms of change?

I believe it to be the destiny of the human species and of planetary life



itself to migrate-that we're not terrestrial, we are predestined to leave the womb planet and to move through post-terrestrial space.

Do you believe, as one person wrote, we either "grow or die"?

Yes. Not grow in size, but grow in intelligence, speed and precision.

What do you see as the relationship between human evolution and space migration?

They are completely intertwined. It is our evolution or destiny to migrate from the planet as it was our destiny to leave the water and become amphibian, and then later land creatures. I believe the sequence from sea to shoreline to land to air to space is built into our DNA blueprint.

Do you see a relationship between how we view the future, space migration, and our image of ourselves as people?

Yes, after reading the scientific papers about space migration, I became convinced that we are not basically terrestrial, that we are seeded and spend our immature larval state within the embryonic confines of a planet. But when we can attain the escape velocity to evolve, we will leave the nursery planet, and find our adult evolutionary status as mobile entities within the solar system, and eventually within the galaxy.

You have also called this movement into space a "birth into the universe." Do you think this "birth" will inspire the creation of another cosmic myth, similar to those of the ancient Greeks and Romans?

TWO WORLDS

Yes, I think of the fact that we are not designed to spend all of our years on the earth-our now-larval creature is ready to mutate. It's more than a myth-it's a genetic reality. The myths of Homer and Virgil are simply terrestrial migratory myths celebrating the movement from the east to the west, along the Mediterranean and across the Atlantic, but the movement from earth to space is like the movement from water to land. It's a genetic imperative.

Captain Freitag was asked to comment on the belief held by Dr. Leary and others that the movement into space is the next step for humanity's evolution.

I believe it's an alternative, not necessarily the alternative. I think, as I mentioned earlier, that the oceans offer tremendous possibilities and habitats under the ocean, for mining or for industry, which means removing some of the objectionable parts of our society from land and putting them under the oceans.

Later in the interview, Captain Freitag went in to greater detail on the philosophical basis of the space movement. He brought out a paper from his desk.

I spent some time writing this several years ago; it's a quote from a talk I gave:

"Turning for a moment to philosophy, I see two very striking facts about our world of today. One is the explosive growth of the world's population of the twentieth century, and the other is the advent of space exploration. I feel intensely that these two events do not coincide by accident. Some inner motivations are leading humanity to new and unknown shores. Therefore, we are gathering our strength and reorganizing our social structures.

"As I mentioned, life is a force which has persisted on earth for three billion years, and it's spread across this planet like a grassfire . . . but three billion years it took it to spread. It's gone out to touch the moon, and it's now touching the other points of the galaxy. This life will survive for many millions of years more, and it will continue to expand and to weave its way out into the Cosmos.

"Almost instinctively, humanity will follow this push, and settle on other planets. I believe that's going to happen. Thus, our population explosion may not be a bizarre mistake of nature at all, as some claim. It may be just preparation for space travel which is part of our destiny because the solar system could not be conquered by a mere three billion beings."

So I agree with what he [Dr. Leary] is saying. I disagree violently with this time scale . . . that it's a now thing. It is not a now thing. I go on to say:

"We are convinced beyond doubt that humanity will colonize the planets. When we will start this-whether it be 1984, 2001, or a couple of centuries later. And whether it be done by the United States, or the Soviets, or a joint project involving all the nations in the world-I don't know. But I am profoundly sure that humanity will go on these voyages."

Now, I believe in what he's saying -- eventually. What I'm trying to get across is that too many people today are trying to make this something that's happening now. I don't mean to be a footdragger, but it's just got to take time.

Is this strictly a personal view you have expressed concerning the philosophy of moving into space?

No, I think parts of it are definitely shared by NASA. The colonization of the planets is probably something that we do see. But let me say that a view not too far from the one I expressed is shared by a great number of people in NASA, particularly the people in the planning area. I think it's significant that we (i.e., NASA) don't disagree with what was in that quote. . . just how you go about doing it and what is done.

The Consciousness Movement of the Sixties and the Space Movement of the Seventies

"You cannot create anything externally which you have not experienced internally."

Dr. Leary, most people know you in terms of what you did in the sixties and the consciousness movement. Would you explain the relationship between the consciousness movement of the sixties and the movement into space?

I see human events as being genetically predetermined. It was inevitable that the first generation of young people after Hiroshima would develop a consciousness movement which would allow them to detach their bodies and their nervous systems from the blind robot direction of the Human Ant Hill. It was inevitable that the second generation after Hiroshima would use the expanded and liberated consciousness of of the preceding generation to create an externalization of the internal vision which the consciousness movement produced.

What made it inevitable that the consciousness movement develop after Hiroshima and Nagasaki?

The terrestrial ballgame was over with Hiroshima. There could be no more territorial warfare; no more imperial conflict; no more technological competition on the planet. We had outgrown the planet with Alamogordo.

In order to leave the planet, we have to detach our nervous systems and get control of our own bodies, and essentially, to mutate beyond the Hive of Domestication that characterized our species before 1960.

Since 1960, almost every American has been somewhat involved in some form of rebirth or consciousness experience. The Gallup poll recently demonstrated that over half of all Protestants have had rebirth experiences, which are watered-down versions of the consciousness movement of the 1960's.

What makes it inevitable for the second step to occur (i.e., space migration)?

Once human beings have become detached from their commitment to insectoid or hive directions and search within their own neurology, the visions which emerge inevitably point to the post-territorial destiny of our species. But post-territorial visions could not be tolerated before humanity had attained the technological sophistication which was demonstrated in the nuclear fission experiments.

I believe that these sequences of technology-both inner and outer-are quite routine and standard on all biological planets. There's nothing that unique about the human species, nor about our planetary development here on Earth.

So the inner consciousness movement was just the preliminary step to the movement in to space?

Yes. You cannot create anything externally which you have not experienced internally. Everything that humanity had done externally with our machines, with our technology, with our material structures, have always been preceded by a neurological or inner visionary revelation.

To illustrate this point, I cite the case of Albert Einstein, who, we are told, continually attempted to imagine or to experience, what it would be like to be a photon . . . that is, to be traveling at the speed of light. Once he could (through self-hypnosis) coax his nervous system to operate in speed-of-light terms, it was obviously a simple matter for him to understand and then write the equations which have so revolutionized our physics.

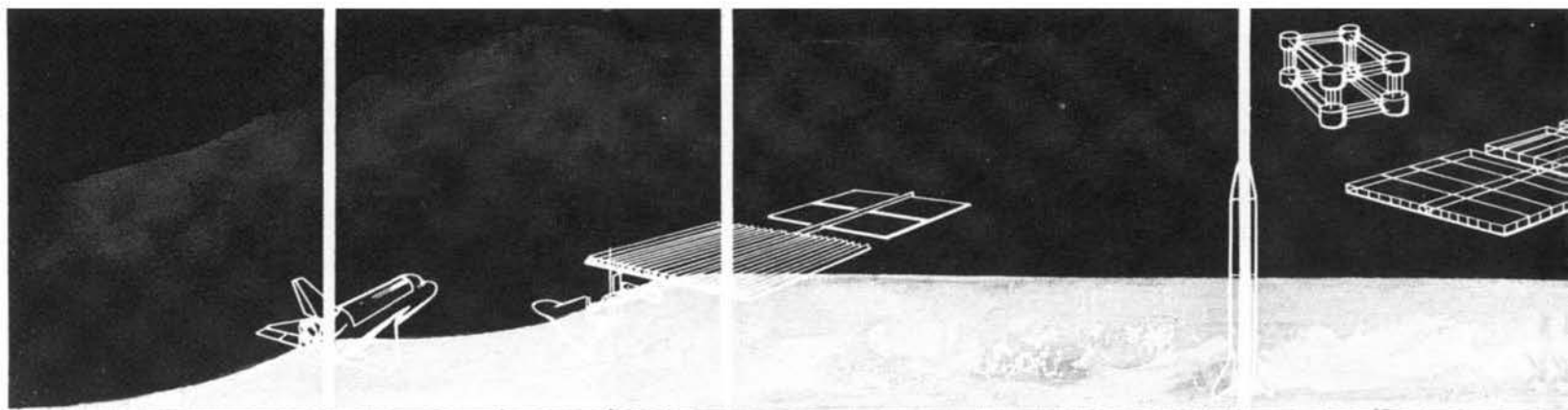
The Einstein story makes the point that physics, chemistry, and engineering should be experienced-and usually have to be experienced-before the equations are written. Physics and engineering without the experiential is a depersonalized and inhuman enterprise.

And there are other scientists who have had such experiences?

Well, I don't know. I think there are never more than a handful -- five or ten -- scientists alive at any one time in human history. The rest are engineers or reproducers. I suppose that every scientist has had to have some way of turning on his nervous system to experience what he was thinking about. Certainly, Darwin did this in his epic-making voyages to the Pacific.

Captain Freitag of NASA was asked if he saw any connection between the consciousness movement of the sixties and the present space migration movement. He commented:

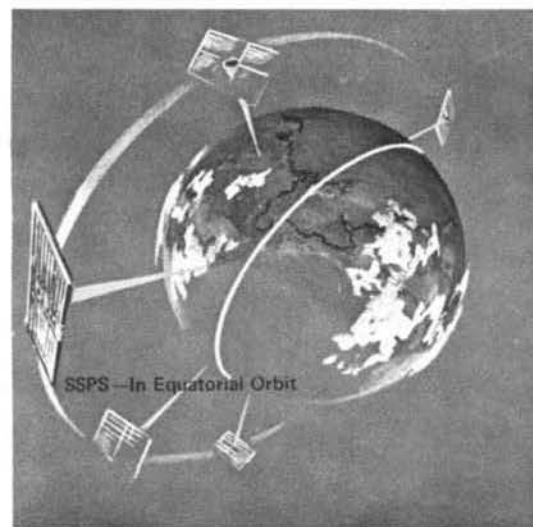
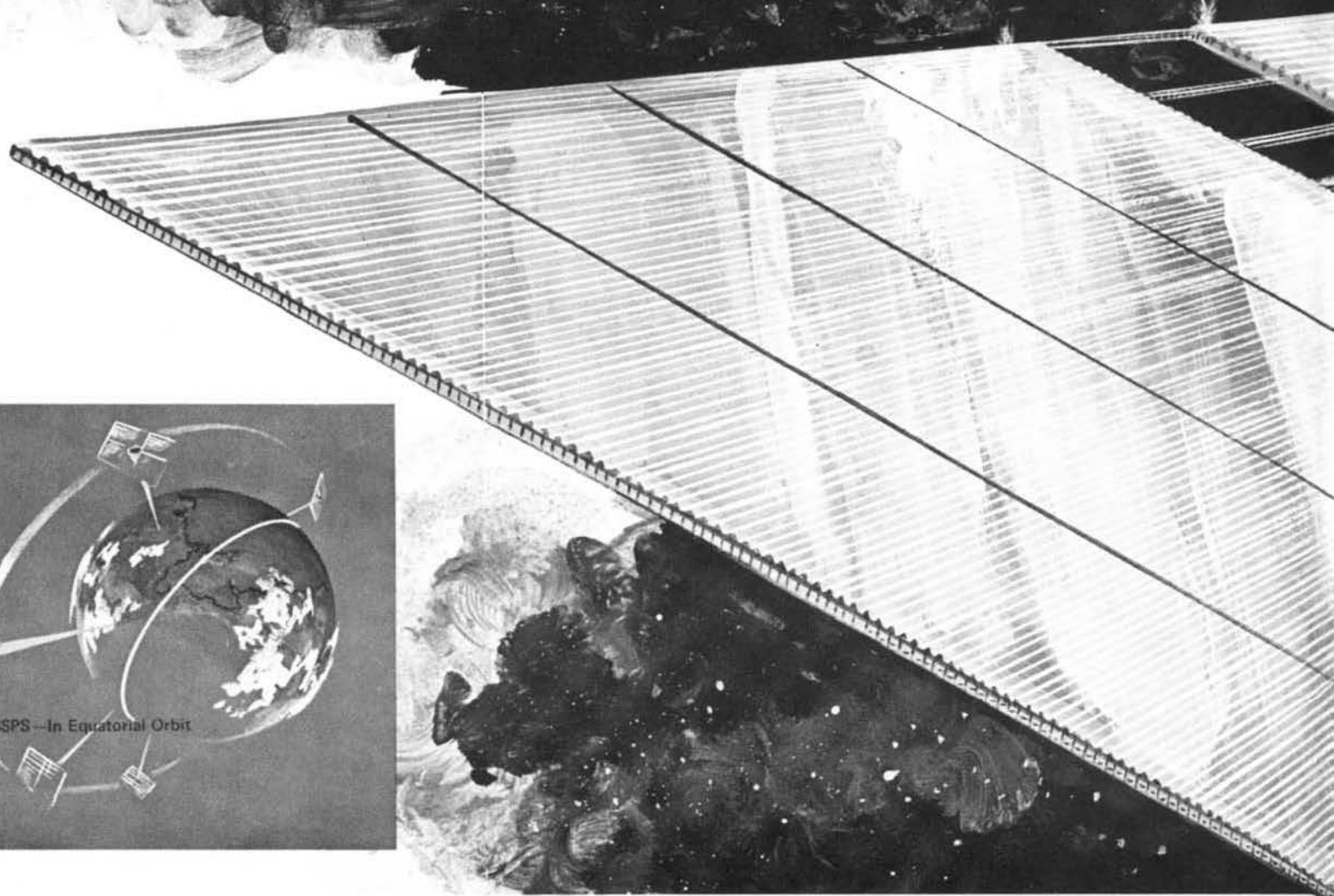
Absolutely no connection whatsoever. I think it was just timing. There may be some connection by inspection. Were space not available to them, if technology



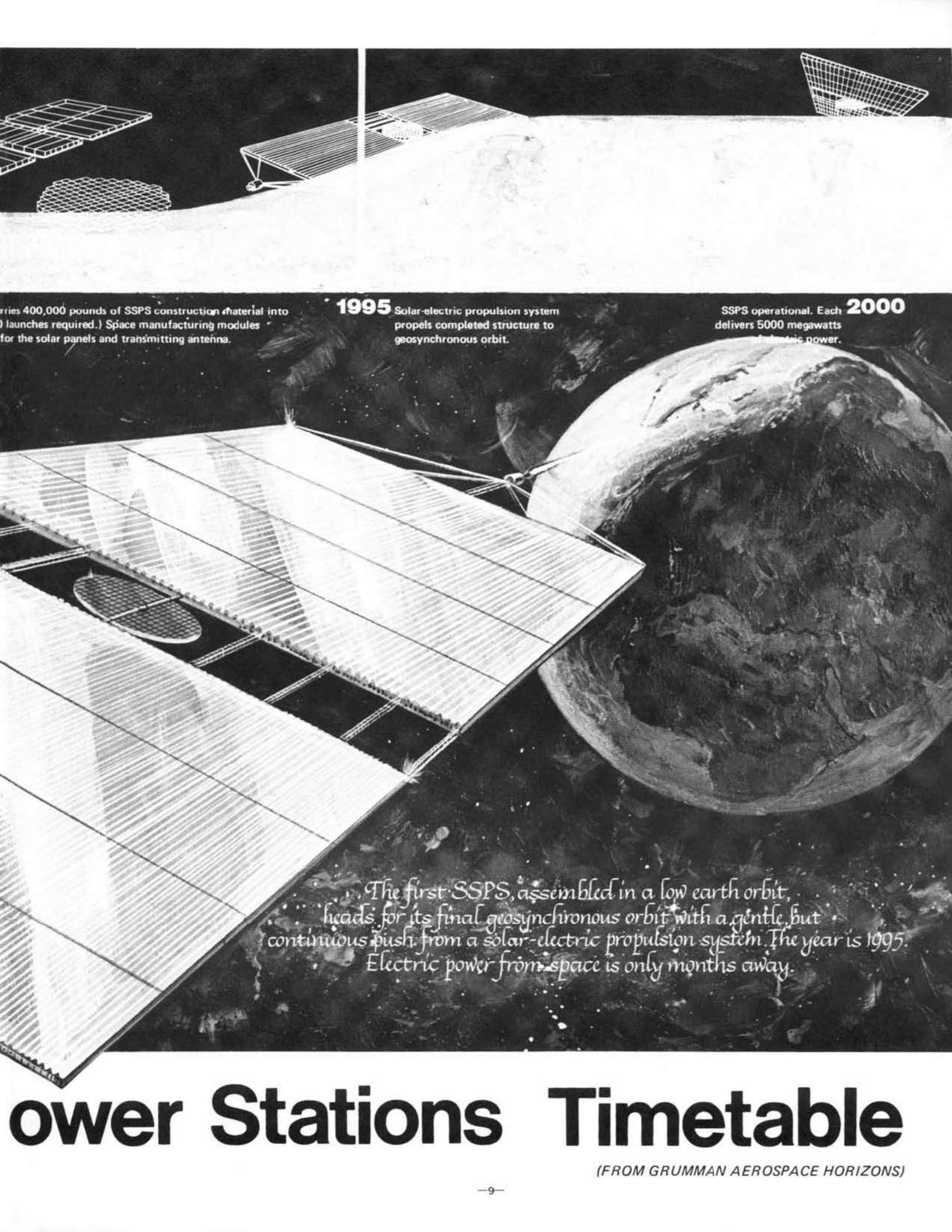
1980 Space Shuttle available for early technical development of the SSPS.

1985 Space Power Development Lab demonstrates the operation of an SSPS.

1990 Heavy Lift Launch Vehicle carries large structure into low earth orbit. (Estimate 150 tons) automatically build structure for SSPS.



Satellite Solar P



carries 400,000 pounds of SSPS construction material into
(10 launches required.) Space manufacturing modules
for the solar panels and transmitting antenna.

1995 Solar-electric propulsion system
propels completed structure to
geosynchronous orbit.

2000 SSPS operational. Each
delivers 5000 megawatts
of electric power.

The first SSPS, assembled in a low earth orbit,
heads for its final geosynchronous orbit with a gentle, but
continuous push from a solar-electric propulsion system. The year is 1995.
Electric power from space is only months away.

Power Stations Timetable

(FROM GRUMMAN AEROSPACE HORIZONS)

had not demonstrated to the world that space was a viable place to go, that same movement would have found another outlet.

That outlet might have been migration to Timbuctu; it might have been migration under the oceans; it might have been an outlet in some other manifestation-music-or a thousand and one spiritual things. It might have been a great religious movement; it might have been something else -- anticommunism -- you can name anything you want.

Space happens to be an outlet. It happens to be a very pleasant outlet; it has many desirable features; and it is happening. So I think it is a coincidence. That coincidence-again-may be something that some great planner above has gone beyond and laid out.

There would have been another outlet if it had not been space. If we had killed the first man in orbit in the sixties, and killed the second man in orbit, this program would be dead, we would know without any doubt that it's impossible to go into space.

Grassroots in Outer Space

Dr. Leary, what is the virtue of establishing a colony? Who wants to go to a colony?

Well, it's like a butterfly . . . a caterpillar becoming a butterfly and learning how to fly . . . like a bird in the nest just getting ready to flap its wings and soar out over the air. Nothing is more exciting than to be in a position where you are just about to live out your predetermined destiny.

Do you think there should be a citizens' space migration movement?

I think that there should be many such movements. I think that every group of people who share any sort of communal vision which they want to externalize should band together; raise the money; and generate the energy to set up their own space habitat.

The Mormons should do it; the Catholics should do it; the vegetarians should do it. It's not just one big citizens' group.

Diversity -- just as the Plymouth mothers and fathers joined together to build their Mayflower -- exactly *that model* should be used. There should be no reliance on big government or big industry or big citizens' groups.

We should encourage diversity. We should get the Salvation Army; the ladies' softball league; the Sierra Club; and the National Rifle Association-let them have their own space cylinder. That's fantastic. I'm all for it.

What to Do for an Encore?

According to Dr. Leary and others involved in the space movement, there seems to be tremendous growth in the public's interest in space. Captain Freitag, do you have a similar impression?

I don't accept that as what's really happening . . . we're seeing a *resurgence*. You recall the interest in space in 1967, '68, and '69, which was extremely broad. We're just beginning to get back up to a small percentage of the interest that we had in the country at that time. What happened in my opinion, is that after the lunar landing, we found ourselves in the position of "What are you going to do for an encore?" People lost interest.

In the first place, we wound down the space program to something far less dramatic. There will never be anything in our lifetime as dramatic as putting a man on the moon-that's a once-in-an-epoch flight.

You can land on Mars, or you can land on another planet. But it will never compare to the threshold we stepped over when we landed on the Moon. That's the first time humanity left this planet.

At that time, we also had three or four things going on. We had a very great upswing in Viet Nam; it totally preoccupied the nation's interest. As far as government was concerned, we were pumping \$40 billion a year into Viet Nam. You couldn't put large amounts of money into space, spending that kind of money.

At long last, we started paying the price of inflation, which came about at that point in time. The civil rights problems, the assassination of Dr. King, and the campus riots took the interest away from space.

Meanwhile, there was nothing really going on in space, because we had made a very conscious decision to phase out the Apollo program and move into the Space Shuttle which would take a decade to bring into being. In that period, there was only extremely minor activity going on . . . minor new activity. There was a great expansion of the continuing activity -spreading communications throughout the world and so forth. So now, we're beginning to understand what this new capability of space is. We see a resurgence of interest in it.

Space and the Oceans

Captain Freitag:

It's a strange thing-we started off this conversation talking about the popularity of space. All during the period of the Apollo program, we kept track of polls, typically run by Congressmen, on how popular the space program is. If you average all the polls taken during that decade when we were reaching for the moon, you seem to find that roughly 65% of the people wanted to go into space. That's two out of three people who think that space is good.

There were times, like after the Apollo fire, when maybe it was 15%; there were times, like after the lunar landing, when it was nearly 100%.

In that same period, you take polls

like "let's build cities under the ocean." Why isn't there a great migration to go under the oceans just like Leary says we want to go into space? It turns out that only about 10 or 15% even want to explore the ocean, let alone build habitats under the sea to mine those great resources. They don't want to do it.

So two-thirds of the people think space is great, just like they thought aviation was great in the last fifty years. So, I think, with that motivation, people *will* move out into space. But it will not be a grassroots migration; it will be a very logical, step-by-step process. I don't want to say controlled. It will be highly voluntary and highly supportive, it will be highly disciplined and highly organized, because that is the only way that you could ever survive in space.

What do you think NASA and the U.S. government should be doing as far as space colonization and industrialization is concerned, Dr. Leary?

I'm not that concerned with NASA and the United States government. Everything they do is fine. NASA is simply a bureaucratic agency serving the American people. And, the government -- shocking as this may sound -- is simply a servant of the American people. So, I think it's a citizens' situation . . . it's a free enterprise situation . . . it's a mainstreet, grassroots situation.

Far from worshipping and being subservient to NASA and the government, I think it's for them to listen to us; we'll tell them what to do. We'll tell them what we want. Neither the government bureaucracy or NASA has had that foresight in the past. It's up to us to tell them; they are our servants and our employees.

Hanging Out in Space

Captain Freitag, do you believe that a citizens' grassroots movement in to space, privately funded, is a possibility?

I think it's got to be institutionalized, and I use that term again on the basis that in order just to exist in space, it's such a tremendous effort . . . billions and billions of dollars. . . It's many, many times anything this world has ever tried to do-not only us (the United States), but everyone else. The program is hundreds of times the size of the Apollo program. You don't do this with grassroots movements.

If you can go out there and hang out by your fingernails like the colonists did at Massachusetts in 1620, where the natural environment allowed them to survive, then you have a chance for a grassroots movement. But you have to take all those things you are accustomed to here on Earth out to space with you -- and they've got to be there first.

I'm talking about just the simple things like heat, light, energy, and air, and the things that you take for granted here. By the time that is done, for every pound of people you take out, you take out

hundreds of pounds of equipment to keep them alive.

If you don't have it done right, you will kill them psychologically almost immediately, cause there is nothing to do out there until you have this big activity there. To generate that from a grassroots financing point is like saying we're going to establish something comparable to the government of the United States on a purely voluntary basis.

Even the United States with all their resources can't do it by themselves. We don't know how to do it yet. How can a grassroots movement do it, if you haven't got those chances? Now, eventually, I think it will happen, but not until after the exploration has been done.

NASA's Catch 22

What do you think NASA and the government should do, Captain Freitag?

I think what we need to do is to establish a very broad research program, probably sponsored by NASA, in which we'd establish two, three, four hundred grants around the country to hundreds of universities examining all the problems associated with building a colony in space, with building a permanent habitat; and doing the basic research on what would be necessary to make that happen.

How do you develop advanced propulsion? How do you process lunar materials? Start this by training hundreds of people at college age level. By the time their careers mature in the next thirty to forty years, they and their students and their disciples will eventually have enough of a base, broadened throughout the entire country, to attack the problem of technology. I may sound like a pessimist, but I'm not. I'm an optimist. It's this office which is furnishing the money to keep O'Neill busy. We need that type of work.

But at the same time, we've just got to keep our feet on the ground, because if we go too far on out in the future, we lose our connection with pragmatic people who say "What have you done for me lately? . . . Have you done something that is economically profitable? Have you done something which is of sociological benefit to the millions of people on earth today, not to a small few in the future? Have you done something to lessen international tensions. . . or what?"

It isn't what you *could* do . . . it's what *have* you done.

Space is for the Birds

Dr. Leary was asked to comment on the politics involved in the movement in to space.

I think that most partisan politics is a primitive mammalian reaction involving control of territory and herd or tribe vertical dominance. I think that once the migration to space has been made, with the accessibility and unlimited access to

space, territorial politics and partisan competitions for dominance will be tremendously minimized.

Bureaucrats want to control everything and limit everything to their own province. . . that's just one of the givens. We must not worry about failing. We are being forced off the planet just like birds are forced out of the nest. We can't fail . . . cannot make mistakes.

You see, migration from the old world to the new was inevitable. Certain people tried to control it; certain people tried to have monopolies; certain bureaucrats tried to limit it . . . sure. But nothing could stop it. Nothing could prevent the migration, and eventually, the independent liberation of the New World people.

I do feel space migration is an intelligence test of one's understanding of government. There's a naive assumption that space belongs to NASA, or that space belongs to the government in Washington. It doesn't: we, the people of the United States, have the final say on who will go to space and how we will go.

I'm not at all intimidated by bureaucrats in NASA, their fears, or their paranoia about my interest. I want to support NASA and government officials who are leading us into space; on the otherhand, I have no sense of intimidation.

NASA bureaucrats are *my* servants . . . and the servants of every taxpayer. If they act too paranoid, we'll fire them. If they act open-minded and creative, we'll promote them.

Moving Out into the Cosmos

"Life has reached out. . . and touched five planets."

Captain Freitag, would you comment on Dr. Leary's statements that humanity is being forced off this planet and that nothing can prevent the migration of "The New World people?"

I can comment on that three ways. In the first place, he starts off by saying that we're being forced off the planet. I couldn't disagree more; we are not being forced off the planet. What he is talking about there is the "limits to growth" theory. I think that the limits to growth haven't even been explored. We're four billion people on this planet today, and I

have perfect confidence that this planet can support 20 or 30 billion. I think we will solve that problem of population explosion by technology and by education long before we're forced off this planet. I disagree with any implication that there's a limit to growth and that we're being forced off the planet.

The second point, which is probably more significant, is the inevitability of exploration. It is no more inevitable than the inevitable migration to the South Pole or North Pole. Those two places have been on this planet since day one; they've been explored; they're rich in resources. But they are not habitable.

Now, technology can make them habitable—we have proven that. People have lived at the South Pole year round. But there's nobody beating the bushes to go to the South Pole; and there's nobody beating the bushes to go to a lot of the deserts and uninhabitable areas of this earth. No one is trying to live at the top of the Himalayas.

Space is an extremely hostile environment *without protection*. The implication of space as a docile place where great masses of the population would go is just not an accepted thesis at this point in time.

I think the time will come when there is a demand to go to space to do things -- and to do some monumental things -- that we just cannot do here on Earth. I think manufacturing a space station is one of the ideas I'm talking about. Solar power satellites inevitably could be done in space. I really think it will be done with our supporting base on Earth first. But migration for the sake of moving out into space is just not a natural thing

Now, I believe—and I've been quoted many, many times on this—that there is a natural philosophical movement which says, "Yes, we're going to explore and we're going to move out into the Cosmos." I don't want to be negative about it.

Just in these last three years, life has reached out and touched five planets that have never been touched by life before -- and we have actually walked on the Moon. In a whole lifetime. . . in the whole eons of time, nothing [like this] has happened. There is some great force that is moving us in that direction.

To be concluded next issue.



This bumper sticker is available from Criteria, see the first letter on page 15.

Conferences, Classes, Papers Called For...

1977 PRINCETON-AIAA CONFERENCE, MAY 9-12, 1977

Session Title	Special Topic
Material Resources	Lunar Data Lunar Polar Orbiter Asteroidal Data Asteroidal Missions
Rocketry and Trajectories	Earth to LEO (inv.) Above LEO (inv.) Trajec. (inv.)
Mass-Drivers	Review thru 7/76 (inv.) MIT work 76-77 (inv.) Model tests (inv.) MD Reaction Engines Review thru 7/76 (3 additional papers)
Chemical Processing	
Large Space Structures	
industrial Operations in Space	6 papers, 15 min. each Concluding with 2 invited papers
Human Factors	Physiological params. Psychosocial Ecosystems Any topic
Products of SMF	SSPS Survey Telescopes, labs, etc. Exploration 1 contrib. paper
Systems	Systems Analysis Econometric Analysis Economic Management Structures
Social System Interactions	Education International and Legal Considerations Antropological
Summary Session	

Notes: 1) Dates were changed to 9-12 May after September A&A announcement.
2) Some topic and speaker changes may still be made, but probably not major rearrangements (main committee meetings done).

supply energy to Earth. Finally, we will explore humanity's hopes of traveling to other planets and perhaps even beyond the solar system to the stars."

For further information, call (312) 322-0304 or write to the Adler Planetarium, 1300 South Lake Shore Drive, Chicago, Illinois 60605:

SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE

"Who are We?" "How did we get here?" "Are we alone in the Universe?" The answers to these questions have broad, scientific implications, as well as deep philosophical, sociological and theological meaning. The Search for Extraterrestrial Intelligence (SETI) has begun . . .

The Forum for the Advancement of Students in Science and Technology (FASST), and the student programs division of the American Institute of Aeronautics and Astronautics (AIAA) invite you to take part in the search by participating in a special symposium, "THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI)" to be held at the Ames Research Center, near San Francisco, February 24-25, 1977.

Conference speakers and special discussion groups will highlight the symposium dedicated to learning current technological approaches for locating extraterrestrial civilizations and evaluating possible ramifications of discovering and contacting extraterrestrial intelligences upon Earthkind.

The program will involve the following topics: *The Cosmic Picture*: Is anyone really out there?; *The Origin of Life*: Chemical and biological considerations; *Evolution of Technological Civilizations*; *The Search Begins*: Methods and technology needed; *Cultural Implications of Detection and Contact with Extra terrestrial Intelligences*.

Directed primarily toward college and university students, the symposium welcomes participation by interested professionals and faculty. A wide cross section of disciplines will be involved, i.e., anthropology, theology, life science, engineering, sociology, physics and astronomy.

Registration fee is \$10.00. This fee includes tour, symposium materials, and special banquet with guest speaker.

The program is being developed by AIAA/FASST in cooperation with the Ames Research Center's SETI and Educational Programs staff.

For further information, contact: FFAST/SETI, 1785 Massachusetts Avenue, N.W., Washington, D.C. 20036. Phone: (202) 483-2900 or the Ames Center (415) 965-5543.

FUTURISTICS CONTEST DEADLINE

The 1977 Contest in Cultural Futuristics will focus on three areas: alternative cultural patterns on Earth; anthropological considerations in the design of the first orbiting extra-terrestrial community for 10,000 residents; and long range implications of the transition into extraterrestrial living. Considerations such as heterogenization and symbiotization in post-terrestrial cultural evolution and post-sapiens biological evolution may be included.

Either essay or fiction format may be used. Selected papers will form a symposium at the 1977 AAA annual meeting. April 1, 1977, is the contest deadline. Rules are available by sending a self-addressed, stamped envelope to Carol Motts, Speculative Anthropology Society, 10151 Heather Court, Westminister, California 92683.

CLASS BEGINS ON SPACE COLONIES AND TRAVEL

As part of the Adler Planetarium (Chicago) 1976-77 program of instruction in Astronomy and Navigation, James Seevers is teaching a course entitled "Space Colonies and Space Travel," January 13 - March 17. The course announcement reads:

"The possibility of building and living in space colonies during our own generation has apparently arrived. Repeated studies show that large, wheel-shaped, spinning space stations-housing and feeding 10,000 people of all ages and skills-are already feasible and can even pay for themselves by building orbiting solar power stations for Earth. We will study carefully how such colonies may be built in lunar orbit (using a 200-people base on the moon), what the pleasures and problems of living in space would be, and how solar power stations could

AAS/AIAA CONFERENCE -- INDUSTRIALIZATION AND COLONIZATION OF SPACE

San Francisco Bay Area
October 18, 19, 20, 1977

The American Astronautical Society, in conjunction with the AIAA Technical Committee, announces a multi-dimensional conference on the industrialization and colonization of space. The conference will focus on commercial activities in space over the next ten years.

There will be technical sessions on *Large Space Structures (piloted and unpiloted)*; *Manufacturing for Profit*; and *Economical Transport Systems*. Sessions are also planned to discuss *Space Law*; *Space Community Planning*; *Psycho-Social Considerations for Space Communities*; and *Economic Realities of Space*.

Papers may consider-but are not limited to-the following subject areas:

Technical

- Low-cost fabrication and assembly techniques for large structures in space
- Optimum shapes of large space structures
- Limits of size in space
- Materials for large, light-weight space structures
- Shielding techniques for communities
- Design considerations for solar storm shelters
- Radiation considerations: low-Earth orbit vs. geosynchronous orbit vs. cis-lunar orbit
- Identification of tools needed for assembly of structures in space
- Automated fabrication and assembly vs. human fabrication and assembly
- High capacity power alternatives for in-space use
- Control of in-space manufacturing quality
- Necessary research before commercial production plants can be implemented
- Methods of increasing the number of experiments in orbit
- In-space inter-system interfacing techniques
- Low-cost transportation techniques
- Technique for high frequency launch to orbit and rendezvous
- Techniques for rescue and/or return of personnel



Lunar base and launch track -- Field Enterprises.

- Single person transport modes for in-space assembly
- Low orbit to high orbit transport alternatives: Cost-effective solutions
- Materials resources obtainable from extra-terrestrial sources

Space Law

- Property rights in space
- Freeports for commercial space use
- The status of privately owned space objects and colonies
- Legal ties of a space community to Earth
- Internal legal options for space colonies
- The impact of existing and imminent treaties on commercial space operations
- The legal framework for intra-space cabotage
- Rights of multi-national corporations in space
- Rights and protection of information from space
- Rights of entrepreneurs in space commerce

Space Community Planning

- Architectural and structural considerations
- Designing humans into the system
- Person selection techniques
- Analogies of Earth communities with space communities
- Internal economic flow considerations
- Ways of making the community economically self-sufficient
- Effect of various G-levels on human activities, manufacturing processes, and agricultural efficiencies
- Design of a typical room
- Anticipated internal and external traffic flows
- Moderate to large community shapes
- Intra-community transportation methods
- Food production in space communities
- Recreational activities and facilities
- Space medicine and health care

Psycho-Social Considerations for Space Communities

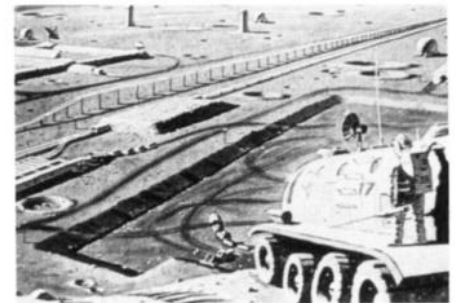
- The effects of packing on human behavior in space
- To what human need level should a space community strive to satisfy
- Anticipated boundaries of stay-time in space
- Ranking of services for human needs in space
- Design considerations for the human element

Economic Realities of Space

- Near-term economic justifiers of space activities
- Perceived risk factors in industrializing and colonizing space
- How to finance medium to large scale space ventures
- Major cost drivers in costing space communities
- Economic trade-offs: low Earth orbit vs. geosynchronous orbit vs. cis-lunar space
- Economic trade-offs: large unified

- space structures vs. smaller independent space structures
- Effects of population numbers and physical mass on colony cost
- Economic priorities of commercial space activities
- Earth needs for space goods and services
- Bootstrap profit makers
- What private industry needs to invest large amounts in space research

Abstracts of 200 to 500 words should be forwarded prior to 1 May 1977 to the Technical Program Chairman: Paul L. Sigler, EARTH/SPACE, Inc., 4151 Middlefield Road, Palo Alto, California 94303. Authors will receive notification by 1 June 1977 of acceptance of papers.



Artist's conception of lunar mine and mass driver -- National Geographic.

ORBITAL STATIONS?

Phillip Parker

Academician Georgi Petrov, in an interview with *Pravda* on the 3rd of September 1976, said that the "flight made by Boris Volynin and Vitely Zholobov on the Salyut-5 space station represents a substantial contribution to the development of cosmonautics. He said that space technology, making use of the high vacuum and weightlessness would also occupy a considerable place in orbital space stations, much of which might be of industrial significance.

"In time," he stated, "I think it will prove expedient to build stations designed for years and even decades of human service by changing crews of twenty to thirty. In due course there will probably be super-large, multi-purpose orbital complexes with crews of one hundred or more. Naturally, these would be constructed from components delivered from the Earth by comparatively small rockets. The construction of such craft is, of course, a matter of the next few decades. But each new experiment in the cosmos brings the time nearer."

The Salyut-5 crew remained in orbit for forty-eight days, landing in the Soyuz-21 spacecraft on August 24. The USSR has announced that several foreign cosmonauts are in training for future international flights in the 1978-1983 time frame. These cosmonauts are from other socialist countries.

US/SOVIET MULTILATERAL SPACE STATION DISCUSSED

Leonard David, Washington

NASA and the USSR Academy of Sciences have agreed on a wide range of cooperative space efforts for the future, including the possibility of an international space station.

Led by Dr. A. M. Lovelace, Deputy Director of NASA and Academician B. N. Petrov, Chairman of the Soviet Interkosmos, U.S. and Soviet technicians outlined the first stages of a renewed interest in future space cooperation. The October 19-22 meeting calls for "consideration of the feasibility of creating a future international orbital station, on a bilateral or multilateral basis."

The international space station concept would follow a number of smaller cooperative programs, with early attention paid to a "Salyut-Shuttle" program. Agreement has centered around use of a Soviet Salyut space station and a U.S.-launched Space Shuttle, for a projected 1981 rendezvous and docking and for "conducting a program of joint scientific and applied experiments and investigations."

ADVERSARY FORMAT FOR SPACE COLONY COURSE

Vid Beldavs, on special assignment from Cummins Engine Company, is designing a course entitled "Space Colonization and National Priorities" that will utilize an adversary hearing format. He will be teaching the course at COE College, Cedar Rapids, Iowa.

The students will be divided roughly into three groups- (1) committee, (2) advocates for, and (3) advocates against. Each group will have to prepare and do research in support of their respective roles. At the onset of the course the students will go through a structured brainstorming/consensus-making process to reach a decision on important goals for the country. These goals arrived at by consensus will serve as the criteria against which the various proposals will be judged.

The course will last approximately one month, meeting two to three hours a day, three times a week. The final output of the course will reflect the pro and con arguments as well as the final recommendation by the "committee." The intent at this time is to send the report to interested members of Congress as well as persons involved in the space colonization effort.

newsletters

Speculative Anthropology

Carol J. Motts, active L-5 member, has organized *Speculative Anthropology*, a newsletter covering cultural futuristics

and space technology. It is billed as "The forum of the Speculative Anthropology Society," and carries news and articles on activity and speculation in the field. To subscribe, send a check or money order to Carol J. Motts, *Speculative Anthropology Society*, Newsletter Dept., 10151 Heather Court, Westminster, CA 92863.

Anthro-Tech

Anthro-Tech: A Journal of Speculative Anthropology is a new newsletter that directs itself to the study of humanity in a technological world. The study of human life in space is one of the main themes of *Anthro-Tech*. We encourage contributions of articles by L-5 readers to the newsletter. Both scientific and speculative articles will be considered for publication. The subscription rate is \$3.00 for four issues. Requests for subscriptions should be sent to Darlene Thomas, Lock Haven State College, Lock Haven, Pennsylvania 17745. Please indicate if you wish to start a subscription with the first issue, which was published Fall, 1976.



The catalog of slides available from the Society didn't make it into this issue; we've been buried by orders from our Christmas mailing and haven't put it together yet; rather than hold up the newsletter we prefer to mail the slide brochure separately, so look for it in your mail soon.

Special mention just has to be made at some point of Vid Beldavs (see article above). Seems a week doesn't go by without a phone call from him with news about NASA or ERDA's plans for space industrialization or the lack of same. V for Victory, Vid.

Existing L-5 local chapters and those in the process of formation (or re-formation) should let us know when and where they plan to meet. If we can have the information by the first of the month, it can be announced in that month's *L-5 News*.

Deadline for other material-articles and longer news reports-is two weeks earlier.

The November issue was not actually mailed until December 2, but it looks like the December *L-5 News* will be entrusted to our postal friends on about December 22. We hope to eventually pull that date up (earlier) by about one week.

If you have a June 1976 *L-5 News*, it's a collector's item. We are no longer shipping that particular back issue except in xerographic form. Back issues are

\$1.00 each, printed or xerographed.

Other items for sale by the Society are . . . (deep breath) . . . the two Bernal Sphere postcards (interior and exterior views), 15¢ each or 50 (of one kind) for \$3.00; posters on the same subjects, \$3.50 each (two or more, \$3.00 each); slides: nontechnical set, \$8.00 (16 slides), technical set \$8.00 (16 slides), supplemental set, \$4.00 (8 slides), lecture information packet, \$1.83; *High Frontier* by G. K. O'Neill, \$7.50 (special price, see below); reproductions of published and unpublished articles are 50¢ per title plus 7¢ per page -- send a self-addressed, stamped envelope for a list of what is available (if you can't wait, order the "complete set" of copies of previously published materials for \$5.82).

Important: please add \$2 handling to any order.

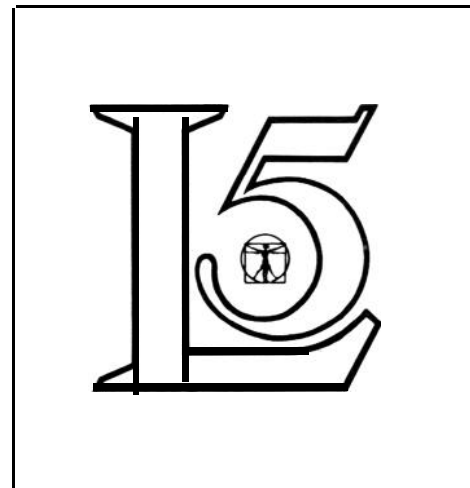
The regular retail price of Dr. O'Neill's book is \$8.95, but our \$2 handling charge enables us to offer it for an apparently lower price.

WEST EUROPEAN BRANCH -- ORGANIZERS REQUIRED!

In November 1976, the West European Branch of the L-5 Society was one year old and the current coordinator Phillip J. Parker, has been in office for the same time. The office of coordinator is now open and applications are invited from members for the position.

Duties of the coordinator include servicing membership enquiries, preparing the branch newsletter, dispatching both U.S.A./W.E. newsletters, maintaining the cash flow accounts, exchanging correspondence with members in West Europe/U.S.A., liaison with L-5 Society HQ, preparing publicity and doing publicity stands and generally looking after L-5 interests in West Europe. It is essential that the coordinator have access to a typewriter and a duplicating machine.

If you would like to become coordinator, please write to Phillip J. Parker, Director, L-5 Society (West Europe), 40 Lamb Street, Kidsgrove, Stoke-on-Trent, ST7 4AL, England, U.K.



Letters

Enclosed please find our contribution to bumper-sticker art. The message will not be lost on you, since you were among the first to see the sense in space colonies. If you are interested in having more of the same, contact us—we are selling them at cost: \$2.00 each [see page 11].

The sticker was created to express our viewpoint during a conference held here in the cities (Space Colonization and Exploration -- December 4 and 5, 1976). *Criteria* was, and still is, based upon experimentation within the built environment; our interest in space colonization is more recent, but equally serious. Question: are there any L-5ers in our vicinity?

Lee Dunnette
Criteria
100 First Street North
Minneapolis, Minnesota
55401
(612) 338-4761

I would like to comment on some of the cost comparisons recently published in the *L-5 News*. These comparisons are likely to be meaningless. Unless a great deal of care is taken to ensure that all ground rules, assumptions, and costing methodologies used to derive the values being compared, are truly equivalent, invalid results are probable. To illustrate: suppose a system with no fuel cost (e.g., a solar power plant) is estimated to cost \$2000/kWe. This value must be amortized over a 30-year plant life, including interest costs. Analyst A selects a discount rate of 7½%, resulting in a capital charge factor of 0.838, and computes the busbar power cost as follows:

$$\begin{aligned} \text{cost in mills/kWe} = \\ \frac{1000 \times \$2000/\text{kWe} \times .0838 \text{ per year}}{8766 \text{ hours/year} \times 0.9 \text{ plant factor}} \\ = 21 \text{ mills/kWe} \end{aligned}$$

The 7½% discount rate reflects a typical cost of money for a constant-dollar analysis (no inflation). Utilities presently,

in our inflating economy, pay 10% to 12% for their money and include taxes and insurance in their capital costs, resulting in a representative capital charge factor of 0.15. Thus a \$2000/kWe system if bought today by a utility would be calculated to have a busbar cost of capital investment of about 38 mills/kWh.

Another analyst might consider a \$2000/kWe system (today's estimate) available 20 years in the future, in an economy inflating at 5% per year, and would calculate a capital cost in then-year dollars of \$5307/kWe. With the 0.15 capital charge and a plant factor as low as 0.6, the estimate of busbar power cost is 151 mills/kWh.

These examples do not exceed the range of assumptions, ground rules, and methods used by various analysts. Further differences clearly exist in degrees of technical conservatism, cost estimating conservatism, and in handling of such matters as operating costs, profit, distribution costs, amortization of development costs, and government subsidy.

My view is that cost comparisons, between today's depletable energy sources and the various possibilities for future nondepletable energy sources, are not constructive. Someday we have to move to nondepletable systems. Cost and technical uncertainties for all such systems are great enough that a rational selection cannot be made now. Any nondepletable system that exhibits promise of technical feasibility and economic practicality (the SPS clearly falls in this class) should be pursued vigorously until a valid reason is found to discard it. Estimates of the time to develop nondepletable systems and implement them on a large scale are roughly equal to the estimates of useful lifetime remaining for depletable energy sources. Selection of a "best" nondepletable option today is not a rational strategy. What if we found out years later that we couldn't make it work?

Gordon R. Woodcock
Bellevue, Washington

I am writing for two reasons: first, I hope the L-5 Society will not confine its activities merely to establishing Earth Orbital Space Colonies, but will also go even further—to the stars. It is never too early to want to go further, and there is plenty of room in the Universe for other ideas and approaches. I believe the L-5 Society will never disband.

Secondly, I want to answer those who push space colonies because they will solve all our problems. No, space colonies will *not* end: war, hate, over-population, evil, pollution, politics, or stupidity. These things happen because we are humans. And if they *are* solvable, it could easily be done here on Earth.

But there is a very good and necessary reason for us to build these marvelous things in space: because we are civilized. And all civilizations build for a higher purpose, rather than mere utility. Examples of this abound, but let us look at those lovely cathedrals which rise so fantastically into the sky. From the end of the Roman Empire until the crusades, nothing substantial was built, for the people knew the world would come to an end 1,000 years after Christ. But the dreadful day came and behold, the Earth remained intact! In less than three hundred years, every village had its own cathedral. Everyone labored to raise these stone temples, noble and peasant alike. And everyone could enter these churches (except for the infidel!), irregardless of class or nationality. Cathedrals were built because the people believed in the *future*.

And we, of the L-5 Society, believe in the future. We will work to preserve our beloved Earth, but we shall also strike out for the stars! And space colonies shall be just one more manifestation of humanity's need to drive forward.

P.S. About immortality: our children, monuments, books, and artifacts make us immortal. If we each lived 1,000 years, progress would come to a standstill, for we change only because we fear the oblivion of death. Besides, we'd be just as destructive and neurotic as today!

Elaine Meinel
New York, New York

L-5 SOCIETY MEMBERSHIP FORM (please type or print)

N L 6 1 2

L-5 SOCIETY
1620 N. PARK AVE.
TUCSON, AZ 85718

NAME: _____

COMPLETE ADDRESS: _____

AFFILIATION (OPTIONAL): _____

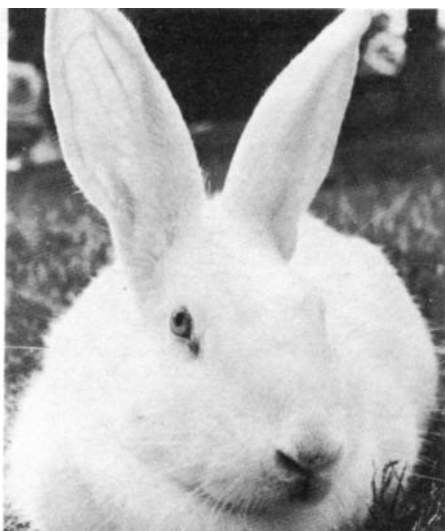
TITLE OR POSITION (OPTIONAL): _____

I am am not interested in being active locally. P h o n e (o p t i o n a l)

___ Please enroll me as a member of L-5 Society (\$20 per year regular, \$10 per year for students). A check or money order is enclosed. (Membership includes *L-5 News*, \$3 to members; the balance -- \$17 or \$7 -- is a tax-deductible donation.)

___ Please enter the above as a nonmember *L-5 News* subscriber (\$20 per year). A check or purchase order is enclosed.

___ Enclosed find a donation of \$ _____. (Donations to L-5 Society are tax-deductible.)



I have noticed that the idea of using rabbits for food on the L-5 colony has been brought up in the last few issues of the newsletter. I feel that this idea should be more carefully examined. A rabbit is by no means an ideal animal to use as far as converting waste materials to food is concerned. After you take away the big feet and the ears, there isn't much left to eat on your average hare. The famous ability of rabbits to "multiply" is also greatly exaggerated as they refuse to breed if the slightest disturbance in their environment occurs. If a cat walks by their hutch, they will become nervous and unsociable.

As a suitable substitute for rabbits I would suggest that eternal friend of science, the guinea-pig. It eats approximately the same kind of materials as a rabbit, but it is composed mostly of edible parts and has a much more reliable breeding cycle (which is usually 1 litter of 2, every 3 months). Both animals, however, suffer from the same disadvantage. They produce large quantities of droppings that would be absolutely useless for anything, unless you wanted to start showers of meteorites with them.

*Don Hutton
Burlington, Ontario*

It is true that rabbits butcher out to only about 50% of live weight. However, of that amount, 90% is directly usable food (the remainder being bone and gristle). Chicken and beef, on the other hand, are full of big bones and gristle. According to Professor Ken Olson, a specialist in rabbit raising, rabbit meat has a larger percentage of edible food than that of any other domestic animal.

As far as food conversion is concerned, rabbits are highly efficient in converting grain and alfalfa. A given acreage plan ted in an alfalfa/grain mixture could produce as much rabbit protein as the same acreage in grain alone. (Soybeans would produce about 50% more protein.)

Having raised rabbits for many years, I am impressed by their health and ability to multiply. Perhaps they are more reluctant to breed in Canada. It should be noted that the rabbits were first domesticated in West Africa about 1000 years ago; as they are native to a tropical region they may have health and breeding problems in northern climates.

Guinea pigs, first domesticated in the Andes, may be worth raising for food as their diet and feed conversion are comparable to that of rabbits Their low reproductive rate is a problem, though. Commercial rabbitries in the Southwest U.S. produce, on the average, 42 fryer rabbits from each doe. If guinea pigs are limited to 8 young per year, a far larger inventory of breeders will be required. Their small size also increases the expense of butchering.

Rabbit meat is more expensive than chicken meat because chickens are raised on such a large scale that their raising and butchering has become largely automated. (Chicken meat is also cheaper because the high quality protein they need comes largely from fish meal. In space, in the absence of massive oceans to harvest, chickens might be far more expensive than plant-eating animals)

No organic gardener would let you get away with that remark about rabbit and guinea pig manure! -- CH

In the October L-5 News, one of the chief objections put forward by Keith Henson concerning Bob Parkinson's proposal to establish a permanent Lunar colony was that obtaining continuous solar energy would be impossible since there is a fourteen day Lunar night, and that it would be too expensive to build nuclear power stations to make the base economically feasible.

*On this count, he is wrong, for there is a place where the sun shines continuously: near the Lunar South Pole, by the Leibnitz mountains. A Lunar colony could operate easily at this point. (See H. E. Ross, *Space Flight*, vol. 17, pp, 409-410).*

*Dr. G. Matloff, NYU
New York, New York*

I have certainly always regarded space travel as the means to insure the survival of the human race as a species. I figured seed groups of people relocated on planets here or in other stellar systems would be the means of that survival. I had assumed that the great mass of humanity was doomed. I am now convinced that the exploitation of even our immediate spatial neighborhood is a means of achieving universal affluence -- Jerry Pournelle's "survival with style."

I hadn't realized just how pessimistic I was until I became optimistic. I'm busy with extensive professional, educational, and family activities; but I'll make time for activities in this effort.

*Bruce R. Quayle
Utica, Michigan*

I would like to second the suggestion that the L-5 Society change its name to "Space Colonization Society" made by David M. Fradin in his letter to the editor in the September issue. Our organization is now entering a period of rapid expansion which can be accelerated by enabling association of our major goal with our name. Perhaps a survey of suggested names through the newsletter would be appropriate.

*John Moran
Los Angeles, California*

MAILING LIST

We have received some worthy requests to exchange mailing lists. Also, local chapters of L-5 Society have requested lists of members in their areas.

To protect the privacy of those who abhor unsolicited mail, we request anyone who does not want to be listed in distributions of our mailing list to specifically inform us of that preference and we will warn our computer. *Semper fidelis*