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

L5 NEWS

NUMBER 12 A NEWSLETTER FROM THE L-5 SOCIETY AUGUST, 1976

Study group slashes L5 cost est.

A team of 12 researchers at NASA Ames Research Center this summer has concluded that the L-5 solar energy proposal will cost between 30-60 billion dollars and that, given an Apollo-style effort, the first solar power satellite could be beaming energy to Earth in 1992. A more cautious scenario, where development of each project phase would be delayed until each previous phase was fully tested, would see power satellites in operation by 1999.

The previous summer, 28 researchers at Ames had bracketed the cost estimate between 100 and 200 billion for a more elaborate program with less emphasis on space manufacturing facilities.

The 12 researchers called for the establishment of a habitat (the "Crystal Palace") containing 6,000 people. They would live in a "hatbox" in contrast to the "bicycle tire" (also known as the Stanford Torus) of the previous summer's design.

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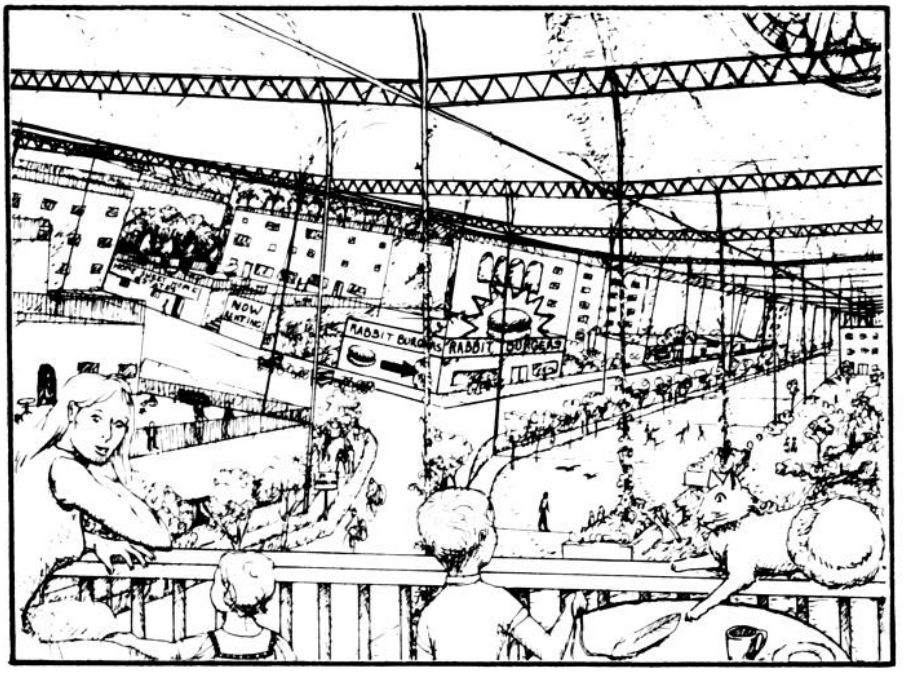


Artist's conception of "Crystal Palace" habitat. Drawing by Carolyn Henson.

Jobs in Space

NASA TO RECRUIT SPACE SHUTTLE ASTRONAUTS

NASA has issued a call for Space Shuttle astronaut candidates. Applications will be accepted until June 30, 1977 and all applicants will be informed of selection by December, 1977.

At least 15 pilot candidates and 15 mission specialist candidates will be selected to report to the Lyndon B. Johnson Space Center, Houston, Tex., on July 1, 1978, for two years of training and evaluation. Final selection as an astronaut will depend on satisfactory completion of the evaluation period.

NASA is committed to an affirmative action program with a goal of having qualified minorities and women among the newly selected astronaut candidates. Therefore, minority and women candidates are encouraged to apply.

Pilot applicants must have a bachelor's degree from an accredited institution in engineering, physical science or mathematics or have completed all requirements for a degree by Dec. 31, 1977. An advanced degree or equivalent experience is desired. They must have at least 1,000 hours first pilot time, with 2,000 or more desirable. High performance jet aircraft and flight test experience is highly desirable. They must pass a NASA Class I space flight physical. Height between 64 and 76 inches is desired.

Applicants for mission specialist candidate positions are not required to be pilots. Educational qualifications are the same as for pilot applicants except that biological science degrees are included. Mission specialist applicants must be able to pass a NASA Class II

(cont'd. on next page)

space flight physical. Height between 60 and 76 inches is desired.

Pay for civilian candidates will be based on the Federal Government's General Schedule pay scale from grades GS-7 through GS-15, with approximate salaries from $11,000 to $34,000 per year. Candidates will be compensated based on individual academic achievements and experience. Other benefits include vacation and sick leave and participation in the Federal Government retirement, group health and life insurance plans.

Civilian applicants may obtain a packet of application material from JSC. Requests should be mailed to either Astronaut (Mission Specialist) Candidate Program or Astronaut (Pilot) Candidate Program, Code AHX, NASA Johnson Space Center, Houston, Tex. 77058.

Military personnel should apply through their respective military departments using procedures which will be disseminated later this year by DOD. Military candidates will be detailed to JSC but will remain in active military status for pay, benefits, leave and other military matters.

Currently, 31 persons are available as Space Shuttle crew, including nine scientists. Twenty-eight of them are astronauts assigned to the Johnson Space Center and three hold government positions in Washington, D.C.

The Space Shuttle is a reusable vehicle that will replace virtually all of this nation's space launch vehicles. Shuttle missions could include deploying and retrieving satellites, servicing satellites in orbit, operating laboratories for astronomy, Earth sciences, space processing and manufacturing, and developing and servicing a permanent space station.

Launched like a rocket, the Shuttle will perform Earth orbital missions of up to 30 days, then land like an airplane and be refurbished for another mission. Pilot astronauts will control the Shuttle during launch, orbital maneuvers and landings and be responsible for maintaining vehicle systems. Mission specialist astronauts will be responsible for the coordination of overall orbiter operations in the areas of flight planning, consumables usage and other activities affecting payload operations. At the discretion of the payload sponsor, the mission specialist may assist in the management of payload operations, and may, in specific cases, serve as the, payload specialist. They will be able to continue in their chosen fields of research and to propose, develop and conduct experiments.

Crews could consist of as many as seven people-commander, pilot, mission specialist and up to four payload specialists, who need not be NASA employees and who will be nominated by the sponsors of the payload being flown. Payload specialists will operate specific payload equipment where their special skills are needed.

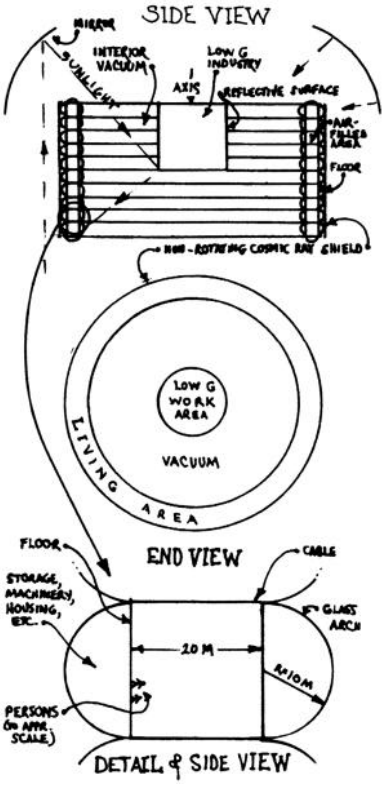
Potential users of the Space Shuttle include government agencies and private industries from the United States and abroad.

(continued from p. 1, col. 2)

The study was conducted June 21 through July 30. Participants were David Criswell, Frank Chilton, Gerald Driggers,

1976 NASA Study's "Crystal Palace"

Vital Statistics:
Population 6000 people
Radius 235 M; RPM 1.95
Length 220 M
Total structural mass (including agricultural area not shown) 49,000 tons
Cosmic ray shield 3,100,000 tons
1 g "gravity" at rim
54 M^2 /person in shielded area
38 M^2 agricultural area/person
Structure mass/person 8.2 tons



Albert Hibbs, Brian O'Leary, Gerard O'Neill, William Phinney, Eric Drexler, James Garmarian, Bart Hibbs, David Kaplan, Jonathan Newman and John Phillips. Consultants included John Blume, Hugh Davis, Owen Garriott, Peter Glaser, Henry Kolm, Gordon Woodcock and T.A. Heppenheimer -- Al Chambers was the study administrator.

Several papers detailing the findings of the study group will be published by the AIAA this fall. Those interested in joining this organization should write to the AIAA, 1290 Avenue of the Americas, New York, N.Y. 10019 or call 212-581-4300.

INTERSOCIETY CONFERENCE ON ENVIRONMENTAL SYSTEMS

New Colony Design Unveiled

Gerard K. O'Neill was the keynote speaker at the Intersociety Conference on Environmental Systems, held in San Diego, July 12-15. In his talk, "Outlook for Space" he gave a brief summary of the concept of space colonization. He then revealed some details of the progress being made on the subject by his research team (which includes L-5 members Jerry Driggers, Eric Drexler, and T. A. Heppenheimer) at NASA/Ames Research Center this summer.

O'Neill projected that the first colony and solar power satellite production facilities could be placed in operation 15-20 years from the date the project would be started. The number of people needed to operate and maintain the space production facilities was estimated at a minimum of three to seven thousand.

O'Neill unveiled a new colony configuration with a diameter of 500 meters and a spherical shape. Concentrated light would enter through windows in the end, reflecting off mirrors on the axis. A water inventory of 5 tons per person would provide the proposed 10,000 inhabitants with plenty of streams and swimming pools. (Rumor has it the study group dreamed up this parameter at one of O'Neill's frequent swimming parties.)

One of the more significant findings of the study group was that it will be feasible to operate the lunar mass driver, which will ship lunar ores into high earth orbit, at 100 gs of acceleration. The length of track needed to accelerate the payloads would be less than 2 miles, requiring considerably less track than was previously considered necessary. The specific impulse delivered by the mass driver, a linear synchronous electric device, if used as a rocket engine, would be comparable to a plasma jet.

A panel discussion with audience participation followed, focusing on the problems of environmental control and farming in space. Panel members were Philip Quattrone, NASA/ARC; D. C. Popma, and William L. Smith, NASA 'Headquarters; Robert C. Reid, MIT; and Jack Spurlock, Georgia Institute of Technology. They expressed varying degrees of concern over the difficulties involved in farming in space. MIT's Reid stated, "I have an eggplant in my garden and it's sick. If that happened in space, it would be all over!"

A member of the audience, Carolyn Henson, who wrote "Closed Ecological Systems of High Agricultural Yield," presented at the 1975 Princeton Space Manufacturing Facilities Conference, and who is the soft spoken, unassuming author of this article, replied, "In aerospace engineering we need fail-safe design. If something goes wrong you

C. H.

have a crashed plane. But on farms things normally go wrong, and farmers are used to it. Even in space, it won't be disastrous if the eggplants get sick. You can store food against crop failure. You can have many separate farms, just as on Earth, so that any individual crop failure represents only a partial loss of that food supply. If space farmers lose a crop, they will write it off on their taxes and plant something else."

"Who are they going to pay taxes to?" replied Reid.

For answers to that and many other questions, be sure to read future issues of the L-5 News.

BOUNTY OFFERED

The L-5 News is offering a $25 reward for an interview with either of the candidates for President on the L-5 project.

NASA NIXES CHLORELLA BURGERS

Interview with Phillip Quattrone, Chief of the Advanced Life Support Research Project at NASA/Ames Research Center

Carolyn Henson

Henson: I understand your group at Ames does more blue-sky type research and that the people at Johnson Space Flight Center are responsible for turning your ideas into hardware.

Quattrone: Yes, we look at system development from proof of concept up to one person design capability.

Henson: For years we've heard that people in space will dine on algae burgers. A year and a half ago, Soviet scientist Alexander Kamin praised chlorella algae as "cosmic factories" and "models of the future space industry." Is NASA conducting research into algae?

Quattrone: NASA is currently not sponsoring any work in chlorella. For many years we supported work on chlorella and hydrogen fixing bacteria. The sum and substance of that work was that, yes, we could develop systems that were continuous, but, no, we couldn't feed it to anybody.

Henson: So people don't really like chlorella burgers that much.

Quattrone: It hasn't ever been shown that humans can eat algae without developing gastrointestinal problems.

Henson: So it's not just a matter of the flavor, then?

Quattrone: Well, you and I are normally eating around 15% protein; the rest is largely carbohydrate and fat. With material from most unicellular organisms you're talking 60-75% protein. I don't believe for a minute the nutritionists are going to believe you can feed that percentage in a diet.

Henson: In the keynote speech for the Environmental Systems Conference, Gerard O'Neill presented his plan for space colonies. What research steps do you believe are necessary to create those beautiful green scenes you see in the paintings of his colonies?

Quattrone: I believe we are going to go through many iterations of O'Neill's idea of a space colony. I don't think even O'Neill believes his current concept of a space colony is going to fly per se. I don't know whether it is feasible to have a one gravity field in a space colony. If we are dealing with a reduced gravity field then certainly there is a great deal of research and development that has to be undertaken by the agency and by the country to develop a closed ecosystem.

During the past 13-15 years we have spent a great deal of resources to develop what we call physical-chemical life support systems. We have developed regenerable CO_2 scrubber system technology for CO_2 reduction and H_20 reclamation. We have yet to fly only a molecular sieve on the Skylab and we are back to flying lithium hydroxide on the Shuttle again.

Henson: What was the problem with the molecular sieve?

Quattrone: There isn't any problem with the sieve per se. The Shuttle has a "dollar bow wave" problem. They need all the dollars they can get their hands on to develop the Shuttle; therefore they don't want to develop any advanced technology to fly on it, or as little as possible, in order to get the Shuttle to fly within budget and on time.

It is my opinion that in order to develop the closed ecosystem that O'Neill is talking about, or say a zero or one-sixth g habitat, for example, he needs a lunar colony with a mini-closed ecology. This means we're going to have microbiological species, selected species of plants and animals. In order to demonstrate that these systems are compatible or that each species will function in space, we are going to have to test it in space.

We, as aerospace engineers, have been living with 99.99% reliability for years. That means you have 1 chance out of 10,000 of failure. We believe that it will probably take a long amount of time -- our current predictions are anywhere from 25-75 years-to demonstrate a closed ecological system. I don't mean prove it on the ground, I mean prove it in space. As part of the Office of Aeronautics and Space Technology Summer Workshop, we took a look at this question and we feel you have to demonstrate every critical piece in flight before you get it accepted for flight.

Henson: To get away from the subject of "closed ecology", how soon do you think we will be attempting to grow at least some of the food people need in space?

Quattrone: First, let us define "need". Are we talking about nutritional needs or hobby shop needs?

Henson: I see two factors here: the psychological factor, and the second is strictly economic. At what point do you see either of these factors becoming significant?

Quattrone: In Spacelab plants will probably be grown strictly from a science viewpoint to see what effect zero g has on them.

NASA has sponsored work with lettuce and tomatoes with the idea that these would be grown in space for psychological needs-for fresh tossed salad kinds of things. I guess I wouldn't see them grown in space for food until we have a space station, and then it would be from a psychological standpoint.

Henson: Right now McDonnell Douglas and Grumman Aerospace are working on a study for a 200-person orbiting facility, tentatively planned for the mid-eighties. Are they working with you on this project?

Quattrone: No, they aren't in contact with us.

Will the Grumman and McDonnell Douglas space station studies provide fresh tossed salad and bacon lettuce and tomato sandwiches for the astronauts? On this suspensful note we will have to leave our readers.

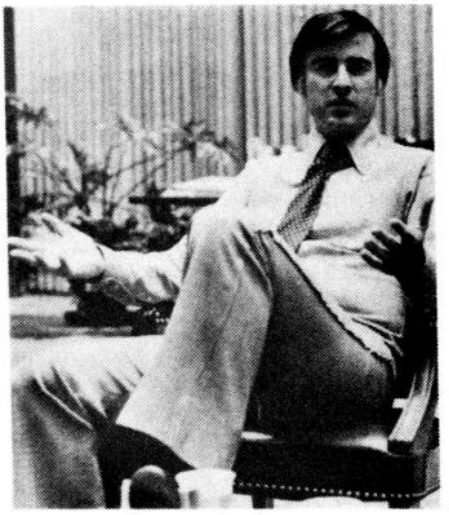
O'NEILL TO HEAD LDEF/USE TASK FORCE

USRA (Universities Space Research Association) has asked Dr. Gerard O'Neill to head its task group on Large-Scale Space/Lunar Industry. A number of concepts, materials, surface, and structure tests will need to be conducted in support of any effort in large-scale space structures. LDEF (Long Duration Exposure Facility) will offer a unique opportunity for three to six month exposures to the space environment followed by recovery of the experiments for ground-based analysis. USRA's role in the LDEF program consists of providing an interface between NASA and the university community, including the following tasks:

'(1) Provide the academic community with information about research opportunities afforded by LDEF;
(2) Offer technical assistance in the definition of experiments for LDEF;
(3) Receive, review and select proposals for experiments and make recommendations for support and inclusion on LDEF missions;
(4) Assist Principal Investigators in obtaining financial support for experiment development;
(5) Manage the development of selected experiments to insure flight readiness and compatibility.

If you would like to become involved in this program, write to USRA LDEF/ USE Program Office, P.O. Box 5127, Charlottesville, VA 22903 or phone 804-295-7141. They provide a free newsletter.

Dr. Gerard O'Neill testifying before the Senate Subcommittee on Aerospace Technology and National Needs.



California Governor Jerry Brown

STEWART BRAND ON JERRY BROWN ON SPACE COLONIES

From an interview of Stewart Brand by The Village Voice, *June 21, 1976, in an article critical of Brown.*

SAUSALITO - Walled in behind a stack of cardboard boxes in his warehouse office Stewart Brand tells us we have the governor all wrong. Brand produced the Whole Earth Catalogue and now edits The Co-Evolution Quarterly. He has spent some time with Brown and published parleys with the governor, Gregory Bateson, and others in his magazine. Almost more than any other publication in the state the quarterly (circulation 28,000) gives one access to ideological currents in California and Brown's links to techno-zen.

Brand: "He's more of a process person than an issues person. He doesn't take an issue flat out until he's in it and will refuse to commit himself till he has done that. . . . The major environmental thing is that he has more of a whole systems head."

Us: "Is he philosophically for no growth?"

Brand: "That's it. That's the whole ball of wax, not only philosophically, but behaviorally."

Us: "How does he deal with poor people in this perspective?"

Brand: "I think he's getting into the fact that a low-energy economy is a high labor economy, that in a sense the energy problem and the jobs problem can't solve each other just by coexisting." Brand stops to take down an endorsement for Brown for President from Paul Ehrlich, promoter of Spaceship Earth and author of "Population Bomb." ("It is clear," goes the endorsement, "that he has more than a superficial commitment to novel approaches to our environmental and other problems.") Brand has been publishing, in his magazine, articles about space colonies, plantations in space.

Us: "Is Brown really in favor of space colonies?"

Brand: "He has asked Gerard O'Neill, who is the major designer of space colonies, to give a presentation to the California Energy Commission, which he did. And the Energy Commission is looking to put money into O'Neill's research. . . . It's something very large and very interesting in terms of a vision. It's a long incremental business which would conceivably have several million people in far Earth orbit." Space colonies, said Brand enthusiastically, might have some bearing on California's high unemployment rate: "I do know that one of Brown's interests in space colonies is that it would be an enormous construction effort, with low environmental detriment and quite possibly high benefit."

Us (petulantly): "But what does he think the ideal society would look like?"

Brand (tolerantly): He'd say that's the wrong question, because the answering of it prevents the realization of it. As soon as you've got a plan of what everyone wants to do, there's no way it's going to happen."

TIM LEARY ON SNAKE OIL, LIBERALS, AMINO-UGANDA

This article by Dr. Timothy Leary is more or less a *reply to "No Snake Oil Salesmen Need Apply,"* L-5 News, April, 1976, p. 5.

Since Hiroshima, territorial war as a stimulus for intellectual advancement has been replaced by space rivalry. Since Peenemunde and Sputnik it has been obvious that the most intellectually and survivally interesting issue on this planet concerns humanity's transition to extraterrestrial life.

The familiar east-west competition continues, of course, on the surface of the planet. Indeed, we might speculate that such transcontinental rivalries exist on all nursery planets at that stage in evolution when neurological-primates start assembly-line tool-making preparatory for post-planetary migration. But Apollo-Soyuz is probably an accurate forecast of Inter-National collaboration in Space Colonization.

> "There can be no doubt that in the future the crews of orbital stations will be international and space exploration will become a matter involving the whole planet."
>
> Academician V. Glushko quoted in *Izvestia,* August 1975.

This cooperation among super-powers may seem, at first impression, to auger a utopian state of global harmony. But evolutionary currents always run deeper than the political and it is most important that Apollo-Soyuz linkages not conceal the fact that Space Migration confronts our species with the most critical choice it has faced in, perhaps,

the last 10,000 years.

We recall that, after 1492, the various European powers set out boldly to impose upon the new world their own bizarre national versions of reality. Thus were created such astonishing cultural mutations as Spanish-America, Anglo-India and Amino-Uganda.

Let us have no illusions. Space Migration will produce the most intense ontological struggles our planet has seen since the reptilian-mammalian conflict of long-ago. Space Migration offers our unfinished species the opportunity to create new realities, new habitats, new neural perspectives, new worlds unlimited by territorial longitudes or gravitational chauvinisms.

Shortly after the first lunar landing, one Thomas Paine, head of NASA's Apollo program, produced in his exultation one of the most partisan statements since the Reformation. "This," said Paine, "is a victory for the crew-cut guys who use slide-rules, read the bible and salute the flag." Let us applaud Director Paine who in one magnificent flight of rhetoric manages to alienate all tax-payers who are female, non-engineers, non-protestants, and prefer non-marine hair styles. Substitute the word "Marx" for "bible" and the NASA version of whose reality should control space is in close agreement with Soviet planners.

Thus we see an upcoming conflict over the future of human evolution; a debate which is not political but rather philosophic and finds its roots, not in transient national rivalries, but in an inevitable tension which has existed for the last several centuries and which can best be described as technology versus humanism, engineering versus ecology, poetry versus logic, freedom versus control and snake-oil versus motor-oil.

For the last 30 years I have been preoccupied with this wretched misunderstanding between engineering and humanism and have attempted to personalize, neurologize, eroticize and subjectify engineers, and on the other hand to make more rigorous, precise, replicable and objective the language and thought habits of poets and philosophers. Interestingly enough, both engineers and philosopher-humanists are hopelessly trapped in the wheels of their own abstractions and control mechanisms. We are led to wonder whether the solution to these rigidities which prevent engineer-bureaucrats from communicating smoothly with each other as well as harmoniously meshing with the humanists is a certain lack of neurological flexibility which can accurately be described as "snake-oil deprivation,"

This polarity between technology and humanism is artificial and statistically common-place-i.e., stupid. It is both the self-appointed liberal humanists and the civil service engineers who threaten Space Migration with their clashing

doctrinaire opinions-the former peevishly suspecting that any escape from earth gravity is an elitist liberation from their compulsory egalitarian plans of limited-growth and intra-planetary bussing.

The Space Migrant's reply to the socialists' complaint is, of course, "let the meek inherit the earth; we have farther-out plans." To which the liberal's stern reproach is: "You have no right to float away from this planet with the ill-gotten gains you have wrenched from the poor." The obvious response to the liberals is, as always, to buy them off. When the administrators are shown that private-enterprise-space migration, like 15th Century colonization, will return enormous energy riches, the distribution of which they will be allowed to administer, they will be intellectually offended but practically mollified.

The Apollo project, we recall, perfectly executed its mission: to return moon-soil samples which turned out to be rich in the raw materials necessary for the construction of space colonies. All this, we suspect, was a serendipitous and mildly disturbing side-effect to the NASA planners whose visions did not at the time include the possibility that civilian Americans and their families might insist on getting into the pioneer-frontier action.

As G. Harry Stine speculates in his book, *The Third Industrial Revolution,* the industrialization of space opens enormous new perspectives: "...new industrial empires will be forged, new billionaire industrial moguls will emerge." Much more significant than the economic are the cultural possibilities of Space Migration. It is the remarkable anthropological genius of Gerard O'Neill to recognize that the establishment of thousands of space-cylinder habitations will allow for an enormous plurality of culture-styles and moral systems. Literally each group of colonists who band together to finance and design a Space Habitat will be in the position of creating a new consensual reality. Within the limits of physical security the colonists can determine the political, cultural and aesthetic dimensions of the psyche-space they inhabit.

Comparisons with 15th Century colonization or with the first two industrial revolutions are too modest. The migration situation may be more analogous to the movement from marine to amphibian life or from reptile to mammalian. Imagine, if you can, the snake-oil commercials at the time of amphibious migration:

TAKE ADVANTAGE OF THESE UNLIMITED REAL ESTATE POSSIBILITIES: SWAMPS, SHORELINES. FORESTS, PRAIRIES. CAVES, BURROWS!!!! YOU CAN BE THE FIRST ONE ON YOUR BLOCK TO GROW SCALES, FUR, FEATHERS; TO SQUIRM, SCRAMBLE. LOCOMOTE ON MULTI-PEDAL APPENDAGES!!!'

We do well to listen to the shrewd advice of Astronaut Russell Schweickart (published in *CoEvolution Quarterly)* to keep government bureaucracies out of Space Colonization and rely on private initiative and personal investment of vision.

Was it not exactly "snake-oil" that stimulated the last Age of Exploration? Marco Polo returning with spices, pungents, perfumes, soft silks, strange herbs and medicaments? Upon what substances was the wealth of the East India Company founded? Did not Ponce de Leon set off after the Elixir of Life? Did not Coronado seek the fabled Seven Cities of Gold?

If Space Migration is going to be anything more than insectoid bureaucracy or another Alaska pipeline adventure controlled by the oil politicians, the lunar Mafia and the Inter-Planetary Teamster's Union, it is going to be "snake-oil" that softens the rigidity, soothes us through the moments of hardship and makes the venture one of hedonic liberation and experimental diversity.

conferences...

PRINCETON PLANS L-5 PROJECT CONFERENCE

Tentative plans for a conference on the L-5 project at Princeton May 11-13, 1977, were reported to the L-5 News. The conference would be sponsored jointly by NASA-AIAA and Princeton. This is the first conference on the subject since the Space Manufacturing Conference held in 1974. Watch AIAA publications and the L-5 News for further information.

Apollo Astronaut Russell Schweickart

AAS/AIAA BICENTENNIAL SPACE SYMPOSIUM

ASTRONAUT SCHWEICKART TO CHAIR POWERSAT SESSION

The American Astronautical Society and the American Institute of Aeronautics and Astronautics are sponsoring a Bicentennial Space Symposium October 6, 7 and 8, 1976, in Washington, D.C. Sessions of special interest to L-5 members are "Mankind's Commerce: The Industrialization of Space," and chaired by Hon. Jack Campbell and "Mankind's Resources: The Need to Augment Earth's Stores," chaired by Russell L. Schweickart. This latter session will consider solar power from space and the mining of lunar resources.

Those who wish to obtain registration forms should write to the American Astronautical Society, 6060 Duke St., Alexandria, VA 22304.

SPACE LAW CONFERENCE

The AIAA jointly with the IISL-IAF are conducting a seminar October 10th through October 16th, 1976, at Anaheim, California, at which approximately six Soviet attorneys from the Academy of Sciences and about twenty professional attorney members of the Aerospace Law Committee of the American Bar Association will participate. It is the 19th Colloquium on the Law of Outer Space of the IISL. The four topics to be covered are:

1. The future of Space Law
2. Space Law and Energy
3. Relationship of Air Law and Space Law
4. Various subjects

The Chairman of this Outer Space Law and Science seminar will be Professor Carl Q. Christol of the Department of Political Science of the University of Southern California. You will be interested to know that papers will also be given by Ronald Stowe of the State Department and by Stephen Doyle, formerly a Sub-Committee Chairman of the ABA Aerospace Law Committee, with particular emphasis on communications. Also papers will be given by six members of the Aerospace Law Committee. Many other reports will be given by distinguished US and USSR outer space scientists.

ENERGY CONFERENCE TO INCLUDE SPACE POWER

This year's Intersociety Energy Conversion Engineering Conference will include three separate sessions on Space Power. The conference will be held September 12-I7 at the Sahara Tahoe Hotel in Stateline, Nevada. Of particular interest to L-5 members are four papers on photovoltaic solar cells for space applications; a paper on "Transportation Options for Satellite Solar Power Systems," by Gordon R. Woodcock and E. E. Davis; "Thermal Engine Solar Powersats," by Daniel L. Gregory; and "Derivation of a Low Cost Satellite Power System," by James E. and Ronald N. Drummond (to be presented at a session on Advanced Concepts).

Other programs will include five sessions on Geothermal Energy; three sessions on Coal and Oil Shale; four on Solar Power (which will include papers on "Comparative Performance of Solar Thermal Power Generation Concepts," by G. L. Schrenk, and "New Concepts in Solar Photovoltaic Electric Power Systems Design," by E. Federman, R. Ferber and P. Pittman); two sessions on Electric Vehicles; three on Electrochemistry; two on Brayton Cycles and Expanders (which will include papers on "Operational Evaluation of a Closed Brayton Cycle Laboratory Engine," by G. D. Duvall, and "The Mini Brayton 1300 We Space Power Engine," by J. Dunn, F. X. Dobler, and R. D. Gable); three sessions on Hydrogen; two on Rankine Cycles; two on Wind Power; two on Thermoelectrics; two on Nuclear Power (which will include a paper on "Heat Pipe Nuclear Reactor for Space Power," by D. R. Keonig); four sessions on Energy Conservation and Storage; two on Urban Energy Management; and single sessions on Heat Pipes, Advanced Auto Propulsion, Biomedical Power, Stirling Cycles Engines, Thermionics ("NASA Thermionic Conversion Program," by J. G. Lundholm and J. F. Morris), MHD and Other Topping Cycles, and Alternative Fuels.

The following registration fees are in order:

	Prior to Sept. 5, 1976	After Sept. 5, 1976
Regular	$75.00	$90.00
Student	$20.00	$20.00

These prices include a copy of the Conference Record (to be distributed at the door) which will contain all 250 papers that are to be presented. Those wishing to attend should either send a check for the appropriate amount before September 5, 1976, to:

American Institute of Chemical Engineers
Meeting Department
345 East 47 Street
New York, NY 10017

or pay the higher amount at the door. L-5 News will be reporting on the Conference in the future.

ERDA PUBLIC MEETING IN SAN FRANCISCO

ENERGY TECHNOLOGIES FOR THE WEST

The Energy Research and Development Administration (ERDA) is sponsoring a public meeting at the Sheraton-Palace Hotel, San Francisco, September 20-22, to discuss the National Plan for Energy Research, Development, and Demonstration.

The Steering Committee includes such diverse organizations as the Electric Power Research Institute, the Western Interstate Nuclear Board, Friends of the Earth, and the Sierra Club.

Persons who wish to attend, comment on the Plan at the meeting, or to submit written testimony should contact Martha D. Dixon, Coordinator, San Francisco Public Meeting, ERDA, 1333 Broadway, Oakland, CA 94612.

L-5 AT WORLD CON

The L-5 Society will be represented at the World Science Fiction Convention, Kansas City, September 2-6, by L-5 Director Keith Henson. He will be speaking on the "Life in Space" panel, chaired by L-5 member and well known science and science-fiction writer Jerry Pournelle. Other panel members include Norman Spinrad and Larry Niven.

L-5 members who are in the area or who are planning to attend are requested to call the L-5 headquarters in Tucson as the Society has a table at the Con and will need help to keep it open.

UC SAN DIEGO'S PHYSICS DEPT. SPONSORS COLLOQUIUM ON SATELLITE SOLAR POWER

The University of California, San Diego's Department of Physics is sponsoring a colloquium on "Low Cost Solar Power From Satellites (with Ferroelectric Heat Engines)" to be delivered by Dr. James E. Drummond, the Director of Plasma Engineering at Maxwell Laboratories, Inc., and Editor of *IEEE Transactions on Plasma Science.* The colloquium will be held October 6 at 4:00 PM in the Undergraduate Science Building (USE), Room 2622 (Revelle Campus). The colloquium is open to the public, and interested L-5 members are invited to attend.

AIAA/FASST TO CONDUCT STUDENT CONFERENCE ON THE SEARCH FOR LIFE IN OUR SOLAR SYSTEM

The American Institute of Aeronautics and Astronautics (AIAA) and the Forum for the Advancement of Students in Science and Technology (FASST) are pleased to announce a student conference on "The Search for Life in our Solar System," to be held October 8 at the Jet Propulsion Laboratory in Pasadena, California. Participation is limited to college and university students and teachers.

Several major scientists involved in the search for extraterrestrial life, including key Viking Project personnel, have been invited to participate in this student symposium. The October conference will deal with the following issues:

Evolution of our Cosmic Perspective
The Biology of the Solar System
Development of the Viking Program & First Results
The Future of Unmanned Probes
Manned Exploration of the Planet Mars
After Viking-What?
Our Place in the Universe & the Search for Extraterrestrial intelligence

A final program and listing of speakers is available on request from FASST. A small registration fee (less than $10.00) will include the closing dinner.

The conference is being designed so that students can develop a better understanding of the biological, geosciences, as well as the engineering contributions being made to the search for life by our planetary space exploration programs.

For additional information, please contact Leonard David, Director of Student Programs, FASST, 1785 Massachusetts Avenue, N.W., Washington, D.C. 20036.

ACCESS TO ENERGY

Earth/Space News

One of the prime drivers of future space planning is the dream of "cheap" power from Space. The L-5 colony system, for instance, is dedicated to Solar Satellite Power Systems (SSPS) as *the* means of economically justifying its colonies in Space. However, to be truly justified, the SSPS must not only bring positive return to the colony, but must also compete on price with other sources of energy.

One of the statements made quite often by L-5 proponents is that no foreseeable energy source will be able to compete on price with the SSPS -- once it's in place. This is a very strong statement, and certainly needs much more quantitative analysis before it can be justified to the satisfaction of the energy companies, potential users, and the person who pays for it: the taxpayer. In the analysis, both existing energy sources and realistic near-term energy sources must be considered. Any source which promises firm prices at less than 15 mills/kWh will not allow breakeven for the presently defined L-5/SSPS system for over 35 years.

This is not to say the SSPS cannot be justified. With everchanging technologies, it holds perhaps as much chance to further reduce its own costs and difficulties of development as do other energy forms. However, it would behoove the serious planner to be well aware of the alternatives before he makes a $100 Billion (or $200 Billion, or $400 Billion) decision to throw his entire weight behind SSPS as the solution to the energy problem.

One alternative energy source, discussed in the May issue of *Access to Energy,* is the migma fusion technique -- being developed by the Fusion Energy Corporation in Princeton, NJ. The fusion technique holds promise of being able to produce up to 6 MW in a power cell only 4 feet in diameter. Further, it is a concept which -- by the claims of its innovator, Dr. Bogdan Maglich -- can achieve break-even in two years, and can produce commercial energy within six years. At a truly economical cost.

The migma fusion concept may or may not come to be. There's a lot of work yet to be done. But the energy planner *must* be aware of pending alternatives in energy, if he is to make a rational decision.

Access to Energy is a newsletter which regularly discusses every conceivable energy form in a straight-forward, no nonsense manner. The newsletter is published monthly by Dr. Petr Beckmann, professor of electrical engineering at the University of Colorado. It is explicitly "pro-science, pro-technology, pro-free enterprise." Dr. Beckmann is equally capable in describing technical aspects of new and existing energy forms, and in vaporizing myths which are currently receiving heavy media attention. In a working environment of hoaxes and Luddites, it would benefit the advocate of common sense to be prepared to counter half-truths with well-grounded truths. Dr. Beckmann's *Access to Energy* is an excellent source of intellectual ammunition.

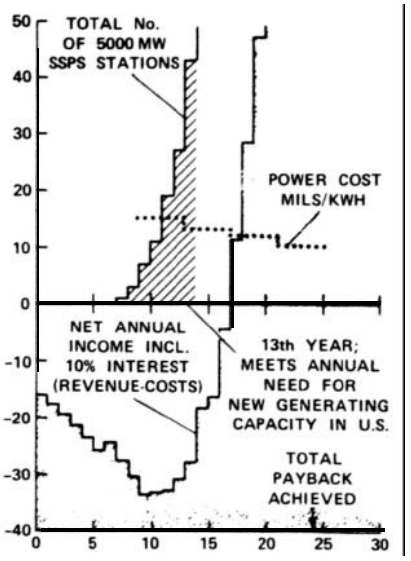
Subscriptions are $9 per year, and may be ordered from

Access to Energy
Box 2298
Boulder, Colorado 80302.

REPLY TO "ACCESS TO ENERGY": L-5 ACTIVISTS BEWARE!

Carolyn Henson

The author of the above article apparently ran into some overly enthusiastic L-5 supporters. To our knowledge there has been nothing in print proposing that solar power in space is the *only* energy source that will be competitive in the future. Please remember: we haven't proven anything yet. Our project just looks pretty promising.



However, we do have to take issue with the assertion of the Earth/Space News that with a price of 15 mils per kWh that it would take over 35 years to break even on the project. Gerard O'Neill in "Space Colonies and Energy Supply to the Earth," *Science,* Dec. 5, 1975, pp. 943-947, estimates that repayment of all research and development and construction costs plus 10% real interest (that is, above inflation) per year, would occur 24 years from the beginning of the project, or 12 years from the start of actual solar power generation. In this scenario, total project cost (up to the total payback point) is assumed to be $178 billion, and power cost is assumed to start at 15 mils per kWh and drop gradually to 10 mils per kWh by the

time payback is achieved.

Mark Hopkins, in "A Preliminary Cost Benefit Analysis of Space Colonization", submitted to the Federal Energy Administration, goes into great detail (59 pages worth) on the techniques and assumptions behind O'Neill's calculations of the payback period. A copy of Hopkin's report is available from the L-5 Society for $4.

The Earth/Space News does not say how they determined that the "presently defined L-5/SSPS system" could not allow breakeven for 35 years. If they or anyone else have discovered flaws in O'Neill's and Hopkin's analysis of the project we would like to hear about them.

It should also be noted that the FEA has estimated that $580 billion will be spent on capital investment in energy over the next 10 years (Energy *Reporter,* April, 1976, p. 1). The L-5/SSPS option would cost about $100 billion in its first 10 years, or about 1/6 of the U.S. energy capital budget. This would by no means be a case of putting the "entire weight" of energy investment behind this program.

FUSION WOES

As fusion is one of the potential competitors of solar energy from space (currently the primary justification for L-5 colonies), readers of the L-5 News may wish to read the editorial in Science, July 23, and the articles of W. D. Metz, June 25 and July 2.

The editorial starts off:

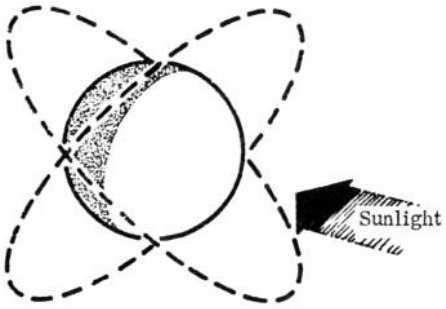
"Viewed from a distance, energy from the fusion of light nuclei is a glamorous concept. Advocates have talked of obtaining unlimited amounts of cheap, clean energy from the virtually inexhaustible deuterium of the oceans. But looked at closely, deuterium fusion is far from practical application: if achieved it will be costly, and it will create large quantities of radioactive substances."

Compared with the problems fusion engineering faces, construction of solar power plants from L-5 colonies seems simple-or is it only that we just haven't found the hard problems yet? -K.H.

LOW COST POWERSAT SYSTEM

An abstract of a paper by James E. Drummond of Max well Laboratories, Inc., and Ronald N. Drummond, which will be presented at the Intersociety Energy Conversion Engineering Conference in Stateline, Nevada, September 12 - 17.

Criteria for selection of the optimum orbit for a Satellite Solar Power Station (SSPS) are presented. To meet these criteria fully, two orbital belts at an average 4650 km altitude situated at plus and minus 45 degrees to the plane of the ecliptic appear to be the best. These low iso-insolation orbits are compared with the previously proposed geostationary

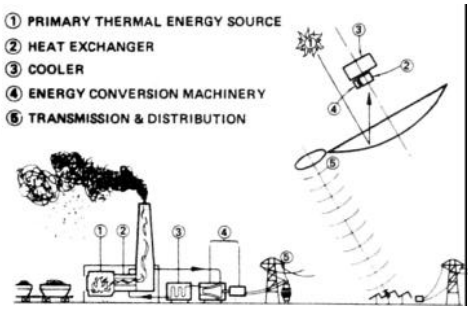


Two belts of satellites provide solar power continuously to Earth in the form of beamed microwave power. Every point on Earth can be reached.

orbit for Power Generation Satellites. It is concluded that the lower orbits, for a number of reasons, among them their far greater economy, can best realize the potential of the SSPS concept. Preliminary design configurations for both photovoltaic and turbogenerator iso-insolation Power Satellites (IPS) are described. Furthermore, a new power generation system is discussed.

This system-a thermal engine-is able to eliminate the need for mechanical turbines to generate electricity and therefore is an order of magnitude lighter than the turbo-generator system.

Two probable transportation modes for and IPS are considered. A combination of all these factors appears to yield a final power cost on the ground of only six mills per kwh and greatly reduced disturbance of the ionosphere.



Conventional/powersat turbogenerators.

ANOTHER ROAD TO COLONIZING SPACE

James E. Drummond
Ronald N. Drummond

By following an evolutionary path to space colonization, it should be possible to "pay-as-we-go" on the road to exo-industrial development. What is an economically and technologically viable first step toward industrialized space? The answer may be in a combination of small-scale processing and in development of Satellite Solar Power (SSP). Not necessarily, it should be noted, power from huge geostationary satellites each serving a small region on Earth as proposed by Peter E. Glaser[4], the Boeing Company[5], or Gerard K. O'Neilll. Power at the busbar, generated by coal or oil, costs 20 to 35 mils per kilowatt-hour[6]. Costs for more advanced coal and nuclear alternatives should be approximately 25 mils/kWh by 1990[7]. For the same time period, power from geosynchronous satellites is projected to cost at least 27 mils/kWh, if not much more[8]. This cost could be reduced to 16 mils/kWh with the investment of perhaps several tens of billions of dollars to develop a huge, single-stage-to-orbit aerospace freighter, or to develop L-5 manufacturing facilities for power satellite production.

Most of the proposed thermonuclear power plants would, like the coal and oil powered generators, disperse one and a half times as much energy into our environment than they sell in the form of electricity. These huge thermonuclear plants thermally pollute from point sources. While the total heat released might not upset the global heat balance, it could adversely affect local environments. The same kind of problem could be found with power from geo-stationary power satellites: the power beam is so intense in the radio-frequency part of the spectrum that it might restructure the area of the ionosphere it penetrated[9].

We can make Satellite Solar Power available to all the world, with ±45° sun synchronous orbits. It can make power available in extreme northern and southern latitudes; it also cuts the scale of individual power satellites from 5000 megawatts to 200 megawatts, about the size of conventional steam generators. This is due to the decrease in the diffraction limited power satellite antenna size with the shorter distance between transmitter and receiver (4600 and 4700 km vs. 35,800 km for geosynchronous orbit).

We may begin to see low Earth-orbital space peopled with construction and maintenance crews for power satellites and with the operators of small-scale space processing plants. These are not the cities of O'Neill; this is a nation of dispersed, hard-working, self-reliant, highly skilled, highly paid individuals-the generation of homesteaders that might precede the city-builders.

Because each Earth power receiver would receive the power it needs from many, non-stationary directions, each beam need be only a few per cent of the intensity of the beam from a geostationary powersat where it penetrates the ionosphere. What effect there is is transient: no part of the ionosphere is in the line of transmission for more than a minute.

For up to 1.2 hours a night several nights running every Spring and Fall, a geosynchronous satellite would be in shadow; at these times, the power would stop flowing. (Peter Glaser suggests that a second satellite a score of degrees out of phase in the same orbit could serve

the eclipsed area during these times, but this compounds costs.) The lower orbits, which would precess 360° annually, are the permanent sunshine belts of this planet.

Space manufacturing facilities are not required for this approach, and the great development cost of the aerospace freighter is avoided. We can still turn to the technologists, with a more modest request: accelerated development of low mass power converters. There are several conversion techniques which could lead to lower weight powersats. We refer to one in which not only are the foundations clear in principle, but projections based upon presently measured material parameters may allow an order-of-magnitude reduction in weight over even optimistic forecasts of solar cell and turbo-generator technology, the Cascaded Dielectric Power Converter (CDPC).[10-12] This estimate is 0.35 grams per watt of power output including interstage heat transfer, take-out circuitry, solar concentrators, and structural framework. It is not an asymptotic projection, but one that should be demonstrable within about five years. With projected performance, the cost of electrical energy at busbars on Earth would drop to 6.2 mils per kilowatt-hour![12] SSP could begin to carry its share of the world's load as soon as shuttle 2 is ready.

The Homesteaders of Space

It may become a new era of the individual. The clusters of powersats will eventually consist of about twenty-five, 200 megawatt units. Each of these units will be made up of about ten, twenty megawatt sub-units. Each sub-unit could be carried into one of the iso-insolation orbits by a single shuttle flight and it could be assembled in two weeks by a man and wife team!

Every month or so they could take a few days off to visit their closest neighbors and attend an all-orbit round dance; changing orbital phase wouldn't cost that much fuel. When they got to the dance hall, a fixed up old shuttle fuel tank, they could have a good time in the best tradition of the old West.

These people would be motivated not only by high wages, but by their own personal stake in space.

By the time we are ready for cities in space, there will be a sparsely settled, but proud and vigorous nation of individuals populating space from the power orbits of Earth to the mines of the moon. And *then* the aerospace freighter will come; like the railroad a century ago, the freighter a half century hence will crystallize and unite the scattered people. Then, as before, cities will arise in the midst of human wealth, in the fulness of time.

Acknowledgements:
We wish to thank a number of our associates for helpful comments affecting portions of this paper: J. Burgess, R.A. Fitch, D. Fitzgerald, C.M. Hensen, R. Hunter, P. Korn, R.E. LeQuay, W.R. Martini, A. Mondelli, G. Nester, F.W. Perkins, L. Van Deerlin, and D.J. White.

References:
1) Gerard K. O'Neill, "Space Colonies and Energy Supply to the Earth" **Science,** 190, 5 December 1975 pp 943-7.
2) Gerard K. O'NeiIl, interview in **Penthouse,** August 1976, pp. 87-90: 174-6.
3) Ron Chernow, "Colonies in Space May Turn Out to be Nice Places to Live", **Smithsonian,** February, 1976. pp. 62-9.
4) Peter E. Glaser, in **Solar Power From Satellites, Hearings Before the Subcommittee on Aerospace Technology and National Needs of the Committee on Aeronautical and Space Sciences, U. S. Senate, 94th Congress, 2nd Session, 19 and 21 January 1976** (U. S. Government Printing Office, Washington, 1976) pp. 2-41.
5) Gordon R. Woodcock and Daniel L. Gregory, "OrbItal Solar Energy Technological Advances", in **Proceedings of the Tenth Intersociety Energy Conversion Engineering Conference** (IEEE, New York, 1975). pp. 1057-64.
6) John Winch, in **1977 NASA Authorization, Hearings Before the Subcommittee on Space Science and Applications of the Committee on Science and Technology, U. S. House of Representatives, 94th Congress, 1st and 2nd Sessions, on H.R. 11573: 13-17 October, 6, 11-13, and 18 November 1975. (No. 331, Volume I, Part 1** (U.S. Government Printing Office, Washington, 1975). p. 256.
7) Ibid.
8) Edward Greenblat, in **Solar Power from Satellites,** op. cit., p. 153.
9) James E. and Ronald N. Drummond, "Derivation of a Low Cost Satellite Power System", in **Proceedings of the Tenth Intersociety Energy Conversion Engineering Conference** (IEEE, New York, in press).
10) James E. Drummond. "Dielectric Power Conversion", in **Proceedings of the Tenth Intersociety Energy Conversion Engineering Conference** (IEEE, New York, 1975). pp. 569-75.
11) James E. and Ronald N. Drummond, "Low Cost Satellite Solar Power" in **Solar Satellite Power System Concepts, Hearing Before the Subcommittee on Space Science and Applications and the Subcommittee on Energy Research, Development, and Demonstration of the Committee on Science and Technology, U.S. House of Representatives, 94th Congress, 2nd Session, 20 February 1976** (U.S. Government Printing Office. Washington, in press).
12) James E. and Ronald N. Drummond, "Derivation of a Low Cost Satellite Power System", op. cit.

AIAA ADDRESSES REPUBLICAN AND DEMOCRATIC PLATFORM COMMITTEES

Klaus Heiss of the American Institute of Aeronautics and Astronautics appeared before both the May 1 Democratic Platform Committee meeting and the June 22 Republican Platform Committee. Heiss called for:

1. The need to establish a global resources information system by 1985.
2. Shuttle experiments for space industrialization, including solar power generation for Earth.
3. Continued exploration of space.
4. An increase in Federal R & D funding. Heiss noted that total U.S. R & D funding has fallen from 3% of GNP in 1964 to 2% in 1975 (half of that funded by industry).

Heiss observed that the fact that the total U.S. space program costs "only" $3 billion per year came as a surprise to some committee members, who were aware of the much larger budgets of several other Federal programs. (HEW, for example, spends $3 billion every 9 days.)

LISTENING TO THE UNIVERSE

Jay S. Huebner, Department of Natural Sciences, University of North Florida, Jacksonville, FL 32216

Reprinted from IEEE Spectrum, *June 1976.*

I wish to point out that the search for signals from extraterrestrial civilizations described by Machol[1] could be more thoroughly and economically conducted from outer space. Large steerable antennas are expensive to build for use on the Earth, as they must support their own weight and be able to withstand wind storms. In addition the Earth's sources of electromagnetic noise, and the absorption and reflection of our atmosphere add substantially to the problems of receiving and detecting the signals. These problems may well be insurmountable from Earth if the other civilizations use frequencies other than those near the water hole.

The availability of virtually unlimited solar energy, the apparent ease of manufacturing the required instruments and antenna,[2,3,4] the absence of weight, wind, an atmosphere, and sources of interference in outer space lead me to conclude that intelligent civilizations will assume that we would only attempt to receive their messages in outer space. The history of the Earth, viewed in units of geological time, is that we acquired the ability to detect electromagnetic waves outside the visible region of the spectrum at the same time that we acquired the ability to go to outer space. It seems possible, perhaps likely, that other civilizations would reason that a civilization not intelligent enough to conduct significant manufacturing in outer space would not be advanced enough to interpret messages from space.

I suggest those who support the search for signals from intelligent civilizations in space may wish to consider supporting efforts to colonize space[5] as the most efficient means to accomplish their objectives.

1. R.E. Machol. **IEEE Spectrum,** March 1976. pp. 42-47.
2. G.K. O'Neill, **Physics Today,** Sept. 1974, pp. 32-40.
3. G.H. Stine, **The Third Industrial Revolution,** G.P. Putnam's Sons, New York (1975).
4. G.K. O'Neill, **Science** 190 (1975) 943-947.
5. The L-5 Society, 1620 N. Park, Tucson, AZ 85719. See J.S. Huebner, Forum, **IEEE Spectrum,** Jan. 1976. pp. 38-39.

SOVIET COSMONAUTS ON L-5

The two cosmonauts who spent 63 days in orbit aboard Salut 4, V. I. Sevastyanov and P. I. Klimuk, recently visited Princeton to chat with some of Professor Gerard O'Neill's students about the L-5 concept.

At the International Council of Scientific Union's Committee on Space Research meeting in Philadelphia, the cosmonauts discussed the L-5 concept with reporters. "People have to go into space," stated Sevastyanov. "Earth's resources are limited."

Klimuk expressed a reservation about life aboard Salut 4: "There are no pretty girls up there." U.S. astronauts may escape that problem, however, if NASA's current effort to recruit women for Shuttle crews is fruitful.

RUSSIAN WOMEN ON PEDESTAL

SOVIETS "PROTECT" THEM FROM RIGORS OF COSMONAUT PROFESSION

The husband of the only woman cosmonaut, Gen. Andrian Nikolayev, commenting on the current Soviet policy excluding women from careers as cosmonauts, said, "A cosmonaut has to be a pilot, a commander, an engineer and a scientist. We love our women very much, and we spare them as much as possible." He added that at some point women would be allowed to work in space stations as "specialists".

This article was submitted by EROS (Equal Rights in Outer Space).

HELP THE L-5 NEWS

The L-5 News staff appreciates the help of those who send in copies of articles appearing in magazines and newspapers. We especially need photographs and drawings.

Home, Home on Lagrange

T. A. Heppenheimer

One of the most common questions at lectures on space colonies is "how can I make sure I'm chosen to go?" NASA hasn't yet made any plans for crew selections for the big colonies. How do you think people should be chosen? One of the participants in this summer's study on space colonization at NASA/ARC has speculated on the process:

It started in the late 1980's, with an announcement sent out from Washington to be put up in the nation's post offices. It read as follows:

FEDERAL EMPLOYMENT OPPORTUNITIES IN SPACE

Several thousand positions are now open, for skilled and semiskilled workers capable of assisting in the construction and operation of the initial Space Colony. Additional positions are open for the construction in space of the initial group of Solar Power Satellites.

Preference is to be given to single workers, male and female, under age 30. Married couples, both of whom are acceptable for these employment opportunities, also are welcome to apply. Facilities for child care will be limited, so that preference will be given to couples with no more than one child. Affirmative Action hiring procedures are in force.

Applications are invited from workers with experience in the following industries: Shipbuilding, Heavy Electrical Construction, Industrial Construction. Also, applications are invited from persons with backgrounds in Experimental Agriculture, Chemistry, or Plant Science.

Wage scales are in accord with the Davis-Bacon Act. In addition, employees who hold their positions through the end of construction of the initial Space Colony, will be granted clear title to a home within the Colony.

Applicants are invited to sent a completed Federal Form 57 to:

Space Industrialization Administration
Department SC
600 Independence Avenue S.W.
Washington, D.C. 20546

The Federal Government is an Equal Opportunity Employer M/F.

This simple statement summed up, in a few words, much of the philosophy which would guide the colonization effort. To begin, it reflected the fact that the principal types of jobs in the colony, requiring new hiring, would be associated with large-scale construction or with running the colony's agricultural and life-support systems. There would, of course, be a number of professional and administrative positions in the colony. But these would be filled largely from the pre-existing project staff, by people who already were engaged in the Earth-based design and development work.

Beyond this, however, the statement reflected a deliberate effort to colonize space following the historical precedents of the colonization of America, and of the settlement of the West.

The statement quite deliberately implied an effort to avoid overly rigid criteria for selection. It would have been quite possible to staff the project with philosopher-workmen in the tradition of Eric Hoffer, with Ph.D's and other advanced degree holders who happened to be making a living in the building trades. (Certainly, there were quite enough of those.) However, space colonization advocates realized they would defeat their own purpose if they followed restrictive selection policies, which would lead to public perception of the project as benefitting only a chosen, elitist few. So far as possible, it appeared desirable that selection for positions in the colony should be on the basis of "first come, first served."

Moreover, such a policy would open the option of a new life to precisely those people who would welcome it. This point deserves elaboration. It is not the settled, the secure, the affluent who have historically been attracted by the risks and opportunities of a new frontier. Rather, it has been those people, often young, with energy and ambition, but with only limited opportunities at home, who have been so attracted.

In its early days, space colonization was controversial. There were those who questioned its value, who scoffed at the idea that people could build comfortable lives in space. Indeed, for many people, the life of a pioneering space colonist would have represented a definite step down.

But there is another, more numerous group of people for whom this was certainly not the case. I, and many of my friends, were from this group. A typical member would be a construction worker who lives in an apartment in Brooklyn. He commutes by subway to construction sites in Queens or the Bronx. He thinks

For many people the life of a pioneering space colonist would have represented a definite step down, but there is another, more numerous group of people for whom this was certainly not the case.

the Adirondacks are in South America, and when he visits the ocean, it is at Bradley Beach or Coney Island, where he finds all the solitude of a seal rookery. For over thirty years now, space colonization has been offering to people like these a definite step up.

But if space was to be colonized by a more-or-less random sample of the young and ambitious, seeking escape from a world they never made, then there was a pitfall to be avoided. This was the problem of the boom-town. This problem was very clear along the route of the Alaska Pipeline, built a few years before the start of colonization, by just the type of worker who turned out to be attracted by the colonization project. In Alaska, the workers were mostly men, who were paid very high wages but who were not part of a settled society. As a result, there was an enormous growth of crime and prostitution, accompanied by a roaring inflation. Alaska in those days was very much like Nevada in the days of the Comstock Lode; the physical ecology of the tundra was being preserved, but the social ecology of the state took years to recover.

The policy of space colonization contained two measures to avoid this pitfall. The first was the requirement that from the start, the work force had to have approximately equal numbers of men and women. A work force mostly of men would soon have given rise to a most unpleasant social atmosphere, resembling, if not a boom town, then 'possibly a prison or an army camp. A sexually mixed work force would ensure the development of a much more normal society. The colonists would meet, fall in and out of love, marry or divorce or live together, and proceed to establish homes and families.

In addition, the pay policies were designed to foster a stable society. The Davis-Bacon Act requires that Federal construction workers be paid the "prevailing" wage, which typically is an adequate but hardly lavish rate. Even more important, however, was the provision that those who build the colony could thus attain that common goal of American society-a home owned free and clear. This provision was a modern version of the Homestead Act of 1862. That Act provided that any farmer who would work his land for a term of years, would receive clear title to it. By thus stimulating the development of the family farm, that Act greatly contributed to the growth both of American agriculture and of the states of the Midwest.

So these policies were intended to encourage the settlement of space, not by opportunists or speculators, but by homeowning families. This certainly tended to promote the growth of a stable, civilized society in space.

These policies, of course, had a bearing upon the internal economy of the colony. There were social engineers, in the early days (some of them are still around) who tried, rather arbitrarily, to impose internal economic and social policies so as to achieve their personal ideals of utopia. Fortunately, that was avoided. In its engineering design, the colony rested upon soundly proven principles, such as the use of current rocket technology. Similarly, it seemed advisable to found the colony society upon such familiar concepts as the nuclear family, the privately-owned home, and the use of money as a medium of exchange. Some people said that the colony should have a "non-money economy," whatever that means. It's difficult to see what such proposals demonstrated, other than the love of novelty on the part of their proponents.

So, there were those post-office announcements. There also were a lot of would-be space colonists who sent in Form 57. One of them was me. From the large piles of these forms which mounted up at 600 Independence Avenue S.W., the most interesting applicants were invited for interviews, and in due course the lucky selectees received a letter:

"Dear Sir or Madam:

"It is with considerable pleasure that the Space Industrialization Administration offers you employment in the work force now preparing assembly of the Space Colony and Power Satellites. Your salary will be $20,000 per annum, subject to Federal tax but not to any state tax.

"Please return the enclosed form in the event you wish to accept this offer. Should you accept, you will report for training to the Space Colony Training Center, Houston, Texas, no later than May 30, 1988. You are then eligible for reimbursement of travel and moving expenses, up to a limit of 6000 pounds of personal and household belongings. Further information is provided in the enclosed brochure."

The brochure, titled "Living and Working in Space", was an attractive description of the life to be found in the colonies, as well as of the nature and importance of the work we were to do. We newly-hired colonists learned that in Houston we would be moving into a simulated space colony-a full-scale mockup of the colony interior, complete with garden apartments and closed-cycle life support, as well as with training facilities for the industrial operations we would be undertaking in space. The apartments were unfurnished, but we were to furnish them to our taste, with the 6000 pounds each of us could bring.

It all was rather heady, and we were not displeased when on May 30, 1988, the President of the United States came down to greet us. So it was with considerable elan that we started our new lives. We were told that the first colonists would leave for space in about a year, with all to be moved there within the following six months. We also were told that from the start we would be regarded and were to regard ourselves, as if we were living in space. In practice, this meant: once in the Houston "colony", we couldn't get out except through a lengthy bureaucratic hassle. No trips to Earth, as it were; and any colonist who insisted on visiting Earth would soon find himself no longer a colonist.

During the early decades of space colonization, this policy would be the cause of considerable controversy, much irony, and occasional tragedy. Intuitively, one would think that the way out to the colonies is difficult whereas the way back is easy. In fact, the reverse was so, because of the characteristics of the space transportation systems in use.

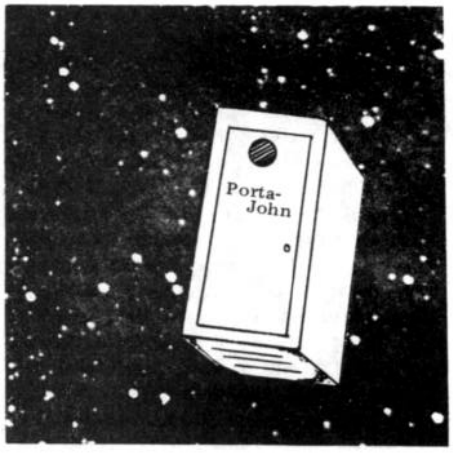
For the outward trips, both to the Moon and to the colony, there was a well-developed system. There were Heavy Lift Launchers, built with a winged and recoverable variation of the old Saturn V first stage, along with a hydrogen-fueled upper stage. The upper stage was based on hardware from the Space Shuttle program. This combination put 200 tons into low orbit. Then, there was a large space-based rocket-it is still in use-to carry the cargo onward. It used, for propellant, hydrogen brought from the Earth, along with oxygen obtained from

lunar rocks at the colony. The oxygen, valuable though it is, actually is a by-product of the extensive ore-processing operations which produce the aluminum and other metals for the colony. This space-based rocket has long been shuttling routinely between low Earth orbit, three hundred miles up, and deep space.

So there was a well-advanced system for carrying people and freight on the outward leg. The problems arose on the return to Earth. The space-based rocket could readily carry people to the low orbit, which is 99.9% of the distance to Earth, from either the Moon or the colony. But there was no regularly scheduled return service to cover that last 0.1%.

For many years there was only one way to get down, and that was with the Space Shuttle. The second stage of the Heavy Lift Launchers were not recoverable or reusable; their engines and instruments were packaged for re-entry, but their main structures were not. The problem then arose from this: Space Shuttle flights were common, but opportunities for return by Shuttle were rare.

Some people got down by a kind of space hitchhiking. This involved the fact that there was a fairly constant Shuttle traffic to orbit and back, engaged in the routine business of launching and maintaining the world's communications and Earth-observation satellites. Occasionally, too, there was a Spacelab flight, wherein the Shuttle would stay in orbit for up to a month. On such flights, the Shuttle often was in such an orbit that the space-based rocket could rendezvous with it. A returning colonist could go to the low orbit and hitch a ride on the Shuttle; there was usually room in the crew compartment of the latter to rig a couple of jump-seats for the return.



. . . all the ambience its name implies."

There were, indeed, regular flights from the Moon and the colony to Earth. These were principally reserved, however, for the senior administrators and lunar work crews, who were in space on temporary tours of duty. When it was time to rotate homeward a group of these people, the Space Industrialization Administration would set up special Shuttle flights, each with a compartment capable of holding 100 people (in rather cramped quarters) for the return. Additional colonists often were accommodated, but this was only on a standby, space-available basis.

So the whole colonization effort was directed to taking people and equipment out, not to bringing them back. It was planned on the assumption that most of us would want to stay, to make space our home. Any request for return had to be processed through the bureaucracy, to be coordinated with upcoming flight schedules. Occasionally there would be an extracurricular return (one enterprising chap met his Congressman during a congressional junket to the colony and posed as his aide, with the Congressman's assent), but in general the system worked. Most of us truly were highly motivated, and fully aware of our commitment to leave Earth for good. But in the early days of training, it was discomfiting to some to learn that they could pick up Houston stations on the radio, yet could not go out to visit that city.

The training was directed to two goals. Of course, we had to learn our trades, acquiring familiarity with the equipment and developing our skills. But in addition we were to experience life in what, so far as could be built on the Earth, was a genuine space colony. Inevitably, some found it was not for them, and dropped out. It was far easier to allow for this when their leaving involved walking out a door into the Texas sunshine, rather than returning from space.

There was another purpose as well, which was served by the training program. As we learned soon after our arrival in Houston, we would not be spending our early years in space in anything so commodious or comfortable as the actual colony. Instead, we would be living and working in a facility known to all as the "construction shack"-a place with all the ambience its name implies. But we had additional motivation to do the construction of the colony quickly, for having once lived in it, as it were.

"Home, Home on Lagrange" will be continued in the next issue of L-5 News.

CARBON CYCLING IN SPACE COMMUNITIES

James Kemp f

Whatever type of farming method is chosen for the space colonies at L-5, strict recycling of bioelements will be necessary, to reduce resupply from the Earth or elsewhere. Carbon, hydrogen, and nitrogen are rare on the moon and the biosystems of the space communities must be designed to minimize losses of these elements. In addition, numerous micronutrients are required, in the form of certain minerals, for good growth of people, animals, and plants. Designing the biosystems of the space habitat will require calculating the flow rates and pathways for all the recycled elements.

In the habitat ecosystem, the rate of carbon fixation must be balanced against the rate of carbon waste production for proper recycling. Estimates of waste production can be made from data on daily per-person carbon waste production from the 1968 Stanford Summer Study, in which the daily per-person solid human waste production rate was estimated at 100 g. About 90% of this is undigested cellulose [polymeric glucose, $(C_6H_{10}O_5)_n$] and of that 90%, 40 g is carbon. In addition, the daily per-person production of gaseous carbon waste (CO_2) usually runs to 1050 g, of which 287 g is carbon. The recycling rate of the space habitat must therefore be 327 g C per person-day.[1]

The NASA studies of the early sixties and Howard Odum, in his *American Biological Teacher* article, made two assumptions about carbon recycling systems in space which, in the light of recent thinking, are uncalled-for:

1) That any space biosystem would be limited by materials and energy, and

2) that bacteria are the most efficient method of decomposition and algae the most efficient method of fixation.

Using solar energy and materials from the moon eliminates the first assumption. Consideration of the efficiencies, on a qualitative basis, of biological and nonbiological alternatives to the second second assumption will show that algae and bacteria are really not the best producers and decomposers.[2,3]

Although a detailed engineering analysis has yet to be made, decomposition seems to be the area where mechanical components will be most useful in closed ecosystems. Biological decomposition is messy, slow, and almost always generates undesirable side products. In a "natural" ecosystem, which Howard Odum advocates as the best method to use in space, the carbon dioxide evolution of soil generally runs at about 1.2-8.4 g per sq. m-day.[4] Nearly 4 sq. m would be necessary to process the solid wastes of a single person. Decomposition might be speeded up by concentrating the wastes in a microbial reactor, as in the designs for closed ecosystems advanced during the early sixties, but biological decomposition always leaves a certain amount of unusable biological material behind, even if only the biomass of the decomposing bacteria. Taste and nutritional considerations would seem to preclude using these bacteria or algae grown from decomposition products as food, as the early studies advocated. (After all, who wants to eat bacteria and algae anyway?)

Clearly, a mechanical decomposition system, in the form of a catalytic burner, as suggested by the Hensons, or a wet oxidation system would be preferred.

On the other hand, no mechanical system has yet been designed which can fix carbon with the area efficiency of photosynthesis. In addition, a chemical means of producing tasty food from the raw materials has yet to be achieved. Carbon fixation would seem to be the process which could best be accomplished biologically.

Estimates of the amount of per-person area needed for a operating space farm have been advanced on the basis of crop yields on Earth and human nutrition requirements. Keith and Carolyn Henson used hydroponic crop yields and information on human nutrition, along with yields of animal protein products from domestic animals, to arrive at a per-person area of 32 sq. m. Drs. I. Richards and P. Parker estimated that from 250-430 sq. m/person would be needed, using linear programming based on human nutritional needs and crop yields from conventional agriculture. Richards and Parker assumed that direct farming of the lunar regolith would be the method of choice for the space farm, while the Hensons advocated a hydroponic system.[5,6]

The efficiency of photosynthesis on Earth would seem to put a lower limit on the amount of area needed to fix carbon and regenerate oxygen. Depending on the intensity of culture, conversion of from .l% (for ranch farming) to 4% (for experimental culture) of the total incoming solar radiation to high energy carbon compounds has been achieved. Assuming a solar flux of 500 ly per day, a quantum efficiency of 10, a respiratory loss of 33%. and an atmospheric carbon dioxide concentration.[7] the corresponding carbon fixation rates are from 9.8 x 10^{-6} to 3.92 x 10^{-4} g C per sq. cm-day. Assuming a recycling requirement of 327 g C per person-day, per person space farm areas of from 33.4 to .834 sq m would be necessary to cycle carbon.

Comparison with previously quoted figures shows that crop yield, rather than carbon fixation rate, appears to be the more critical factor as far as space farm area is concerned. Because a large percentage of most food crops incorporate carbon into leaves, stems, and other nonedible structures, crop yields represent only a small portion of the total carbon fixed. The efficiency of crop production can be increased by using domestic animals to convert non-edible plant materials to usable protein, but the carbon cycling load imposed by domestic animals must be weighed against their protein contribution.

Many refinements must be made in these figures before a workable design can be made for the space farm. In addition, it cannot be assumed that the recycling of all the other micro and macro nutrients is not critical. For example, during childhood, the human body requires more calcium than it excretes, for bone growth, and thus acts as a calcium sink. If this should be true of other elements at other times of life, the habitat's biosystems must be designed to accommodate the shortage. The more efficient the habitat's biosystems are, the less resupply (at high cost) is necessary, so biosystems designed for maximum efficiency of recycling should also be the most cost-effective.

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1) **Moonlab,** Stanford Summer Study, 1968.

2) **The Closed Life Support System,** NASA SP-134.

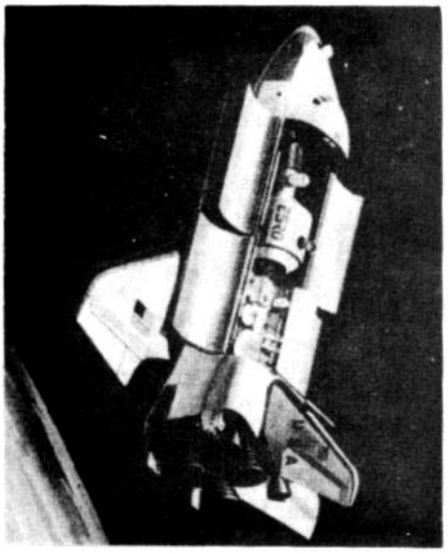
3) Odum, "Limits of Remote Ecosystems Containing Man," **American Biological Teacher,** *25,* pp. 424-443, 1964.

4) di Castri and Mourey, **Mediterranean Type Ecosystems -- Origin and Structure,** p. 208. 1973.

5) Henson and Henson, "Closed Ecosystems of High Agricultural Yield," 1975.

6) Richards and Parker, "Estimates of Crop Areas for Large Scale Space Colonies," 1975.

7) Rosenburg, **Microclimate: The Biological Environment,** pp. 213-215.



SHUTTLE STUDENT PROGRAM

NASA is evaluating how a space shuttle payload development program involving primarily university students could be formed. The idea, proposed by the Forum for the Advancement of Students in Science and Technology, Inc. (FASST), also has started to win some congressional interest. FASST hopes to be able to have wording incorporated in such NASA documents as Spacelab announcements of flight opportunity that will facilitate student participation. The forum is also seeking financial support.

For additional information, please contact Leonard David, Director of Student Programs, FASST, 1785 Massachusetts Avenue, N.W., Washington, D.C. 20036.

L-5 SOCIETY LOCAL CHAPTERS

The **New York** Chapter is coordinated by Dan McHugh and Loren Abdulezer, 333 J St., Brooklyn, N.Y. 10021.

The **Seattle** Chapter can be contacted through Marcia W. Buxton, 928 18th Ave W., Kirkland WA.

The **San Diego** Chapter can be reached through Jeff Bytof, 1848 Fread Lane, Cardiff, CA 92007.

The **Bloomington** Chapter can be reached through William Gardiner, 756 S. Lincoln St., Bloomington, Indiana 47401.

Predating the formation of the L-5 Society is the **MIT Space Habitat Study Group.** Formed by veteran L-5 staffer Eric Drexler, the current Study Group president is Beverly Bugos. She can be reached at the Political Science Department, MIT, Cambridge, MA.

The **New Jersey** Chapter can be reached through William Agosto, 9 Franklin Blvd., Somerset, NJ 08873.

The **West European** Chapter is coordinated through Phillip John Parker, 24 Fifth Ave., Kidsgrove, Stoke-on-Trent, ST7 1DA, England, U.K.

Our contact in **Australia** is Kim Peart, G.P.O. Box 1441P, Hobart 7001, Tasmania, Australia.

Israeli technical translator Jack Halpern has just established the **Japan** Chapter of the Society. He can be reached at 923 Nishiyano Kokufucho, Tokushima City 77931, Japan.

The **Los Angeles** Chapter can be reached through James M. Parker, 402 E. Badillo, Apt. 5, Covina, CA 91723.

A list of locally-active members of the L-5 Society is available from Society headquarters, 1620 N. Park Ave., Tucson, AZ 85719.

BOOK REVIEW

The Hunger of Eve, Barbara Marx Hubbard, Stackpole, Parisburg, Virginia.

In the waning days of the Apollo program, Rep. "Tiger" Teague (D-Texas) pushed a bill through Congress authorizing Barbara Hubbard, an heiress and mother of five, to buy the hardware and services for an entire Apollo mission.

She had stormed the halls of NASA and Congress with a small band of supporters composed of such diverse people as a Catholic nun and a retired Air Force officer. Her project, "Harvest Moon," was eventually defeated by a slow and unimaginative bureaucracy.

What happens when a housewife turns crusader? Barbara Marx Hubbard's book chronicles her odyssey toward the future: how she expanded her role as housewife and mother to become an author, lecturer, and chairperson of The Committee for the Future.

While Barbara's "Harvest Moon" was stymied, she has been far more successful

with her latest project: the colonization of space. In the summer of 1974, when the concept was unknown, she financed Eric Drexler (now an L-5 activist) to work as a research assistant to Gerard K. O'Neill on space colonization.

In the fall of 1975, seeing the fledgling L-5 Society struggling for existence, she infused it with money and advice. She is now a Director of the Society.

Barbara is going on a nationwide tour to promote *The Hunger of Eve.* She will kick it off with a press conference in Washington, D.C., September 13; she will appear in Boston, September 20-22; New York City, September 22-25; Minneapolis, September 27-29; Chicago, September 29 - October 2; and Toronto, October 4-6.

The Hunger of Eve will be available through the L-5 Society (about September 15), hardbound, $8.95 plus fifty cents postage and handling.

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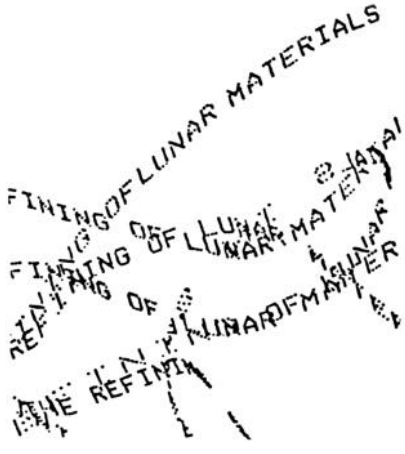
"Gerry O'Neill and His Solar Powered Space Factory", Robert C. Lutz-Nagey, *Automation,* July, 1976, pp. 22-33.



Artwork by K. E. Drexler

"A System for the Refining of Lunar Materials in Space," by K. Eric Drexler, is available from the L-5 Society for $2. Eric has been a research assistant to Princeton Physics Professor Gerard K. O'Neill since 1974. He participated in the 1976 NASA/Ames Research Center study on space colonization, where he researched the problems of refining lunar materials.

The paper includes block diagrams and is well footnoted. It will be of value to those who are giving technical lectures on space colonies and industrialization.

AGING TOMORROW

What will it be like to grow old in the future? When will the aging process be stopped? Will it be possible to rejuvenate the aged? How will an extended lifespan aid in the exploration of space?

Aging Tomorrow attempts to answer these and other questions of concern to futurists with accurate, up-to-date information, interviews with experimental scientists, and imaginative ideas about the world of the future.

The inaugural issue of *Aging Tomorrow* features profiles of today's controversial "youth" drugs and a candid interview with Dr. Robert N. Butler, the new director of the newly-created National Institute on Aging.

Aging Tomorrow is edited by Saul Kent, former editor of *Immortality* and a frequent contributor to *The Immortalist* It is published on a bimonthly basis. Charter subscriptions are $6/year; copies of the inaugural issue are $1.50 each.

Write to: *Aging Tomorrow,* Box 617-PL, Cathedral Station, New York, N.Y. 10025.

FROM WEST EUROPEAN L-5 NEWSLETTER

Libration Cloud Photography

NASA's Office of Space Flight PIO, Dave Garrett - an 'old' friend - has confirmed that the Skylab Student Experiment, 'Lunar Libration Points Photography' did not take place due to lack of viewing opportunity of the cloud. The experiment number was ED-21.

The Editor has suggested that maybe the L-5 Society (W. European Branch) could persuade the European Space Agency (ESA) to take along a small, secondary experiment for an early 80's Spacelab mission whereby the crew (maybe in their spatial relaxation time?) could undertake photography of the L-5/ L-4 points for the Branch? Has anyone any ideas in developing this further, i.e., definition of the equipment required, pointing requirements, viewing opportunities? Assistance can be given with Spacelab features since the Editor does have a copy of the ESA Spacelab Payload Accommodation Handbook-the experimenters provisional 'bible'. Additionally, many details can similarly be given for NASA's Shuttle since the Editor also has a copy of the Shuttle Payload Accommodations handbook.

Australian L-5 Branch

The name/address of the current Australian Co-ordinator is:

Kim Peart
L-5 Society, Australian Branch
G.P.O. Box 1441P,
Hobart 7001
Tasmania,
Australia.

To help the Australian Branch begin operations, the W. European Branch issued a news release and a small, feature article to the Australian press and New Zealand press, as well as supplying Kim with latest copies of 'L-5 News'. We hope to hear from our 'Down Under' colleagues soon!

Inside

THE L-5 SOCIETY

The L-5 staff this month included Nicholas Elbaum, of Geofstown, New Hampshire; Eric Drexler, of Cambridge, Massachusetts; and Tucsonans Dennis Riggin, Andy Schuerger, Daniel Lomax, Jonathon Nix, and Keith and Carolyn Henson.

Thanks to a generous donation from William O'Boyle, of New York, the Society has had a paid staff (one person) since the last week in July, our half-time administrator, Daniel Lomax. If your check comes back and your order does not, he is the one to complain to.

We are also investing some of our special funding in this, the most extensive and expensive newsletter of our history. We Plan to bulk-mail copies to those who have previously inquired about the Society, but did not join; and also to some other lists we can use. If, by some oversight, you receive an extra issue, we would appreciate your passing it on to a friend.

If enough response is generated by this mailing and by our booth at World Con, we should be able to maintain at least a 16 page newsletter; otherwise it may go back to 8-12 pages.

HAPPY ANNIVERSARY!

The L-5 Society has been in existence for a year now. This issue is the last of Volume One.

We don't have any members at L-5 yet, but otherwise the concept has made a lot of progress toward becoming an accepted idea.

The first *L-5 News,* last September, reported on political support from Rep. Morris Udall, the first Summer Study, and Dr. O'Neill's testimony before Congress. As you can see from this issue, the L-5 concept is now of concern to groups ranging from lawyers to farmers. A number of conferences are planned, and even NASA has started to speak out.

From this year's Summer Study at NASA/Ames, it looks like the Society may not be in existence too long: our goal, which is to have tens of thousands of people living and working in space, could be realized by 1990.

We of the L-5 staff are deeply appreciative of the efforts of all those who have helped: the many staff volunteers, those who have contributed articles and news, and the generous support of members and donors who made possible our first year of service.

LOCAL ADVERTISING

Friends of the Society can help it to expand its membership by placing the following advertisement in local college or university newspapers, and in other publications as appropriate.

Members who wish to arrange the placement of an ad but who cannot afford to donate the cost of the ad should write the Administrator, L-5 Society, 1620 N. Park Ave., Tucson, AZ 85719, providing details, including the name and address of the publication, approximate circulation, and cost of a minimum insertion. The Society will then, budget permitting, place the ad with the publication.

SPACE COLONIES: latest news, progress reports, job opportunities - read L-5 NEWS (monthly) included in L-S Society membership, $20/yr. (students, $10). Members include most major space colony researchers. Request trial membership from L-5 Society, A2,1620N. Park Ave., Tucson, AZ 85719. No obligation.

Letters

The greatest problem now is not our inability to take advantage of the opportunity of space, but rather the lack of awareness on the part of many national and corporate leaders of space investment and development as the only solution to our long-term problem: ideological survival.

However, because we are the nation that never lost the pioneer spirit, once national and corporate leaders become aware of the problem and its solution, most will not ignore the opportunity to relive our heritage.

Yes, going into a future of space exploration will in many ways be similar to going into the past. During the 1800s in America, the vastnessof the unexplored continent increased the value of each individual in the Westward movement. The unknown promoted cooperation. There was unity in purpose and excitement in discovery.

In this respect, Americans will be drawn much closer together as they challenge the inconceivable vastness of the universe. The worth of each individual will increase during this endless Outward movement. America will once again become one family, pushing back an infinite wilderness, an endless sea of time and space.

As a people, we cannot be confined! We are a magnificent eagle that should not be caged! It is our destiny to soar among the stars! Of all nations, ours has the opportunity to look into the face of God. We must not allow this 200-year experiment in human fulfillment to fail. We are the hope of humanity! We are the vision of tomorrow!

Robert M. Sprankle
Miami, Florida

There are needed a number of study groups or task forces to work on the hundreds of technical details mentioned by Dr. Gray in your June 1976 newsletter. We should organize these groups similar to the professional societies such as the American Society of Mechanical Engineers.

Using these groups we would establish ourselves and our organization as experts to be called upon for the staffing of the actual program and manning the first space habitats. These groups should publish in acceptable formats problem assessments, backgrounds, solutions, etc.

Several study groups or task forces that come to mind immediately are:

1. Environmental Systems and Integration.
2. Social Systems.
3. Failure Modes.
4. Medical and Infectious Diseases.
5. Resources.
6. Damage Assessments and Prevention.
7. Logistics.
8. Information Storage and Retrieval.

In closing I suggest we start several study groups and submit the requested articles to the British Interplanetary Society (June *L-5 News,* p. 5). I am willing to work on one of the study groups, and if anyone else in the Bay Area is interested, please contact me either at work (415) 768-2534, or home (415) 355-7825.

Ray S. Leonard
Pacifica, California

I am no scientist, only a simple art student, who reads science and science fiction, and believes man should move off into the Universe, where his technology and computers can truly grow. At heart I am a naturalist, and in spirit I am a Viking.

Kim Peart
Hobart, Tasmania
Australia

INTERIOR VIEW OF STANFORD TORUS

On the back cover is artist Don Davis's conception of the Interior of the Stanford Torus, a huge space colony design from the 1975 NASA/Ames Summer Study on Space Colonization.

Stationed a quarter of a million miles from Earth and constructed almost entirely of ore mined from the Moon, the colony would contain a population of 10,000 people. They would live and work in an Earth-like environment inside a vast wheel more than a mile in diameter.

Trees, grassy parks, birds - even streams and ponds will help give a familiar setting for the colony's population. Beneath the upper living area is a level of offices, stores, service buildings, and facilities for light industry.

Screened from harmful cosmic rays by the overhead chevron mirrors, the colonizers would enjoy unlimited sunlight. Those sections of the colony devoted to intensive agricultural use would make use of the sunlight to supply the total food requirements for the colony.

L-5 SOCIETY MEMBERSHIP FORM (please type or print)
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AFFILIATION (OPTIONAL): _____

TITLE OR POSITION (OPTIONAL): _____

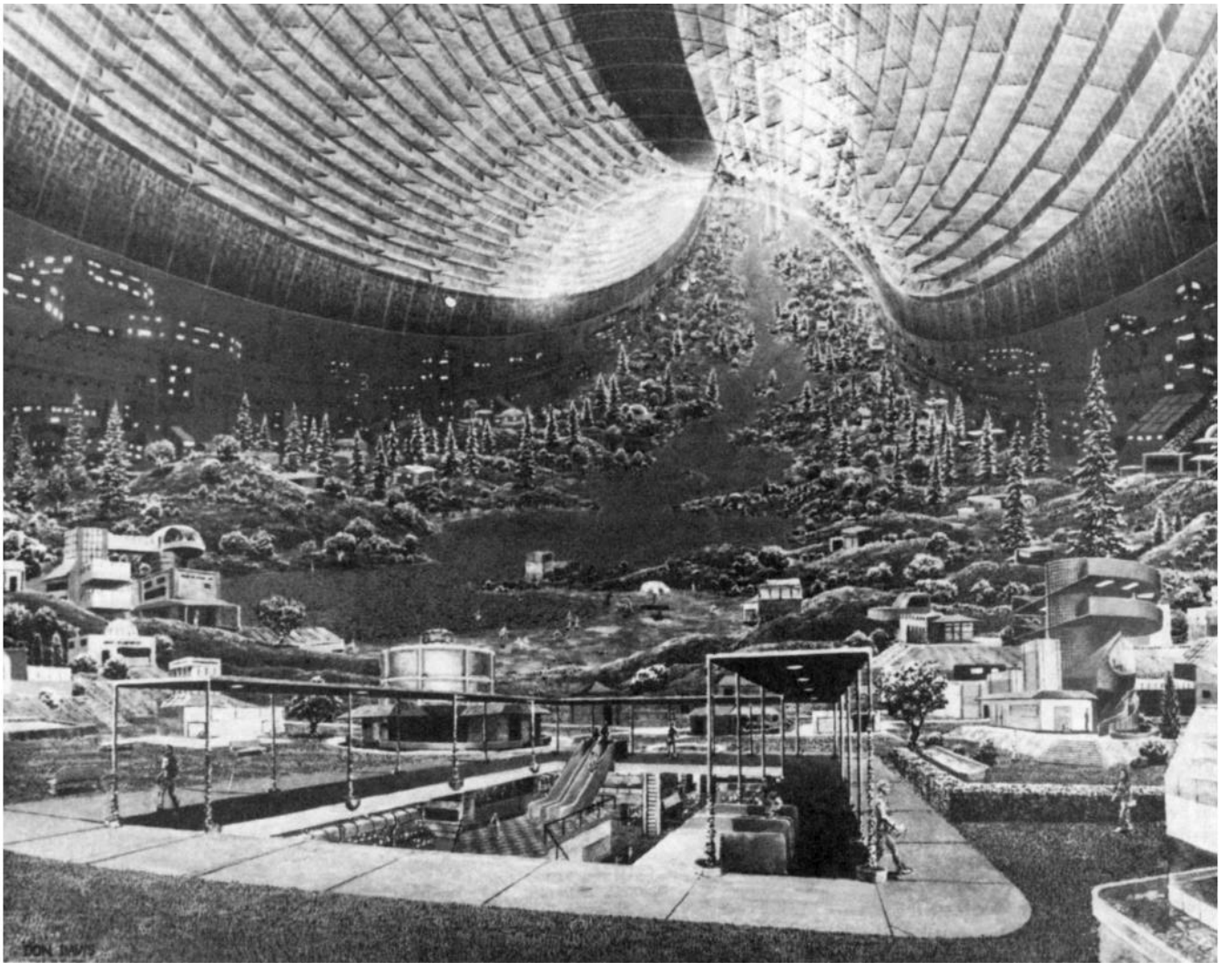
I am -- am not -- interested in being active locally.

___ Back issues of L-5 News available, $1.00 each.

___ Please enroll me as an L-5 Society Member. I am enclosing a check for $ _____ (regular membership, $20.00; student membership. $10.00; memberships include subscription to L-5 News).

___ Please enter an institutional membership to receive L-5 News for our organization/library as indicated above. We enclose a check for **$** _____ (institutional or library membership, $100.00; special library subscription with one month delayed mailing, *$20.00).*

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



L-5 NEWS

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