

L-5 NEWS

A Newsletter from the L-5 Society
Number 7 * March * 1976

MOON CONFERENCE

A special session of the Seventh Lunar Conference, "Utilization of Lunar Materials and Expertise for Large Scale Operations in Space," was held March 16 at Johnson Space Center. Chaired by David R. Criswell of the Lunar Science Institute and Robert M. Walker of Washington University, it was heavily oriented towards the concepts presented by G. K. O'Neill in his publications, "The Colonization of Space," *Physics Today*, September 1974, and "Space Colonies and Energy Supply to the Earth," *Science*, p. 943-947, December 5, 1975.

T. A. Heppenheimer will report on the conference in the next L-5 News.

SPACE COLONIZATION AT ASME CONVENTION

The 1976 Design Engineering Conference, sponsored by the Design Engineering Division of the American Society of Mechanical Engineers, will be held at McCormick Place, Chicago, April 5-8.

Session 8.4, to be held April 6, 12:30-2:30 P.M., a plenary session, is titled "Future Design Problems in Space Colonization."

"Space Colonization: An Overview of Human Destiny in Space" will be presented by Richard D. Johnson, Chief, Flight Experiments Office, NASA Ames Research Center.

"Aspects of Fabrication in Space Utilizing Extraterrestrial Resources" will be presented by Martin Bloom, Aerodynamics Laboratories, Polytechnic Institute of New York.

"Materials, Chemical Processing, and Closed System Ecology Aspects of Space Habitats" will be presented by K. Eric Drexler of Massachusetts Institute of Technology.

"Space Production of Satellite Solar Power Stations" will be presented by William N. Agosto of Microwave Semiconductor Corp. This paper has been previously made available to L-5 members and will be published in the May, 1976, *IEEE Spectrum*.

MINI SYMPOSIUM

The American Institute of Aeronautics and Astronautics and Marshall Space Flight Center are cosponsoring a mini symposium May 26 and 27.

The four sessions will be "Space Manufacturing and Processing," "Solar Space Power," "Space Habitation," and "Advanced Space Transportation (Beyond Shuttle)."

L-5 members are invited to attend. More details will follow in the next L-5 News.

SPACE BASE WINS NASA APPROVAL

March 5, James T. Murphy, Marshall Space Flight Center Director of Program Development, announced a plan to build a space station in geosynchronous orbit which will house 200 people. It will be constructed in low earth orbit, out of materials ferried up in the space shuttle; solar electric propulsion will then move it to geosynchronous orbit.

The purpose of the orbiting facility will be to serve as a base for the development of space industrialization and the construction of solar power satellite stations.

Grumman Aerospace Company will run an 18 month study of the concept for MSFC. McDonnell Douglas Astronautics will conduct a similar study for Johnson Space Flight Center. After the Grumman and McDonnell Douglas studies are evaluated, a decision to enter the design and development phase could come by 1978. Construction of the facility would then begin in the early 1980s.

Grumman has also contracted with MSFC to study a heavy lift launch vehicle to be used in the proposed space industrialization program.

O'NEILL WORKING GROUP FORMED

A five-member private working group has been formed to promote O'Neill's proposal for a high orbital manufacturing facility and to add credibility to the concept. O'Neill chairs the group, composed of Rene Miller of MIT, Stephen Cheston of Georgetown University, David Criswell of the Lunar Sciences Institute, and Gerald Driggers of Southern Research Institute.

The group hopes to raise nearly \$1.3 million to fund a proposed three-year research program to spread the word. The working group is circulating its "white paper" describing its plan of action to organize nationwide research on high orbital manufacturing. A proposed Center for High Orbital Manufacturing at Princeton under O'Neill would coordinate the work.

A recent inquiry to ERDA by Rep. Morris Udall met with the response that O'Neill's proposal appeared "intriguing," but "prohibitively expensive compared to other solar-electric applications being pursued, both in terms of cost and energy payback." ERDA nonetheless designated H. Richard Bleiden, assistant director for solar-electric applications, to carry out further discussions. The group hopes to tap some of ERDA's solar energy budget. But, as Teem told Senator Ford's hearing, ERDA has no money committed to space based power stations studies for FY 1977.

With 25 years or more to see an operational space satellite power station (SSPS), it may be difficult to stimulate Congress to provide funding, considering

its difficulty in looking only one or two years ahead. But if fossil fuel prices skyrocket, and nuclear materials proliferate, the SSPS may yet turn out to be one of the few energy recourses of humanity in the twenty-first century.

Reprinted from "National Scene," the March, 1976, issue of Astronautics and Aeronautics, a publication of the American Institute of Aeronautics and Astronautics.

REAL REASON TEEM RESIGNED

Excerpt from an AP release, March 7

The scientist who recently quit as the government's solar energy chief says he resigned in a dispute over interference by White House budget cutters and priorities in solar energy spending, rather than only for personal reasons as announced by presidential aides.

John M. Teem, former assistant administrator of the Energy Research and Development Administration in charge of solar, geothermal, and advanced energy systems, said the White House Office of Management and Budget "is getting involved in much greater detail than it should" in solar energy planning.

SOLAR POWER SATELLITES: PLUGGING THEM BACK IN

NASA's James C. Fletcher and ERDA Administrator Robert Seamans met June 25, 1975, to discuss NASA's energy research program. At that time they signed a memorandum of understanding which stated that the decision to fund the development of solar power satellites was to be ERDA's responsibility.

Funding was to be appropriated to ERDA and channelled through to NASA.

Seamans and Fletcher had apparently believed that "seed money" (necessary to gather data on which ERDA could make a decision), as distinct from development money, was to continue to be NASA's responsibility. As a result, ERDA's former Assistant Administrator for Solar, Geothermal and Advanced Energy Systems, John Teem, did not evaluate the need for solar satellite power station seed money.

It came as a surprise to Teem when, this January, the Office of Management and Budget (OMB) interpreted the "memorandum of understanding" to mean that all NASA solar power satellite seed money was to be terminated.

The House Science and Technology Committee, chaired by Olin Teague (D-Texas), is hoping to rectify the misunderstanding. The NASA Authorization Bill for Fiscal Year 1977 includes five million dollars for solar satellite power station seed money under the Space Research and Technology line item.

There is still the possibility that the appropriation may not make it through Congress; if it does, OMB may advise President Ford to impound the funds. It

is not likely that Congress can be motivated to act to override the impoundment of a sum as small as five million dollars.

The Senate Subcommittee on Aerospace Technology and National Needs is working on ways to solve the funding problem without having to run through the appropriation process. (The L-5 News will report on the subcommittee's actions next month.)

The subcommittee is hopeful that OMB and the President can be persuaded to be sympathetic toward the difficulties ERDA and NASA have encountered in solar power satellite funding, and allow them to follow the spirit rather than the letter of the June 25 memorandum.

SENATOR WENDELL FORD ON POWER SATELLITES

Alice Babcock

The following is an interview with Senator Wendell Ford (D-Kentucky), a member of the Senate Aerospace Committee, and chairman of the subcommittee on Technology Utilization and National Needs. This subcommittee held hearings, January 19-21 of this year, at which Dr. O'Neill testified on his design for a solar energy satellite. Senator Ford was interviewed on the implications of these hearings on February 17.

Which of the three energy satellite proposals - O'Neill's, Glaser's, or Boeing's - do you think is tie most politically acceptable?

I don't think any of them will be politically acceptable, or not acceptable, until we are able to say, within reason, or to convince the public that the energy will be competitive. The testimony that we had indicated that it could be, and in all probability would be, competitive, but they wouldn't want to say for sure.

I think we need to do two things, and the first thing lends itself to the second. First, you have to continue with the research. O'Neill, and Glaser, and NASA, and all of them believe that this can be done. I think the three opinions that it can be done, once you mesh them together in a concentrated effort, will really expedite it. But until we decide which one of them is going to be the most feasible, and then really accomplish our goal, we need to continue doing research until we make that decision.

Secondly, if the decision has been made that it is feasible, that it will be economically competitive, then the public will accept it, because of the environment, and that sort of thing. If we have to say it isn't going to be economically feasible, that we're going to put it off until we have a crisis of some kind, then the public will not want us to spend the money in this space arena.

Do you think education of the public is enough to convince them to pay the cost of energy satellites? It's a big price tag.

But the price tag will be worth it if we can get the return in the solar energy that's sent down here, and for all practical purposes, it's environmentally clean. And we're generating power and don't have to worry about nuclear explosions and all this sort of thing. I think we're on the right track, but we have to be reasonably sure, and in this field of space science, about all you can be is *reasonably* sure, and with our space ship going up, what we're able to do with that will reflect on this also, because we're going to be able to fuse metals that we cannot fuse in this atmosphere, and other things.

I feel pretty good about it. I feel positive about it, and I feel there will be some concern about this colony in space.

What do you feel is the likelihood of these colonies being developed?

I make the pitch that when I was a small boy, my daddy would give me ten cents on Saturday, and I'd spend a nickel of that to get a Buck Rogers comic book. My grandfather fussed at me, and of course that was forty years ago, for wasting my money and this would never happen. We're not going to see things floating around in space. We're not going to send men to the moon, and that sort of thing. But it's happened in my life time, and I think we have a great opportunity to do it.

There are more aspects to these satellites than power production, such as low temperature and vacuum technology and manufacturing, both of which are very difficult to do here on Earth. Are these being considered as near-future projects for NASA?

Well, once we get the space ship up, and we're able to prove that we can fuse metals and mix metals in the Space Lab, then the other things can come off.

First, the space shuttle will take the Lab up to do these things in that atmosphere that will be beneficial to us here. Then people will see the benefit, which is our responsibility: to see that they understand what the benefit is, and the return on their dollar.

You know, if my son is sick, money doesn't mean very much in order to get him well. Dollars are being spent to increase our longevity, and these sorts of things. We have people going to these chambers, to be revitalized; we've got a lot of interest in that around today. All these things are going on now.

So the money is there to be spent?

I think so. But we have to be sure about it. There's a conservative air around today. Very conservative. The pendulum's swinging back now. Let me add one more thing—we have to have enthusiastic leadership in the White House—someone there who can see that we need to push it (the space program) a little bit.

I think we can encourage ERDA to contract with NASA, and encourage

ERDA to fund Boeing, and O'Neill, and others so they can go ahead with their demonstration—they're in that pilot stage now, and kind of getting into that demonstration area.

What kind of time scale would you project for all these developments?

Well—we're talking about '95 and I think, if it works out as I think it's going to, we can probably see the solar energy in '90. So we're talking about 15 to 20 years. I'm saying *if* it goes as I think it will go, with the enthusiasm I have for it.

NEW AMES SPACE PROGRAMS

Robert Anton Wilson

Ames Research Center is planning to follow up its successful 1975 summer seminar on space colonization by a similar 1976 seminar, again featuring Professor Gerald K. O'Neill. While the date has not been fixed, the seminar is planned to last six to eight weeks, and NASA has provided \$50,000 funding.

According to Jesco von Puttkamer of NASA's Office of Advanced Programs, the 1976 seminar will explore space colonization "one level deeper than last year," and will include more detailed concentration on closed ecological systems in space and propulsion systems, among other topics.

Von Puttkamer also informed *L5 News* that governmental attitudes toward space colonization have changed markedly in the last year. "The new wind blowing in Washington is an updraft," he said, adding that colonization is no longer "incredible" to politicians. He cautioned, however, that talk about space cities as the next step is still premature where government officials are concerned. We can't "jump to colonization," von Puttkamer concludes, rather we must move from the space laboratory to the space city "step by step."

The first "space facility" that is more than a laboratory—a virtual "construction camp" in space—can be ready by 1985, in von Puttkamer's scenario, and space colonization can then begin, he says, in the late 1980s or early 1990s.

Also scheduled at Ames this summer is a program on the detection of planets outside our solar system. Scheduled for ten weeks, 14 June to 20 August, this will involve 20 college and university faculty members. The study will examine the advantages and disadvantages of several strategies for the detection of such planets, including observation from the earth's surface, from balloon-based instruments, or from space satellites.

Robert Wilson is the co-author of *Illuminatus*, Dell Books, 1975; he also writes for *Playboy* and *Oui*.

NEW MEXICANS EXAMINE SOLAR CELLS

Sandia Laboratories in Albuquerque will manage a portion of the Energy

Research and Development Administration's National Photovoltaic Conversion Program.

The staff will try to lower the cost of solar cells, which turn sunlight directly into electricity. Other goals include making the units more efficient. Today's cells can use less than twenty per cent of the sun's light.

ERDA hopes that solar cells will rival conventional peakload electric generators by 1985. Sandia says today's photovoltaic systems make electricity for about \$20,000 per peak kilowatt. That figure should drop to less than \$500 over the next decade.

Other recipients of ERDA program funding are Jet Propulsion Labs, in Pasadena, California, and NASA's Lewis Research Center in Cleveland. For more information, contact Sandia's Public Information Division, Albuquerque, New Mexico 87115.

SPACE INDUSTRIALIZATION: CAPTAIN FRIETAG OF NASA

Ann Elizabeth Robinson

February 12, 1976:

"We believe that as the rest of this century unfolds, there's going to be many, many possibilities for the utilization of space that we really haven't looked at."

"We're looking for the space station to become operational in the period 1985-86."

"We believe that by the nineties we'll be making very major steps towards permanent occupancy of space and reasonable self-sufficiency in space"

These comments from Captain Robert F. Frietag, NASA Deputy Director of Advanced Programs, in Washington, DC., reflect the seriousness with which NASA is approaching the concept of space industrialization.

The space industrialization concept was developed in depth by pioneer Krafft Ehricke in the early seventies, specifically in his unpublished work, *The Extra-terrestrial Imperative*. The idea has been popularized in recent months by Princeton physicist Dr. Gerard K. O'Neill as part of the more comprehensive space colonization concept.

Rumblings of space industrialization projects in NASA were heard in the L5 network. But what these projects were remained to be confirmed. In an interview with Captain Frietag on February 12, 1976, the picture was clarified.

Two major projects emerged: (1) The development of a Manned Orbiting Facility or "space station" and (2) The preparation of a synoptic survey on space industrialization. An edited version of the interview follows.

What plans does Marshall Space Flight Center in Huntsville, Alabama, have for studying space manufacturing techniques?

"The Marshall Space Flight Center (MSFC) is the center most concerned with space manufacturing techniques, from the

near term to the very, very long term. For example, they have flown experiments on the recent Apollo-Soyuz joint mission.

Some of the experiments included the separation of chemicals by taking advantage of the weightless environment.

"On the longer term basis, MSFC is studying a type of laboratory that could be placed in the space lab for extended zero gravity or space manufacturing type of experiments. . . . that would be not only materials processing, but also the processing of pharmaceuticals or liquids, perhaps even the molding of lenses.

"Then, on the very, very long term-- ten to twenty years from now -- MSFC is looking into the possibility of devoting entire space stations to space processing or space manufacturing on a very broad basis . . . literally taking advantage of the space environment by putting factories in space. This would probably occur in the late 80s or late 90s.

"All sorts of things could be done in that time period: manufacturing of items that use materials that are brought up from earth, processed and returned to earth; or, eventually, taking extra-terrestrial materials from the asteroids or the moon, processing them, and then bringing them back to earth."

Captain Frietag believes there are four steps in the transition from earth-only to earth-and-space industrialization. In the first phase, unique products would be made in space--those of relatively low volume and extremely high value that could be made only in space. Captain Frietag says it is speculated that crystals can be grown in space for one-hundredth to one-thousandth the cost at which they are grown on earth (\$10.00 per pound).

Next, space manufacturers would concentrate on items which could be built *better* in space. Gradually, they will move into items which can be made *cheaper* in space; and, finally large volumes which can be totally self-sufficient.

What are characteristics of space that makes it suitable for specialized manufacturing, such as that of crystals and lenses?

"There are several features that make it very worthwhile. First, the environment of zero gravity is a totally new environment. On earth, the effects of gravity are always working on us. To use the example of bubbles. . . : if you mix steel up like a milkshake, the bubbles quickly rise to the top because they're lighter, and the steel goes to the bottom. But, if you did that in zero gravity, the bubbles remain equally distributed all the way through, because gravity is not trying to separate the materials.

"Another feature is the very high vacuum in space, which is almost unlimited. Another one which is extremely important is that on earth you have a biosphere which is subject to pollution. Any materials which you have

in space would just eventually travel off in space, and the atmosphere would not be contaminated."

Asked whether a law of diminishing return might be in effect over the very long range concerning the pollution of the universe, Frietag commented that our progress would be stopped by other limitations, such as food and living space, first.

"Another feature of space that is so unique is that we have unlimited power -- solar power. It's a change to use tremendous amounts of power without using up the earth's resources. The free resources of space are what I'm talking about.

"In addition to solar power, there are additional resources such as materials and metals on the asteroids and on the moon which are literally untapped at this point in time."

What are your plans for a Manned Orbiting Facility at Marshall?

"At the present time we are studying a Manned Orbiting Facility--a permanent space station--which will orbit around the earth. We're looking at the possibility of it orbiting at low earth orbit, at geosynchronous orbit, and at lunar orbit. We have a study just getting underway which will last for about 18 months on the nature of such a space station.

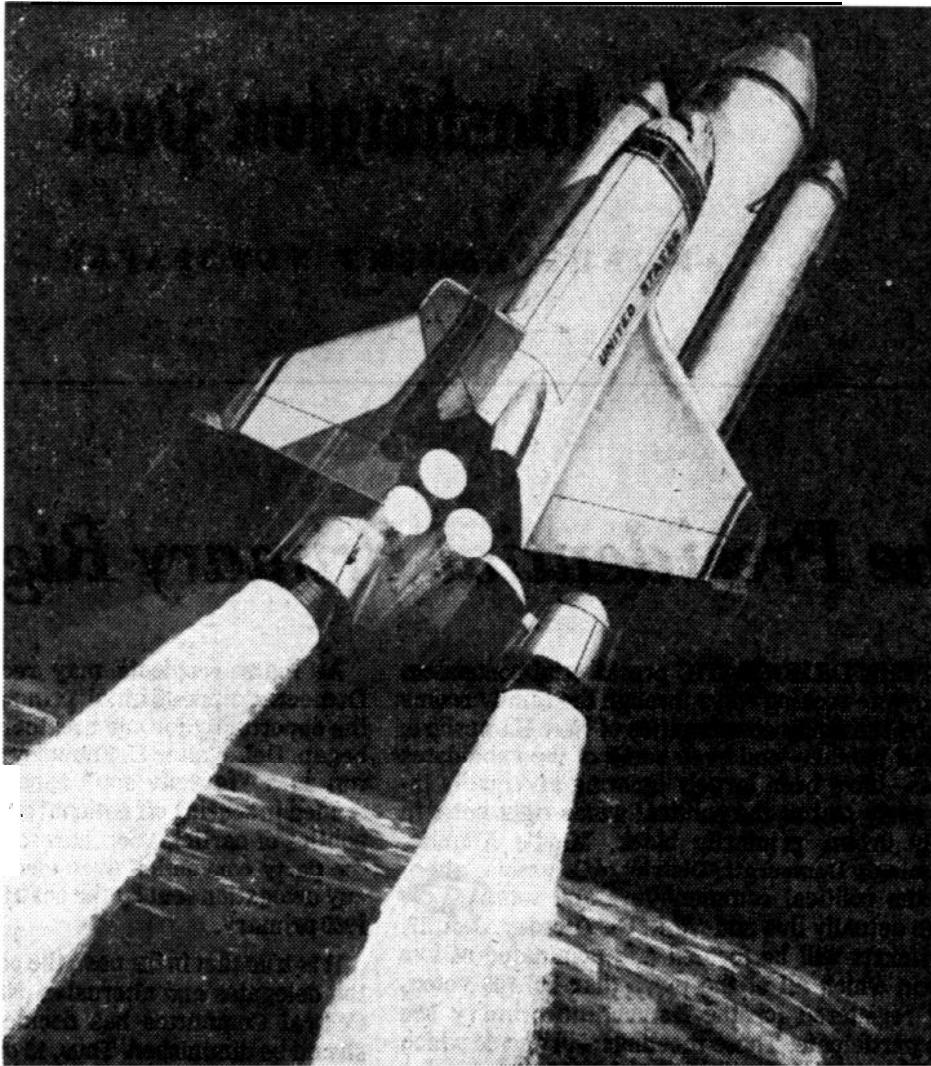
"After a year and a half or two years, we'll examine these and hope to make a decision to go forth with one or another as a piece of equipment. We're looking for the space station to become operational in the period from 1985-1986."

Frietag went on to say that the space station is simply a building block in the whole set of equipment that is needed. The space shuttle is another, and an orbital vehicle to move from low altitude to high altitude is still another.

"Now the space industrialization activity is a little different thing. We believe that as the rest of this century unfolds, there are going to be many, many possibilities for utilization of space that we really haven't looked at.

"Space processing and space manufacturing are obviously some of the things we'd be interested in: the development of solar energy, or nuclear energy, to use in space or on earth; observation of earth's resources from space; repairing and servicing satellites in space; building large structures in space for many purposes; mining the moon or the asteroids; data processing; reflecting sunlight from huge mirrors to illuminate earth; controlling the weather or climate by focusing solar energy; putting hospitals in space, particularly for problems like heart trouble; establishing a base for disposing of nuclear wastes. We could even have, in years to come, a Hilton Hotel in space.

"So, we're asking a series of



5-Million-Pound Space Shuttle

contractors to look into these really long term industrialized or commercialized uses of space to give an idea of which ones are the most significant ones; when they might appear; and how they relate to each other."

According to Captain Frietag, there is no industrial firm involved at this time. It is strictly within the government. NASA is in the process of preparing a statement of work which will be issued to industry for their bid within the next six to ten weeks (from date of interview).

The study, a synoptic survey, will be a one-year contract. The plans for the study were presented to Congress as part of the budget program for the Office of Space Flight, one of the four major departments of NASA. Entitled "Advanced Program Planning," and conducted by John Yardley, Associate Administrator of NASA for Space Flight, the testimony was submitted to the Senate Committee on Aeronautical and Space Sciences on January 27, 1976 (chaired by Senator Moss) and to the House Subcommittee on Space Sciences and Applications, of the Committee on Science and Technology, on February 3, 1976 (chaired by Representative Don Fuqua).

When asked about a recently quoted remark that HEW spends the equivalent of NASA's annual budget every ten days, Frietag replied:

"HEW has about 150 billion dollars a year, and NASA's budget is around 3. So, that means they have about 50 times as much as we do... and one fiftieth of 385 is just roughly every eight or ten days."

Frietag commented, though, that HEW funds are tied up in expenses such as social security, pensions, and interest on the national debt. One the other hand, he said most of NASA's money is "disposable income."

"It goes toward creating new technologies or new systems. It's like the old Chinese proverb: 'If you find a hungry man and give him a fish, he comes back the next day hungry. But, if you teach him to fish, you may have solved the problem for a lifetime.'"

"That's the kind of thing we're doing . . . , we're trying to develop new technology and new ways of doing things which either create new industries or new products."

As an example of new ways of operating in space, Captain Frietag spoke

of the move away from the cardinal principle of "complexity on the ground" toward the building of large, complex structures in space.

The space shuttle will provide mobility into and out of space easily; the space station will make permanent occupancy of space possible. Therefore, large structures, such as gigantic antennae, several miles across, can be built in space; the ground receiver or transmitter could then be small.

"We could be talking over wristwatch radios instead of using the wires which we're all wired together with on this planet."

Large solar power stations, five miles by ten miles, could be used to generate power, or a giant radar could serve the entire East Coast. Every rowboat or sailboat, or even an ocean liner, could have a \$50 receiver on it-instead of one costing today's \$5000. Captain Frietag said that NASA has identified several hundred new systems of this nature which are really dramatic in concept.

He uses the words "space industrialization" in a broad sense to include not only manufacturing, but also tourism and agribusiness. Commenting on the possibilities for agribusiness in space:

"I think this is an extremely reasonable proposition. When it will occur and how it will occur is a great unknown. I don't think anyone really knows. We believe that by the 90s we'll be making very major steps towards permanent occupancy of space and reasonable self-sufficiency. But to get to the point of total self-sufficiency where you can replicate your facilities is probably going to take us sometime well into the twenty-first century.

"It's one thing to manufacture raw materials on the earth, with all the resources, then take them into space and assemble them, and use them. But its another thing to start with raw materials. To do this suggests a planned society of the highest order. I think the technological problems are easier than the sociological problems."

Have you been considering the sociological problems in your space industrialization studies?

"Yes. However, the study that I referred to earlier is not intended to look into that aspect of space industrialization. It will be more or less what could be done either from a technological, engineering, or manufacturing point of view. What you *could* do, not what you *should* do."

In the tight budget period, NASA has difficulty making ends meet on the technological aspects of space exploration and development. To explore the sociological aspects, which Captain Frietag believes are very important, either NASA needs more money, or someone else with the interest and capability should be doing such studies.

In the recent Twelfth Annual Convention of the American Institute of Aeronautics and Astronautics, Margaret Mead stated that she believed going into space could be an initiative to greater cooperation here on earth. Captain Frietag had this to say:

"With no doubt it is. It has already been proven with the Apollo-Soyuz results. It is probably the one mechanism that has increased cooperation effectively. The activities that we had with the Soviet Union leading up to and through the Apollo-Soyuz were the greatest understanding between our two nations since prior to World War I. The understanding of how they do their work was probably more stimulated by the Apollo-Soyuz mission than by anything else.

"Why is that? Well, it turns out to be a virgin area, where there is no vested interest; and cooperation can be established on an understood basis without having to give up a prior position that you held (as in a territorial activity or even a military activity). It's always easier when you're starting afresh than when you're living with either old wounds or precedents."

In a final comment, Captain Frietag expressed his belief in a resurgence of interest in the space program.

"I see the winds moving right now . . . moving rapidly."

**POWERSAT:
A POWER PLANT
IN GEOSYNCHRONOUS ORBIT
BEAMING ENERGY TO EARTH**

Supplement to statement of Richard W. Taylor, Vice President, The Boeing Co., before the Senate Subcommittee on Aerospace Technology and National Needs, January 19, 1976.

A solar power plant in a geosynchronous orbit could collect solar energy at maximum efficiency. It would be illuminated over 99 per cent of the time by sunlight unattenuated by Earth's atmosphere or weather (even on a clear day, sunlight at ground level is only about 65 per cent of its intensity above the atmosphere). In space, the collector can be aimed directly at the Sun, maximizing its effectiveness.

A heat engine converter is shown. Sunlight would be concentrated by the collector into a cavity, providing heat for a set of helium gas turbines. The satellite's alternators would be driven by Brayton cycle turbines typical of present-day jet aircraft. But, unlike a jet's turbine which vents off fuel-heated air after it turns the engine's fan, the Powersat turbine would use the Sun as its only fuel and operate on a closed loop. Helium would be heated in the cavity, pass through the turbines, then flow through a space radiator where the helium's heat would be rejected. The helium then would return to the cavity to begin the cycle. Electric power is routed to a phased array RF generator where it is converted to a narrow microwave beam at 2450 Mhz by high-efficiency crossed-field amplifiers (amplitrons).

The beam can be directed to any desired load point visible from the satellite, which appears stationary relative to Earth's surface. At the load point, the power beam is reconverted to

DC electric power by a fixed receiving antenna about five miles in diameter. A grid interface converter changes the DC power to 60 hz high voltage AC.

Satellites generating 2500 to 10,000 megawatts of useful output on the ground appear feasible. A modular approach can provide this range of capability with a standard satellite design. In space there are no site-peculiar design requirements; a standard satellite design can serve all locations.

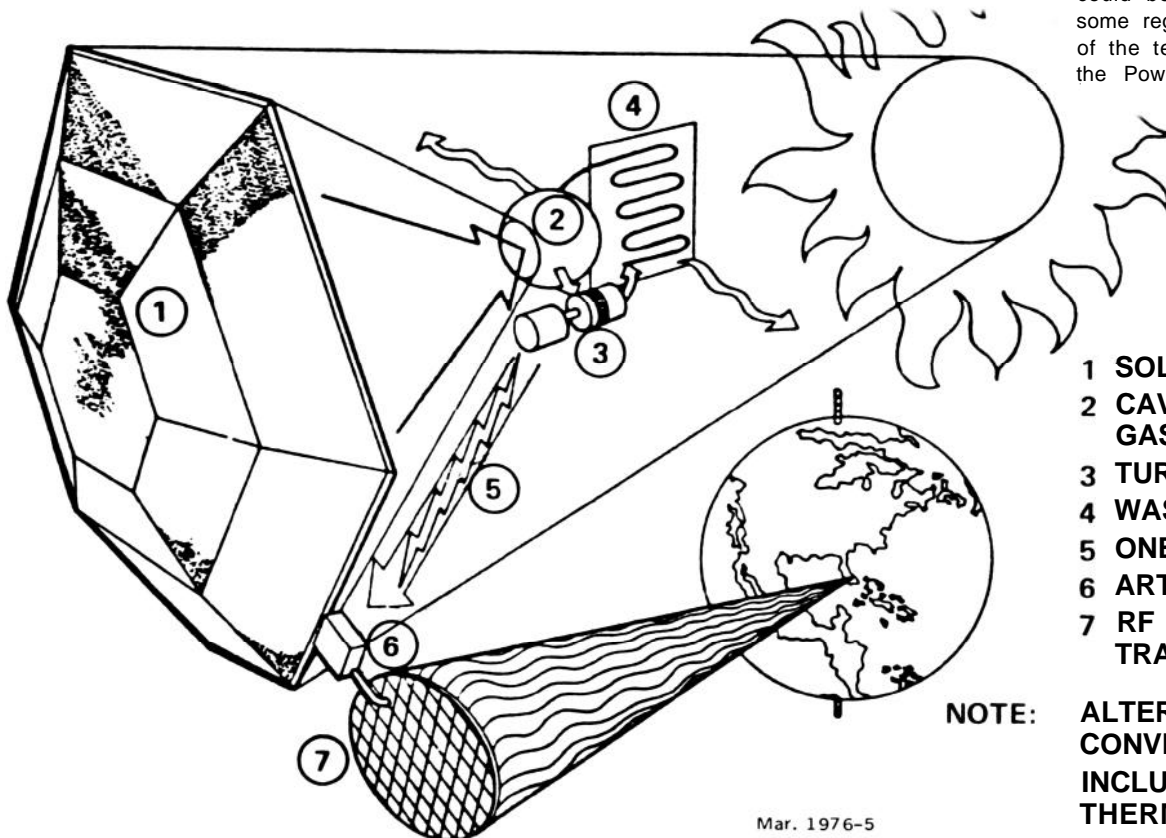
The helium turbine conversions system is but one approach; solar cell (photo-voltaic) and thermionic conversion systems also should be investigated.

The Boeing thermal electric configuration for Powersat grew out of work on a ground-based thermal electric power station being pursued by Boeing Engineering and Construction, a division specially dedicated to activities in the energy field.

The Sun is reflected by steerable focusing mirrors into a thermal cavity on the tower. This thermal energy powers a heat engine that generates electricity. The solar reflecting mirrors are 23 feet in diameter, and the tower is 95 feet taller than the Washington Monument. The plastic bubbles, designed to withstand 100 mile-an-hour winds, provide environmental protection for the light-weight mirrors.

Boeing Engineering and Construction is doing concept work on the mirrors for both the Energy Research and Development Administration and Electric Power Research Institute.

The ERDA program eventually could lead to a regional solar power system that could be economically competitive in some regions of the United States. Much of the technology would be applicable to the Powersat concept.



**ILLUMINATION IN
GEOSYNCHRONOUS
ORBIT IS NEARLY
CONTINUOUS**

- 1 SOLAR CONCENTRATOR
- 2 CAVITY ABSORBER
GAS HEATER
- 3 TURBOGENERATOR
- 4 WASTE HEAT RADIATOR
- 5 ONBOARD DISTRIBUTION
- 6 ARTICULATED JOINT
- 7 RF GENERATION AND
TRANSMISSION

**NOTE: ALTERNATE POWER
CONVERSION MEANS
INCLUDE PHOTOVOLTAIC AND
THERMIONIC**

ERDA-MIT ENERGY RESEARCH PROGRAM

The Energy Research and Development Administration (ERDA) has negotiated an agreement for support of a coordinated multidisciplinary energy research program at the Massachusetts Institute of Technology (MIT).

Approximately \$1.5 million has been authorized in FY 1976 for initial support of the approved research efforts.

The energy research program will be conducted under an institutional agreement between ERDA and MIT and is based on a comprehensive proposal submitted by MIT last year. Under the agreement, multidisciplinary research will be pursued by MIT faculty and students in eight program areas: fossil energy; nuclear energy; solar and advanced energy systems; conservation; environmental technology and planning; R&D strategy and policy analysis; international studies; and exploratory research, program coordination and educational activities.

Research tasks selected for support in this agreement have been reviewed and evaluated by ERDA.

The institutional agreement will run for three years and contains provisions for a semi-annual senior level review of progress and plans, in addition to normal technical evaluation of specific research tasks. New and extended projects can be incorporated into the institutional agreement when approved for support by ERDA program offices.

The ERDA-MIT institutional agreement will be conducted at MIT by Dr. David White, Director of the MIT Energy Laboratory and at ERDA by a special review committee chaired by Dr. Michael Yarymovych, Assistant Administrator for Field Operations.

The institutional award to MIT is the first of its type to be made by ERDA. Proposals from other academic institutions are being evaluated by ERDA program offices.

ERDA anticipates that the bulk of funding for university-based energy projects will be handled on the normal project-by-project basis. However, institutional agreements may be considered, where appropriate, to provide a flexible mechanism through which ERDA can support and foster research and supporting activities with educational institutions which have major energy-focused programs supporting the goals and objectives of the National Energy Research, Development and Demonstration Program.

UN CONFERENCE ON HABITAT

The UN Conference on Habitat will be held in Vancouver, Canada, May 27-June 11. The L-5 Society will be represented at the Conference by Peter Vajk of Science Applications, Inc., and Magoroh Maruyama, of Portland State University. The Society has not yet been able to

raise the money to cover their expenses; those interested in helping should contact Carolyn Henson at the L-5 office, 1620, N. Park, Tucson AZ 85719, 602-622-1344.

An artist who has done a good deal of artwork for NASA, Andre Fontaine-Gagnon, of Kingston, Ontario, has donated to the L-5 Society one of his paintings, which he has given us permission to sell in order to raise funds.

The painting has not yet arrived; as soon as it comes in, however, we will be happy to send photographs of it to anyone who is interested in supporting the L-5 presentation at the Conference on Habitat by purchasing the painting. Dr. Fontaine-Gagnon's curator, Mr. Craig Pare, has appraised the painting at \$900.

Fontaine-Gagnon will be presenting an art show and lecture, "Probing the Universe," at the Montreal Olympics this summer. One of his painting to be displayed will be entitled "The L-5 Society."

In the near future we will receive a set of 32 slides of his artwork, which NASA has prepared for lectures, for distribution to our members.

HETEROGENISTICS

A sizeable number of L-5 members have expressed an interest in contacting extra terrestrial intelligent species -- in science fiction lingo, alien sentients. Heterogenistics has a serious bearing on this subject.

Recent conferences in several fields of biological and social sciences* indicated emergence of new epistemologies dealing with increase of heterogeneity and symbiotization due to differentiation-amplifying *mutual* causal loops, in other words, decrease of thermodynamic entropy and increase of amount of information as basic principles of biological and social processes.

Consequently an epistemological and conceptual restructuring which cuts across biological and social sciences seems necessary. For example, we know that in human society there are individual differences in personality, and such differences are often useful in fulfilling mutual emotional needs. Each person needs other persons who are different. But how much do we know regarding intraspecific heterogeneity and symbiosis among animals and plants?

Often variations have been regarded as quantitative deviations from the average, rather than something qualitative and indispensable. Another consideration is that too little attention has been paid to interaction between intraspecific heterogenous elements which generate new social and cultural structures and patterns, often non-hierarchically. In social science, heterogeneity has been frequently considered only as a source of conflict, even though in biology we know that homogeneity often causes

competition and conflict while symbiosis is possible thanks to heterogeneity. The new epistemologies require new ways of asking questions. We might call this new direction "heterogenistics."

The reformulation necessitates input from several fields of biological and social sciences. I would appreciate ideas from readers.

Magoroh Maruyama
Systems Science Program
Portland State University
P.O. Box 751
Portland, Oregon 97207

*Examples: (1) 1974 AAAS Meeting, Symposium on Paradigmatology (2) 1975 Amer. Anthropol. Assn. Meeting: Symposium on the Challenge of Cognitive Variability; also Symposium on Mind, Culture, Society, the Relevance of Evolution to the Reductionist/Emergence Problem. (3) 1976 Animal Behavior Meeting.

EXCERPTS FROM L-5 SOCIETY, UK BRANCH NEWSLETTER

LEADING SPACE COLONY SCIENTIST COMING TO UK

Dr. Thomas Heppenheimer, a leading space colony protagonist and a research planetary scientist, is coming to the UK in early April, 1976, on a space study course. Dr. Heppenheimer, a leading L-5 Society member, was one of the leading participants in the 1975 Summer Study Course, on space colony topics, organized by NASA/ASEE/Stanford University, in which over 25 scientists took part in an early assessment of space colony techniques.

Whilst in the UK, Dr. Heppenheimer will be discussing the latest stateside ideas for space colonization techniques with members of the L-5 Society, UK Branch, and will be bringing several new reports, artwork, and other items for study by the UK members. He will also be delivering a lecture on space colonization to members of the Institute of Astronomy at the University of Cambridge, on the 13th April, 1976, at 2:30 P.M.

FAMOUS INTERNATIONAL SPACE ARTIST JOINS L-5 SOCIETY

David A. Hardy, one of the world's leading space artists, has joined the L-5 Society, UK Branch, and will be helping to illustrate Society news items, and, hopefully, providing artwork for other society publications. David has illustrated many books on spaceflight and science fiction book covers. Many of his original paintings now adorn the walls of the studies of such famous people as Wernher von Braun and Dr. Tom Paine (ex-NASA).

SPACE COLONY NUTRITIONAL SCHEME PROPOSED

Dr. Ian Richards, an L-5 UK member, has recently completed an analysis of nutritional requirements and a basic agricultural concept for an early 10,000 person space colony. Copies of the paper, describing this work, are available to L-5 members only. Dr. Richards has used a

large computer to analyse a number of equations that he produced-the first time that this has been applied to a space colony project. United States L-5 members, Keith and Carolyn Henson, are taking a keen interest in this paper since they are doing similar research work in Arizona and they are now in liason with Ian Richards on this topic.

ALTERNATIVE MIRROR GEOMETRY

Another early UK L-5 members, Peter Voke of University College, London, has proposed an alternative mirror geometry for the "O'Neill twin cylinder" space colony idea which has a number of advantages over the original planar aluminium mirrors that O'Neill originally proposed. Copies of the paper describing this suggestion are available to members.

SPACE COLONY LECTURES

11 March, 1976, 2:00-5:00. "Space Colonies-Our Tomorrow," Faculty of Environmental Studies, Forest Road, Walthamstow, London E17.

31 March, 1976, 9:30-5:00. BIS Main Meeting, Small Physics Theatre, University College, Gower Street, London (near Euston station). "Lagrange Point Space Colonies" paper (illustrated) to be presented.

10 March 1976, 7:30 P.M., Newark Engineering Society, Newark Technical College, Newark, Notts. Space Research (including space colony ideas).

13 April 1976, 2:30 P.M. Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge. "Space Colonisation" by Dr. Heppenheimer.

SPACE SHUTTLE ROLL-OUT

The roll-out of the first Orbiter vehicle for the NASA Space Shuttle transport system has been scheduled for the 17th September 1976. The Space Shuttle system will form an essential key element in space colony programmes. The first orbital mission for the space shuttle is planned for the last quarter of 1979.

L-5 TAX STATUS

The L-5 Society, just to be on the safe side, is currently operating under the tax-exempt aegis of the Campus Christian Center at the University of Arizona. In the meantime, our application for independent tax-exempt status with the IRS is in process. Our lawyer, Barbara Fisher, who works with the Office of the Arizona Attorney General, has told us that there should be no difficulty in acquiring this status.

GIFT SUBSCRIPTIONS

Our thanks to the few hardy souls who gave April Fools' Day gift subscriptions to friends or enemies.

This month, the libertarian element of our membership can celebrate by sending gift Income Tax Day subscriptions to people who want to move to the asteroid belt in order to avoid governments and taxation.

L-5 STAFF

The L-5 Staff this month consisted solely of Tucsonans Andrew Germaine, Daniel Lomax, and Keith and Carolyn Henson.

Several L-5 activists from around the country are planning to put in time on the staff this spring and summer. We await their arrival impatiently as there seems to be an unending supply of work at the office!

Keith and Carolyn Henson renew their offer of free room and board for visiting L-5 staff in the scorching summer wasteland of Tucson.

L-5 SOCIETY BY LAWS

The new bylaws, revised according to the requests of members, have been adopted by the Board of Directors. Future revisions will require a 2/3 vote of L-5 members. Copies of the bylaws are available upon request.

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UNDERWHELMING RESPONSE

The following article ran in the February L-5 News:

The National Congress on Aerospace Education is holding a convention April 2 in Las Vegas and has scheduled presentations by FASST and the L-5 Society. As an economy move FASST and L-5 plan to send one of the Tucson L-5 staff to represent both organization, and split the transportation cost between them. A contribution of \$50 would cover the Society's half of the cost, and would be most appreciated by both organizations!

The response was underwhelming: not one cent has been contributed. If any L-5 members feel that it is worth \$50 for the Society to make this presentation April 2, there is still just barely time to send in a contribution.

BUMPER STICKER CONTEST

Several members have proposed bumper stickers. The L-5 Society hereby announces a contest to find a *brief* slogan suitable suitable for a bumper sticker. First prize will be ten free bumper stickers. Remember, if the slogan is too long, other motorists will have to tailgate in order to read it, and the L-5 membership is currently too small for us to be able to afford to lose any people in traffic mishaps.

CAMPAIGN NEWS

February 24, in a press conference following the New Hampshire primary election, candidate Morris Udall called for the development of renewable energy resources, adding that "solar satellite power stations show a great deal of promise."

L-5 SOCIETY MEMBERSHIP FORM (PLEASE TYPE OR PRINT)

NAME: _____

COMPLETE ADDRESS: _____

AFFILIATION (OPTIONAL): _____

TITLE or POSITION (OPTIONAL): _____

I am - - a m n o t - - interested in being active locally.

___ Back issues 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).

___ Please enter an institutional membership to receive the "L-5 News" for our organization/library as indicated above. We enclose a check for \$ _____ (institutional or library membership \$100; special library subscription with one month delayed mailing \$20).

COMMENTS AND REQUESTS _____

L-5 NEWS

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Please send in address changes as soon as possible. Type or print clearly and include Zip Code.

SPACE FARM COURSE PLANNED AT U OF ARIZONA

An interdisciplinary studies course on the space farm problem is planned next fall under the auspices of the Systems and Industrial Engineering Department of The University of Arizona.

Students in engineering, microbiology, plant physiology, animal husbandry, nutrition, etc., are welcomed and needed. Those interested in transferring to The University of Arizona in order to take this course should write the Registrar and Director of Admissions, The University of Arizona, Tucson, AZ 85721.

Those who wish more details on the study group should contact Carolyn Henson, L-5 Society, 1620 N. Park, Tucson, AZ 85719. (602-622-1344.)

TUCSON SPACE FARM STUDIES

A seminar on the design of the space farm for the proposed L-5 colonies is being conducted by Melvin Schonhorst, a plant sciences professor at the University of Arizona. He is also working with another U. of A. professor, Ken Olson, on a related project involving the raising of

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rabbits on greenhouse alfalfa. They have determined that rabbits raised on alfalfa are able to complete their entire life cycle without signs of nutritional deficiency.

Alfalfa-fed rabbits, due to their high feed conversion efficiency (three times that of cattle) and prolific reproductive rates, were proposed as the primary meat source for prospective colonists by two other Tucsonans, Keith and Carolyn Henson of Analog Precision, at the May 1975 Princeton Space Manufacturing Facilities Conference. They also proposed that grain and waste agricultural products be fed to goats, as they produce twice as much milk for a given amount of feed as dairy cattle. The Hensons have suggested that at least the dairy section of the space farm could be run at less than Earth gravity as the sight of nannies capering in low-G could provide entertainment for the colonists.

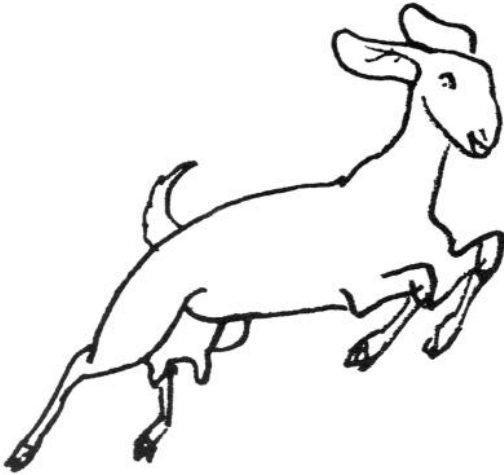
LETTERS

I had a thought about Sherman DeForest's remarks on p. 5 of L-5 News No. 6. Should we approach the charging of large orbital constructs as a problem, or an opportunity? Is there anything we might be able to use those large voltage differences for? For example, could they be useful for helping to keep mirrors on power satellites properly sun-oriented?

Larry Friesen
Clay Center, Kansas

Is anyone considering the high winds that may occur in a space cylinder every dawn and sunset? With a 4 mile diameter the air at the rim is moving at about 400 miles per hour. With dawn, this air is heated by the sunlight and rises to a region of less velocity (stiff breeze, what?) and when the sun "sets" this air cools, sinks, and lands on the ground with a similar delta-v. Is any of this true and if so, what are the consequences and possible cures?

W. Bogen
Detroit, Michigan



L-5 NEWS
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Tucson, Arizona 85719

MOON CONFERENCE
ASME CONVENTION
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NASA APPROVES SPACE STATION STUDY
O'NEILL WORKING GROUP FORMED
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