L5 NEWS

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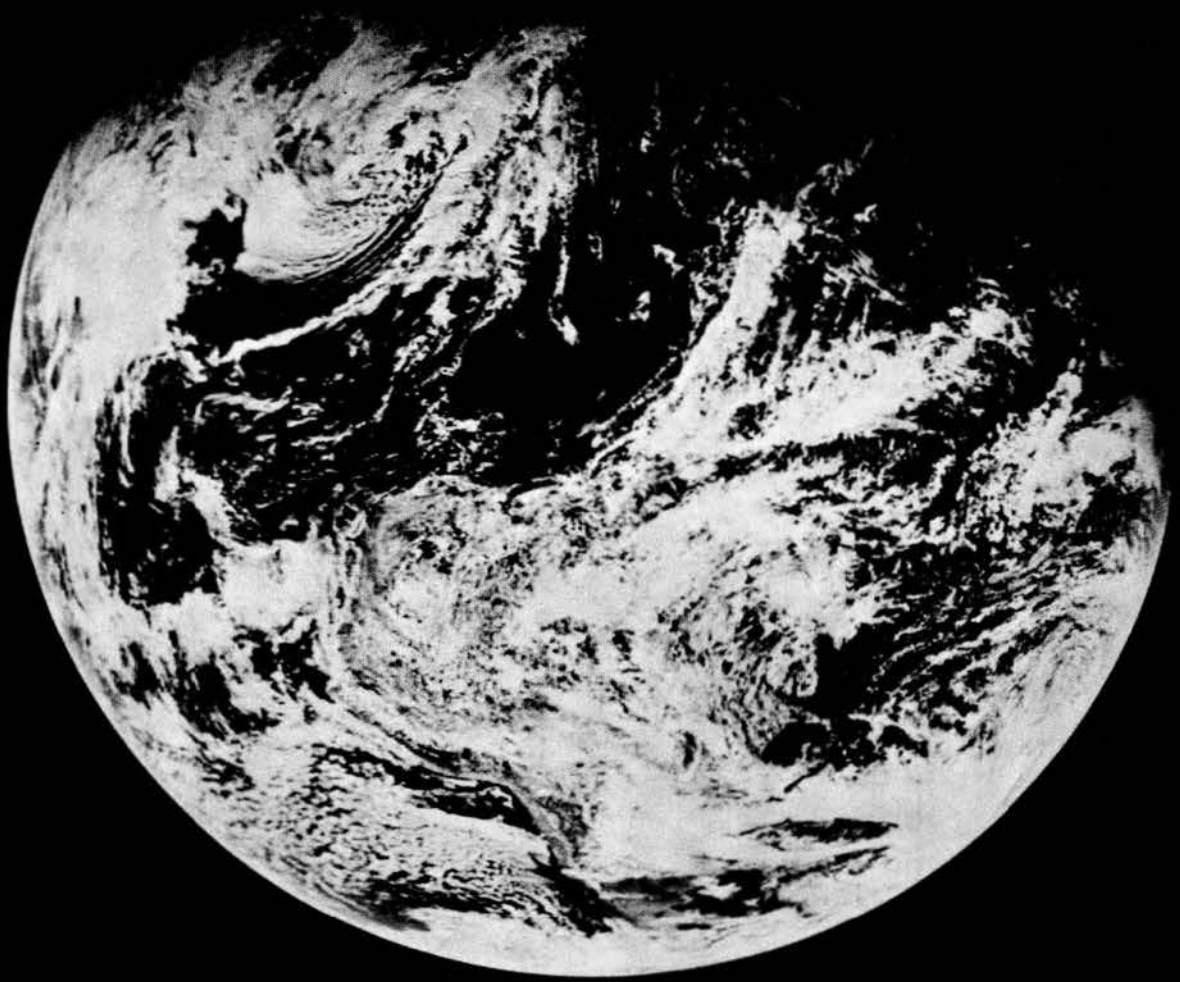

L-5 NEWS

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In this issue:

Editor's Note: I would like to thank frequent **L-5 News** contributor Eric Drexler for holding down the editor's desk this month. His work allowed me to take a much appreciated rest after the birth of my third child, Valerie Aurora, June 8. I'll be back on the editor's job with the next issue. —*Carolyn Henson, President, L-5 Society.*

Cover: The planet Earth, showing North and South America.

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THE NEW SPACE PROGRAM: *Conflict, Cooperation, and Common Interest*

by Eric Drexler

Because you are a member of the New Space Program community, you share strong common interests with everyone who supports a goal of the New Space Program. The New Space Program community needs a better understanding of itself and of its common interests if it is to act effectively on the national political scene.

Recent years have seen the growth of renewed support for space, but with a new set of goals. The old space program had three sides: human exploration, automated probes, and useful satellites. Of these, the first has died, the second has languished, and the third has passed on into the realm of the accepted and routine. The New Space Program (NSP) has three major sides as well: space industrialization, satellite solar power, and space colonization. Like the old space program, with its human exploration vs. automated probes conflict, the NSP has its warring factions. Fortunately (considering the sorry state of funding for the old space program), enlightened self-interest provides grounds for greater cooperation among us.

The goals of the NSP require large-scale space operations. To support any goal of the NSP is to have an interest in better lift vehicles, large space structures, power systems, orbit transfer vehicles, teleoperators, space stations, solar furnace/antenna surface configuration technology, knowledge of human physiology in space, knowledge of materials processing in space, and so on down an endless list of space-related knowledge and capabilities. *Common technologies create powerful common interests within the NSP community*.

The goals of the NSP require public and political support for space. To support any goal of the NSP is to have an interest in a public perception of space capabilities as a desirable national goal, and of space activities as an important part of our future. Such a public perception, together with more direct political pressure, will help increase federal support for space research and activities, will encourage the US to negotiate favorable treaties, and will result in a more favorable situation in the federal bureaucracies. Since "space" is to a large extent a single category in the public mind, *a common political environment creates powerful common interests within the NSP community*.

Despite these common technical and political interests and the limited cooperation they have produced, a corrosive atmosphere of conflict pervades the New Space Program community. Supporters of differing NSP goals and means to goals (i.e., the ground-launched approach to SPS, the space manufacturing facility approach to SPS, etc.) commonly object to each other's efforts for one or more of the following reasons:

1) The goal advocated is too far-out to be credible to anyone (or to Congress, or to conservative engineers in related fields, or whatever), and hence advocacy of the goal discredits the space program and my project.

2) The means advocated for reaching a legitimate goal are too far out, or are inferior to my proposal, and should be eliminated from further consideration or greatly de-emphasized.

3) Money is scarce, and my project deserves the lion's share of it.

For these reasons, planetary scientists (eyeing space manufacturing as a justification for planetary exploration) have claimed that *only* space manufacturing can make SPS a viable concept, SPS advocates have claimed that space colonies are not feasible this century, space manufacturing advocates have played up the possible environmental hazards of launching SPS systems with big boosters, and supporters of more modest space efforts have called for more caution lest the public find itself disappointed. In articles, lectures, and congressional testimony, spokespeople for various camps have failed to support each other's goals, have emphasized the cost of technologies required for other's proposals, have taken pains to disassociate themselves from other groups (even those working for broadly similar goals), have joked about other's goals, and have used other proposals as scapegoats when their own proposal comes under criticism. These efforts have

FLIPPO BILL PASSES HOUSE

After many postponements, HR 12505 came to a vote on the floor of the House Thursday, June 22, in the late afternoon. It passed, 267 to 96. While this large margin should help smooth its future course, the end is not yet in sight.

In the House, it must now pass the Appropriations Subcommittee on HUD-Independent Agencies, chaired by Rep. Howard Boland (D-MA). Its prospects in this subcommittee seem bright, as Boland voted "aye" on the floor. In light of his previous opposition to many of NASA's planned projects, supporters of SPS owe Boland a hearty "thank you".

Progress in the Senate seems less certain. Senator John Melcher (D-MT) introduced S 2860 (the Senate version of HR 12505) last May, but hearings have not yet been scheduled. Owing to a backlog of work, Melcher expects hearings to be held no earlier than late July, shortening the time available to complete the legislative process in this session.

If passed, the Flippo bill will provide $25 million for SPS research in fiscal 1979, permitting vitally needed technology verification and development work, as well as a closer examination of SPS environmental impacts.

not noticeably increased anyone's funding, nor have they furthered development of lift vehicles, large space structures, power systems, and so on. They have even poisoned the atmosphere for the constructive technical criticism required to improve or weed out poor ideas. In short, everyone loses.

Is there a way everyone could win? Is there a way of looking at the New Space Program which would encourage more cooperation and less destructive forms of competition? Let us consider the sources of conflict, and possible ways of reducing it.

First, should the NSP have fewer goals? Fewer goals would decrease the range of support. Would lessened interest in space colonies increase support for SPS? I think not. Would lessened interest in SPS increase support for space colonies? Certainly not! Is the SPS a credible goal? Congress seems to think so. Are space colonies a credible goal? The only serious question is *when* — fifteen years, fifty years, or a century. Since space colonies have generated vigorous grass-roots support for SPS and space industrialization, advocates of the latter would seem ill-advised to spend effort attacking the former. Indeed, it is hard to conceive of a ground-launched SPS program, with the cheap space transportation it implies, not eventually leading to a growing space population, better space living facilities, and exploitation of space materials. In short, all our goals are credible, and all our goals help gather support: *diverse goals strengthen the New Space Program.*

Second, should fewer competing means be proposed to achieve these goals? Fewer means, like fewer redundant systems, would decrease the chance of reaching our goals, and would weaken our case for development of the technology base common to all large-scale space enterprises. So long as technical criticism weeds out worthless proposals, *competing means strengthen the New Space Program.*

Third, is destructive competition an effective way to help one's project? Advanced space planning is a minute sliver of the federal budget, and hence is elastic. At best, elimination of a competitor might slightly increase the funds available for other work — while crippling the case for the NSP as a whole. More realistically, *attempts* at destroying a competitor result in counterattack, weakening of both sides, and even greater losses to the NSP. Benefits from destructive competition range from small to negative.

In light of our technical and political common interests, and of the strength inherent in diverse goals and competing options, and of the futility of attempting to destroy the competition, cooperation would seem advisable. A few suggestions:

1) Project a positive attitude towards the whole range of NSP goals. After all, are space industrialization, solar power satellites, or space colonies actually bad ideas? Have any of them been shown to be impossible?

2) Support further study of all viable concepts. This will cost little at present, will encourage others to return the favor by supporting study of your concept, and besides — what better way to uncover the flaws in your competitor's ideas?

3) Make sure the flaws in your competitor's concept are studied, by supplying technical criticism — preferably in technical circles rather than before congressional committees.

4) Be open about uncertainties and difficulties both for credibility's sake and as reasons for further study.

5) Discourage NSP community members from destructive behavior by friendly-but-critical phone calls and letters in response to harmful public statements.

In his congressional testimony of April 14, Dr. Peter Glaser sets a good example:

"The SPS development program will focus development efforts on space processing, fabrication, assembly and maintenance; human habitations in orbit; space transportation efficiency, and the need for future exploitation of extraterrestrial resources, thus setting the stage for achievements which may transcend anything that heretofore has been accomplished by the human species."

If we recognize our common interests and interact more constructively, the NSP community will become more unified and more effective. Together, we have considerable credibility and political power. Together, we can bring the New Space Program into the national arena, defend it successfully, and set this country back on the road to space.

Suppose Isabella Had Said "No"?

by Robert G. Nichols

"Suppose Isabella had said'NO'", reads the caption on the poster hanging over my desk. The poster shows an illustration of the Moon behind Saturn V at liftoff. Beneath these is a drawing of Columbus' three ships at sea.

Well, what would have happened had the Genoese navigator failed to pursuade Queen Isabella to finance his expedition to what he thought would be China and India? Obviously history would be changed, but in the long run its course would have been similar.

At the end of the 15th century, the Renaissance was rapidly spreading from Italy to the rest of Europe. European traders were bringing back treasures from the East: Spices, cloth and wonderous works of art, as well as Eastern sciences, mathematics and philosophy. The European universities were quick to assimilate the new sciences and information, including a bit of knowledge handed down from the early Greeks: The Earth is round.

Christopher Columbus must have been exposed to this information while studying to be a navigator. His idea that the Orient could be reached by sailing west was in no way unique. It was an idea whose time had come. Columbus was simply the first navigator of repute who managed to fit out an expedition to prove it.

If Columbus had failed to acquire the needed funds, if Isabella had said "NO", then history would credit another navigator with the discovery of the New World. He might have been from another country but he would have been armed with the same information.

The poster over my desk draws the analogy between Spain financing Columbus's expedition and the U.S. funding NASA's space exploration. Spain reaped immeasurable riches from Columbus' and subsequent travels to the New World. The U.S. has the opportunity to gain immeasurable benefits from its space program. Only a few of these benefits have been realized but others will soon be evident. Space industrialization, the next step in this nation's space efforts, will offer us myriad products, processes and services. The construction of powersats will reduce, if not eliminate, this nation's dependence of foreign oil. Telesats could make the term "global village" a reality.

There are signs, however, that the U.S. may be terminating its all-out support of the space program. NASA's funds have been cut repeatedly.

It is as if Queen Isabella, having seen its riches, discontinued expeditions to the New World. If Spain had ended such exploration, other nations would have taken the lead. The Portuguese, the Dutch, the British—all would have exploited the riches on the western side of the Atlantic, leaving the dregs and castoffs to Spain.

In a like manner, should the U.S. reduce its efforts toward space industrialization, others will press on. Already the U.S.S.R. has many more successful launches than the U.S. The Russians have built a space station where they are currently conducting research into space manufacturing. Great Britain, France, West Germany and Japan all have active space programs. A private firm, OTRAG, has built a space port in Zaire. They claim to be able to deliver a payload into orbit more cheaply than the space shuttle.

If the U.S. decides to cut back its space program, space industrialization will be carried on by others. It might take longer, but the "Third Industrial Revolution" will occur. Americans will simply enjoy less of the benefits.

Suppose Isabella *had* said "NO." Well, Europe would still have found its way to the New World. But the people of Mexico might be speaking Dutch instead of Spanish.

SPACE HABITATS BY ACCIDENT?

Speaking at the 1978 Robert H. Goddard Memorial dinner in Washington, D.C. in March, Dr. Hans Mark, Under Secretary for the Air Force, offered his views on the future of space exploration.

Keyed to the year 2000, Mark believed by that date "normal" people will have flown in space, pointing out that as many as a hundred people sitting in a future Goddard dinner will have partaken in orbital flight.

Also by 2000, space will include permanent residents but, emphasized Mark, it would not take place by the popular O'Neill concept. "It will happen by accident," felt Mark, believing that maintenance stations will provide a service to repair and replace earth-assisting application spacecraft. "The friendly telephone repair man will be there," and as space living conditions improve, such repair men "will volunteer for extra duty" concluded Mark.

Expanding his presentation to include the entire universe, Mark stressed that "a new horizon of knowledge will be created" producing "a new feeling about ourselves". The possible understanding of such cosmic wonders as neutron stars, black holes, quasars and the properties of matter will lead to a unified field theory Mark felt, which in turn will create an "intellectual revolution of our understanding of planet Earth in the universe".

SPS PROMOTED TO DOE BACK-BURNER

by Eric Drexler

Yes, the SPS has been moved up onto the back-burner from the dust behind the stove DOE established an SPS program office last April, and now has an SPS group at Argonne National Laboratory, in Argonne, Illinois. Further, DOE now has plans to supplement its previous "SPS Concept Development and Evaluation Plan".

This plan calls for DOE to spend $3,341,000 on environmental impact studies, socioeconomic impact studies, and comparisons with other energy systems during fiscal '79, while NASA spends $1,300,000 on system definition studies. In fiscal '80, DOE funding and NASA funding are to **drop,** by $714,000 and $500,000 respectively. No money is to be spent on space-related technology work, which most researchers consider a high priority.

DOE now plans to request an addition of unknown size to the 1980 budget for what they call Ground Based Exploratory Research, apparently to be spent primarily for evaluation of microwave effects. One source in DOE states that this request was sent to OMB in late May; another states that it will not be ready until October.

In response to questioning, one source in DOE stated that the Flippo bill funds would be useful for getting long-term environmental studies under way — "if OMB will let us spend it" — while another stated that the Flippo bill was "premature," and that microwave effects should be studied in great depth before even beginning to develop and test SPS technology. Opinion in DOE has it that evaluation of the chronic effects (if any) of low-level microwave exposure will require 20 years.

People in Space—An ESA European Viewpoint

by Phillip J. Parker

With the United States busily preparing its Space Shuttle vehicle for the beginning of a new era in space activities in the 1980's and the Soviet Union increasing the pace of its spaceflight programme towards permanently staffed space stations, I recently questioned officials of the European Space Agency (ESA) on how they foresaw European activity in the sphere of human spaceflight and in the wider overarching concept of space industrialisation.

For about one year, ESA has been actively defining the possible elements to an extension of the present Spacelab reusable space laboratory (which ESA is producing as Europe's contribution to the USA's Space Transportation System) that might possibly lead to a contribution to space stations. As a first near-term step, shortcomings of the present Spacelab design could be removed, including giving higher power to the Spacelab payload, extending mission duration beyond seven days and including selected improvements in certain subsystem areas. A second and third Spacelab follow-on development step could foresee contributions towards a power module — which is beginning to figure increasingly in NASA studies of future space station steps. The Spacelab would be made compatible with the power module with respect to interfaces, particularly concerning higher power levels and heat rejection. Mission duration capability would be increased and steps initiated to make Spacelab more autonomous from the Shuttle Orbiter. This might include, for example, the deployment of Spacelab pallets from the Orbiter and their attachment to the Power Module

A fourth step under consideration could be the deployment of the Spacelab module and to intoduce either intermittently or permanently operations in connection with the Power Module. The last far-term step under consideration is the applicability of Spacelab as an element of Space Stations. Further options under discussion are the contribution of solar arrays to the Power Module (if built by NASA), mission-dedicated Spacelabs (e.g. materials processing, life sciences), and further co-operation with NASA in its studies of space stations.

A Social Psychologist Looks at the Space Program

by Charles J. Divine

I would like to discuss some reasons why the space program has seen opposition in recent years. An understanding of past objections may help us understand objections to the new proposals for space. I also plan to explore, briefly, the impact upon humanity these new ideas may have.

Many people oppose these proposals on grounds that they are impossible (Senator Proxmire described them as a "nutty fantasy"). Remarkably new ideas have been greeted in similar fashion in the past. The first steamboat was called "Fulton's folly." The purchase of Alaska was called "Seward's folly." Thomas Hobbs predicted disaster for the new democracy of the United States. Late in the nineteenth century, physicists predicted little future development for their science (a noted British physicist, Lord Kelvin, remarked "The future of physics lies in the tenth decimal place."). It took three years for the Wright brothers to win recognition for their efforts. Recently I read in a newspaper that Japan abandoned work in nuclear weapons during 1943 after concluding that such weapons could not be developed before the end of the war. The people who voiced these opinions were neither foolish nor incompetent; their reasons were frequently well thought out. The success of the seemingly impossible was rooted not in the conventional ideas of the time but in a new set of ideas which extended human knowledge.

Other problems confront these new proposals for space development. Supporters of the space program have justified it in terms of international politics, scientific exploration or as a grand adventure for humanity (or at least a few humans). People have thus come to see the space program as an expenditure of our wealth and, to many, an extremely ill advised one at that. As an example of this attitude when I started to bring up these ideas with an acquaintance, her first remark was "I don't want to hear about it. People are starving and we can't afford that space nonsense." She didn't even want to listen to an idea which could greatly benefit the world's starving millions, because it was a "space" program.

Further contributing to the wasteful image of our space program is its exposure. Our space program has been carried out in full view of the world. Its successes, failures and costs have been widely reported. This stands in great contrast to, for example, the development of the modern computer, which was developed in private laboratories at private expense and given to the world in already useable form. When a computer breaks in a lab, it requires specialized instruments to detect it. When a rocket blows up on a launch pad, a child can tell something has gone wrong.

A further difficulty of the space program is the long time required to develop any new technology. With much of the development visible to the general public, this creates problems. A space scientist or engineer cannot work quietly in the laboratory and present his results as if by magic, hence progress seems comparatively slow.

Also increasing the impact of cost is the fact that the government spends our tax dollars on space research but does not directly reap the benefits thereof, as a corporation reaps benefits from its research expenditures. This not only makes calculating the relation between cost and benefit more difficult, but also tends to destroy the link between the two in the average person's mind.

Adding to this problem is the lack of full awareness by the public of the benefits already obtained from the space program. Rockwell International's *Why Space is Important to Our Future* is quite informative in this regard; I learned a great deal from it.

Regarding this impact of space on public thinking, there are important reasons for supporting House Concurrent Resolution 451. In recent years we have heard much talk about the limits of our world and how these limits will adversely affect our democratic society. Work on space industrialization and settlement will demonstrate the fundamental shortcoming of *The Limits of Growth:* Forrester's model ignores technological innovation. Vajk (1976) and Boyd (1972), by incorporating technological change in their model, arrive at results quite the opposite of Forrester's.

As a social psychologist, I have become concerned about the society proposed by many limits of growth advocates. Their proposals seem to regard democracy and individual freedom as incompatible with survival. Research in social psychology, as reported in Kelley and Thibaut (1969) and Gibb (1969), seems to indicate that democratic organization styles, with great individual freedom, are considerably more effective in solving complex problems, such as those encountered in developing technology. Seeming to bear out this analysis are the numerous difficulties encountered by the Soviet Union in recent years by its failure to develop, or even effectively use, modern technology. It would thus seem that by limiting freedom and weakening democracy, the limits of growth advocates might produce the failures they seek to avoid.

It would seem that a determined attack upon some of our problems could also give American society a vitality which has been missing in recent years. We seem beset by a wide variety of intractable problems--energy, unemployment, poverty, pollution. By attacking these problems in a forthright, imaginative manner we may restore the hope any society needs to function well and thus turn our society around.

Such an effort would also remind people that ofttimes many attempts are required before success is obtained, but when success is reached, it can repay all the failures many times over. Columbus' voyage to the Americas was not the first--many preceded him. But his voyage served to open up the Western hemisphere to the Eastern and led to vast benefits for Europe.

In this essay I have briefly indicated why we should support this new work in space. I have also attempted to deal with some of the objections raised in the past to such work. If you would like to discuss these ideas in greater detail or at more length, please contact me.

Charles J. Divine
214 Park Lane
Trenton, NJ 08609

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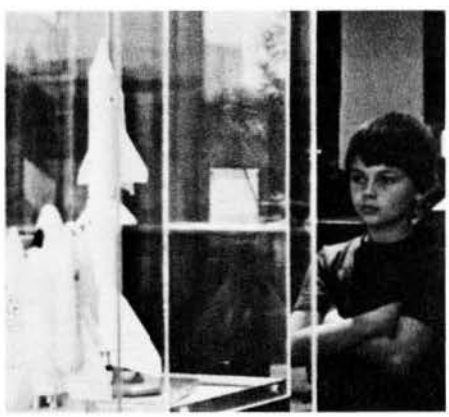


BOEING, ADL OUTLINE SPS DEVELOPMENT PLANS

by Eric Drexler

On April 13 and 14, O. C. Boileau, President of Boeing Aerospace Company, and Dr. Peter Glaser, Vice President of Arthur D. Little, Inc. testified before subcommittees of the House Committee on Science and Technology in support of the Solar Power Satellite Research, Development, and Demonstration Act of 1978---the Flippo bill. Their testimony gives us a picture of what a vigorous SPS development program should include, and discusses some of the less obvious benefits of such a program.

The supplement to Boileau's statement begins by pointing out that the U.S. spent roughly $200 billion on energy last year, and that of this sum $45 billion went overseas to purchase oil. It argues that a domestically controllable, non-depletable source of energy is vital to U.S. economic stability. Of the many energy alternatives that have been discussed, only fusion reactors, breeder reactors, and SPS are continuously available, non-depletable, non-regional sources of electric power. He points out that nuclear power research receives about one billion dollars per year, as compared to about five million for SPS —a factor of 200.

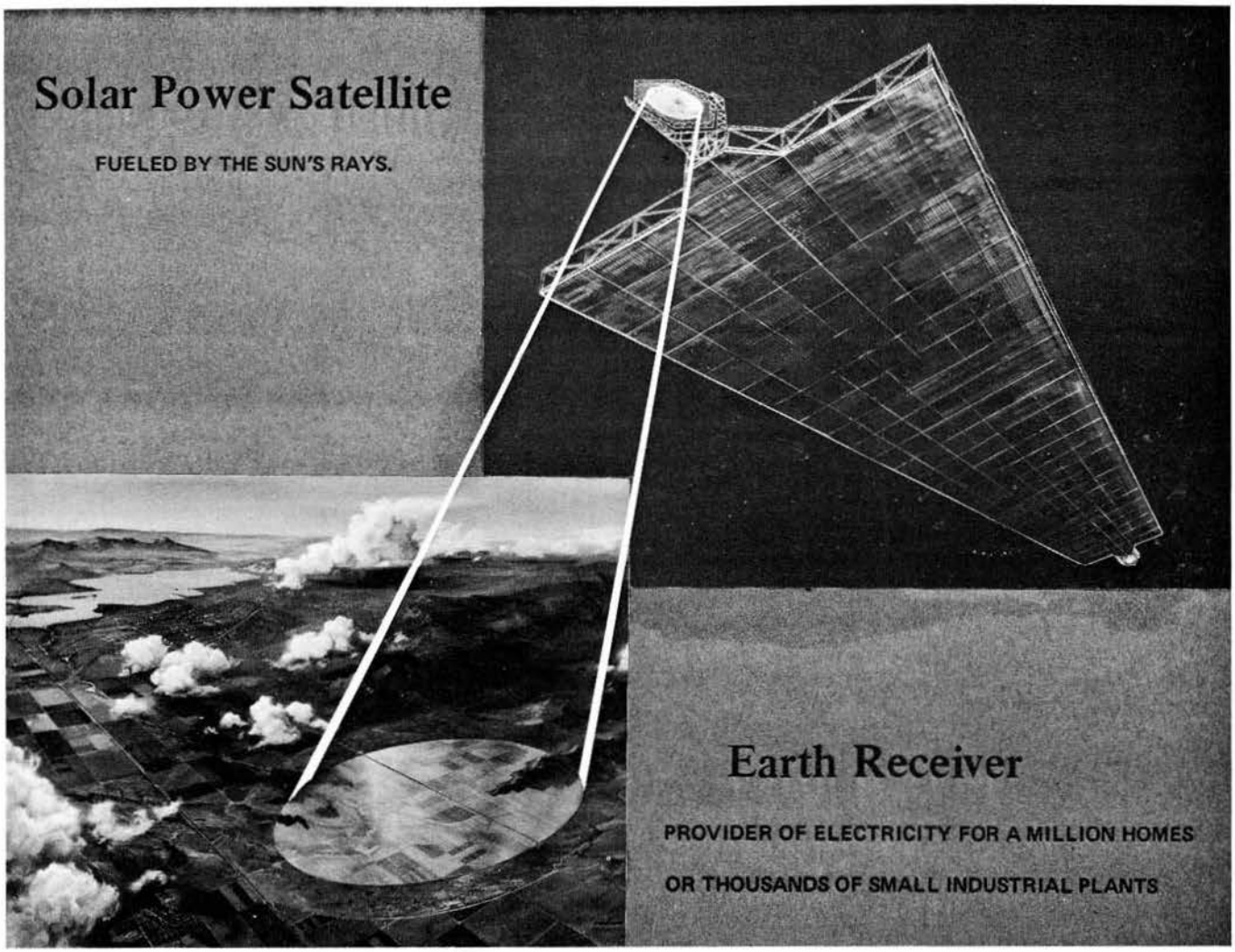
Reviewing past research, Boileau concludes that studies have shown SPS technology to be feasible, and that remaining questions revolve around cost reduction and a better understanding of system impacts. To answer these questions, Boeing proposes a three-phase technology developement and verification program, consisting of:

---Ground-based technology verification
---Flight tests
---Technology verification power unit

For the first, Boeing details a five-year, $173 million program ($25 million in the first year, as provided for in the Flippo bill) to develop and test solar cells, materials, structures, thermal engines and systems, power distribution controls, microwave power transmission systems, flight control systems, space construction operations, and space environmental effects.

Following and overlapping this, they propose some seven years of flight tests for technology verification, starting in 1980. This would include $50 to $100 million for a microwave interferometer experiment, some $675 million for shuttle sorties, and $2.1 billion for a power system test bed unit in low orbit, assuming the preceeding work gives favorable results.

To test the effects of long-term microwave exposure in an inexpensive manner, they propose to string microwave oven amplitrons over four acres of ground,



providing space for a variety of plants, animals, and types of land-use. A similar, adjacent piece of land would be prepared as a control.

Dr. Glaser's testimony begins by briefly discussing the technical merits of the SPS, then cites Dr. Frank Press, White House science advisor, as saying that high technology industries in general have shown almost three times the growth rate, twice the productivity increase, nine times the employment growth rate, and only one sixth the price increase of low technology industries. He further points out that SPS provides the best of both worlds, in that its high technology side is complemented by its need for employment-generating mass production of components. In addition, SPS could make the U.S. an energy exporting nation, helping to reverse the drain on our balance of payments.

After reviewing past work on the SPS, Glaser concludes that the technology to build them exists, and that risk analysis and prospects for economic viability justify proceeding with the next phase of development. He believes the Flippo bill would provide a vital supplement to the existing study program, permitting the terrestrial tests and space experiments needed to advance the credibility of the SPS concept. He outlines a development program consisting of three overlapping phases: concept feasibility studies (in progress since 1972), technology advancement, and demonstration projects. For the second phase, he proposes a five-year program with a total cost of $200 million---roughly 10% of the funding for advanced nuclear energy options.

Dr. Glaser then discusses some long-term implications and short-term benefits:

"Although studies to date have indicated that the SPS may indeed be one of the most promising options for generating electrical power which could be available in the post-1990 period, it would be premature to propose today a national commitment to actual deployment and operation of the system on a scale commensurate with energy needs. All that is needed now is a limited development program, as discussed above, aimed at resolving those outstanding issues which will determine the eventual priority to be given the SPS in the overall national energy plan.

"In addition to providing the information needed for timely decision, this program could contribute significantly to the achievement of much more immediate policy goals. Even in its early phases, a serious study of the SPS would be a most dramatic energy initiative. Unlike other energy R&D efforts, the SPS development program would capitalize on the international prestige generated by very successful U.S. space programs, especially Apollo. Although the scale of the SPS challenges the imagination, few will doubt the technical capability of this nation to deploy such systems in orbit. Like Apollo, the SPS is a major technological enterprise which can fire the spirits of people everywhere, engage international participation and cooperation, and, if it is successful, provide a powerful stimulus to economic growth, here and abroad. It is not a panacea, but it does offer a combination of desirable characteristics unmatched by any other proposed energy source.

"Because of these factors, a development program of the type envisioned in HR10601 could yield these short-term benefits:

(i) Slowing oil price inflation

By giving notice to oil supplying nations that a viable and significant alternative to dependence on oil was under investigation, the SPS development program could lead to some restraint in continued escalation of the world oil price. It should be noted that the cost to this nation of imported oil is such that deferment of an annual increase of only 0.1% (or about a penny per barrel) would pay for the program proposed here.

(ii) Changing public perceptions of the future

Because of its dramatic character and profound implications, the SPS development program can help engender positive attitudes towards the future in a way that could not be expected from, say, a commitment to coal gasification. In particular, it could modify the common opinion that nothing much is being done about the energy crisis. Moreover, a prerequisite for deployment of the SPS is development of a truly economical capability for transportation to orbit and for large-scale construction in space: the possibility therefore arises of other forms of space industrialization and, eventually, of human settlement off Earth. The consequences for the future of man may include the indefinite postponement of limits imposed by terrestrial resource exhaustion. Even in its early stages, the SPS program may thus help the current gloom and restore the classic American confidence in the future. Like Apollo, the SPS can serve the social purpose of "getting this country moving again"; but, unlike Apollo, the program can be justified in quite pragmatic terms.

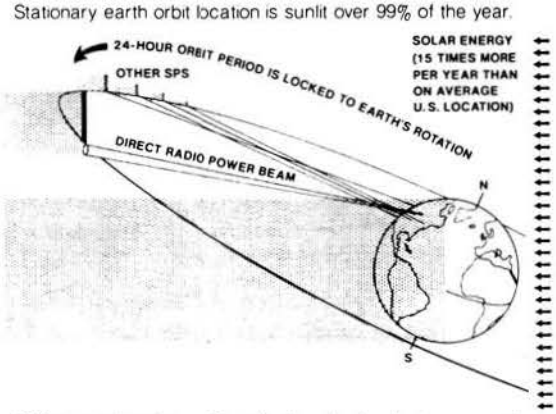
"It is difficult to quantify these types of benefits. But it is clear that they may be sufficient to justify the level of funding I have proposed for the next several years, even without regard to the longer-term promise of the SPS. However, these benefits can accrue only if the SPS program is credible: it must be funded at a sufficient level to demonstrate convincingly that this is a serious program. Present expenditures, approximating one percent of the total DOE solar energy budget, or of the budgets for other advanced energy sources, cannot be expected to achieve these goals."

Dr. Glaser's testimony concludes by discussing the goals of the Sunsat Energy Council (see "Sunsat Energy Council Formed," April **L-5 News**).

His testimony is particularly noteworthy for its support of a wide range of space goals, including industrialization, habitation, and mining. Such actions help to build a sense of community and common interest among supporters of these goals, which in turn will aid us in becoming a more effective political force (see "The New Space Program: Conflict, Cooperation, and Common Interest," in this issue).

Supporters of the SPS could build an even stronger sense of common interest by planning to devote a few percent of SPS funds to studies of how and when non-terrestrial materials should be phased into SPS production. NASA finds such studies credible (see "Lunar Resources Study Underway," May **L-5 News**), as does Congress (see "High Frontier Bill Introduced," April **L-5 News**). In addition to broadening the base of support for SPS funding and providing the overall proposal with more flexibility, such an action would increase one of the short-term benefits of the SPS program cited by Dr. Glaser: it would help in changing public perceptions of the future for the better. □

Stationary earth orbit location is sunlit over 99% of the year.



SPS is a solar dam. Once built no further fuel is required

Offshore Satellite Solar Power Receiver Studied

by Tom Brosz

An offshore structures division of a major Texas corporation is studying a proposal suggesting the possibility of constructing an offshore antenna to receive energy from solar power satellites and deliver it to coastal cities.

The solar power satellite system uses a large satellite placed in an orbit which makes it appear to remain over a single position on the earth's surface. This satellite collects energy from the sun night and day, and transmits the energy in the form of a tight microwave beam to a point below it on the earth.

The microwaves are collected by a large receiving antenna on the ground, and converted into electricity for use.

The ground receiving antenna is a flat surfaced array which is spread over several square miles to intercept as much of the microwave beam as possible. Some designs cover a roughly circular area 7 kilometers across.

Despite the enormous size of the antenna, it is actually quite lightweight. The antenna surface is made up of receiving elements placed half a wavelength of microwaves apart (about 10 cm.). This grid of elements receives the microwaves, converts it to electricity, rectifies it to DC power, and funnels it into transmission lines. This grid intercepts almost all of the microwaves, allowing very little to strike the ground below the antenna. However, the grid allows most of the normal sunlight and rainfall through its chicken wire-like structure.

The efficiency of the system can approach nearly 100% in conversion, and the large area of the antenna permits leftover heat to be slowly released into the air around it. Hence, very little thermal pollution results.

The major problem with the antenna system has been locating the system far enough from major useful areas so as not to use up valuable landscape, yet have it close enough to the electrical customers to reduce the length of energy-wasting transmission lines.

The offshore structures division feels that one answer may be to locate the receiving antenna in shallow water offshore from coastal cities. Landspace would then be located close to the users of the electrical power.

Since most coastal cities are major shipping ports, the antenna would either have to be placed out of shipping lanes (difficult with such a large object) or built on high supporting towers to allow ships to pass along underneath. The height and width of the largest ship required to pass under the structure's "roof" would dictate the major dimensions of the antenna. This extra height would also keep the antenna clear of high waves and most spray, although the operation of the antenna is only slightly hampered by rain and moisture.

Initial designs show the flat antenna array supported on a field of towers resembling those used in oil well platforms, and using similar structural techniques to anchor them to the shallow bottom of the coastal sea. Heavy structure is required to protect the antenna from damage during high winds, common in southern and eastern U.S. coastal waters.

Studies will need to be made to research effects, if any, on shallow water wildlife and fishing. The antenna itself would seem to have little effect, as mentioned earlier, and the tower structures may even enhance sea life by providing shelter for fish and plants in the manner of natural reefs. If the structure is placed so as to be between the coastal cities and the prevailing direction of storm activity, it may even be possible that wind and wave action could be reduced by the maze of towers and antenna structure. This could result in reduced damage from frequent tropical storms.

The flaw in the offshore system would appear to be costs. A land-based antenna would have to be placed in remote areas of little used land, but would require much smaller supporting structures since it need be placed only a few feet off the ground.

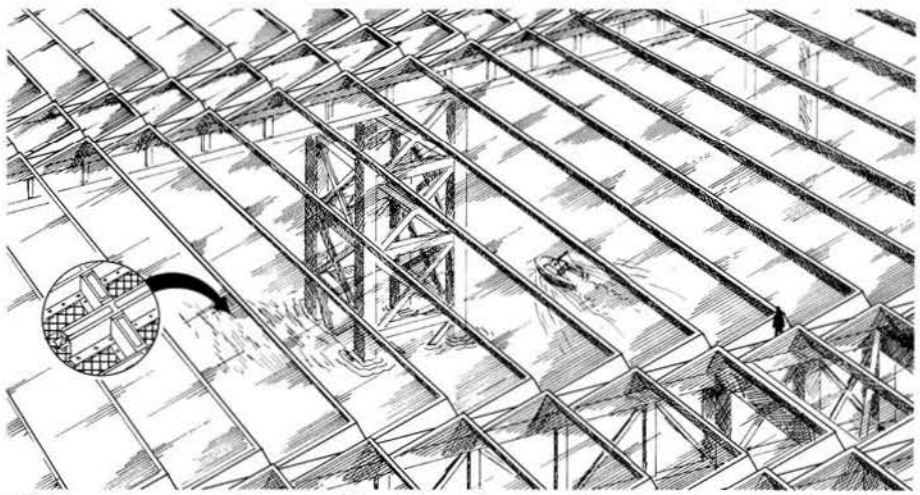
Ships do not need to pass underneath (though automobiles might), and it does not need to resist oceanic winds and waves. A land-based stucture would be built on the much cheaper principle of a chain-link fence rather than an oil-well platform. This cost must be balanced against the increased costs of the land-based system's need for much longer transmission lines to the power users. Transmission costs may be reduced somewhat by using DC transmission, though installation costs would not be greatly improved.

Other cost factors to be examined:

- increased fishing production due to "artificial reefs" of offshore antenna support towers
- possible use of support towers for oil drilling structures beneath the antenna's shielding effect, saving money on platform construction
- increased shipping costs due to having to pass through the rows of towers parallel to the rows instead of making a passage along a possibly shorter route through the area.
- Decreases in efficiency of microwave transmission due to passage through moister ocean air rather than dry, clear air over land-based system (usually assumed to be in some type of desert area due to criteria of low land value)

It is likely that costs not involving the antenna, such as launch costs and construction costs for the power satellite itself, will be nearly identical for both offshore and land antenna systems.

Reprinted from **The Foundation Report: Advances in Commercial and General Space Developments.** *Available for $15/yr. from Foundation, 85 East Geranium Avenue, St. Paul, MN 55117.*



A bird's-eye view of an offshore receiving antenna for a satellite solar power system. Detail shows enclosure for electronic components which turn microwaves into electrical energy. "Chickenwire" grid prevents microwaves from passing through the rectenna.

Laser Propulsion to Geosynchronous Orbit

by Eric Drexler

The laser propulsion concept, developed by Arthur Kantrowitz, chairman of AVCO Everett Research Laboratory, offers a promising alternative to chemical rockets as a means of getting off Earth. Although still in a very early stage of development, the outlines of a system concept have begun to firm up. The results are impressive.

Rockets work best when their exhaust velocity is not much less than the velocity they must reach. Unfortunately, the energy per unit mass available from chemical fuels limits the exhaust velocity of chemical rockets to about 4.5 kilometers/second, while the velocity they must reach to escape Earth or achieve a high orbit is about 11 kilometers/second. It is this mismatch between exhaust velocity and mission velocity that drives rocket designers to multiple stages containing vast amounts of fuel in the lightest possible tanks and structures. This, in turn, means large, expensive vehicles which are difficult to reuse. While chemicla rockets can be greatly improved through advanced designs (i.e., fully reusable shuttles and single-stage-to-orbit vehicles), alternatives seem worth considering.

Laser propulsion would sidestep the limits of chemical rockets by supplying power to the vehicle from a station on the ground. Laser heating of an inert propellant such as water can produce exhaust velocities around 8 kilometers/second, a good match to the task of carrying payloads (such as power satellite components) to geosynchronous orbit. This, in turn, cuts the ratio of propellant to payload, permits single-stage vehicles, and makes lightweight structures far less important.

The laser power needed to launch a vehicle into space scales directly with its mass, the ratio being approximately one billion watts (1 GW) per ton of payload. Since the cost of the system depends mainly on the laser power required, small vehicles seem best. Most studies have assumed a payload of one ton, about a thirtieth that of the shuttle.

Since infrared carbon dioxide lasers can be made roughly 20 to 30% efficient, a 1 GW laser will require around 4 GW of electric power and considerable cooling capacity (note power lines and pipes in figure 3). Reliability and ease of construction favor a bank of small lasers over a single big one. High-power laser development is classified, and the Department of Defense has not owned up to having a laser larger than 0.2 million watts (MW) — a development now quite a few years old. A declassified photograph of a large CO2 laser, together with standard scaling relationships, suggests that the U.S. now has lasers of some tens of MW, a quite adequate size.

The atmosphere poses problems to the propagation of laser beams, including absorption and thermal blooming. Both water and carbon dioxide absorb carbon dioxide laser light. To escape most of the former, the laser launching station would be located on a mountain top. The effects of the latter are reduced by elevation as well, but the phenomenon of atmospheric bleaching—momentarily saturating the absorbing CO2 with light so that it becomes transparent—helps even more.

Thermal blooming results when laser heating of the air makes it shift, destroying the focus of the beam by refraction. The Department of Defense has taken an interest in this problem, and workers in the field believe that it can be compensated for by use of actively controlled, flexible mirrors at the laser launching station. A good focus at a distance of 1000 kilometers and as much as 60 degrees from the zenith seems achievable.

The favored vehicle engine design involves a block of solid propellant (or a porous plate moistened with liquid propellant) surrounded by a short metal skirt (see figure 4). A weak laser pulse would vaporize a controlled amount of propellant, which would then expand in a fraction of a second into a layer about seven centimeters thick across the bottom of the vehicle. A powerful laser pulse would then heat the vapor to a high temperature, and the vapor would expand at high speed, giving the vehicle an impulse of thrust. The cycle would then repeat.

Such a vehicle could be quite cheap. Since the propellant tank (or block) is so small, it need not be designed to the absolute minimum weight — an automotive level of technology should suffice. Since many such vehicles would be needed, they would be built on an assembly line basis — again, very similar to automotive technology. If the electronics, sensors, pumps, and other valuable components were included in detachable reusable packages, one might readily believe the cost projection on the lower vehicle-cost line of figure 6: a mere $20/kilogram to geosynchronous orbit, for a traffic model typical of ground-launched SPS construction. This possibility makes laser propulsion well worth further investigation.

Laser propulsion work is still at a comparatively primitive stage of development. Calculations have been performed to answer most of the obvious questions, and experiments have been performed at the AVCO Everett Research Laboratory on small model engines. Classified work has apparently answered many of the questions relating to the laser and beam propagation. While NASA has virtually

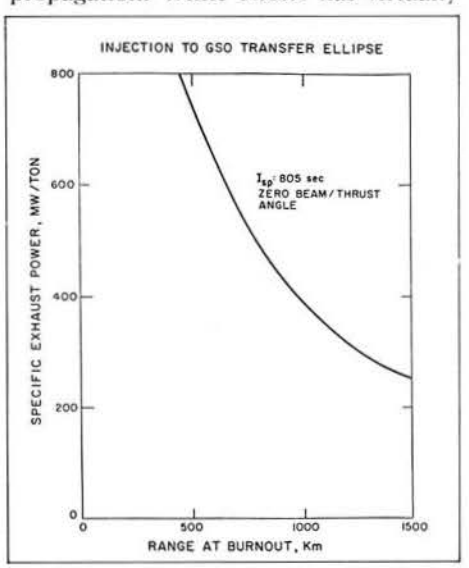


Figure 1

The exhaust power per unit burnout mass necessary to inject a single stage vehicle into a geosynchronous transfer ellipse is shown.[1,2]

Launch from earth at a °60 angle from the zenith is assumed. Less power is needed if the laser can accelerate the vehicle over longer ranges, but this requires better optics and/or a larger (and hence higher drag) receiver on the rocket.

The necessary laser size is obtained by multiplying the curve by the desired mass injected into orbit and dividing by the product of the internal efficiency of the engine times the atmospheric transmission (typically 0.8 to 0.9).

Circularization of the orbit at apogee could be accomplished with a solid propellant rocket to give the necessary 1.7 km/sec velocity increment. However, this reduces the payload by about a factor of two. Alternately, a relay mirror at geosynchronous orbit would be used for laser propelled circularization, which would give a post burn mass of approximately 80% the apogee mass

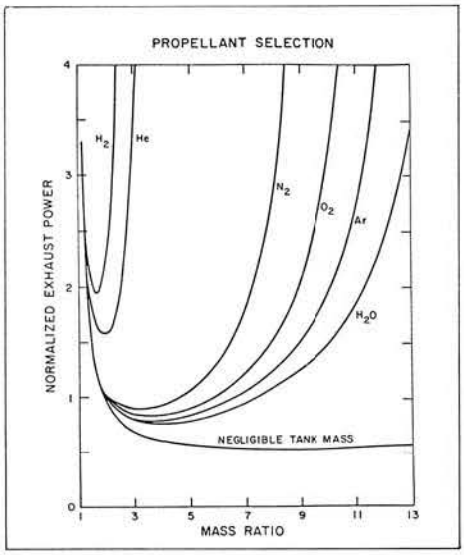


Figure 2

Laser Propulsion allows selection of propellant on bases other than specific enthalpy. Since the capital cost of the lasers tends to dominate the economics of laser propulsion, it is desirable to minimize the laser power necessary to launch a given mass. Hydrogen and helium are poor choices due to their low density and the consequent weight of the tankage. Water gives good results with a mass ratio (initial mass burnout mass) of five. This corresponds to the velocity ratio approximately 1.6 (final vehicle velocity exhaust velocity) that gives the best propulsive efficiency, i.e. minimum energy expenditures. Argon is also a reasonable choice, and its use might minimize atmospheric pollution effects.

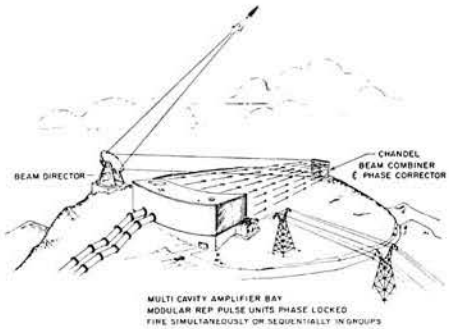


Figure 3

A gigawatt laser facility for laser propulsion could be constructed by combining the beams from a number of laser cavities. The converging beams would be rendered parallel to each other by a multifaceted element, the "chandel." Temporal coherence between the different beams is assured by using a single oscillator laser which drives a branching chain of amplifiers. Alternately a number of oscillators could be phase locked by injection of a signal, strong compared to spontaneous emission, derived from a single master oscillator. The spatial phase front is adjusted to give a diffraction limited beam at the rocket. Compensation is made for thermal blooming and inaccuracies in the beam director by adjusting the chandel elements or by introducing phase compensation in each laser. Signals for these corrections would be obtained by optical feedback from the rocket.

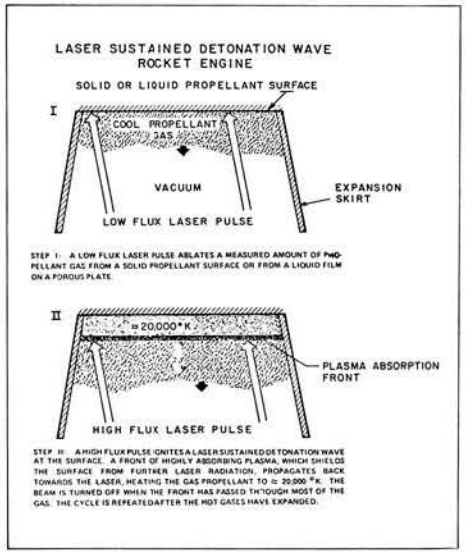


Figure 4

The laser sustained detonation wave rocket engine[2] is one of several approaches[4,5,6] to achieving the specific impulses necessary for single stage ascent to geosynchronous orbit. Since it is a pulsed device, atmospheric bleaching can be achieved to give good transmission at the 10.6 μ wavelength. The first pulse determines the amount of propellant to be heated and the second pulse does the heating. This allows control of the specific impulse, which scales as (flux/density).

Typical operating conditions for an 800 s I_{sp} engine would involve evaporating propellant to give an average density of 1-3 normal atmospheric over a distance of approximately 7cm from the base. A 2×10^7 watt-cm^2 thrust pulse; of 10 us duration heats the propellant and puts an impulsive load of approximately 30 atm on the base. The subsequent expansion is confined by a skirt of approximately 70 cm length. The calculated internal efficiency is 44%. Internal efficiency is defined as the ratio of one half the gas mass times the square of the effective exhaust velocity divided by the incident energy.

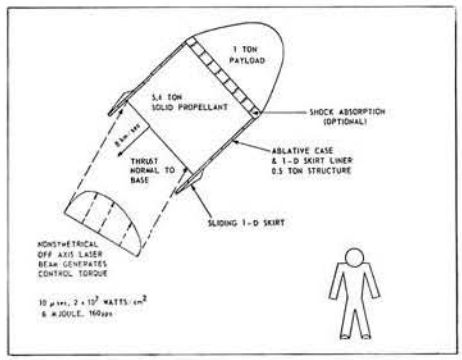


Figure 5

This figure presents a conceptual vehicle design for a single stage to geosynchronous orbit rocket using solid propellant. Reinforced ice is a possible propellant candidate. The flux distribution of the thrust pulse and the propellant metering pulse is controlled by optical feedback to the laser from sensors on the vehicle (not shown). Control torques are generated by using non-symmetrical flux distribution. The thrust generated by the detonation wave is normal to the base of the rocket, and this allows the laser beam to be somewhat off axis to the vehicle. Payloads such as coils of metal to be fabricated into large space trusses would not need cushioning against the impulsive accelerations. For more sensitive loads, peak acceleration could be kept less than 150% times average accelerations using maximum spring (or gas bellows) travel of less than 10 cm.

ignored laser propulsion as a means of ground-to-orbit transportation (it would compete with the shuttle, after all!), they have supported study of it for orbit-to-orbit flight. The Department of Defense, being less wedded to the shuttle, is supporting ground-to-orbit work. Why they are interested in a system with the capability of launching many thousands of tons per year is open to speculation.

Compared to large space freighters, laser propulsion offers several potential benefits to space industry, including lower development cost, lower operating cost, and lower environmental impact. Of these, the first two are uncertain and the last is of uncertain value; however, if release of water in the stratosphere should someday prove to limit rocket traffic, laser propulsion can either permit a larger payload per unit of water released, or can sidestep the issue entirely by using argon (an inert gas making up roughly 1% of the atmosphere) instead.

On the political side, other nations might view such a laser facility as a threat. In addition to giving the U.S. an impressive launch capability (Russia would doubtless prefer we had none), a 1 GW beam capable of being focused 1000 kilometers up would make a fine anti-satellite weapon. Making the facility part of an international spaceport could resolve this problem, and could help make better use of its enormous launch capability at an early date.

For space mines and space colonies, laser propulsion is a mixed blessing. On one hand, cheap transportation from Earth decreases the motivation for establishing space mines and space manufacturing facilities, and hence undermines the rationale for the O'Neill scenario. On the other hand, cheap space transportation will cut the cost of all operations in space, including space mines and space manufacturing. To the best of my knowledge, no one has given detailed consideration to how lowered launch costs affect the value of space manufacturing, but one thing seems certain: laser propulsion can at worst delay the utilization of non-terrestrial materials, while making their eventual use more certain, more economical, and more accessible to people as a whole.

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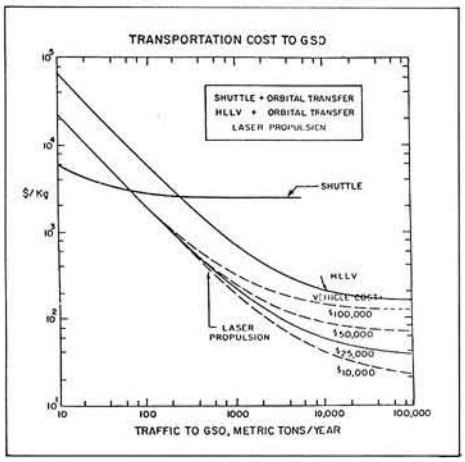


Figure 6

Due to the large capital costs of the lasers and the captive electrical generating facility, the full economic benefits of laser propulsion are only realized at large traffic levels. The 10^5 ton/year launch capability is sufficient to emplace a number of 5 G watt satellite solar power stations per year. Thus the energy payback time on the 4 G watt average launch power is short.

Even at a low traffic level of 100 tons/year, the laser propulsion system is competitive with the shuttle. Actually two systems are complementary since the shuttle can carry those loads which could not possibly be broken down into one ton masses.

The shuttle costs are based on payload optimization[7]. The cost at low traffic levels shows the effect of Orbital Transfer Vehicle[8] amortization. At very high traffic levels, economies of production would undoubtedly reduce the shuttle costs. The HLLV cost projections are also from Ref. 8.

BIBLIOGRAPHY UPDATE

by Conrad Schneiker

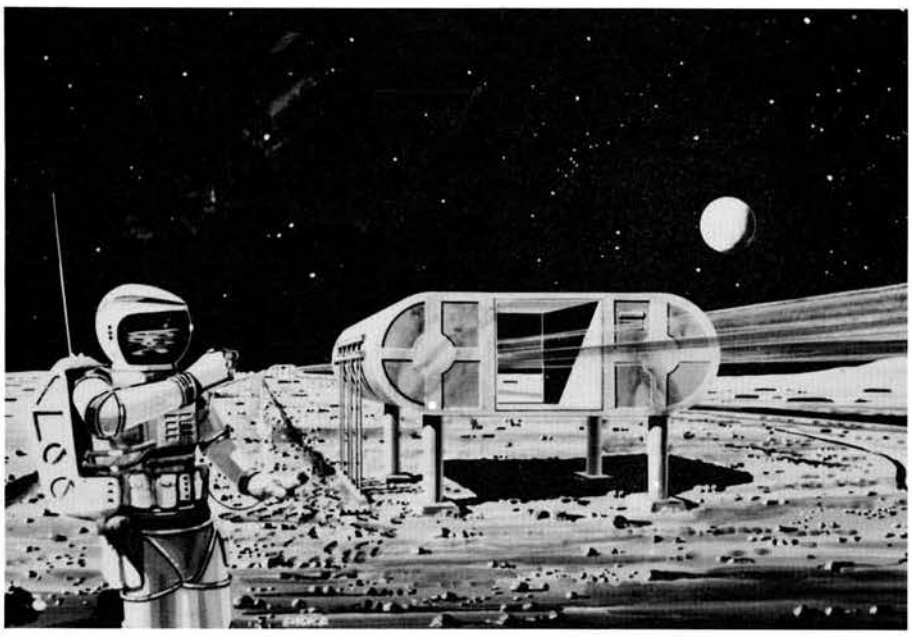
"Mining The Moon And Asteroids And Living in Space"
Brian O'Leary
Astronautics & Aeronautics, March 1978
Commentary on striking color paintings illustrating key facets of space manufacturing studied at the 1977 NASA-Ames Summer Study.

"The Low (Profile) Road to Space Manufacturing"
Gerard K. O'Neill
Astronautics & Aeronautics, March 1978
The article we (at **L-5 NEWS**) have all been waiting for. It describes an exciting new possibility for speeding up space industrialization. This involves powdering the Shuttle's external tank for solar-powered mass-driver propellant, yielding a 'breakthrough in space transportation economics." This and other developments cited greatly reduce the "ignition point" time (where dollar income exceeds dollar investment). A wealth of technical data is presented to bring the reader up to date on the latest developments in the High Frontier concept.

"High Frontier—Technical Progress, A Resolution, Commitments"
Gerard K. O'Neill
Astronautics & Aeronautics, March 1978
Introduces a special section in this magazine devoted to the High Frontier concept. The substantial advances made in this concept in 1977 are listed. The problems of promoting this concept as a program and the uncertainties facing it are mentioned. In reply to the oft'ed asked question of whether he will be swayed from his research if the Executive Branch attempts to stamp out research into the High Frontier, O'Neill gives a solid "NO."

IEEE Book Review of
The Zapping of America
P. Brodeur
D.R Justesen Charles Susskind
IEEE Spectrum, May 1978

This excellent review of the book on "deadly" microwaves and the microwave "cover-up" fills large gaps of relevent information ommitted by the book's author. The book's plausibility plummets as the reviewers present case after case of such gaps. Here are some examples. In reviewing the Moscow embassy microwave incident the author ignores the possibility that "revelent" Soviet "findings" are about as genuine as the recent Soviet "expose" of OTRAG's activities — i.e. scare tactics and propaganda. Other possibilities exist: microwaves bouncing off microwave-reflective surfaces subject to sound-induced vibrations may be used to listen in on conversations from a long distance, the U.S. may be using the alleged low-level microwave



An illustration from "Mining the Moon and Asteroids and Living in Space."

danger as a propaganda tool of its own, etc. In consideration of various population groups alleged to be suffering from microwave-induced ailments, the author ignores relevant group characteristics already known to account for increased incidence of such ailments in the groups mentioned (e.g. advanced age, high stress levels, etc.) One case cited as evidence of microwave-caused problems was just that: one case. It was subsequently contradicted by dozens of published experimental studies. In citing an experiment involving white-cell changes in mice, the author omits a crucial fact: the mice irradiated (by "deadly" microwaves) lived LONGER than the control group! And so it goes . . . Of course there can be dangerous levels of microwave radiation, and of course microwave related hazards require serious study, and of course the public should be well informed on the subject. In that light this sensationalistic book is a failure.

Future
April 1978
This new magazine bills itself as "the magazine of science adventure." It seems to be oriented toward the "reality fringe" of the science fiction crowd. It is packed with interesting, very well illustrated (in color) articles. They include Isaac Asimov on "Society in the Future," Jesco von Puttkamer of NASA on "Searching for Life on Mars," interviews with Fred Pohl (SF author) and Doug Trumbell (special effects wizard for 2001, Silent Running, and Close Encounters), a fiction piece set in what looks like an O'Neill Model IV space colony, and much more. And what's this here? It even has a review of the **L-5 News.** For subscription info, write **Future** Magazine, Inc., 475 Park Ave. South, 8th Floor suite, New York, NY 10016.

Space Age Review
January-February 1978
This issue marks an impressive improvement in print quality, layout and content over the previous issue. In addition to articles, there is a fascinating 10 page chronology of major space events of July through December 1977. One of the neat goodies is mention of Robert Truax ("father of the polaris missile") and his scheme to beat NASA at making the first piloted shuttle flight with his own hardware. Price: a mere half million dollars. For subscription info, write **Space Age Review**, 378 Cambridge Ave., Palo Alto, California 94306.

Skylark, Smithy In Space
Dagmar Heller
New Scientist, December 1, 1977
"The West Germans are buying British sounding rockets to learn how to fabricate pure materials under zero-g conditions. Their eyes are fixed firmly on future commercial applications." Some experiments to use the six minute free fall provided by the Skylark rocket are described. This free fall lowers forces on the payload to about 1/10,000 g.

Extraterrestrial Resources In The Solar System
Calvin Alexander
Foundation Report, January 1, 1978
"Materials shortages? Never Again." The materials are there for the taking in the form of asteroids. "To get at this material, there is no requirement for underground or pit mining, no waste disposal problems, no need to pay outrageous prices for energy in the form of process heat." We only need economical space flight.

Space Factories In 1997 -- Part 2
Dave Dooling
Spaceflight, November 1977
Considers difficulties in getting industry involved in space industrialization. Two promising products for space processing are discussed. They are urikinase (for prevention of blood clots) and silicon ribbon (for use in the microelectronics industry). For these items, it appears that space processing offers large advantages over current ground-based processing.

Militarization And The Outer Space Treaty—Time For A Restatement Of Space Law
George M. Robinson
Astronautics & Aeronautics, February 1978
A call to put teeth and resolve into the Outer Space Treaty of 1967 in order to limit the militarization of space.

Freedom Of Passage On The High Seas Of Space, Lt. Col. Richard E. Hanson, USAF-Ret., **Astronautics & Aeronautics,** February 1978
Presents a rationale for uniformed aerospace forces to assure freedom of passage in space, among other things. In effect, this is a call for increased militarization of space.

New Works In Space
James E. Kingsbury
Astronautics & Aeronautics, January 1978
Examines a variety of near-term space programs, both planned and under serious consideration. These include use of large space structures for communications, materials processing, and astronomy.

Economic & Environmental Costs Of Satellite Solar Power
Peter Glaser
Mechanical Engineering, January 1978
Briefly examines economic viability, socio-economic impact, and environmental effects of satellite solar power systems.

News Roundup/The Permanent Occupation of Space
Shana Goldberger
Mechanical Engineering, January 1978
A good overview of the 1977 AAS Industrialization of Space conference. Concentrates on the hardware aspects of space manufacturing.

Bargain Basement Rocket
John Dornberg
Popular Science, March 1978
By far the best article on OTRAG's innovative and common sense commercial approach to rocket launcher construction to appear in print. Details design philosophy, hardware, launch projections, marketing plans and history of this venture. Highly recommended.

"New Developments in Electromagnetic Energy Beaming"
Ervin J. Nalos
Proceedings Of The IEEE, March 1978
This issue summarizes electromagnetic energy beaming trends. Of interest to L5-ers are parts concerned with the microwave frequency spectrum, large-aperture antennas, high power-long distance beaming and radio frequency to direct current conversion. These developments and their impact on the SPS are considered and illustrated via the front cover artwork.

The Disposal of Nuclear Wastes in Space
Michael A. McCallum
Analog, March 1978
Considers nuclear power station economics and safety aspects of nuclear waste disposal. A convincing argument is made for not only the feasibility of nuclear waste disposal in space but for the safety and economy of such a program as well. Extra bonuses include keeping the Shuttle busy and elimination of high-level wastes generated by the U.S. nuclear weapons program.

Air & Space
March 1978
This is the new mini-magazine from the National Air & Space Museum (Smithsonian Institution). It's for (and free to) educators. Twelve pages of professionally done, well illustrated, shorts, non-technical articles on the U.S. space program and related topics appear in this issue.

Space World, April 1978
Without minimizing the enormous difficulties inherent in interstellar flight, methods for achieving it without exotic new technologies are presented. One particularly simple scheme involves a large solar sail — powered by a battery of lasers in solar orbit — and the laser beam's energy flux needn't be especially high.

NORAD Provides A Long Range Look Into Outer Space
"NORAD News Release"
Space World, April 1978
Mentions situations where NORAD's Cheyenne Mountain Intelligence Center has assisted NASA. NORAD can determine whether or not a panel on a satellite is correctly deployed even though the space object is 1,000 miles or more from the radar tracking site.

"Volksraketen For The Third World"
Farooq Hussain
New Scientist, March 23, 1978
Yet another article on OTRAG. Notes the close conformance of the "OTRAG" Penthouse article to East German and Soviet inspired propaganda on the subject. Also mentions a number of glaring errors in that article. Gives a very brief history of OTRAG and some of its technical innovations.
National Scene: "Ariane vs. Space Shuttle"
Wilbur L. Pritchard
Astronautics & Aeronautics, April 1978
"The developing competition between NASA's Space Transportation Systems . . . and the European Space Agency's launch vehicle Ariane presents us with the most fascinating contest in the space business since the U.S. and USSR raced for the Moon of the Sixties." The advantages and drawbacks of the Shuttle vs. Ariane are compared. Neither system emerges as the clear cut winner. The potential user community is so diverse it seems no single system could ever be adequate. In the Shuttle-Ariane drama, politics may be the deciding factor. For example, the U.S. will no longer be able to block competition with the intelsat satellite system.

"Space Transportation — New Heading For The Future"
Robert Salkeld, Donald W. Patterson
Astronautics & Aeronautics, April 1978
Summarizes a forthcoming survey of the new space transportation system and technologies leading to more economical follow-ons.

"Solar Sails"
Steve Lee
The Cornell Engineer, December 1977
Explains the design (square and heliogyro), use (maneuvering), and benefits (no fuel consumed) of solar sailing. "The technology is at hand, the potential is immense; only the funds and the drive to go ahead are missing."

"Cornell Engineer Interview: Dr. Gerald K. O'Neill"
Corey A. Burchman
The Cornell Engineer, December 1977
The interview ranges over many topics including the history and present status of the high frontier concept, the mass-driver, extra-terrestrial life in our galaxy, and the end of the dead-end limits-to-growth world view.

"Into Space By Low Technology?"
Kenneth W. Gatland
Spaceflight, January 1978
An article on OTRAG's hardware, supplemented with a good deal of criticism. The critical remarks are of a technical and economic nature as opposed to the usual silly propaganda. Despite the article's very negative tone, the author concludes: "Whatever the outcome may be one cannot but admire the company's determination to prove a case for low-cost technology in a very difficult field of technical endeavor.

"Satellite Power System LEO vs. GEO Assembly Issues"
John Mockovciak Jr., Rudolph J. Adornato
AIAA Journal Of Energy, January-February 1978
Based on considerations of structural loading, attitude control, and collision probability for a strawman SPS, complete assembly in LEO followed by transport to GEO does not appear technically desirable. The best mix of LEO vs. GEO construction activity remains an open question.

"The Secret U.S.-Soviet Satellite War That Can Destroy The World"
Ernie Volkman
Argosy, April 1978
Despite the sensationalistic title, most of the text concerns spy satellites and their capabilities. There is some discussion of killer satellites, most of it speculative in nature. A few interesting events in this "war" are presented. For example, a spy satellite made use of the discovery that Russian nuclear submarines left a trail of (presumably radioactive) iodine allowing easy detection and tracking of these subs from space.

"Space for Women"
Space World, March 1978
This article was derived from a symposium concentrating on ". . . the realities of careers for young women." Includes a good discussion of the important topic of career-building.

"OTRAG: This Space For Sale"
James Oberg
Future, July 1978
A brief summary of the OTRAG adventure, which is ". . . as bizarre as any science-fiction scenario could hope to be."

"On Humanity's Role In Space"
Jesco Von Puttkamer
Spaceflight, February 1978
Considers societal, political, economic, psychological and operational aspects of roles humanity can play in space utilization. ". . . in anticipating the future it is important to emphasize that any limits that people can now set are most likely naive."

"The Air Scooping Nuclear-Electric Propulsion Concept For Advanced Orbital Space Transportation Mission."
R.H. Reichel
Journal Of The British Interplanetary Society, February 1978
An economic analysis of an LO_2/LN_2 collection system operating in a very low 109km orbit shows great cost savings for delivery of propellents to high earth orbits.

'Space: Industry's New Frontier"
Vernon Louviere
Nation's Business, February 1978
A long article describing the Space Shuttle program and the new era of space industrialization it may give rise to. Many new business opportunities and large projects likely to exist at that time are discussed.

SOLAR REVIEW AVAILABLE

"Solar Energy Research and Development: Program Balance," DOE/IR-0004, February, 1978, is available at the National Technical Information Service (NTIS) for $4.50. This DOE report was a review by the General Advisory Committee of the Energy Research and Development Administration (ERDA), which became the Solar Working Group when ERDA was incorporated into DOE last October. Copies may be ordered from NTIS at 5285 Port Royal Road, Springfield, Virginia 22161.

Two documents done for the Solar Working Group by SRI International entitled: "Solar Energy Research and Development: Program Balance," Annex, Volume I, HCP/M2693-01 and Volume II,

HCP/M2693-02, provide more detail. These two volumes are expected to be available from NTIS in the near future.

A new guide to DOE's solar energy programs contains information on program activities and structure, procurement methods and sources of solar energy information. Written in non-technical language, the guide describes technologies being emphasized in the various programs of the Division of Solar Technology: thermal power, photovoltaics, fuels from biomass, ocean thermal energy conversion, wind and satellite power systems. It also covers the following programs under the Assistant Secretary for Conservation and Solar Applications: heating and cooling applications, agricultural and industrial process heat and technology transfer.

Guide to Solar Energy Programs, DOE publication ET-0036, is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (ask for Stock No. 061-000-00042-9). Price: $2.40.

Market Announcement: For 1979 Publication Anthology: Working Title "The High Frontier"

Theme anthology of stories involving permanent colonies not on planets: "O'Neill Colonies", other artificial environments for permanent habitation, including asteroid civilizations but with major stress on artificial nature of environment (which presumably becomes "natural" to the inhabitants).

Nominal advance against pro-rata share of 50% of all royalties received by author. Book will be represented by Lurton Blassingame Agency and agent fees will be deducted. The book will be marketed abroad, some overseas sales already assured, pro rata royalties will be paid on all foreign sales. US publisher is ACE Books.

Rights bought: non-exclusive world anthology rights only.

As in my past anthologies, authors are invited to write stories for this collection and market the serial rights for publication prior to publication of the collection. Higher advances will be paid for original stories, but **pro-rata** shares will not be different. Sufficient time will be allowed for serial publication.

Previously serialized or anthologized stories also welcome.

Stories should use the non-planetary habitation as an integral part of the story, although a sufficiently good story in which the habitation is merely incidental will be considered. Send with ms. SASE and business-size SASE for editorial reply to Jerry Pournelle, 12051 Laurel Terrace Drive, Studio City, California, 91604.

The Sunsat Energy Council and the L-5 Society joined forces to make presentations and hand out solar power satellite literature at Sun Day festivities May 3 in 17 communities.

Local coordinators were Charles A. Carr for Los Angeles; Gary Barnhard for Washington, D.C.; Peter Vajk for San Francisco; Robin Snelson for New York City; Bill Wheaton for Boston; Julia Tracy for Seattle; Chuck Lundgren for Sacramento; Peter Mikes for Dallas; Michael Shields for San Diego; Lawrence Boyle and Jim Seevers for Chicago; Debby Byrd for Austin; Ken McCormick for Philadelphia; Riley Bishop for Kansas City; Bill Gardiner for Atlanta; Jon Roland for San Antonio; and Tim Katterman for Raleigh, NC. Rice University in Houston, Texas put on a display which included a working model of an SPS, complete with microwave transmission.

In some communities, most notably Philadelphia, solar power satellite proponents were met with active hostility by local Sun Day organizers. The reason given for their SPS antipathy was opposition to centralized and "high technology" power sources—of any nature.

However, in most communities the solar power satellite proponents were accepted as part of the "legitimate" solar energy community. Our thanks to all of you who worked together on the Sun Day project!

For more information about Sunsat, write or call:

Sunsat Energy Council
600 New Hampshire Ave. NW
Suite 480
Washington, DC 20037
202/338-8874

"SUN DAY" RESOLUTION

"May 3, 1978, is going to be Sun Day, a day of celebration for solar energy. If the public's reaction to it is anywhere near as enthusiastic as the Congress, Sun Day will be a very popular event indeed . . . . Sun Day is not anti-anything. It is simply and solely prosolar energy. For one day energy problems will take a back seat to an energy solution. While no single solar technology is going to solve our energy problems, the combination of all solar technologies can handle many of our needs. And Sun Day can make people aware of the scope and potential of solar energy." —*Sen. Charles Percy before the Senate in support of the joint resolution (H.J. Res. 715) proclaiming May 3, 1978, "Sun Day" which was passed.*

Zuni Chant Fails Ottinger

In one of Sun Day's first ceremonies, Rep. Richard Ottinger (well known to L-5 readers for his anti-SPS activism) and James Jeffords led 1,500 solar power devotees to the peak of Cadillac Mountain in Maine to greet the rising sun. Unfortunately, the weather was uncooperative, with clouds blocking the view. The crowd tried a sunrise call used by the Zuni Indians, to no avail.

Unfazed, Ottinger announced "We're here to celebrate the dawning of the solar age and bring the Administration kicking and screaming into it."

We recommend that Ottinger try his Zuni chant in geosynchronous orbit next time. We can *guarantee* the results.—*CH*

Even if the organizers of the Sun Day are opposed or even hostile to anything which may "smell of high technology" such as SPS, we at L-5 should restrain ourselves

from any activity which may be interpreted as a negative attitude toward SP terrestrial (SPT).

Last thing we want is to create in the public mind an image of SPS and SPT as two opposed or competing concepts. SPT may have been over sold, but it is nonetheless needed and it is in line with public sentiment.

Peter Mikes
Dallas, Texas

The L-5 Space Futures Society table during Sun Day festivities in Philadelphia.

Ken McCormick delivers introductory lecture on SPS for Sun Day activities in Philadelphia.

I would like to remind you of the fact that, although I did my best to coordinate the efforts of the Space Futures Society with those of the Sunsat Energy Council and the local chaper of the AIAA, I was by no means *the* local coordinator for Sun Day, as was reported in the LIS newsletter. I was just one of the several members of the Space Futures Society who worked hard to put on a presentation in Philadelphia which drew more of a crowd than the rest of the solar energy groups combined.

I think the mention of active L-5'ers in your newsletter is an important morale booster for those mentioned, but to single out one person for mention in an area where many are active can be an inadvertent slight to those not mentioned. If anyone should receive credit for our very successful presentation here, it is Rich Bowers, without who, since he organized the local group, there probably would not have been any presentation at all. Rich also made arrangements for our lecture hall and information booth, and was really the driving force behind all our Sun Day activities. Our slide show was prepared by Jon Alexander, with assistance from myself, Eric Laursen, Ron Smolin, Marc Hess, and Paul Hess.

I delivered a short speech before the slide show, which was presented by Jon Alexander; Ron Smolin then spoke about our organization, and Eric Laursen and I fielded questions. Ron Smolin and I both sent out press releases for Space Futures, Sunsat, and AIAA. Ron designed and printed our advertising posters; all active members of our group distributed the posters. The L5/Sunsat information booth was manned in turn by Ron Smolin, myself, Paul Hess, Marc Hess, and Rich Bowers.

Because the above mentioned people worked just as hard or harder than I did to bring about our presentation, and because other members of our group have put on local presentations at other times, it was somewhat of an embarrassment for me to be singled out for mention by LIS. I would be most grateful if you would, if it is at all possible, rectify the situation.

Jon Alexander and I joined Bruce Bon and Ray Hoover of the Maryland Alliance to distribute L5 Society literature and space colonization books at a recent science fiction convention in Washington D.C.. As at the New York convention which Jon Alexander and I also attended, the blue, one inch L5 buttons sold very well.

Thank you for your kind mention in the LIS newsletter of the National Action Committee for Space. We are not attempting to recruit members of the L-5 Society into the National Action Committee because they already have a very fine legislative information service--your own. You have done an outstanding job so far, and it has never been our intention to compete with you. I fear that we would look somewhat the worse in comparision, anyway.

The main purpose of the National Action Committee at this time is to provide for people who are not L5 Society members a legislative information service such as we both began to advertise last November. We feel that there are many members of other organizations who are eager to take action to support an enlarged space program, but who, for one reason or another, have not yet joined the L5 Society.

Ken McCormick
Birchrunville, PA

Inside the L-5 Society

Call for Papers

The American Astronautical Society's 25th Anniversary Conference, "The Future United States Space Program" will be held October 30 through November 2 in Houston, Texas.

The L-5 Society, a co-sponsor of the conference, is organizing a session for the afternoon of October 30 titled "Social Aspects of Space". Topics which fall under this heading include (but are not limited to) internal social and political structures that might be found in space settlements; social/political/environmental effects of large scale space industries, power satellites and space settlements on the Earth; possibilities for private space enterprises and their impact; and the political problems of funding space projects.

We hope that this session will inspire some controversy. If you have an interest in giving a paper which contradicts what you feel is the space colony "party line", by all means send us an abstract! Papers which bring up historical parallels, discuss treaties and bills under consideration, explore recent research findings, or propose innovative concepts are desired—generalized tomes on the virtues of capitalism, heterogeneity, feminism, "ecology", etc. are not desired.

Please mail your abstracts to the L-5 Society, 1620 N. Park, Tucson, AZ 85719 before August 30. The session will be chaired by Carolyn Henson; co-chairman is Don Hervey.

Boston L-5

"Why it is urgent that we look out into space at the present time, is that the prophets of doom may be right."

The Boston Chapter of the L-5 Society celebrated its founding at a May 17 wine and cheese social. The celebration was sponsored by SPACE, a Boston-based educational organization concerned with increasing public awareness of the potentials of space industrialization. Among the forty-plus people in attendance

were former astronaut, Phil Chapman; Arthur Kantrowitz, Director of Research at Avco-Everett Labs; Eric Drexler, Kevin Fine, Marc Hopkins and Bill Wheaton.

Wayne Jefferson, founder of SPACE, opened the evening by announcing that efforts were underway to proclaim July 20 as Massachusetts Space Awareness Day. Governor Michael Dukakis has been approached and is expected to make the proclamation some time in June. SPACE has had notable success with its past projects. In recent months its members have appeared on radio and television programs and have lectured before audiences throughout Massachusetts. A non-profit group, SPACE will be incorporated during the summer months.

Bob Nichols, who organized the L-5 chapter, outlined some of the projects the chapter will undertake. Nichols sees the chapter as being oriented toward television and radio talk shows. Nichols added that he had been in contact with the Boston PBS affiliate, WGBH, which expressed interest in televising a debate next season on space colonization. The chapter will be instrumental in organizing the debate.

After Nichols' talk the meeting turned to technical presentations by Kevin Fine and Eric Drexler. Fine gave a short overview and history of mass driver projects. He also discussed the newest mass driver now being constructed at Princeton by Gerard O'Neill. Eric Drexler gave a talk on the use of thin metal film solar sails for interplanetary transportation. Drexler believes that such sails may prove to be the most economical means of traveling in the inner solar system.

Dr. Phil Chapman delivered the keynote speech. He observed, "Our sun puts out enough energy to provide (an adequate standard of living) for something like ten million times the present world population. In order to utilize large amounts of energy, as well as to generate large amounts of energy, we have no option but to go out into space.

"One of the reasons, then, for pursuing a massive invasion of space by the human race is that it does free us from these various limits which people are telling us are going to mean that we have to lower our sights and live in a much more Spartan style in the future than we do now.

"Why it is urgent that we look out into space at the present time, is that the prophets of doom may be right. If we postpone establishing beachheads and colonies out in space, then we're going to find that there are other pressing needs that are going to come upon us. We're moving rapidly towards a situation in which the underdeveloped countries are going to demand their piece of the cake. And if we wait until we share out the cake . . . if the goods of the world, the present gross world product, is distributed evenly across the world, then you would find that there is very little surplus. Indeed, to feed adequately all the people we're going to have in the world in the year 2000 would require 70% of the present world energy production.

"We need to use the surplus in the interim, before that gets changed, to establish a beachhead in space so that we can go on expanding, so that we can go on living in an environment in which the pie is getting bigger and bigger instead of being preoccupied with dividing the pie up into smaller and smaller slices.

"There is one final reason, and perhaps the most overpowering reason, why I think it's essential that we press on rapidly with getting into space and that has to do with the nature of the human spirit, the nature of what man is, of what makes life worth living, of what makes man different from animals.

"I feel that this is best expressed in a poem, of which I am very fond, that Wade asked me to read to you this evening, and that is Tennyson's "Ulysses".

It little profits that an idle king,
By this still hearth, among these barren crags,
Match'd with an aged wife, I mete and dole
Unequal laws unto a savage race,
That hoard, and sleep, and feed, and know not me.
I cannot rest from travel; I will drink
Life to the lees. All times I have enjoy'd
Greatly, have suffer'd greatly, both with those
That loved me, and alone; on shore, and when
Thro' scudding drifts the rainy Hyades
Vext the dim sea. I am become a name;
For always roaming with a hungry heart
Much have I seen and known,—cities of men
And manners, climates, councils, governments,
Myself not least, but honor'd of them all,—
And drunk delight of battle with my peers,
Far on the ringing plains of windy Troy.
I am a part of all that I have met;
Yet all experience is an arch wherethro'
Gleams that untravell'd world whose margin fades
For ever and for ever when I move.
How dull it is to pause, to make an end,
To rust unburnish'd, not to shine in use!
As tho' to breathe were life! Life piled on life
Were all too little, and of one to me
Little remains; but every hour is saved
From that eternal silence, something more,
A bringer of new things; and vile it were
For some three suns to store and hoard myself,
And this gray spirit yearning in desire
To follow knowledge like a sinking star,
Beyond the utmost bound of human thought.
This is my son, mine own Telemachus,
To whom I leave the sceptre and the isle,—
Well-loved of me, discerning to fulfil
This labor, by slow prudence to make mild
A rugged people, and thro' soft degrees
Subdue them to the useful and the good.
Most blameless is he, centred in the sphere
Of common duties, decent not to fail
In offices of tenderness, and pay
Meet adoration to my household gods,
When I am gone. He works his work, I mine.
There lies the port; the vessel puffs her sail;
There gloom the dark, broad seas. My mariners,
Souls that have toil'd, and wrought,
and thought with me,—
That ever with a frolic welcome took
The thunder and the sunshine, and opposed
Free hearts, free foreheads,—you and I are old;
Old age hath yet his honor and his toil.
Death closes all; but something ere the end,
Some work of noble note, may yet be done,
Not unbecoming men that strove with Gods.
The lights begin to twinkle from the rocks;
The long day wanes; the slow moon climbs; the deep
Moans round with many voices. Come, my friends,
'Tis not too late to seek a newer world.
Push off, and sitting well in order smite
The sounding furrows; for my purpose holds
To sail beyond the sunset, and the baths
Of all the western stars, until I die.
It may be that the gulfs will wash us down;
It may be we shall touch the Happy Isles,
And see the great Achilles, whom we knew.
Tho' much is taken much abides; and tho'
We are not now that strength which in old days
Moved earth and heaven, that which we are, we are,—
One equal temper of heroic hearts,
Made weak by time and fate, but strong in will
To strive, to seek, to find, and not to yield.

"I think the spirit of Tennyson's "Ulysses" is one which has been downgraded in this society in the last few years. The spirit of Telemachus which says let us do the immediate things that need to be done, that we have to worry about—'what do we do about sewerage disposal'?—is the spirit which has today become dominant in our society. I for one am thankful that the spirit of Ulysses is still alive and well and living in Tucson."

Phil brought his talk to a close with a toast to the new L-5 Chapter and SPACE: "I would like to offer a toast to the proposition that this next generation has got to get up and out so that the next generation won't find itself down and out."

Phil's toast was received with a warm and loud chorus of here-here, bravo, and general joyous cheers.

Eric Drexler brought the evening's ceremony to a close saying: "This concept has gone a long, long way from 1970 when I started working on it. There was a time when no one was interested in this and, from that perspective, I think that we're half-way there."

After the formal presentations, the social continued on into the night with a dozen people discussing projects and arguing over strategies for the future until after dawn.

Anyone in the new England region who is interested in becoming involved in the L-5 Chapter please contact Bob Nichols at 110 Ewing Drive, Stoughton, Mass., 02072. Tel. 617/344-9570

Governor Proclaims Space Awareness Day

On June 26 governor Michael Dukakis of Massachusetts proclaimed July 20th as Massachusetts Space Awareness Day. This commemoration of the first Moon landing was initiated by the Boston-based organization, S.P.A.C.E., to provide a focus for promoting awareness of the New Space Program through the local media and specially organized activities. Similar efforts by other organizations around the country could turn July 20, 1979—tenth anniversery of the Apollo 11 landing—into a significant national event.

New L-5 Chapters

Tulsa L-5
President: Tom Huffman
3424 E. 41st
Tulsa, OK 74135
Secretary/Archivist: Andrew Westphal
Treasurer: Gary McClure

University of Houston L-5
c/o Physics Department
University of Houston
Houston, TX 77004

North Carolina State L-5
Robert Baldwin, Coordinator
Rt. 4 Box 121A
Waxhaw, NC 28173

State-Wide Organization Planned

Five local chapters of the L-5 Society in Texas are proud to announce our intent to form a state-wide organization. We plan to hold a charter convention on 26 August in Austin, and invite all interested Texans to attend. For more information, contact R.J. Howe, interim chairman, at (512) 472-8930, or write 306 East 30th, No. 108, Austin TX, 78705.

BAY AREA L-5

The Bay Area Chapter of the L-5 Society has been launched by an enthusiastic group meeting in Berkeley, California. The Chapter President is Mike Davis and the Secretary-Treasurer is David Brandt-Erichsen. The Chapter address is 814 Miramar Avenue, Berkeley, CA 94707. Anyone interested in participating please write or call David at (415) 526-9346 (home) or 645-5990 (work) or Mike at 845-2285 (evenings).

We are looking for (1) a free meeting place where we can hold regular monthly meetings, show films, give public lectures, and which can hold 50 or 60 people; and (2) free use of a 16 mm movie projector. If you know of either, please let us know right away.

The primary purposes of our chapter are to educate the public reguarding the possibility and desirability of space colonization, and to educate ourselves so we can better accomplish this. Our first major goal is to start a chapter at the University of California in Berkeley and to open the Fall quarter with a large publicity campaign. We intend to spend the summer gearing up for this.

We are preparing a slide show which we will make available to anyone in the area.

If any of you would like to participate with us, please let us know.

LA L-5

OASIS (Organization for the Advancement of Space Industries and Settlements, the Los Angeles L-5 chapter) will be holding regular meetings on the fourth Sunday of every month at 7 P.M. The July 23 meeting will be held at the Kiwanis Youth Center, 2525 Valley Dr. in Hermosa Beach. For more information or directions call Terry Savage, 374-1381 or 536-3209.

Status Report - John Muir High School

Howard Gluckman and John Sigwing of Space Science Media Group recently attended a meeting to demonstrate the equipment they use in their multi-media presentations on space colonies. The school has agreed to pay for the two to bring their presentation to Muir in early June when it is completed. The presentation is designed to be entertaining as well as educational, which should make it very suitable for high school students.

Several members are currently working on a questionaire to be distributed to L-5 members and the general student body. The questionaire would be designed to determine who would be best physically and psychologically suited to travel in the space shuttle and live in a space colony. The winner would be given an award, such as a model of the space shuttle, or something similarly appropriate and inexpensive. The main purpose of the project is to let students know how easy it is really to fly in the shuttle and to supply some needed L-5 publicity.

On other fronts, we hope to have a candy sale to help our rather pitiful account. We have obtained a relatively large selection of films to show at our meetings from NASA Ames Research Center, and hope to have several lecturers, including a J.P.L. employee scheduled to fly in the shuttle. We continue to pass out as much L-5 literature and other materials as we possibly can to as many people as possible.

Canadian Lecturer

Peter Jedicke, of London, Ontario, has given a talk on Space Colonies at a number of meetings, including the Royal Astronomical Society of Canada in Toronto, Hamilton, Niagara Falls, and London, and Viking, Alberta on May 22. Peter would be happy to give his talk anywhere in Southwestern Ontario, and he can be contacted at 519-433-2992.

FINANCIAL NOTE

Last month's "Revenue and Expense Statement, July 1, 1977 — April 30, 1978" showed a net operating surplus of $3,363.28. This is *not* money in the bank, itching to be spent: it is merely an increase in the quantity "assets minus debts."

BALANCE SHEET
May 1, 1978

ASSETS	
Bank	$(157.91)
Office Equipment	9,252.00
TOTAL ASSETS:	$ 9,094.09
LIABILITIES:	
Current Loans Payable	$ 420.33
Payroll Taxes Accrued	26.45
Note Payable, Office Equipment	7,864.20
TOTAL LIABILITIES	$ 8,310.98
CAPITAL ACCOUNT	$ (2,580.17)
Plus Surplus to Date	3,363.28
NET WORTH:	$ 783.11
TOTAL LIABILITIES AND CAPITAL:	$ 9,094.09

Translators Needed

Phil Parker would like members to contact him if they are able to perform a small amount of translation from English to French and English to German for him. This will enable membership details to be circulated in those languages as well as English.

Letters

"Nothing but Hard Rock"

In O'Neill's article in your March '78 issue I run across a puzzling statement:

> "But no opportunity waits forever, and the chance we now have can be lost within a few years."

I don't understand this at all. What chance is he speaking of, and why can it be lost within a few years? Surely he is not suggesting that if the Russians get into space in a large way before we do, it will be impossible for us to get there. After all, we are told that space is so large and rich that there is room for everyone out there and more. So what difference does it make who gets there first?

There seems some kind of implication that if the Russians get there first they can prevent us from coming out. Is this implication intended? It would follow then, that if we got there first we could prevent them from getting out. Is this the hidden message?

If O'Neill's words do not mean this, what do they mean?

I'm really not asking rhetorical questions here. I would like an answer. On the outside chance that you may not feel inclined to give me one, I am going to pass these questions along to Senator Proxmire and others, who may ask somewhat more insistently, if you know what I mean.

A small point. O'Neill talks about lunar "soil". I understand something about the processes by which soil is generated on the surface of the Earth—the action of wind and rain, of water freezing and thawing, and various biological processes. None of these exist on the Moon. Is O'Neill talking about that lunar dust? I would think quite a lot of something would have to be added to it to make it behave like soil as we know it on the surface of the Earth. How deep is that dust? And what is underneath it? I would guess nothing but hard rock. An exceptionally unpromising environment for any kind of construction.

John Holt
Boston, MA

In reply to Mr. Holt's question, the reference was to an economic rather than a military time-window. It has been pointed out by a number of observers that within one or two decades the economic position of the United States may be even more unfavorable than it is now for the initiation of any major new long-term venture to improve the economy. The approach to zero-population-growth results in a rise in the average age of our population, with a corresponding increasing welfare and social security tax load and a decreasing work force in the prime earning years to pay the necessary taxes. Rising energy costs combine with our losing, year by year, more and more of the share of the worldwide market to industrial newcomers who still retain the sense of vigorous forward motion that we have, to a great extent, lost. Our balance of payments deficit ran 4.5 billion dollars in one month alone this Spring and is projected to rise to $100 billion per year by 1985, with a consequent even more severe inflation and erosion of disposable capital.

Already the weight of these increasing problems has become so overwhelming that successive administrations in Washington spend most of their time coping with day-to-day crises; there is none of the sweeping youthful confidence and vision that spurred the country on to such past ventures as the transcontinental railroad and the Panama canal (both of great economic benefit in their time, whatever their faults). Washington has forgotten that no nation gets rich just by saving money; it must go out and make it as well. The danger is that even if a President with that kind of vision were to appear, if he or she arrives later than one or two decades from now the economic chains of crisis may be so tightly locked that there will be no disposable capital to fund any major new initiative, and that the increasing conservatism of an aging population will not support new ventures in any case. England has already travelled that road, and we are not far behind. Every businessman knows that "you have to spend money to make money," but realization of that fact, based on experience, may come too late if it arrives ten or twenty years from now.

As to the growing of plants in lunar soil, that was already demonstrated some years ago during the Apollo project. As is obvious and as I have detailed in **The High Frontier**, it is necessary to add water and nutrients (i.e. nitrogenous chemicals). The lunar soil is already well supplied with most of the necessary trace elements, because they have not been leached away by centuries of farming and water runoff, as much of our soil has been.

The final sentence is puzzling: ". . . nothing but hard rock. An exceptionally unpromising environment for any kind of construction." The highest buildings in the world, those of New York City, are built on the bedrock of Manhattan Island.

Gerard K. O'Neill
Princeton, NJ

According to an unreliable source, some of those plants grown at JSC were of a variety commonly grown in closets—hence the origin of the "high" frontier.

*On the suitability of rock for a construction base, we quote no less an authority than Jesus: ". . . a wise man who built his house upon the rock . . ." (**Matthew 7:24**). Even in those days, rock foundations were FHA approved.—KH*

"Wet Diapers Leftism"

In re the **Mother Jones** article quoting Dr. Aden Meinel against L-5 editor Meinel's SPS's, it appears Daddy has let creeping Andy Youngism into the Garden of Aden . . . Suggest the office send someone over to have a word with him, if you know anyone who has any contacts. Parents should be seen and not heard.

One amusing feature of **Mother Jones'** ridiculous clutching about for a Relevant Issue: the main gestalt of the 1960's wet-diapers leftism, of which **Mother Jones** is a warmed over example, was that Daddy really **should** be seen and not heard. Guess that point of view disappears along with one's imagination, spirit, and hairline.

Note that Robert F. Allnutt, formerly one of the big wheels on one of the two major space committees on the Hill, is now director of Legislative Coordination in the Controller's Office, Department of Energy.

David Murphy
Carterville, Ill.

"Dirty T-Shirts"

Really, Carolyn. I thought it was bad enough when you published pictures of L-5 volunteers in dirty T-shirts and Groucho masks, but *this;* this is the pits! How can you expect anyone to take us seriously

Errata

Credit for the artwork on the May and June covers belongs not to Johnson Space Center, but to Denise Watt, of Houston Texas.

In the May issue, the article "Astronaut to Lead Site Visit Group" states that Philip Chapman flew on the Apollo 14 mission in 1970. Apollo 14 did not fly until 1971, and, owing to a shortage of seats, did not carry Dr. Chapman.

In the June issue, the article "Intrinsically Valuable Materials in Space" states that H group chondritic meteorites contain 5 to 9×10^6 grams of platinum per gram of metal. The correct exponent, unfortunately, should have been "-6."

when you stoop to print a grotesquerie like Paul Siegler's "Be Your Own Astronaut?" It was especially disconcerting to find this ugly blemish in the center of what was an otherwise outstanding issue, with excellent articles by James Oberg, Eric Drexler and yourself.

If Siegler's article were some sort of a gag, I wouldn't mind so much, but he actually seems to be touting Robert Truax's proposal to place Evel Knievel or some other hapless "astronaut" atop a makeshift sounding rocket and blast him or her to the edge of space. As the vehicle would tumble uncontrollably (as Truax admits it would) toward a splashdown hopefully somewhere near Truax's ridiculous recovery "fleet" of one boat and three aircraft, the rocket's "pilot" would doubtless find comfort in the fact that Truax has estimated his or her chances of survival at 90 to 98%.

All of this, of course, would be a travesty of early NASA launches which sent chimpanzees and monkeys aloft for purposes of *research*, rather than public spectacle. Aside from the fact that Truax's "astronaut" would pay one million dollars to participate in this misadventure, there are only two reasons for Truax to place a person in his sounding rocket.

First, the use of any creature but a human being for the passenger in this vehicle would surely invite interference from the S.P.C.A.

Second, the prospect of the fiery death of a mere dumb animal would not draw the crowds of leering spectators which Truax hopes to attract.

Siegler seems to think this "Project Private Enterprise" is a good example of what can be accomplished with our capitalist system. If that were really the case, I would have to regard Soviet efforts to exclude private companies from space as being most commendable.

Ken McCormick
Birchrunville, PA

Those T shirts were clean!—CH

Microwave Debate

In response to the article, "Microwaves: SPS Hazard" (**L-5 News**, May 1978), I would like to challenge the statement on page 6 that nuclear radiation differs from microwave radiation by virtue of coming in particles.

Nuclear radiation includes gamma rays, a form of electromagnetic radiation like microwaves and an exceedingly dangerous form in terms of genetic damage and carcinogenicity because of its penetrability.

Convincing Joe Blow in Arkansas, Los Angeles, and all the other places he lives that microwaves do not share the dangers of nuclear radiation because the former are much lower in energy may be more difficult than by telling him they are qualitatively different, but, if we are to attempt to make our point on the basis of incorrect information or oversimplifications, we can expect our opponents to be very quick to charge that we hide unpleasant facts–or don't know what we are talking about!

Marjorie A. Walz
University, MS

Microwaves and gamma rays are indeed both forms of electromagnetic radiation—but we detect one by the oscillating currents it sets up in an antenna and the other by the sharp clicks it produces in a geiger counter. Physics tells us that everything has both a wave and a particle aspect; the simplification I made is standard, for good physical reasons. Microwave photons have roughly 100,000 times less energy than photons of visible light, and roughly 10,000,000,000 times less energy than gamma ray photons. Thermal agitation of the molecules in your body generates infrared photons with 10,000 times the energy of microwave photons. For this reason, microwave photons are seldom of practical interest unless so many are ganged up that the result may be described as a wave.

A number of book reviews have attacked Paul Brodeur's **The Zapping of America: Microwaves, Their Deadly Risk, and the Cover-up** *as sensationalistic and inaccurate (see Bibliography Update). While this helps our position somewhat, the microwave issue is not about to lie down and go away. As reported on page 7 of the 4 May 1978* **Nature**, *the U.S. Congress General Accounting Office has released a report which concludes that the levels of microwaves to which the public is exposed could be dangerous. Regardless of the physical facts, the political situation will likely worsen. Our best policy is still to argue that SPS can meet the strictest standards yet proposed, and is safe even assuming the worst about the effects of low-level microwave exposure. See "MICROWAVES: SPS HAZARD," May* **L-5 News**.*—E.D.*

"Enemy of Space"

Commenting on Tom Heppenheimer's and Tim Kyger's letters: Proxmire is an enemy of space. The man's mind is closed on the subject, as this quote testifies:

"Although the Carter Administration deserves high marks for rethinking the size of the shuttle orbiter fleet, cutting it from five to four orbiters, NASA's fiscal 1979 budget is still marbled with too much fat. For example, why proceed with the $40 million teleoperator retrieval system now? It is foolish to embark on a $14 million program, the search for extraterrestrial intelligence, with a first year cost of $2 million in a time when we are running a huge budget deficit. New starts such as the solar polar mission and the proposed earth radiation budget satellite may not be essential to the nation's well-being. And, of course, the shuttle itself may turn out to be a multi-billion dollar boondoggle."

I rest my case.

Robert Lovell
Shawnee, KS

Space Program Jobs

I have a job with the Link Division of the Singer Company, as a principal systems engineer. The pay is not as good as it should be, perhaps, but at least I'm working in the aerospace field. As you know, Link is building the Space Shuttle Simulator. I've been working here about six months, and Singer-Link is going through a reorganization and plans to increase the number of employees here from about 270 to around 500. There are **some** positions available for persons with no work experience with a degree in computer science, math, physics, and engineering. There are also secretarial and technician positions open at this time.

I hope you can mention this in the L-5 News. I would rather see people here that are dedicated to a career in space, instead of people just holding down a job, and this is one of the few aerospace related firms that are hiring at this time.

Singer plans to have the new employees hired before August, so if there are some readers who can qualify, the opportunity is here now. I will be happy to correspond with any interested party, and help them in any way I can.

The jobs that exist here, in general, will not, unfortunately, qualify a person for mission specialist, but it does make you visible and accessible to the companies that can and to NASA.

The best job opportunities exist for those with experience or a master's or higher degree. The pay is not as good as can be obtained with firms not in the aerospace field (or even some that are), but it does get your foot in the door. It seems strange to me that the aerospace firms pay so poorly, but, if you're as interested in space as I am, it doesn't really matter that much.

Troy Welch
110 Woodlawn #41
Friendswood, TX 77546