

L5NEWS

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L-5 NEWS

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COVER: Looking to space for the future of humankind.

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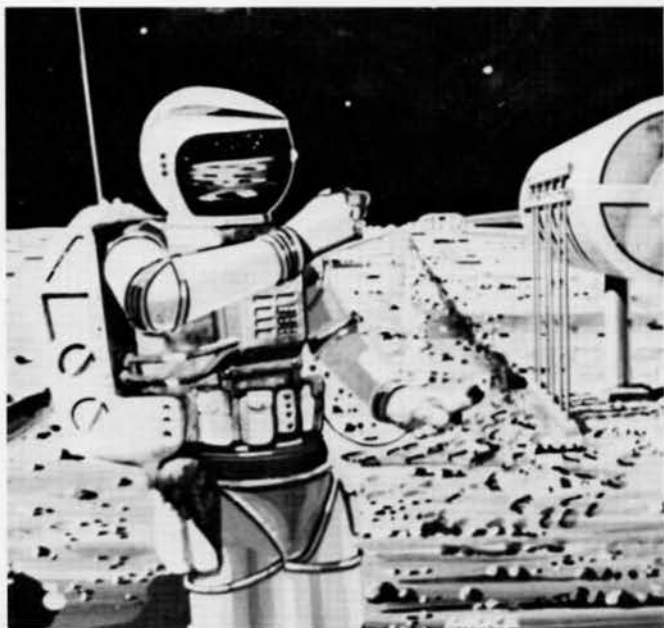
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Space Problems Examined at National AAAS Convention



Scientists explored the "Human Factors of Outer Space Productions" and recognized "Agricultural Systems for Space Habitats."

By ALCESTIS R. OBERG

EDITOR'S NOTE: Many thanks to the members of the L-5 Society who helped cover this convention. Special thanks to Margaret Adamson, Mike Nichols, Mike Pelizzari and Leo and Freny Berkenbile for rendering aid and comfort above and beyond the call of duty.

Our special congratulations go to Stephen Cheston and David Winter for arranging such a fine session on the

"Human Factors of Outer Space Production." The same goes for the well-done session on "Agricultural Systems for Space Habitats" arranged by Jack Spurlock and Micheal Modell.

Houston weather was at its dismal worst for the AAAS (American Association for the Advancement of Science) National Convention January 3-8. Thunder, lightning, heavy rain, cold and fog simultaneously greeted L-5ers who attended the Saturday sessions on

"Human Factors of Outer Space Production" and on "Agricultural Systems for Space Habitats."

And there were other inauspicious omens. All the hotel flags at the old Shamrock Hilton were at half mast, for the fallen Conrad Hilton. Conrad's portrait draped in black greeted all elevator-users. And to make matters worse, the Shamrock's Emerald Room, in which the "Human Factors" talk took place, was a chilling 58 degrees, simulating what life will be like in the

energy-poor '80s. The stout-hearted L-5ers who attended it huddled together for warmth. One L-5er muttered, between chattering teeth, "It's as cold as Proxmire's heart."

The papers, however, were warm with enthusiasm. They dealt with such exciting subjects as farming in space, different designs and safety features for large structures in space, problems with the human body in conditions of weightlessness, testing methods for screening potential space colony inhabitants, and so on. It was as fascinating as reading a good science fiction novel — better, in fact, since these scientists were dealing with existing possibilities.

But the optimism and hope for the future in these papers were not reflected by the economists who attended these meetings or by the journalists who gathered in the lobby and in the restaurant of the hotel. There, conversations were dominated by concern for the very existence of NASA.

Economists at this convention have offered many feasible and practical suggestions on a number of key issues, such as financing high-cost energy projects and looking into the financial potential of materials processing in space. But in private conversation these economists confided that the Carter Administration showed no interest in selling or developing the potentials of space, either in the area of solar power or in space manufacture. Others indicated that their suggestions for even the most minor policy changes in order to stimulate interest in these areas have fallen on deaf ears. And the overall impression was that Carter preferred austerity on Earth to the risks and opportunities of space industrialization in the future.

Even more disconcerting was the rumor, affirmed from many different sources here, that the Administration was planning to take away NASA's autonomous status entirely by attaching it to the Department of Transportation.

While a gathering of journalists pondered the myopia of Carter's space policy in the hotel restaurant, the "new austerity" was underscored by rain which dripped relentlessly from a faulty ceiling, drafts which assaulted the diner from all corners of the room, the absence of butter in a lukewarm buttered rum, and a meal that was cold — stone cold.

"We can do better than this," one person said, thinking perhaps of the 1980 elections, as he watched the sauce on his duck congeal before his eyes.

Who Will Go?

Selection Procedures for Future Space Colonists

"We don't want risk-takers who see danger as a kind of cleansing by fire!" exclaimed Dr. Kirmach Natani from the Department of Psychiatry, University of Oklahoma Health Science Center. In this talk on assessing candidates for jobs in space, he said he hoped this type of individual might be screened out in a selection procedure that would combine psychological and neurological information.

Survivability, social adaptability, high performance in stressed circumstances and innate cautiousness would be desirable qualities in space colony candidates, in addition to expertise in a given field, he said.

Psychological evaluation is often done now by means of psychometric measurements which involve interviewing a candidate and asking this person how he or she feels about various things. Also, socio-cultural background, intelligence and physical well-being are taken into consideration. "But the weakness in this kind of evaluation is that it assumes the individual knows how he feels and is honest about his feelings," Natani said.

A neurometric assessment, on the other hand, tests the nervous system of the candidate and provides a different kind of data. The equipment required for this is a desk microprocessor, flow charts of procedures for testing tasks and responses, and a strange-looking testing apparatus in which the candidate sits in a deliberately uncomfortable hunched position as his or her physiological responses are tested. As the candidate's responses to novel situations and tasks are tested, the physiological data is fed to the computer which compiles and analyses this information immediately, on a specific response-by-response basis. Since the test situations arise suddenly, the candidate does not have time to deliberate but must respond quickly. In this way, the individual's unconscious, nonverbal, innate responses to novel situations can be

assessed.

The weakness of this method is that it favors individuals who do well at visual tasks and perform well in a hunched position. "This could be overcome by giving a battery of tasks in a variety of positions," Natani said.

A neurometric assessment provides much valuable information about the nervous system of an individual. Such an assessment may help future personnel administrators weed out those who are accident prone and those who become negligent and careless when bored. Also a candidate may be counseled in areas of weakness and can be given specific reasons for non-selection. When psychometric and neurometric assessments are combined, a fairly competent and precise evaluation of a candidate can be made. This will aid those who must select and reject candidates for jobs in space.

Because a space habitat is a hazardous environment, thoughtless and reckless behavior on the part of one person may endanger the whole habitat. "It doesn't hurt to choose someone who is somewhat paranoid, that is to say, one who continually takes into account the potential hazards of one's environment," Natani said. And since novel situations are bound to arise in space habitats, it is important to assess and to predict a candidate's behavior ahead of time.

"In the past, astronauts came from stressed backgrounds; they were used to stress and novelty. But now people applying for jobs in space come from unstressed backgrounds; they are not test pilots. Neurometric assessments of these people can play an important role in the screening procedure," Natani claimed.

The clumsy of the world need not despair, though. Once the hazards of space life are reduced, they too could be chosen as space colonists, Natani assured the audience.

No Green Thumb Necessary in Space

CLSS Will Be Run By Computer

"You don't have to be a farmer to grow food in space," said John Phillips of Arizona Research Associates, Inc., Tucson, Arizona. In his presentation entitled "Developing Controlled-Environment Agricultural Systems for Large Space Habitats" (co-authored by Annita Harlan of Pima Community College and Carl Hodges of the University of Arizona), Phillips claimed that agricultural systems in space would be monitored by computers which could regulate nutrients, moisture and other such things.

Much research must be done, of course, before such a reliable, safe closed life support system (CLSS) can be developed for a large space habitat. Diet scenarios must be drawn up to meet the needs of the crew, crop species must be chosen for such a system, various animals must be studied for suitability and the system must be very reliable, predictable and labor efficient. Also, the environment of space must be studied in order to assess its influence on biological components.

However, the controlled-environment agricultural systems (CEA), currently under development and expansion in the U.S., Japan and



Plastic greenhouses in current use can provide experience and research for future closed life support systems.

elsewhere, can provide a good data base of experience and research for CLSS. The use of greenhouses to raise tomatoes in the winter is an example of CEA. Japan, a country with little arable land, uses CEA to a larger extent than the U.S. "Some farmers erect low-cost plastic greenhouses on rice land during the fallow winter season for the production of melons," Phillips said. There are enormous benefits in CEA: very large and predictable yields, and independence from such troublesome factors as poor climate and variable weather. "In the Soviet Union, unfavorable climate is the primary motivator for the production of arbor and tree crops in greenhouses," Phillips said.

But the negative aspects of CEA systems are that they are capital, labor and material resource intensive, he

added. And unfavorable economics has been the main reason why cereal grains and legumes have not been produced on a large commercial scale. Nonetheless, a new ice age or contamination of world food supplies by pesticides and other toxins could make CEA systems more viable in the future.

"Long-term study on the CLSS should also be started," Phillips asserted. Besides use on large space habitats, such an agricultural system can have several applications here on Earth. Already CEA systems are contributing to the food supplies in very congested areas, like Europe and Japan. In a CLSS in which everything is recycled, the inner cities could benefit greatly: "Here there is the space and the need to try new technology for relatively small areas where resources of all kinds have been depleted to the point where a comfortable life cannot be maintained," Phillips said.

He concluded that: "Space is a big enough dream, but it must be made accessible to the individual. Space research concerned with food production touches on a subject that is within the common experience of every person in a society. Research on controlled-environment food production systems for large space habitats may do much to rekindle society's interest and support for space research in general, as food is a subject with which everyone is familiar. A renewed interest in space and the future possibilities for the human race could do much to promote a more positive attitude on the part of individuals in a society that has grown to regard the future with uncertainty, and even with a sense of hopelessness."



Rice grown in a controlled environment.

Closed Life Support Systems

It is difficult to predict just how a closed life support system (CLSS) will work on a space habitat. "But it is possible to design a CLSS on paper and to predict certain problems," said Dr. Michael Modell, Professor of Chemical Engineering at M.I.T. In his presentation, co-authored by Dr. Jack Spurlock of Georgia Institute of Technology, he said there are certain factors which must be determined before an overall design can be accomplished.

Along with oxygen and water, food is an important factor, the driver in a CLSS. Once diet provides us with the "input requirements" of the habitat (i.e. what animal and plant food will be necessary to sustain life in space), then the method of designing a system is fairly clear. The next consideration would be food preparation and processing, along with the equipment necessary to it. And diet and processing together will determine waste. The processing of the waste will require equipment also. Finally, the stability and the control requirements of the total system are taken into consideration.

For instance, will the diet options on a space colony be Earth-like, providing large varieties of food? Or will they be very simple, providing only a few kinds of foods? Or will the diet be very unconventional, made of synthetic foods? Such input will determine whether the waste will be processed biologically, chemically, and so on.

Waste processing will be crucial since processed wastes will be recycled back into the food chain. For example, liquid waste from both animals and

humans can be recycled by a sophisticated method of filtration and reverse osmosis. Solid wastes can be incinerated, the result of which would be carbon dioxide and ash. Ash contains many minerals essential to plant growth, and could be reintroduced into the food chain by being used as a nutrient for plants.

"Water used for washing is easy to recycle," Modell added, "and could be kept separate from other liquid wastes, since the purification of washing water is not as involved as it is for liquid waste." Such domestic water accounts for 80 % of water used in space.

Of course, the cost of a CLSS must be determined by the size of the crew and the length of the mission. The longer a group of people must stay in space, the more feasible it is to have a CLSS, since it is costly to lift essentials such as water and food into space. The cost of a CLSS will probably be assessed in terms of how much the CLSS equipment weighs, how much power it will require in space and how efficient it is in terms of providing the essentials of food, oxygen and water.

Naturally, much experimentation must be done on Earth which will help a great deal in developing the recycling systems needed in space. But in space, there will be many unknowns: the long-term effect of restricted diets, problems arising from the possible lack of some nutrient, yet undiscovered, and substances that may become toxic in a CLSS. "Another factor is our innate fear of the unknown," Modell said. "But that hasn't stopped us yet."

As the Stomach Turns

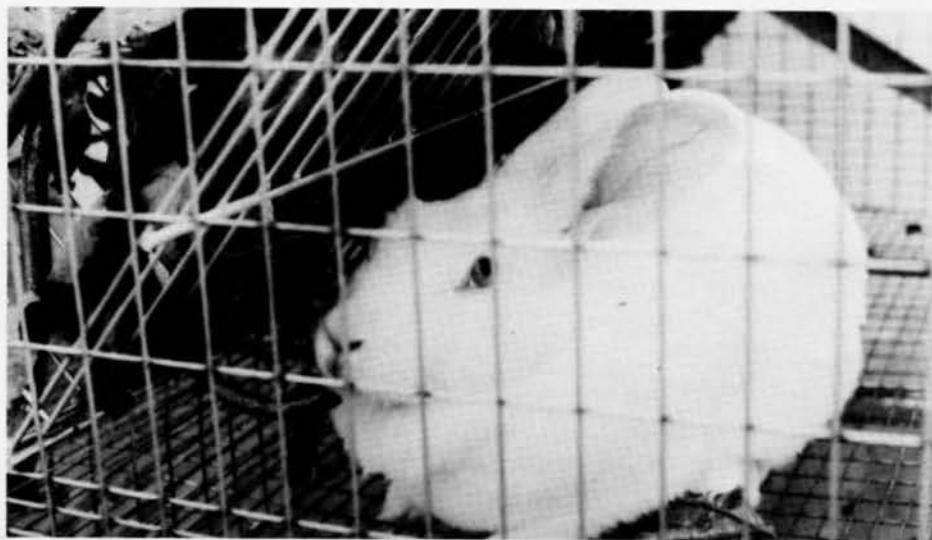
Banqueting probably will not be an activity familiar to space colonists of the near future, unless, of course, they favor powdered substances converted into gelatins, agar-agar, synthetic polymer compounds and formula-diet foods. In a presentation entitled "Physiological Criteria for Closed-Loop Space Food Systems," Dr. Paul Rambaut (whose paper was co-authored with Frank Samonski) from the Office of Life Sciences at the Johnson Space Center claimed that human taste is a peculiar commodity, a composite of sensory properties (flavor, texture, odor, sight, sound and temperature), psychological conditioning and internal chemistry. Looking at the subject of food with the eye of a scientist rather than the palate of a gourmet, he challenged the prevalent belief that "humans require a diet of great variety." He said: "Experimental evidence from many sources shows that individuals can be kept on a single nutrient source for many months without suffering ill effects. It is possible to furnish active people with a formula diet with no adverse physical effect or any measurable change in psychological state."

Rambaut believes that plants lead now as a potential source of space food by virtue of their familiarity, but that synthetic foods, stored nutrients and micro-organisms also have possibilities as food sources. Synthetic foods especially could be given desirable tastes and odor with special food additives and special processing, while fulfilling human nutritional needs at the same time.

The nutritional needs of the human body in space are still not well known. Before Skylab, it was believed that human nutritional needs in space were similar to those on Earth. It is now known that certain nutrients are lost during space flight, especially calcium.

"Examination reveals that calcium is lost exponentially as a function of time in flight. Whereas an average of 50 mg per day is lost on the 10th day, an average of 300 mg is lost on the 84th day. An average of 25 g of calcium was lost from the body during the 84-day flight. Assuming a total body calcium content of about 1 kg, the pool is diminished by approximately 2.5 percent.

"When fecal and urinary losses of calcium are plotted independently, two



Bunnies in space? A possible food source.

kinetically different processes become evident. Urinary calcium rises rapidly following launch and within 30 days achieves a level approximately 100 percent above baseline. It remains at this level for the remainder of the flight. Fecal calcium, on the other hand, does not begin to rise for two or three weeks following launch. Once fecal calcium has begun to increase, it does so at a constant rate for the remainder of the flight.

"Apparently calcium is being mobilized from the bones. At about the same time this mobilization of bone mineral is occurring, less and less calcium is being absorbed from the gastrointestinal tract. Although normally sufficient quantities of vitamin D₂ were being ingested, it is possible that a deficiency was being developed in the conversion of vitamin D₂ to D₁. This will be investigated further on Spacelab 2.

"Therefore, alleviation of the stress of weight-bearing seems to have a significant influence on skeletal metabolism. During the Cosmos satellite series, investigators noted a complete cessation of bone growth in experimental rats during flight.

"The chain of events leading ultimately to bone loss in flight remains elusive. Several ways of ameliorating the bone losses have been studied on the

ground. Protocols involving exercise, compressional suits, lower body negative pressure, and thyrocalcitonin administration have had little effect in moderating the losses induced by prolonged recumbency. Changes in dietary intake, particularly reductions in protein and elevated intakes of diphosphonates, calcium and phosphorus, are promising and point the way to the manipulation of nutritional intake as an important means of counteracting the adverse effects of prolonged weightlessness."

The minimum and maximum limits of other types of foods are still being ascertained. The role fats, carbohydrates and protein will play in future space diet scenarios is not well known. And what form these nutrients will take is another problem. For example, for proper absorption of protein, the protein must be digestible; digestibility varies among proteins, with plant proteins being somewhat less digestible than animal proteins. Digestibility of plant proteins can be improved by refining and by mild heating, but care must be taken not to use intense heat or digestibility will be damaged and some protein lost in the feces.

While needs for various vitamins and minerals are still being assessed, it is easy to take them in supplemental

form. The minimum and maximum limits for some nutrients such as various amino acids, are still not well known for Earth-dwellers, much less for astronauts. "There is, as yet, no evidence for alterations in amino acid metabolism in flight. The basis for the use of methionine, asparagine and glutamic acid supplements by USSR crews in this regard is puzzling," Rambaut said.

He concluded that: "It is probable that certain deteriorative or adaptive processes accompanying space flight can affect nutritional requirements in such a way that intakes which are appropriate under ground-based conditions are suboptimal in flight. In closed systems, there exists an added danger regarding toxicity of high levels of nutrient elements. There is often a narrow tolerance between minimum requirement and toxicity, as in the case of vitamin D. A better grasp of requirements and tolerances, and an efficient monitoring system for metals such as copper, chromium, zinc, and cobalt, will be required."

And what is Dr. Rambaut's view of the final form of space food? "Probably the ideal space food lies somewhere between a simple formula diet and a diet of extravagant variety."

Economic Forecast for Space Projects Gloomy

"The SSPS (Solar Satellite Power System) will not be implemented for at least some 20 years," said Bernard P. Miller, vice president of ECON, Inc., of Princeton, New Jersey, in his talk on the economic factors of outer space production. But he added: "Even though the expense of the SSPS cannot be justified now, it is important to keep this option open for the future."

The future of space materials processing looks almost as bleak. Citing the pessimistic conclusions of the National Academy of Sciences study, Miller called for the establishment of a national space laboratory for materials processing experiments, in order to study more fully the possibilities of space manufacturing. But there are knotty problems involved in establishing such a facility. What will be the construction cost of the laboratory? What will be the charge to users of the facility? Could the laboratory be funded exclusively by the private sector? What would be the policy on patents for joint

endeavors between NASA and industry?

In the meantime, the areas of space technology most likely to receive funding in the near future would be in the areas of Earth observation (with the new LANDSAT due to be launched in 1981) and communications; benefits in both these areas are already well known.

In communications, remote rural communities could benefit from satellite delivery of social service broadcasts in such fields as medicine and education. ECON, Inc. recently studied the feasibility of satellite-aided emergency medical services. Paramedics in remote areas could transmit data to physicians in metropolitan areas via satellite and could render immediate aid to trauma victims. ECON, Inc. estimated that 59,000 lives per year could be saved in this manner in the non-metropolitan regions of the United States if such an emergency medical communications system existed. "The economic benefit of this reduction in mortality would be approximately \$2 billion a year," Miller

said. The conclusion of the study was that such a system would definitely be cost effective.

Miller also encouraged the participation of private industry in space transportation, claiming that a government monopoly in this area is not desirable and will probably inhibit private investment in space in the future. The Shuttle, he said, is expected to rank 223rd in the top 500 U.S. corporations in the next decade; among U.S. airlines it would rank 7th, right below Delta and right above Northwestern. Private industry would probably wish to participate in space transportation, perhaps by owning and servicing the spacecraft while NASA maintained its control of launch and landing facilities.

Miller concluded by saying that current government policies inhibit private investment in space production. "The lack of entrepreneurship is probably the weakest link in the United States space program today," he said.

Standing Room Only

"In the Shuttle, chairs and seats are only provided for those portions of the missions such as launch, reentry, and orbital maneuvers," said Allen Louviere, Chief of Spacecraft Design at the Johnson Space Center. In his presentation entitled "Man and Machine Design for Space Flight," Louviere said that seating apparatus is quite unnecessary, since the human body takes on a comfortable semi-crouched posture in a weightless environment, very different from the upright posture that it takes on earth. Shoes with suction cups on the bottom will provide sufficient anchorage (otherwise the body would float) while also allowing an astronaut a certain comfort and ease of movement.

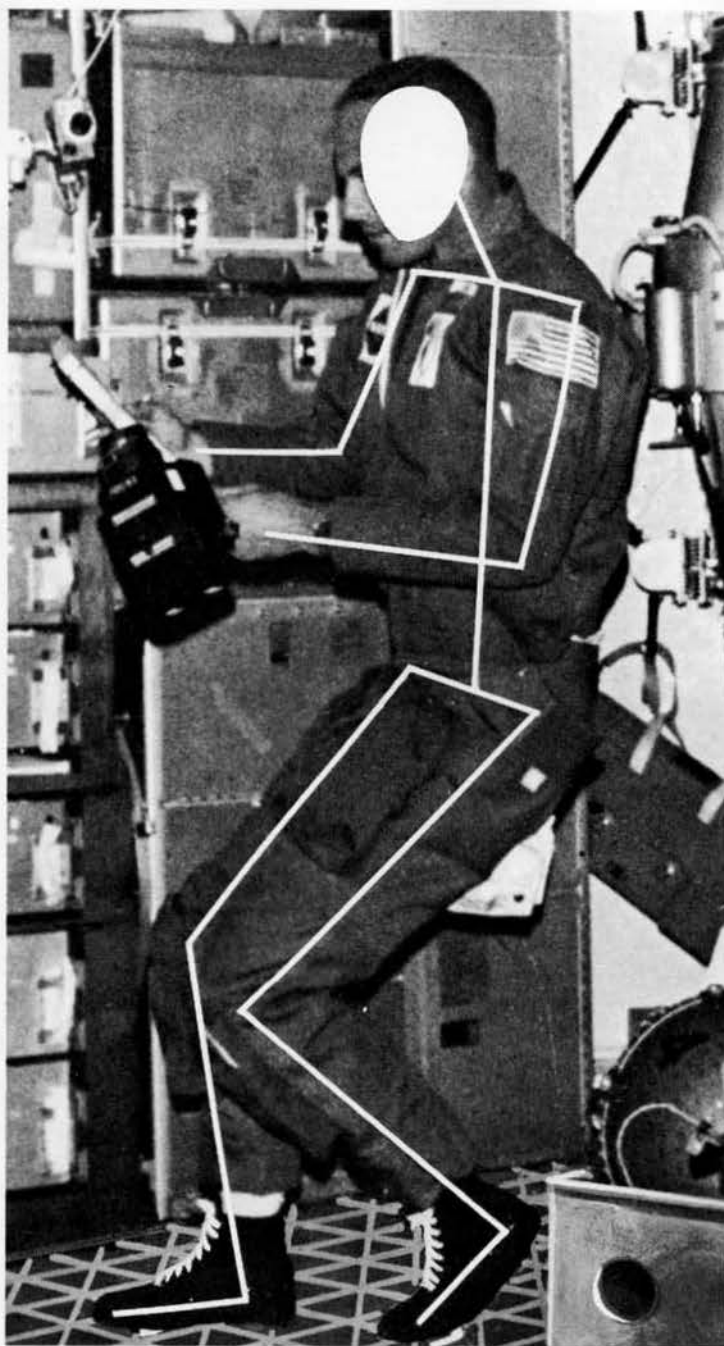
Louviere said many factors must be taken into consideration in designing a spacecraft for comfort and maximum utility. The size and volume of the spacecraft must allow for the various functions that the craft will perform. Crew size and mission duration are the two biggest considerations in volume allotment; Skylab with its "somewhat sumptuous" 10,000 cubic feet allowed for many varied functions.

"There are other more subtle things to consider too," he said. On the Earth's surface we take certain activities for granted: digging into pockets for change, showering with soap and water, sleeping in a horizontal position. But in weightlessness even the most commonplace activities can pose problems. Skylab crewmen's garments had circular pockets "to prevent articles from migrating into corners." A special shower nozzle was installed to help wash off soap, since soap clings tenaciously to the body in weightlessness. Electric shavers were designed so that clippings could be immediately vacuumed up. And since there is no up and down in space, sleeping compartments were not horizontal; in fact, the astronauts slept in sleeping bags tied to the wall.

In the Shuttle-Spacelab missions, the arrangement of the workstations is of primary importance. Two significant factors dominate the design of these workstations: change in body posture

and the requirement to restrain a crewman in place (with shoes equipped with suction cups in this case). The workstations must also be designed to accommodate a variety of body sizes, since variations in the sizes among the international crewmembers, both male and female, will certainly be a factor. Skylab astronauts ranged in height from 66 inches to 72 inches. But in the Shuttle-Spacelab missions, the height range will be significantly greater, from 61 inches to 76 inches.

"Though subtle to outward appearance, these newly derived standards will greatly facilitate the crewmember's task in the weightless environment," Louviere concluded.



Above: Neutral body position.

Below: Suction cups on shoes, a weightless environment crew restraint.



Space Design for Safety

Safety was emphasized in Richard Kline's talk on space habitat design. Kline is deputy director of NASA Advanced Programs at Grumman Aerospace Corporation. "Now that the Shuttle will make space operations routine, thought must be given to the next step in space development: building habitats in which people may remain in space on a more permanent basis," he said.

Kline envisioned two types of space habitats: one in low Earth orbit (LEO) and one in geosynchronous orbit (GEO). He also saw a need for an orbital transfer vehicle (OTV) to transport people between LEO and GEO.

The design for LEO differs substantially from that of GEO. LEO requires only a 4 mm thick aluminum shell, whereas GEO requires a three-layered shell made up of epoxy tiles on the outside (5 mm thick), an aluminum layer in the middle (8 mm thick) and a tantalum layer on the inside (0.5 mm thick). The thicker wall in GEO is necessary for radiation protection, but it causes GEO to be a good deal heavier,

and subsequently much more expensive to build. Because radiation levels are so high in geosynchronous orbit, GEO must also have high reliability equipment and built-in redundancy; in-flight repairs by way of EVA (extra-vehicular activity) would be very dangerous. The cost of this equipment would also add substantially to the cost of building GEO.

Solar flares constitute another danger to GEO inhabitants, something that would not be a concern to LEO inhabitants who are protected from radiation by the Earth's magnetic field. In case of a solar flare, GEO inhabitants could get into the OTV and drop to LEO. Or a special storm shelter could be built right on GEO, with an aluminum shell 150 mm thick. The shelter would be small, just enough to accommodate the crew, but would make evacuation unnecessary.

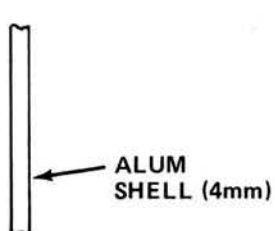
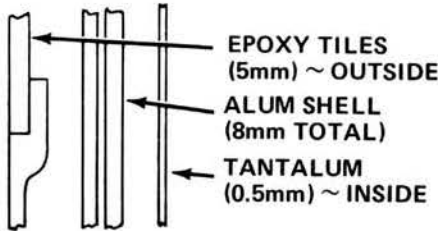
Severe crew illness, accident or failure of a vital system could occur which would require rescue. The cheapest rescue alternative would be to return the crew to LEO in the OTV and wait for a Shuttle to come up from Earth,

rendezvous and dock at LEO, and then return to Earth. This would take approximately 120 hours.

But in case of severe illness, this time lapse is too long. Another possibility is using the "lifeboat technique." The "lifeboat" would be a vehicle capable of returning to Earth from space. It would be docked at LEO. In an emergency, the GEO crew could return to LEO and then return to Earth directly from there in the lifeboat, without having to wait for a Shuttle. This "lifeboat technique" would reduce the rescue time to less than 20 hours. "Direct re-entry from GEO is another possibility, which reduces rescue time to about 6 hours," Kline said.

The final rescue method or combination of methods that would be used will depend on the "risk definitions" for a particular vehicle. Kline concluded that sound design and technology is of crucial importance, "a vital key to helping us capitalize on the Shuttle and evolve toward effective utilization of space."

□

	LEO	GEO
<ul style="list-style-type: none"> • RADIATION PROTECTION <ul style="list-style-type: none"> – CABIN – SOLAR FLARE SHELTER • VOLUME PER MAN <ul style="list-style-type: none"> – CABIN – SOLAR FLARE SHELTER • RESCUE – MAX DELAY • MAINTENANCE <ul style="list-style-type: none"> – BY EVA – COST PER MAN HOUR – TRANSPORT COST OF RECYCLED COMPONENTS 	 <p>ALUM SHELL (4mm)</p> <p>8–10m²</p> <p>5 DAYS</p> <p>ACCEPTABLE</p> <p>\$2,500</p> <p>\$1,000–1,800/kg</p>	 <p>EPOXY TILES (5mm) ~ OUTSIDE</p> <p>ALUM SHELL (8mm TOTAL)</p> <p>TANTALUM (0.5mm) ~ INSIDE</p> <p>SHELL = 150mm ALUM</p> <p>8–10m³</p> <p>0.6m³</p> <p>30 DAYS</p> <p>VERY LIMITED</p> <p>\$9,000</p> <p>\$10,000/kg</p>

Habitation Requirements

Developing Hardware to Support Life on Long-Term Space Missions

On a year-long mission in space, carrying oxygen and water for the crew would be cumbersome and unwieldy. With ideas for future piloted interplanetary missions and a permanently inhabited space station, NASA has faced the task of providing air and water by setting up the Regenerative Life Support Evaluation, work being done by a group of scientists and engineers at Johnson Space Center.

There, flanked by man-sized machines and tanks, the scientists are testing pre-prototype versions of water and air loops that will someday leave for space. "When they say space station, we're ready," said Nick Lance, an engineer at JSC.

For drinking water, squeamishness is set aside. The crew's urine is mixed with flush water, treated with iodine to prevent ammonia formation, then fed into a zero-g storage tank. From there it is fed into "the still," a distillation unit designed for use at zero-g. The liquid cycles through the still until 96 percent evaporates. Solids come out as a gel, concentrated and kept in a tank to be dumped into space later, though there is talk of someday removing the salts and using it as fertilizer.

"Right now, they're carrying two tanks on the Orbiter just to store urine," said Dot Fricks, a NASA chemist. "We're concentrating the waste down into one small package and using the water over again."

She adds that the system uses little energy. "We are able to boil the water at about 80 degrees by evacuating the shell to a low pressure, around 20 mm of mercury. That way the motor that turns the still provides enough heat to evaporate the water."

Fricks herself has never drunk the water, but she asserts it is chemically more pure than that from a tap. "Here at JSC, we don't post-treat it, and it would have too much acid to drink. A later version will have ion exchange resin beds to control pH and an iodine system downstream that will work the way a commercial system uses chlorine."

She adds that "probably once you were used to it, after a day or two, you wouldn't even think about it."

Tests in October showed that the drinking water system is cost-effective if a flight is 30 days or longer.

On the air side, again, equipment is in pre-prototype stages, meaning the next edition will be prototype, then flight hardware. A water electrolysis subsystem, first of three major components in the air loop, produces hydrogen and oxygen. Oxygen is sent to the crew cabin, hydrogen passes to the next subsystem — the carbon dioxide concentrator.

Carbon dioxide and oxygen enter the second subsystem from the cabin. In the concentrator are a number of cells, each cell made up of two electrodes and an absorbent matrix. Carbon dioxide and oxygen blow over the electrodes, reacting and generating power. In the cell, the carbon dioxide becomes a charged molecule, a carbonate ion, which passes through the electrode membrane and reacts. At the second electrode, it comes out carbon dioxide again, only transferred from the air to a stainless steel line. Meanwhile, air minus the carbon dioxide has gone back

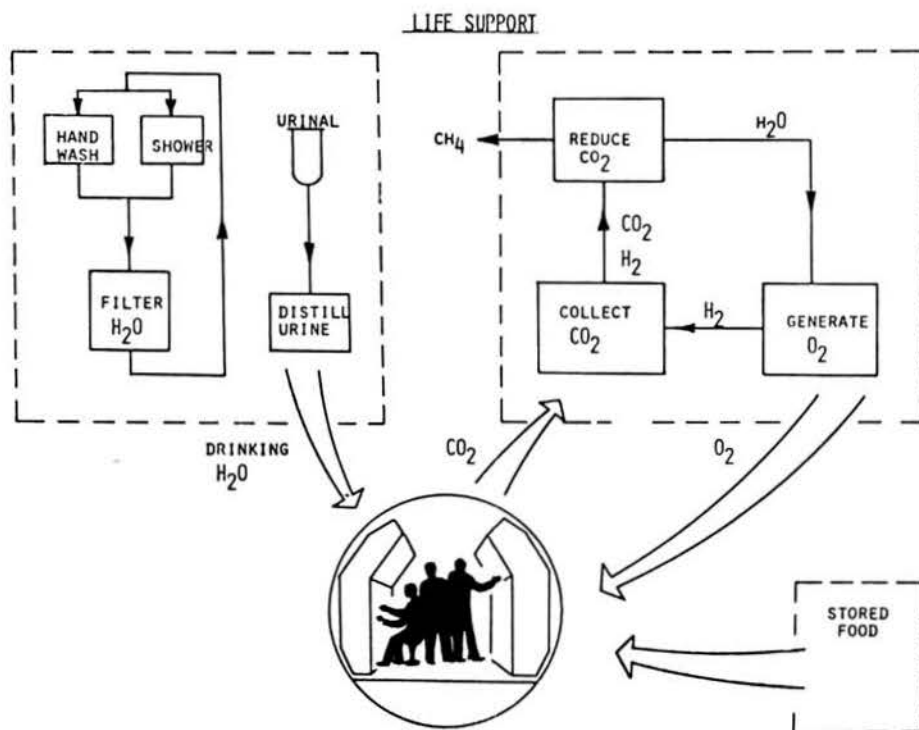
to the cabin.

Next, carbon dioxide and hydrogen pass to the third subsystem, a reactor which combines them creating methane and water. The methane, at this time, is dumped into space, though there is talk of someday using it as a propulsive fuel.

Water leaves the carbon dioxide reduction subsystem and returns to the first step, to be used in electrolysis, closing the loop.

The first air subsystem arrived at JSC in the fall, and has been tested with good results. The second unit arrived in December and still sits, unpacked, in boxes. Lance's work for the next months will be studying how to test the equipment, how to keep conditions right for later tests.

The entire closed life support system will make little noise, comparable to a pump room, or an air conditioning unit operating unnoticed in a home. On a spacecraft, everything depends on saving power and saving weight. Regenerative Life Support is designed to take everything that a person gives off and put it to use.



Space Processing: A New Study

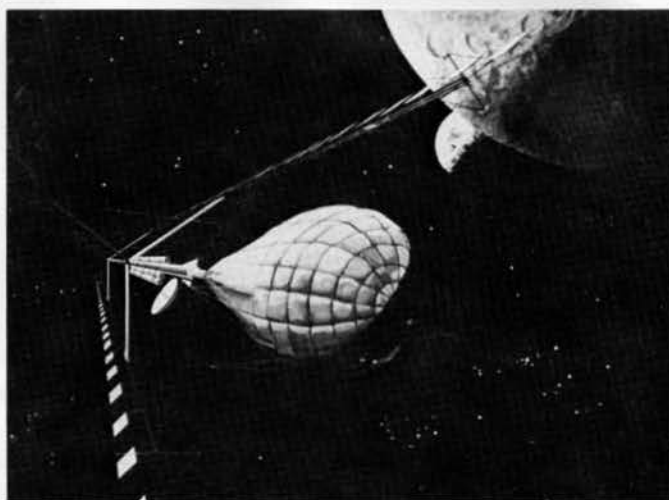
By Mark Hopkins

At the Massachusetts Institute of Technology (M.I.T.) on October 17, 1978, General Accounting Office (G.A.O.) representatives Ed Fritts and Alan Byroade listened attentively to a series of attacks by materials scientists on the STAMPS (Scientific and Technological Aspects of Material Processing in Space) report. Readers of the L-5 NEWS may recall from an article in the August 1978 issue that this recently completed National Academy of Sciences study has generated considerable controversy because of its pessimistic conclusions about the possibility of economically producing materials in space in the near future. The G.A.O. is currently sponsoring a series of small meetings with scientists around the country in order to provide input for their newly initiated study of near-term space processing. The study will, to a lesser extent, also consider longer-run space options. Publication of the final report is expected in the summer of 1979.

Outrage was expressed at M.I.T. because of the extent to which participation in the STAMPS study was dominated by physicists and chemists. It was felt that under these circumstances it is not surprising that the conclusions of the report were more favorable for scientific experiments than they were for more practical applications.

One materials scientist condemned what he felt was a general philosophy in the report: namely, that the theory had to be well understood before it could wisely be applied. He pointed out that the theory was not well understood even for products currently made on Earth. Advances in science often occur **because** of experiments in which the results are not entirely predictable. In his view, a similar approach should be tried in space.

Dismay was also expressed because of the United States' deteriorating position in materials science. We are clearly behind Russia, West Germany, and Japan. The potential for space processing was seen as one of the few remaining American advantages.



Mass drivers have a wide variety of potential applications.

Failure to exploit such an advantage would be foolish.

Along these lines, it was pointed out that the conclusions of the STAMP report are inconsistent with the substantial commitments that the Russians, Europeans, and Japanese have made to space processing. If it pays for them, why not for us?

Space processing was not the only area covered at the meeting. According to Professor Henry Kolm, mass driver-related technology has a wide variety of potential applications in addition to those with which space colony enthusiasts are familiar. These possibilities include launching planes from short runways and providing rapidly advancing troops with supplies fired from bases that are miles behind the front lines. Another possibility is to use the mass driver instead of the first stage of a rocket for transporting payloads from Earth to space. In this instance, a long track would be built along which a rocket would be electromagnetically accelerated. After the rocket left the track and glided to a considerable height, it would ignite and carry the payload the rest of the way into space.

One question raised several times at the meeting was, "Why didn't private enterprise provide the funds for space processing if it is such a worthwhile endeavor?" High risks and troublesome externalities seem to be the chief obstacles to private investment. The risks involved are not completely known. But suppose there are 1,000 possible independent investments of equal size, each of which has a 50% chance of eventually leading to a marketable product. Further, assume that one third of these investments are successful. Then a reasonable rate of profit can be obtained. For example, if an investing

organization is large enough to make all 1,000 investments, the risk of not making a reasonable profit is almost zero. However, if the organization can raise the capital for only one of the investments, the risk is very high, namely, a 50% chance of losing everything. This example demonstrates how private companies can be discouraged from making investments by such risks, but how a large organization, such as the government, stands to make a profit while absorbing the losses.

Externalities occur when all of the benefits from an investment cannot be captured by the funding organization. However, consumer prices charged for the products and subsequent spinoffs are benefits that a company would be unlikely to receive in a space processing development program. Also, history tells us that despite patent protection, some of the technological benefits developed by one company are likely to be captured by other companies. So, externalities are particularly high for long-run technological investments, such as those which are currently available in space processing.

Clearly, a company will not make an investment if it can't capture the benefits. Thus a decision to leave space processing entirely in the hands of private enterprise is likely to mean that many programs which would be worthwhile for the nation as a whole will not be invested in because of high risk and large externalities. If further government-sponsored development occurs, then risk and the extent of the externalities would be reduced, leading to an increasing degree of private enterprise participation in the future. In any case, the results of the new G.A.O. study will be eagerly awaited by all who are interested in future space processing.

New Space Legislation

by Ken McCormick

The coming year in Congress promises to be a busy one for supporters of the space program, with the introduction of far-reaching space legislation and the struggle to keep the already severely-restricted NASA budget intact. Here's what's taking shape in legislation.

Space Policy Bill — Senator Adlai Stevenson's (D-Ill.) Subcommittee on Science, Technology and Space will hold hearings January 25th and 31st, and February 1st to consider space policy bills to be introduced by Senators Stevenson and Schmitt (R.-N.M.). Both bills were originally introduced during the last days of the 95th Congress, at about the same time that President Carter was announcing his new space policy.

Reportedly, there has been a great outcry from the aerospace community in opposition to Schmitt's call for the establishment of "orbital civilization" facilities during the 1990's and piloted Mars and Venus missions. His new version of the bill is expected to avoid the mention of the term "orbital civilization," and will probably speak more generally about the exploration of the solar system over the next 30 years. The bill's section on aeronautics will also be greatly expanded. Broad guidelines for an increase in funding for the space program, included in the bills, are already very controversial.

Senator Stevenson's bill outlines an ambitious program for the next 10 years which is similar, in some respects, to Schmitt's program for the immediate future. It includes provisions for the design and construction of large structures in space for the purposes of communications, remote sensing, and experimentation in electric power generation and human habitation. The bill also calls for experiments to be conducted in the area of space manufacturing, and for continued U.S. leadership in space science and space exploration.

A space policy bill will almost certainly be voted out of committee for

consideration by the full Senate. It may represent a compromise between the Stevenson and Schmitt bills. If so, it will very likely resemble the Stevenson bill more closely, which now has wide support on the committee.

Earth Resources Data Services Bills — Senators Schmitt and Stevenson will also introduce bills to establish organizations for the purpose of gathering and disseminating earth resources data from satellites. Senator Schmitt calls for the creation of a private corporation modeled after COMSAT. Senator Stevenson would like to establish the service first within NASA; he would then move to transfer the service to a private corporation, government corporation, or federal agency within seven years. Hearings are scheduled for March 29th and 30th.

Space Industrialization Act — Representative Don Fuqua (D.-Fla.) will introduce legislation to establish a space industrialization corporation in order to foster profitable ventures in space by reducing entrepreneurial risks. The corporation would find promising industrial ventures and would derive profit from successful projects. Hearings are expected in the House this May.

SPS Bill — Representative Flippo (D.-Ala.) intends to re-introduce legislation to speed research into the SPS energy option. Hearings will be held in the House on March 22nd. However, SPS proponents say their efforts this year will be concentrated on the Senate, since an SPS bill is expected to cruise through the House if the Senate okays it. Who will sponsor SPS legislation in the Senate is unclear at this time.

Budgetary pressures are expected to be extreme this year. If these bills appear to be big spending programs, it could prove disastrous. In fighting for the passage of these bills and for the NASA budget, supporters say they will stress the fact that spending on the space program fights inflation and provides jobs by advancing industrial technology. Whether Congress will heed this argument remains to be seen.

AIAA & SPS

by Ken McCormick

At a press conference at the National Press Club in Washington D.C. this past Jan. 10th, Dr. Jerry Grey, public policy administrator for the American Institute of Aeronautics and Astronautics, supported the solar power satellite (SPS) bill of Representative Flippo. He also expressed reservations about the Department of Energy's SPS program plan and SPS provisions in space policy bills introduced by Senators Harrison Schmitt and Adlai Stevenson III. Grey outlined AIAA's recent position in a paper on SPS, the full text of which appears in the January issue of the AIAA's *Astronautics and Aeronautics*. He said that the Institute advocates the expenditure of \$30 million annually for ground-based SPS research, which would lead to a decision whether or not to proceed with SPS development and demonstration.

In reference to D.O.E.'s present research efforts, Grey said, "AIAA believes that establishing a baseline design for SPS at this time would be premature by at least several years, since it might foreclose a host of promising innovative options." Grey also expressed the opinion that the present effort is at too low a level to draw proper conclusions about SPS, and it could drag on for years without developing the necessary technical verification.

Therefore, the position of AIAA is almost identical to the position taken by Rep. Flippo in his SPS bill. The AIAA's only reservation about the Flippo bill regards the bill's title which refers to "demonstration and development." The text of the bill sets out a research plan leading to demonstration and development, and it is this that the AIAA supports.

Grey said that he was afraid Schmitt and Stevenson were trying to "put the cart before the horse" in providing for an SPS demonstrator in orbit if ground-based studies indicate that SPS is environmentally safe and economically attractive. It is AIAA's position that the necessary ground-based technology verification should be completed before a decision is made on whether and when to proceed with an in-orbit demonstrator. Grey pointed out that opposition to SPS legislation has focused on demonstration and development.

Space Day in New Orleans

By Chuck Landau

Space Day in New Orleans was an unqualified success, despite a cold snap that dropped temperatures from the 80's to the 40's overnight. A well-planned publicity campaign brought approximately 10,000 people to the NASA Michoud Assembly Facility on December 9th for an open house.

A brief outdoor dedication was held for the first stage Saturn V rocket which was being placed on permanent display in New Orleans to honor the space program's progress. This was the last of America's largest rockets, so successful in the Apollo and Skylab programs, but mothballed due to economic considerations. Apollo 13 astronaut and Space Shuttle pilot Fred Haise joined local dignitaries in reviewing the progress to date, and in forecasting an increased interest in the space program with a matching increase in funding.

Inside the space hardware manufacturing and assembly building, exhibits on all aspects of the space program were on display. Movies,

literature, and models of the Space Shuttle, Skylab, Apollo, High Energy Astronomy Observatory, Large Space Telescope and Landsat programs were interspersed with exhibits of the Skylab experiments designed by high school students. Moonrocks, encased in a glass pyramid, were a major attraction.

The manufacturing and assembly of the external fuel tank for the Space Shuttle occupies a major segment of this facility. A tour covering all phases of operation in the forty-three acre building was mapped out, and explanations and diagrams explaining the functions of various machines were posted. Friendly employees and their families were on hand to explain procedures and answer questions.

A tentative decision to make this NASA open-house an annual event indicates a welcome shift in policy. Only an informed and vocal public can save NASA and the exploration of space from devastating budget cuts.

NEWS BRIEFS

ARMED GUARDS POSTED AROUND SHUTTLE

In a story which appeared in the December 26, 1978 edition of the *Washington Star*, aerospace journalist Dick Baumbach reported that Rockwell International has posted security guards around the Shuttle Orbiter spacecraft in order to protect it from damage, either due to malicious sabotage or accident. The thermal protection tiles are very fragile and can be damaged by a fingernail tap.

I. L. Smith, Rockwell's director of production operations, was quoted as saying: "After we get this spaceship out of here, sometime in late February, we won't have anything to do until August. That could mean we will lay off some people. Sometimes workers think it's better to do something stupid so they can have their jobs last longer. It's that simple."

Baumbach reported that instances of damage to the Orbiter have all been accidental so far.

LEAN DAYS AHEAD — NASA'S 1980 BUDGET

Austerity was emphasized in the NASA \$4.6-\$4.8 billion Fiscal 1980 budget. No new flight program starts will be allowed in Fiscal 1980, forcing some of the new programs into budgets for 1981 and 1982; this will cause further schedule problems with programs slated to start in those fiscal years. As a result, NASA will not be allowed to request the 25 kw power module (which would greatly expand Shuttle activities) in Fiscal 1980. The Office of Management and Budget (OMB) wished to delay the power module until Fiscal 1981, allowing only for some early development expenditures in the Fiscal 1980 budget.

Should the power module be pushed back to Fiscal 1981, it would be placed in direct competition with the planned thrust augmentation of the Shuttle, something vital to the launch of 32,000-lb. USAF satellite reconnaissance payloads. The Department of Defense and NASA may have to make funding tradeoffs in order for the thrust



An outdoor dedication was held for the first stage Saturn V rocket, now on permanent display in New Orleans.

augmentation to be made in Fiscal 1981.

Worse yet, the Venus orbiting imaging radar mission (VOIR) might also have to be pushed into Fiscal 1981, placing it in competition with yet another high-priority mission, a spacecraft that could drop a probe into Halley's Comet and then go on to rendezvous with Comet Tempel 2. If the Halley probe/Tempel 2 spacecraft is not started in Fiscal 1981, both comets could not be studied by the same spacecraft. Two separate spacecrafts would be required, making the study much more expensive.

A further complication in this whole budget matter is timing. With a rather imperfect knowledge of celestial mechanics, OMB did not take into consideration the fact that if VOIR fails to get a Fiscal 1981 new start, the opportunity for such a study will be lost, and NASA would have to wait until 1991 for another Venus opportunity.

EUROPEAN MOON PROBE DISCUSSED

The European Space Agency (ESA) has encouraged discussion of an all-European Moon probe to be launched early in the 1980s. Called POLO, for Polar Orbiting Lunar Observatory, the spacecraft would be launched by the ESA "Ariane" booster and would orbit the moon from pole to pole at an altitude of 100 kilometers. From this vantage point, the POLO satellite would map lunar magnetic and gravity fields in regions not investigated by American probes in the Lunar Orbiter and Apollo programs. In addition, gamma and x-ray detectors would scan the surface chemistry and geology.

NASA plans for an American "Lunar Polar Orbiter" (the LPO, or, unofficially, "Prospector") have been axed for budgetary reasons. A fall back effort to fly American instruments on a projected Soviet lunar orbiter in 1980-1982 is in limbo, victim of chilled Washington-Moscow diplomacy.

Besides expanding scientific knowledge of regions of the Moon not explored by Apollo, a lunar polar orbit satellite could search for one of the most valuable lunar resources of all: ice. Its existence in eternally-dark polar craters is predicted by theory, yet no trace of such icecaps has been found in Apollo research. Scientists had hoped to find evidence for lunar polar icecaps (which would probably be buried under several meters of lunar soil, but which could amount to the volume of water in Lake Erie) either from hydrated lunar grains thrown off the polar regions by meteor

impacts, or from bursts of water vapor 'smelled' by instruments left behind at the Apollo landing sites. Neither approach has produced unambiguous evidence of the existence of such polar caps.

European interest in the lunar mission is symptomatic of a new confidence among ESA officials, who are searching for new directions open to European space research. One enthusiastic proposal even called for the launch of a European Moon shot in mid-1980 on the fourth test flight of the Atlas-Centaur-sized Franco-German "Ariane" booster; the payload, which would not be the proposed POLO itself, would have been assembled from backup GEOS-3 satellite parts. But that plan has been rejected, and a more ambitious program of lunar and planetary probes for the mid-1980s is now being prepared for budgetary consideration early next year.

U.S. TO HELP CHINA DEVELOP A SPACE PROGRAM

A delegation from the People's Republic of China has been holding discussions with United States officials since Nov. 28 regarding possible U.S.-Chinese cooperation in the peaceful utilization of space technology.

As a result of these discussions, an informal agreement has been reached in principle on U.S.-Chinese cooperation in the development of the civil communications system of the People's Republic of China. This involves the purchase by China of a U.S. satellite communications system, including the associated ground receiving and distribution equipment. The space portion of the system will be placed in geostationary orbit by the U.S., with continued operation to be carried out in China.

Similar informal agreement in principle has been reached regarding the purchase by China of a ground station capable of receiving Earth resources information from U.S. Landsat remote sensing satellites, including the Landsat-D now under development.

PLANNING BEGINS FOR NEW ASTRONAUT SELECTION

A new call for astronauts may be issued by NASA later this year, according to George Abbey, Director of Flight Operations at NASA's Lyndon B. Johnson Space Center in Houston. Discussing the ongoing training of the current class of 35 astronaut-candidates,

Abbey suggested that a new class will probably be selected before the current class graduates in July 1980.

The new group would be smaller than the present one and could be the first of a routine annual astronaut selection process, officials said. Five to ten individuals, either pilots, mission specialists or scientists from a particular discipline, or some combination, would be picked on an "as needed" basis. Announcements would routinely be made early in a given year with a closing date of June 30, followed by a six month selection process. Those chosen as astronaut-candidates would then report for duty on or about the following July 1.

Exact selection criteria and schedules depend upon Space Shuttle progress and upon attrition and retirement from the current astronaut corps. In contrast to earlier procedures, in which military officers were loaned to NASA indefinitely (only two officers ever returned to their parent service), officers from the current crop of 35 trainee-astronauts will probably be with NASA for between five and eight years, after which they will be expected to return to their parent services. This will serve to increase turnover and open new slots for future selections.

Although no formal selection process is under way, the address for inquiries is still in effect: Code AHX, NASA Lyndon B. Johnson Space Center, Houston, Texas 77058.

SPACE MANUFACTURING CONFERENCE

On May 14-17 the Princeton Space Manufacturing Conference will feature the world's foremost researchers in the fields of space industries, habitats and solar power satellites. Hosted by Princeton physics professor Gerard K. O'Neill, the four day event will wind up with a gala "Space Studies Institute (SSI) Subscribers' Celebration" Thursday afternoon.

To register, write to the Princeton Conference Office, 5 Ivy Lane, Princeton, NJ 08540. No registration is required for the public session on Thursday from 9:00-12:00 a.m. SSI subscribers are requested to let O'Neill know if they plan to attend the Celebration.

If you wish to become a subscriber to O'Neill's SSI, send \$10 (or more!) to Space Studies Institute, Box 82, Princeton, NJ 08540. SSI funds support space colony research; current emphasis is on the mass driver.

Doomsday Has Been Cancelled

by DR. J. PETER VAJK
with a foreword by RUSSELL SCHWEICKART

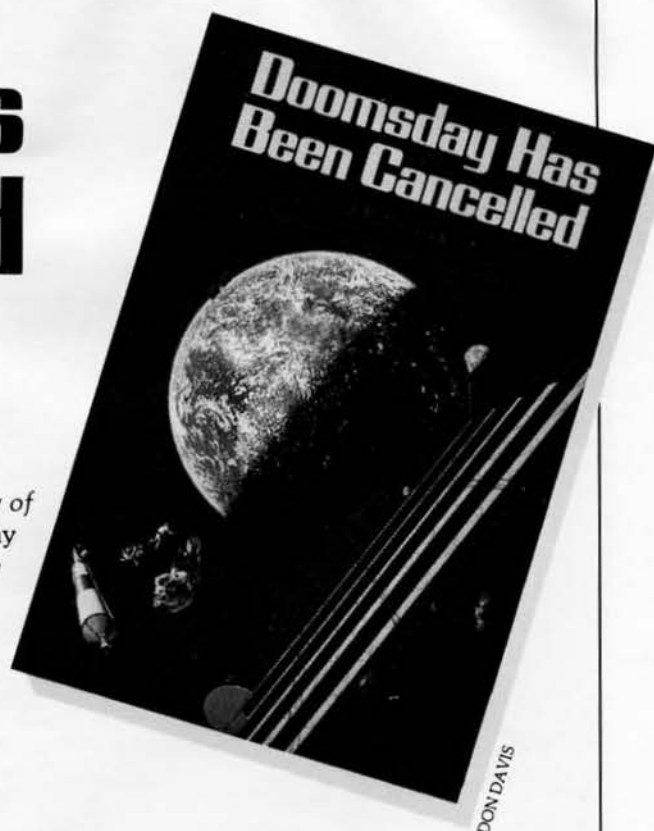
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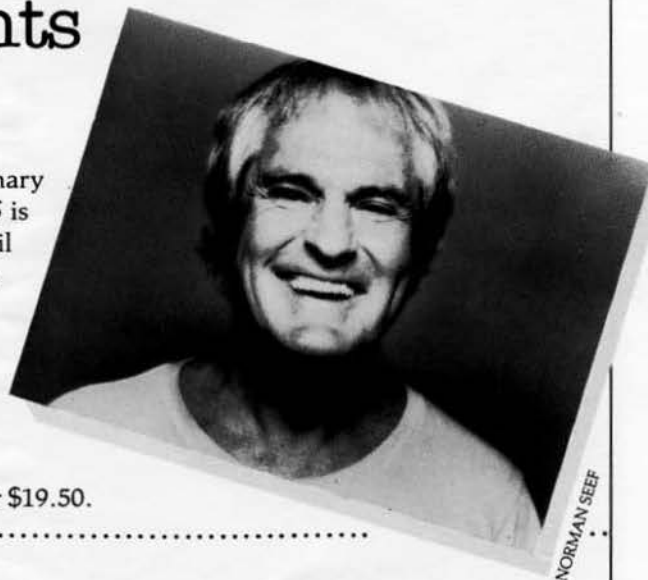
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16th Space Congress Proclaims: Space — Everyone Benefits

In answer to a question which has persisted since the inception of the space program, the 16th Space Congress proudly proclaims SPACE—EVERYONE BENEFITS as its 1979 theme. Under the leadership of General Chairman Curtis A. Stinson, Planning Research Corporation (PRC), and Vice-Chairman Joseph F. Malaga, National Aeronautics and Space Administration (NASA), the steering committee, consisting of members of the government/contractor aerospace team as well as members from the local community, has scheduled this annual symposium for April 25, 26, and

27, in Cocoa Beach, Florida.

The program for the 16th Space Congress will include three panel sessions and six technical paper sessions dealing with such topics as: Space Shuttle and Space Transportation Systems Updates; Spacelab and Other Identified Payloads; Space Applications and Commercialization; and Technology Transfer.

In the aftermath of last year's successful MEET THE ASTRONAUTS panel, plans are being discussed with panel chairman Lee Scherer, Director of Kennedy Space Center, for another

exciting Thursday evening session, which will be free and open to the public. More details will follow at a later date.

In addition to the panel and paper sessions, events will include the 16th Space Congress Banquet and Luncheon, the Youth Science Fair, and the space contractor's Exhibit Hall. The science fair and contractor's exhibits are again free and open to the public.

This year, a special registration rate will be made available to students who wish to attend the 16th Space Congress.

Chuck Morley, Publicity Chairman
P.O. Box 1333
Cocoa Beach, Florida 32931
Telephone: 305/867-7731 and 784-0925

Hugh Harris, Alternate
Telephone: 305/867-2468

Inside the L-5 Society

OHIO L-5 CHAPTER STARTING

An Ohio chapter of the L-5 Society is organizing! If you are interested, or have ideas and suggestions for getting together and helping to get to "L-5 in '95," get with it! Write:

Steven Stein
570 Fairhill Drive
Akron, Ohio 44313

Or call him at 614-424-2553.

HOW TO CREATE AN L-5 CHAPTER

by Carolyn Henson

You want to start an L-5 chapter? How do you begin?

1. *Write Headquarters.* Tell us you want to start a local chapter. We'll send you a copy of the L-5 bylaws, a list of people who have expressed an interest in local action, a list of local chapters, membership flyers and L-5 buttons. Be sure to familiarize yourself with the bylaws.
2. *Contact Local Members.* Find out if there's enough interest to have a "get acquainted" meeting. If you can pull that off, the next move is to determine if you have the time, ability and elbow grease to hold a second meeting, this time for the general public. Be certain that you can schedule something interesting: a lecture, slide show, debate, or a movie.
3. *Hold a Public Meeting.* Be sure to

order any visual aids well in advance. Put out plenty of publicity; write for the "L-5 Slide Catalog" (for details on how to place public service announcements) and send out press releases. If you send an announcement to L-5 headquarters two months in advance, we'll advertise it in the L-5 NEWS. That may lure in some members who haven't expressed an interest in local action.

Save business for the end of the meeting! If you've had a good turnout, it may be appropriate to hold an election of officers.

4. *Elect Officers.* Remember that the officers represent your group both to the public and to the rest of the L-5 Society. Don't elect someone because he/she demands it or promises to donate money. The officers should inspire confidence, should work hard and should be easy to work with. Send your list of officers to headquarters.

5. *Pick a Name.* We have no requirement for names. However, a short, snappy name will get attention. If "L-5" is included in your name, you can take advantage of national publicity. When your friends and neighbors see the L-5 Society on T.V., they'll know you're part of the action.

6. *Initiate Projects.* Your local chapter will be great for making friends and throwing parties. But remember, we're here for a purpose — to get ourselves off the planet! Projects run by local chapters include operating a speakers' bureau (to educate schools, churches and civic

groups); setting up displays at fairs, hearings and civic events; sponsoring lectures, films and slideshows; publishing a local newsletter; and forming a political action group.

7. *Money.* How do you keep financial records? First, open a checking account. You'll need our tax number to do that. When you've formed your chapter write the President of the L-5 Society and she'll give the number to you.

The two most important records to keep are of the money you take in (who gave it, how much and what it was given for) and the money you spend (who the check is made out to, how much and what for). With that information recorded in a cash receipts (income) ledger and a cash disbursements (outgo) ledger, you can then determine how much you spent on, for example, your T-shirt project vs. what it brought in, and how much your local newsletter is costing vs. income from subscriptions. That way you can determine which projects are profitable and which are not. Please note that for expenditures over \$500, you need approval by the L-5 Board of Directors.

But there's no point in keeping records if there's no money to handle! The most straightforward way to raise money is through local dues. However, it's hard to get people to fork over money for a newly-formed chapter of dubious future. The way you part the doubters from their money is by sales: T-shirts, bumper stickers, posters, even a bake sale! Where do you hold your sales?

Science fiction, mystery and comic fans hold conventions all over the country. Ask them for a "huxter's booth." Often they'll donate the space because you're working for a good cause. And you'll get an audience of hundreds, sometimes thousands, of enthusiastic potential customers and recruits. In Tucson we even got a free booth at a custom car show!

How can you hook up with these conventions *early* and get a *free* booth? Two valuable science fiction trade newsletters with all the inside news are: LOCUS, Box 3938, San Francisco, CA 94119 and APOTA, Box 19413, Denver, CO 80219.

For details on how to obtain T-shirts to sell, call: Bob Engelke (toll free) 800-327-5611.

8. *Taxes.* Beware of local sales taxes. In most cases you'll have to pay up in spite of being a "tax exempt" group. Check with your county and state tax people for details.

How can donors to your chapter get a deduction on their income tax? It varies from place to place, but one method always works. Have the donor make out the check to "L-5 Society" and mail it to headquarters with instructions that it is an *earmarked* donation to be sent to *your* chapter. We will deposit it, send a receipt to the donor, and send the fortunate chapter an L-5 check for the same amount.

9. *When Things Go Wrong.* From 11 p.m. to 8 a.m. weekdays, and 11 p.m. Friday to 5 p.m. Sunday long distance phone rates are cheap. Try calling the president of one of those successful L-5 chapters you read about in the L-5 NEWS. They've had worse problems and have lived through them! Yes, you can even call headquarters, but I warn you, we aren't magicians. But we can give advice.

How Can Headquarters Help? We can provide you with free L-5 buttons, posters and membership forms. We also provide copies of the bylaws and the most recent list of those who wish to be locally active.

How To Help Headquarters. Send the L-5 NEWS editor news stories on your successful activities — and bury the mistakes. Scream at your local members if you find out they haven't joined up with the parent L-5 Society yet. Every new member means an improvement in the quality of the L-5 NEWS. And, most important, become a strong force in your community working for the new space program. *Reach for the stars!*

Bylaws Election

In the preceding article on forming a local chapter you will note that there is no step called "Request Approval of Chapter Status." To date, we've never had need of that step; local chapters have been pretty darn good.

But suppose a local chapter runs up a big debt and then dumps it in the lap of headquarters. Do you want part of your dues to be used to pay their bills? Or suppose a crackpot sets up a three-person chapter in your city and makes it a local laughingstock. Then what? Do you want to have to move your L-5 NEWS off the coffee-table and into a closet? As we get more numerous, we cannot be certain that all L-5 chapters will act responsibly and will not harm the interests of other chapters.

At present you can only complain to L-5 headquarters or to L-5 Board members about local chapter goof-ups; but all you will get is advice and sympathy. With these bylaws changes, you can also get some clout: the power to prevent irresponsible people from using the L-5 name, and the power to "defrock" a chapter that goes off the deep end.

With luck we will never have to use these proposed bylaws. But the price of a good organization is constant vigilance and the power to take action when needed.

Carolyn Henson
President, L-5 Society

Bylaws Changes

This is an amendment to the bylaws. The following shall be deleted: Article XIII, Section 6. The following articles shall be added to the by-laws:

Article XIV

Membership

A. The Directors shall have the authority, by resolution requiring a simple majority of a quorum, said vote being taken by any convenient written or electronic means, or at any regular or special meeting of the Directors, to accept an individual or chapter as a member of the organization.

B. The Directors may, by resolution, delegate the authority to accept individual members into the organization to the organization's President. The authority to accept chapters shall not be delegated.

C. Chapters wishing to become members of the organization must present the following:

1. A request for membership.

2. A list of chapter members, at least one of whom is an individual of the organization. This list shall include the mailing address and telephone number of each chapter member.

3. The results of an election of Chapter Officers certified under oath by the official conducting said election.

4. A pro forma financial statement certified under oath by the person responsible for the finances of the chapter.

5. Certified copies of all articles, bylaws or other documents adopted by the chapter.

D. Chapter membership shall be effective upon mailing of a charter to the individual designated as the Executive in charge of the chapter. This charter is and remains the property of the organization and must be surrendered upon its revocation by the Directors or any other dissolution of the chapter. Individual membership shall be effective upon acceptance.

Article XV

Annual Report

Each member chapter shall submit an annual report to the President of the organization on April 12 of each year. This annual report shall be certified by the Executive in charge of the chapter and shall include:

A. A brief description of the activities of the chapter during the past year and its plans for the next year.

B. A list of chapter members as of the report date together with their telephone numbers and addresses.

C. A financial statement.

Article XVI

Suspension and Revocation of Membership

Section 1. Prior to recommending suspension or revocation of membership, the President shall send a written notice to the member concerned. The notice shall include:

A. A brief outline of the information on which the President is acting.

B. The fact that suspension or revocation of membership will be recommended to the Directors unless the member shows cause.

C. A request that the member provide the President with any information the member wishes to have considered by the Directors prior to their acting on the President's recommendation.

D. A time limit for submitting the information.

Section 2. The Directors shall have the authority, by resolution requiring a two-thirds (2/3) vote of a quorum, said vote being taken by any convenient written or electronic means, or at any regular or special meeting of the Directors, to, at the request of any Officer or Director of the organization, suspend or revoke a membership of an individual or Officer shown on the organization's records as being the Executive in charge of the chapter.

Current L-5 Society Bylaws

Article I

The name of this organization shall be the L-5 Society.

Article II

The purposes for which the Corporation is formed are to operate exclusively for charitable and educational purposes, namely to promote space colonization. In furtherance of these goals the corporation may:

- A.
 1. Educate the public with technical and general information.
 2. Conduct research.
 3. Fund research by others on solar energy, space colonization and related areas.
 4. Prepare models for use in space and participate in their use.
 5. Carry out other activities in furtherance of these goals.
- B. In order to carry out and achieve the foregoing purposes the Corporation may:
 1. Receive, hold, administer, lend and expend funds and property.
 2. Make contracts.
 3. Solicit, collect, receive, acquire, expend, invest and lend money and property, both real and personal, received by gift, contribution, bequest or otherwise.
 4. Sell and convert property, both real and personal into cash.
 5. Use the funds of the Corporation for any of the purposes for which this corporation is formed.
 6. Purchase or acquire, hold, use, sell, exchange, assign, convey, lease or otherwise dispose of and mortgage, or encumber real and personal property.
 7. Borrow money with or without security and to incur indebtedness and secure the repayment of the same by mortgage, pledge, or deed of trust on real property or personal property of the Corporation.
- C. The foregoing statement of purpose shall be construed as a statement of pur-

poses and powers and the purposes and powers in each clause shall be regarded as independent purposes and powers. Notwithstanding any of the above statements of purposes and powers, this Corporation shall not engage in activities which in themselves are not in furtherance of the charitable and educational purposes set forth in paragraph A of this article.

Article III

Membership

Section 1. Regular membership in the organization shall consist of all who are willing to serve, attend meetings of the membership, vote, and who have contributed dues for the current year.

Section 2. Student membership in the organization shall be limited to those who are enrolled in a recognized academic institution and shall be entitled to all the privileges and prerogatives of regular members.

Section 3. Institutional membership in this organization is open to all organizations and corporations. Institutional members shall be entitled to all of the privileges and prerogatives of regular members, except that they may not vote at elections, hold elective office in the organization or act as chairman of a standing committee.

Section 4. Nonmembers may attend and participate in all open meetings, social gatherings, and any regular activities of the organization, except that they shall not have a vote in any decisions, and may be required to contribute their fair share toward any expense incurred through such participation.

Section 5. The powers of the members of this organization shall be limited to those usually held by stockholders of a commercial corporation, as such powers may be further limited by the laws of Arizona and the U.S.A. for members of a nonprofit corporation.

Article IV

Dues and Assessments

Section 1. The annual dues for each member of the L-5 Society shall be determined by the Board of Directors.

Section 2. There shall be no general or special assessment levied against the membership, unless approved by a two-thirds (2/3) vote of all members after discussion at a duly constituted meeting. This provision, however, shall not prevent any member or group of members from making voluntary donations to the organization for the support of specific projects.

Article V

Meetings of Members

Section 1. There shall be at least one (1) regular business meeting of the

membership each year, which will be the Annual Election meeting. Special meetings of the membership may be called at any time by concurrence of at least three members of the Board of Directors. The Secretary shall notify members by mail of the time and place of each meeting, at least two weeks in advance. Such meetings may be conducted by mail or by phone.

Section 2. Business of the organization may be transacted at any meeting attended by not less than three members, hereinafter called a quorum, of the Board of Directors. This meeting may be held over the telephone or by mail, with all decisions mailed to the three or more Board Members at that meeting for majority vote in order to be valid.

Section 3. A simple majority vote of a quorum shall decide all issues calling for a vote, unless a greater number shall be required by law or these bylaws. Only paid-up members shall be entitled to vote at these meetings, and each member shall have only one (1) vote on each issue. Votes for amendment of the Bylaws or Annual Elections, and upon demand by any member, the vote on any other question before the meeting, shall be by written secret ballot. Members may vote by U.S. Mail and members shall not be required to be present at any meeting to vote thereon provided notice is given to each member and such notice includes full particulars of the nature and extent of the issue to be voted on.

Section 4. The rules contained in Robert's Rules of Order, Revised shall govern all meetings of the organization in all cases where applicable and not inconsistent with these Bylaws.

Section 5. The authority to approve policy positions, statements on behalf of the L-5 Society, and institution of new programs shall be reserved to the Board of Directors.

Section 6. The decisions reached by duly constituted meetings of the membership shall be binding upon the Board of Directors and shall be executed by the officers to the best of their ability. No member or group of members other than said Directors or Officers shall approach any outside organization or act as representative of the organization without the prior approval and authorization of the Board of Directors granted at a regular or special meeting of said Board.

Article VI

Board of Directors

Section 1. The Board of Directors shall consist of at least five qualified members of the organization who are duly nominated and elected to Directorship by the members at large at an annual election as hereinafter provided. The term of office shall be one (1) year, beginning with the Annual

Meeting.

Section 2. Any vacancy on the Board occurring through death, resignation, disqualification, or any other cause, may be filled for the unexpired term by an affirmative vote of the majority of a quorum of the remaining directors.

Section 3. A Board member may be removed for just cause by a majority of the Board.

Section 4. The Directors shall meet whenever required, at the time and place or by telephone or mail upon written or telephoned request of three or more of the elected officers. Verbal notification to all Board members may be given in any manner necessary to assemble a quorum.

Section 5. Any three (3) members of the Board of Directors shall constitute a quorum for the transaction of the business of the Board.

Section 6. The business of the Board of Directors shall be conducted in such order as the Board may from time to time determine by resolution.

Section 7. The Board of Directors shall have the management and control of the operation of the organization. The Board may exercise all of the powers of the organization, and do all such lawful acts as it deems necessary of the membership as prescribed by these Bylaws and the laws of the state of Arizona and the U.S.A.

Article VII

Officers

Section 1. Officers of the organization shall be a President, Secretary and Treasurer, and Coordinators as needed and authorized by the Board of Directors. As soon as practical after the Annual Meeting and election of the Board, The Board shall nominate and by majority secret ballot elect from the members of the Board the Officers. Each Officer's term of office shall be coterminous with and dependent upon each Officer's tenure as a member of the Board, except that a retiring Officer shall continue to serve until replaced by the new Board.

Section 2. Officers who resign or otherwise vacate their position may be replaced by the Board, using the procedure in Article VI, Section 2 above.

Article VIII

Duties of the Officers

Section 1. President. The President shall preside at membership meetings. The President shall have charge of the business of the organization and shall administer all affairs of the organization in accordance with the Charter and these Bylaws, and shall act as official spokesperson of the Society, but in all cases the President shall be bound by the policy established by the Annual Meetings and the Board of

Directors. The President shall sign all contracts, appoint the Chair of all committees responsible to the President, and may sit as an ex officio member of all committees.

The President may, with approval of the Board of Directors, hire and appoint an Executive Director, to whom may be delegated operational responsibility for such duties as may be appropriate.

Section 2. The Secretary shall maintain records of the proceedings of all meetings and shall discharge such other functions as the President or the Board shall direct. The Secretary shall carry out official correspondence, preserve written records (except financial records), keep the membership roll, provide notice of meetings of the Board or the Society, and shall receive, verify and record all votes of the Board or Annual meeting. The Secretary shall have charge of maintaining and supplying copies of the Charter, these Bylaws, and other official papers of the Society.

Section 3. Treasurer. The Treasurer shall receive, record, and safeguard all monies paid into the organization, including collection of dues. That person shall keep full and accurate books of account for all financial transactions of the organization, and shall render a financial report when called upon by the Board of Directors or the membership. That person shall open the books for inspection at any time deemed necessary or desirable by the Board of the membership. The Treasurer shall pay all bills duly approved by the Board of Directors. The Treasurer shall prepare and present to the Board of Directors an Annual Financial Report, covering all transactions for the calendar

year, July 1 through June 30. The Treasurer shall inform the Secretary of all new memberships and dues paid, as needed.

Section 4. Coordinators. They shall be chosen by majority vote of the Board of Directors to head up specific projects as needed.

Section 5. All correspondence, conveyances, encumbrances, releases, discharges, contracts, or obligations of the organization, of every nature and description shall be executed or countersigned by the President, unless the Board of Directors otherwise directs.

Section 6. Local Chapters. The Board of Directors of the L-5 Society shall recognize any local chapter that has at least one member of the L-5 Society in it and whose activities are in agreement with the Articles of Incorporation and the Bylaws of the Society. Local chapters may include members who are not members of the L-5 Society. Each local chapter shall elect a President, Secretary, and Treasurer. The Secretary of the local chapter shall be responsible for keeping the L-5 Society informed of the local chapter's activities. The Treasurer shall provide the parent organization with the financial records of the local organization when requested by the Board of Directors. Local chapters shall have the right to establish additional bylaws regarding their chapter, providing that the bylaws do not conflict with the Bylaws or Articles of Incorporation of the L-5 Society. The local chapters shall have the right to determine how locally raised money is to be used, providing that its use does not conflict with the Bylaws or Articles of Incorporation of the L-5 Society. The L-5 Society shall, upon

Place
Postage
Here

The L-5 Society
c/o Arizona Research & Associates, Inc.
317 E. Jacinto St.
Tucson, Arizona 85705

(This address is only to be used for this election.)

request of any of its members, provide the names and addresses of the nearest local chapters. The tax status of the L-5 Society shall also cover the local chapters which are recognized by the Board of Directors. If the Board finds that a local chapter has engaged in activities in violation of the Bylaws or Articles of Incorporation of the L-5 Society, it shall revoke its recognition of the local chapter. Any local chapter which is not recognized by the L-5 Society shall not fall under the tax status of the Society, nor shall the Society be held responsible for its actions.

Article IX

Expenditures

Section 1. All proposed expenditures up to and including \$500 may be approved by the Coordinators responsible. All proposed expenditures exceeding \$500.00 shall be approved by the Board of Directors prior to actual disbursement.

Section 2. All expenditures are subject to review by the Board of Directors at any meeting.

Section 3. The Board of Directors is responsible for maintaining appropriate records to account for all property purchases for or owned by the organization.

Article X

Annual Elections

Section 1. At least one month prior to the Annual Meeting, the Board shall appoint a nominating committee, at least three of whom are not current members of the

Board of Directors.

Section 2. Not less than one week prior to the Annual Meeting, the Chairperson of the nominating committee will provide the Secretary with the names of the selected nominees, and the Secretary will notify the membership of the time and place for the meeting, and the names of all current Directors and nominees.

Section 3. At the Annual Meeting, the Chairperson of the nominating committee shall place in nomination the slate of candidates selected. Thereafter, the membership at large may make additional nominations from the floor, and the Secretary shall place in nomination any names proposed by absentee ballot. All such nominees who do not personally decline shall comprise the slate of candidates for election to the Board of Directors.

Section 4. Voting shall be by mail or secret ballot. Each ballot shall be returned to the Secretary, who shall certify the election of each person who shall obtain a majority of votes from among those voting.

Section 5. The President shall cause to be announced in the next available issue of the Society Newsletter the names of such persons as are elected to the Board.

Section 6. The Annual Meeting will be held in June, or earlier if decided by a majority vote of the Board.

Section 7. A special election to elect additional members to the Board of Directors may be called at any time by majority vote of a quorum of the Board of

Directors.

Article XI

Amendment of Bylaws

The Bylaws of this organization may be adopted, amended, or rescinded in whole or in part by a three-stage procedure as follows:

- A. Approval by majority vote of a quorum of members at any duly constituted regular or special meeting of the membership, or by majority vote of a quorum of Directors at any meeting of the Board of Directors.
- B. Publication by U.S. Mail to all current members, of the intention to make, amend, or rescind the Bylaws, with a brief outline of the proposed changes, and notice of time and place for a regular or special meeting of the membership to vote on the proposed changes.
- C. Final approval by a two-thirds (2/3) majority vote of a quorum of members present at a duly constituted meeting of the membership, to be held not less than one month following notification as required above or by two-thirds (2/3) vote of those responding by mail if the vote is held by mail.

Article XII

Indemnification

The L-5 Society, by resolution of the Board of Directors, provides for indemnification by the association of any and all of its Directors or officers or former Directors or officers against expenses actually and necessarily incurred by them in connection with the defense of any action, suit, or proceeding, in which they or any of them are made parties, or a party, by reason of having been Directors or officers of the L-5 Society except in relation to matters as to which such Director or Officer or former Director or Officer shall be adjudged in such action, suit, or proceeding to be liable for negligence or misconduct in the performance of duty and to such matters as shall be settled by agreement predicated on the existence of such liability for negligence or misconduct.

Article XIII

Dissolution

The L-5 Society shall use its funds only to accomplish the objectives and purposes specified in these bylaws, and no part of said funds shall inure, or be distributed, to the members of the L-5 Society. On dissolution of the L-5 Society any funds remaining shall be distributed to one or more regularly organized and qualified charitable, educational, scientific, or philanthropic organizations to be selected by the Board of Directors.

Clip the postcard below to cast your vote in the Bylaws election. Votes will be counted on March 15 and the results will be published in the L-5 News.

L-5 Society Bylaws Election

☐ Yes, I approve the Bylaws amendments.

☐ No, I vote against the amendments

Reasons or comments:

Membership number _____

(This number appears in the upper right corner of the address label on this L-5 News. To insure secrecy of your ballot, this portion of the card will be removed after verification by a disinterested third party. The ballots will then be counted by Prof. Jack Salmon, secretary of the L-5 Board of Directors.)