

# L-5 NEWS

A Newsletter from the L-5 Society

Number 2, Oct-1975

## System Dynamics Applied to Space Communities

The power of system dynamics, as developed by Jay Forrester and others, is in the testing of alternate policies for both long-term and side effects. To date, system dynamics has been used to tell us what won't work, and to explain some of our perplexing failures our social system has experienced.

Recently, J. Peter Vajk of Lawrence Livermore Laboratory (LLL), has developed a 3-sector model, including a space communities sector, based on earlier work with developed and underdeveloped world sectors. This earlier model was developed by D.R. Tuerpe, also of LLL, under the auspices of the Atomic Energy Commission.

Initial results of this work have been made available to the L-5 News. Adjustments in the model are being made in response to suggestions by Dennis Meadows, one of the authors of Limits to Growth, and the energy relationships in the model are being refined with the assistance of H. Newkirk at LLL. Low cost energy from Solar Satellite Power Stations (SSPS) and the exponential growth of the space communities sector are the key factors in the improved model performance.

For those unfamiliar with World Dynamics models who wonder how population could be reduced other than by migration, birth rates in these models are controlled by wealth in the same fashion as empirical data has indicated.

Assumptions and parameters in addition to the Tuerpe model are as follows:

- (1) Energy, currently close to 6% of the gross national product (GNP) for both developed and underdeveloped countries increases somewhat, reaching 7% by the year 2020. This is because, as resources become more scarce, more energy is required to process or recycle them.
- (2) Busbar cost of power in the underdeveloped countries changes slowly from the current rate of about 3 times that of the developed countries to the SSPS power cost.
- (3) A four fold decrease in power cost increases the rate of growth of capital investment by about 2.
- (4) Over a 50-year period, productivity in building SSPS's improves by a factor of 3. Power cost decreases by the square root of the productivity increase. Initial busbar electricity cost of 15 mils per KWH falls to 9 mils in 2020. Note that, compared with the Mark Hopkins article below, these costs are conservatively high.
- (5) Market penetration takes from 1990, date of first energy transmission, until 2012, at which point most electrical energy is SSPS derived. The manufacture of synthetic fuels from electricity takes 10 years after this point to penetrate 40% of the traditional markets for liquid and gas fuels. Another ten years brings the synthetic fuel market up to 75%, and in an additional twenty years to 90%.

By the year 2020, per capita income in the developed world has increased by 12%. Due to factors mentioned above, and a lower base, underdeveloped world wealth per capita has increased by 60%. In 2020 world population stands at 3.55 billion in the underdeveloped world, 1.33 billion in the developed, and 0.03 billion in the space communities. This compares with baseline two sector model runs of 4.39 billion in the underdeveloped world and 1.82 billion in the developed. In the three sector model, the total population increase rate is leveling off rapidly, at 12 million per year in 2020. Half of this increase, mostly from

the underdeveloped world, is leaving the earth for the space communities. Transporting this number of people, including a 700 kg per person baggage requires 1/3 of 10% of SSPS energy production.

The model results will be presented, at least informally, at the "Limits to Growth '75" conference.

The "Limits to Growth '75" conference, to be held near Houston Oct. 19-21, is sponsored by the Club of Rome, University of Houston, and the Mitchell Energy and Development Corp. This is the first of five biennial conferences to consider the implications of alternatives to growth. Keynote speakers will include Dennis Meadows, Jay Forrester, and Herman Kahn (a noted critic of Limits to Growth.)

Support from the Club of Rome to at least carefully investigate the world dynamic potentials of space communities would be a major advance for our work. L-5 members who can help by attending should call Jura Schaf, (312) 324-6913 for registration materials. Registration closes Oct. 15. Please let the L-5 staff know if you are coming.

Sending the workers to the conference that Peter Vajk has requested will be a heavy drain on the resources of the L-5 Society. Those who can assist us should send their contributions to:

Conference Fund  
c/o L-5 Society  
1620 N. Park  
Tucson, Az. 85719

## Economic Analysis

An unpublished paper written subsequent to the Summer Study by one of the participants, Mark Hopkins, a graduate student at Harvard University, entitled "Economic Considerations of Initial Space Colonization," is available to members of the L-5 Society. This paper analyzes the cost, benefits and possible methods to finance the project, partly based on post Summer Study developments. While the results must be treated carefully, the possibility is presented of power from space starting at less than one half of the current busbar price, (8 mils per KWH) and falling to less than one quarter of the current price (3.5 mils per KWH). This work is being reviewed by the Federal Energy Administration.

## NASA/AMES-STANFORD — ASEE SUMMER STUDY

The first issue of the newsletter reported the IO-week summer study on space communities held at the Ames Research Center (ARC) of the National Aeronautics and Space Administration (NASA). A 10-page preliminary report has since been made available, which outlines, in brief form, the team's purpose, design criteria, and conclusions. The team, composed of 28 physical and social scientists from academia and industry, included Mark Hopkins, of Harvard University, Magoroh Maruyama, of Portland State University, T. A. Heppenheimer, of the California Institute of Technology, Eric Hannah, of Princeton University, and Eric Drexler, of MIT. The summer study was sponsored by NASA/ARS, Stanford University, and the American Society for Engineering Education (ASEE)..

The team finds "no fundamental scientific obstacles" to establishing space communities, and goes so far as to hail the concept as "an evolutionary step comparable to the transition of life from the sea to the land or the transition of our own progenitors from life in the primitive forests to the open plains."

The team's habitat design involves a wheel-shaped construction over a mile wide located in the Moon's orbit 240,000 miles from both the Earth and the Moon. One revolution per minute would simulate Earth gravity for the 10,000 residents. The rim of the torus would house shops,

schools, light industry, and closed-loop agriculture. Total mass would reach about 500,000 tons, like the largest ocean super tankers. The team proposes heavy industry be located "outside," to take advantage of weightlessness and high vacuum. Such industry would be dedicated to a) the manufacture of other habitats, and b) the manufacture of satellite solar power stations (SSPS), to be placed in geosynchronous orbits above the Earth. An SSPS would gather sunlight almost constantly, and beam the energy down to receiving stations on Earth as low-density microwaves, which would be converted to electricity and fed into normal distribution systems.

Raw materials would be obtained from the Moon. A Lunar detachment of 100-150 persons could mine and ship a million tons of material to the space habitat to be refined to extract aluminum, titanium, silica, and oxygen.

In designing the space habitat, the team recognized that "living in an entirely man-made structure at high population densities remote from other communities may lead to serious psychological problems. . . a design was chosen permitting lines of sight of over half a mile, a feeling of spaciousness, and proximity to growing things. Considerable thought was given," their report continues, "to architecture and community planning, to permit diversity of development and adaptability while also providing the privacy essential in a population density of more than 60 people per acre." The team estimates that 111 acres would be necessary to produce vegetables, cereals, poultry, ham, and dairy products for a population of 10,000 persons. Animal, plant, and human wastes would be converted to water and agricultural chemicals, and with fast recycling, only small quantities of water and other essentials would be necessary. The total cost of the first habitat is estimated at \$100 billion.

After presenting these findings, the report proposes that such space habitats may "offer a way out from the sense of closure and of limits which is now oppressive to many people on Earth." The report continues: "Particularly in the Americas and other former colonies, growth has been a vehicle of rapid and often progressive social change; it has been a source of opportunity for millions of people. Many people view with distaste a future in which opportunities would become increasingly restricted, and in which new and oppressive political institutions would have to be devised in order to allocate equitable resources which were insufficient to meet the demands. Space colonization may offer a way to bring new wealth to the Earth, and new opportunities to its people, without the environmental damage which has so often accompanied growth in the past."

The team concluded by emphasizing that it was "speaking for itself," and did not represent any official government or university institution. It recommended the U.S., "possibly in cooperation with other nations, take specific steps toward the goal of space colonization."

The final and complete report of the summer study is to be published during the next few months. When publishing details are available, they will be presented in the newsletter. In the meantime, copies of the preliminary report are available to L-5 members.

### **SPACE RESEARCH AND DEVELOPMENT CORPORATION PROPOSED**

A proposal to establish a Space Research and Development Corporation to finance space colonization and other space development has been drafted. Those who would like to examine the draft and submit comments should contact Carolyn Henson, L-5 Society, 1620 N. Park, Tucson, Arizona 85719. The proposal would have the following advantages:

1. Long-term funding could be obtained so that monies would not be dependent on uncertain annual appropriations;

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L-5 Society

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2. The funding would be treated as an investment rather than a current expense, and thus would not appear as red ink on the federal books;

3. Private capital could join in research and development efforts;

4. The investments could be treated as investments or loans and paid back if the space developments proved economically profitable, thus generating a revolving fund to support further activities.

The proposal is modeled after the Reconstruction Finance Corporation, originally proposed by Herbert Hoover in 1932, and on such other institutions as the Export-Import Bank. Legislation to create this type of institution for research and development generally has been introduced by Representative Thomas Downey as H.R. 7841, 94th Cong., 1st Sess (1975), based on the report of the Committee on Consumer Affairs of the Association of the Bar of the City of New York (RECORD of The Association of the Bar, December 1974, p. 718). A similar concept for rebuilding blighted areas has been proposed by Representative Charles Rangel (H.R. 9341, 94th Cong., 1st Sess. [ 1975 ]).

### **Horizons Day Meeting Planned for 1976**

The Committee for the Future, Inc., has established June 26, 1976, as Horizons Day, when groups in the U.S. and abroad will join in a one-day meeting to search for consensus on new horizons for humanity. Local initiatives can be sponsored by representatives of the Bicentennial Committees but local communities and groups who wish to Participate may do so. Further details may be obtained from Ms. Barbara Marx Hubbard, the Committee for the Future, 2325 Porter Street, N.W., Washington D.C. 20008. To defray large information distribution expenses, \$2.00 is requested when applying.

L-5 members may wish to use this event as a forum.

### **AAA Contest In Cultural**

#### **Futuristics**

The American Anthropological Association (AAA) is sponsoring a Contest in Cultural Futuristics, the winners of which will be invited as speakers at a futurism symposium to be held during the 1976 AAA general meeting. Contestants may select from three categories: a) A future cultural alternative for a large, complex society such as the U.S.; b) Post-Industrial international development; and c) Extra-terrestrial (L-5) communities.

Manuscripts, which must be between 20 and 50 double-spaced pages long, may be essay treatments or fictional pieces. Essays should avoid general rules and theories, concentrating on the specifics of the imaginary society. Fiction pieces should emphasize the different social aspects and their interrelationships, avoiding excessive dialogue or complex "plots."

Entries must include a long (250-500 word) abstract and a short one (under 100 words). All winning entries will be published, and the most interesting ones will receive \$100 awards. The contest rules specify that all interested persons may enter, regardless of professional background or rank. Deadline for entries is January 5, 1976. Further information, including guidelines for the three categories, may be obtained from one of the organizers, Dr. Magoroh Maruyama, P. O. Box 751, Portland State University, Portland, Or. 97207 (503/299-4961). Dr. Maruyama was a participant in both the Princeton conference and the Stanford-NASA/Ames-ASEE Summer Study (see other article in this newsletter).

**SSPS Paper Submitted**

Among the longer drafts of submitted articles L-5 News received this month, is one by William N. Agosto, project engineer at Microwave Semiconductor Corp, Somerset, N.J. Titled "Space Production of Satellite Solar Power Stations: An Option for United States Energy Independence Before 2000," it has been submitted to the Institute of Electrical and Electronic Engineers Spectrum and is under consideration. The article contains an in depth technical review of the SSPS concept as modified for space manufacture, and the associated economic and ecological considerations. Members who need a copy of this article should write the L-5 Society.

Coming next issue: Eric Drexler's work on the vapor deposition of massive structures in space; a preview of T.A. Heppenheimer's article, "R & D Requirements for Initial Space Colonization" which will appear in the Dec. issue of "Astronautics and Aeronautics", and a report on the "Limits to Growth '75" conference.

Some of the people who are currently giving talks on space communities are Eric Hannah of Princeton, William Agosto of Microwave Semiconductor Corp., Summer Study co-administrators William Verplank (now at MIT) and Richard Johnson (NASA/ARC); Peter Vajk of LLL, and T. A. Heppenheimer of California Institute of Technology

**LETTERS**

**Nova's Ark**

And the Sons of Science said unto NASA, "Make yourself an Ark of glass and aluminum, the length of which shall be two thousand cubits and its height shall be four hundred cubits. Make it of the Moon and the Sun and the Earth and the Air and set its orb as of the Moon to sail the Heavens. And tie a Docking Station five hundred cubits from the Ark to receive the covered chariots.

"You shall come into the Ark, you, your wife, your sons and your daughters of all the Families of Humankind. And you shall bring seven pairs of rabbits and two goats to keep them alive with you; they shall be male and female. And take with you every sort of high yield food that is eaten and plant it in Styrofoam and water it with mist and it shall serve as food for you and for them.

"For in seven years will be visited upon the Earth forty years of Hunger and Smog and Oil Embargoes and Warfare and Plagues and Ice and Weeping and Despair. But the Ark of glass and metals shall keep the Earth from falling into utter desolation, for it shall send back to the peoples of the Earth Sunlight and Manna and Hope from the Heavens. And it shall be called Nova's Ark."

Philip M. Blackmarr  
Menlo Park, California

**Why?**

The colonization of space, for me, needs no other justification than man's adventurous willing ability to do so. However, the average person, struggling with an already too heavy tax burden and a sagging economy, will rightly demand a well-defined, profitable reason for taking on so vast a project. When asked "why?", any colony advocate would wield a powerful and convincing argument.

To date, the benefits of the American space program rarely surface in everyday life. The technical advances, while greatly useful in manufacturing and many industrial areas, lay one level below individual existence; popping up annoyingly on occasional television commercials in pens that write upside down and strange little moon men pitching breakfast drinks. Likewise, the large stores of knowledge brought back to Earth aid the average individual only circumspectly, never directly.

The space colony project will offer two very tangible, very direct benefits to the taxpayer in ways (s)he will easily understand.

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

NAME \_\_\_\_\_

COMPLETE ADDRESS: \_\_\_\_\_

AFFILIATION(OPTIONAL): \_\_\_\_\_

TITLE or POSITION (OPTIONAL): \_\_\_\_\_

I am  am not  interested in being active locally.

Check here if membership is to start with issue one.

\_\_\_ Please enroll me as an L-5 Society Member. I am enclosing a check for \$\_\_\_\_\_ (regular membership \$20.00; student membership \$10.00).

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

Energy is a key word. One of the many important functions of the colony will be the construction of solar energy satellites. These satellites will provide an inexpensive, never-diminishing supply of energy. Any person (corporation, government) that must purchase energy will recognize this as a solid, real aid to their life.

Secondly, the most immediate effect of the colony will be economic. Government spending on this scale will circulate the tax dollars, stimulating economic growth and generating millions of jobs (good news for the unemployed!). Economics is a good reason for the immediate initiation of the space colonization project.

The other benefits of space colonization will evidence themselves in many ways, but none so dramatically and directly as the economic and energy stemming from the colony. Even though there will always exist those whom logical and good reasons leave unpersuaded, energy and economics can stand alone as justification for the colonization of space.

Shirley Ann Varughese  
North Plainfield, NJ.

(Ms. Varughese is the author of "The Planet Xeno" in **Cultures Beyond the Earth**. Magoroh Maruyama and Arthur Harkins, eds., Vintage Books, 1975.)

# L-5

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**NASA/ARC-Stanford-ASEE Summer Study**  
**Cultural Futuristics Contest**

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## The L-5 Society

The L-S Society is being formed to educate the public about the benefits of space communities and manufacturing facilities, to serve as a clearing house for information and news in this fast developing area and to raise funds to support work on these concepts where public money is not available or is inappropriate. We will send membership cards and newsletters to those who respond. The effectiveness of the society depends on your response. It would be appreciated if you were to copy this newsletter and send it on to others who would be interested. Our clearly stated long range goal will be to disband the society in a mass meeting at L-5.

## ADDRESS CHANGES

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

