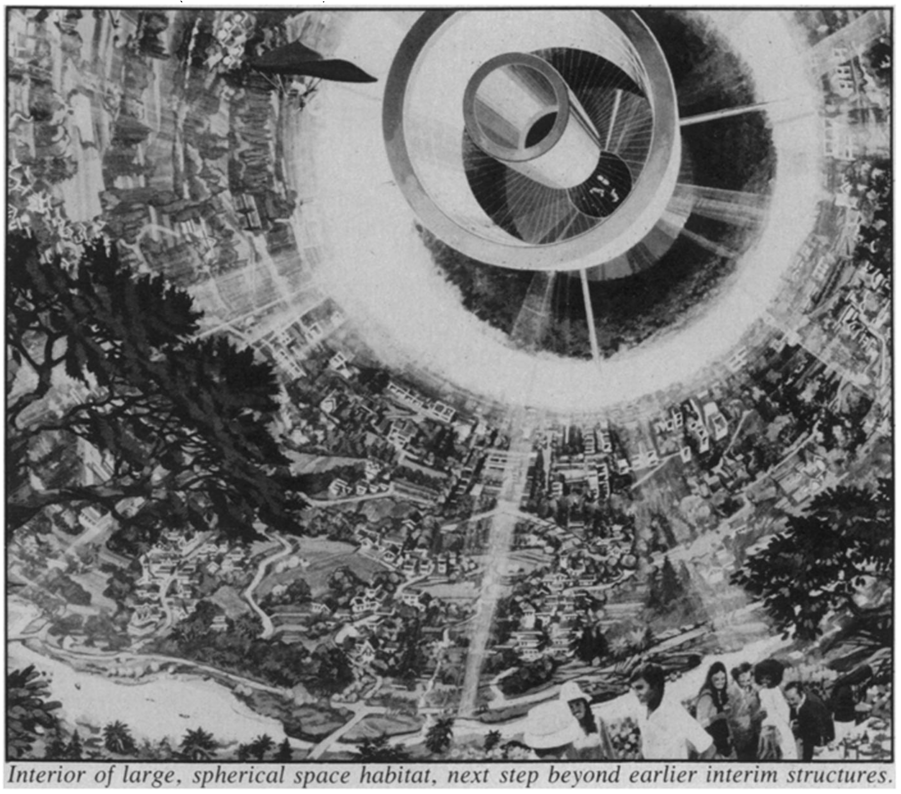
Moon Mines, Space Factories and Colony L5

Scientists have now outlined detailed plans for the three key stations in a self-supporting, industrialized space-colony community

BY MICHAEL GUILLEN



Interior of large, spherical space habitat, next step beyond earlier interim structures.

In just a few years, the notion of space colonization has evolved from a science-fictional dream to the object of serious scientific deliberation. Last summer a concentrated study established the idea's general feasibility (SN: 9/6/75, p. 149). Now a second study this summer has focused its attack on three specific problems, bringing the entire concept even closer to reality.

The scientists, representing an unusually wide variety of disciplines, envisage a self-supporting industrialized space community made up of three separate facilities: one on the moon and two in space.

This scenario requires an excavation and launch site on the moon to obtain the enormous quantity of raw materials necessary to construct this massive complex (about half a million tons). Less energy is required to overcome lunar gravity in "shipping" the lunar soil to the actual space colony than if soil were taken from the earth. Soil mined from the moon will be catapulted across 100,000 kilometers to Lagrange Point-2 (L2), a region of space that represents one of several "balance" points in the gravitational field of the earth-moon system.

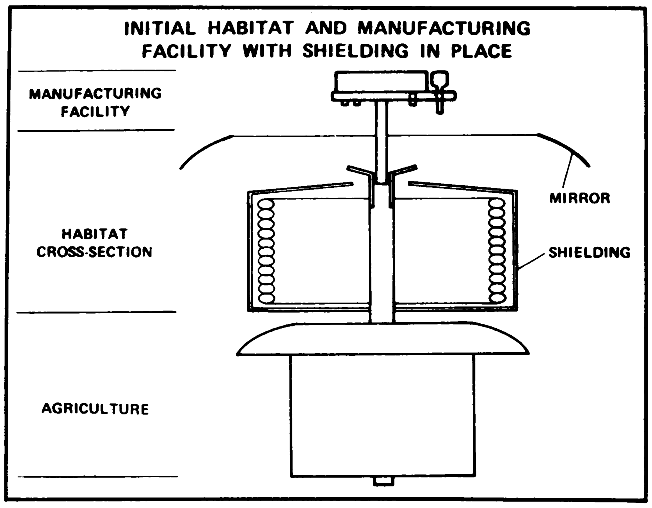
Once arrived, the soil is processed by an orbiting station into its useful constituents (e.g., oxygen, iron, aluminum, and silicon). From L2, the processed material is then "tugged" to the third site at L5, where the actual space habitat, complete with agriculture module and manufacturing plant, resides. L5 is a moving point in space, poised 250,000 miles from both the earth and moon.

A popular conception keeps the plant busy manufacturing solar power satellites (SPS), which placed in geocentric orbits will beam invaluable quantities of converted solar energy back to the earth in the form of microwaves. This general scheme, the proponents, argue, is a way of making space colonization profitable.

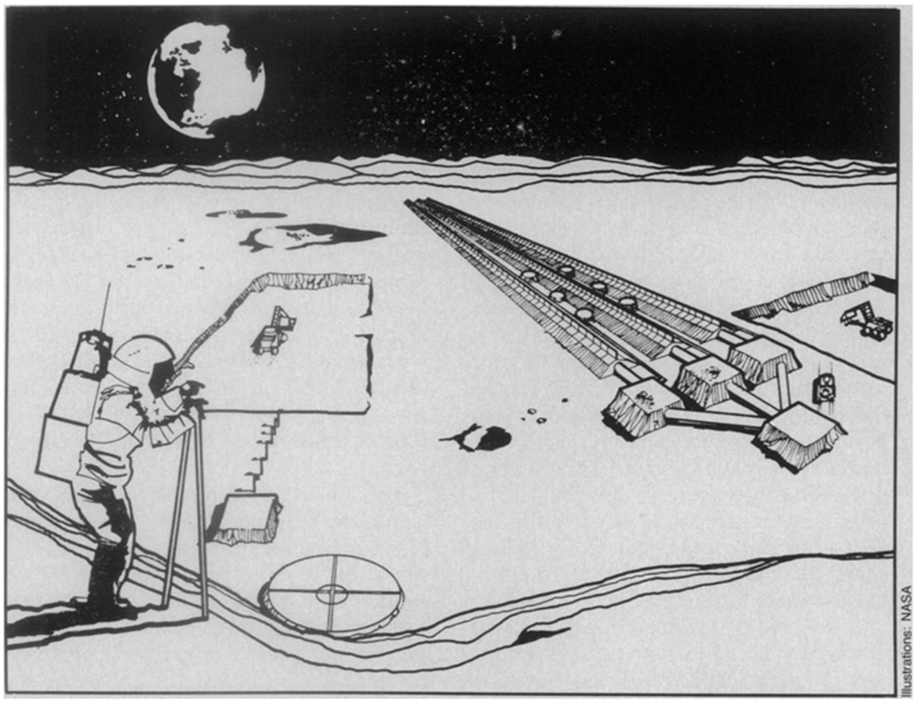
In this summer's study, carried out at NASA's Ames Research Center, scientists discussed detailed plans for the construction of these three key stations. Frank Chilton, staff physicist for Science Applications, Inc. in Palo Alto, Calif., advocates a lunar-based "mass launcher" system utilizing a magnetic levitation process that he originally co-discovered. The propulsion mechanism, first reported in 1972 with reference to a proposed rapid transit system, basically relies on the repulsion derived from two "opposing" magnetic fields. According to Chilton, soil excavated from the moon would be put into sacks made of fiberglass processed from the lunar soil. Each 20-kilogram bundle is then accelerated (to the moon's escape velocity, 1.5 miles per second) in a "bucket" which rides along a magnetic track about four kilometers long. Before it reaches the end, the bucket is halted, releasing its contents into space towards L2. Downrange from the launcher, a lunar station checks and corrects, if necessary, each outgoing bundle's trajectory. From space, one would see a parade of soil "bullets" streaking towards a cosmic-sized "mass catcher." More than its name implies, the catcher's general function would be to collect and then process the incoming soil modules, fiberglass containers and all. Although scientists anticipate that the soil bags would repeatedly follow a single precise trajectory, the catcher would be outfitted with small manuevering rockets.

Chilton's group has gone so far as to select a specific area of the moon, with a topography that fulfills various requirements for a reliable mass launcher system. It is located in the Sea of Tranquility, about 350 miles east of Tranquility base, the Apollo 11 landing site, and southeast of the Maskelyne crater. According to a group member, this site minimizes the restrictions on the design for a successful launcher.

It may appear at this point that much ado is being made for simply processing lunar soil. One might suggest mining and processing in a single location to eliminate the need for an intermediate station at L2. Chilton's group claims to have studied this and other alternatives with results that favor their current proposal. Much of the reason why comes from the difference in costs between transporting materials in



Latest design for cylindrical space colony, with its manufacturing and agricultural sections.



"Mass driver" would catapault modules of lunar soil to processing station in space.

Illustrations: NASA

and out of the lunar gravity field and a station already located in space.

A group headed by Gerald Driggers, from the Southern Research Institute in Birmingham, Ala., proposes a modularized, basically tubular design for the actual processing plant. The plant could efficiently separate out the primary elements in the lunar soil and extrude them into useful industrial shapes. Data obtained primarily from the Apollo missions indicate that the soil contains up to 12 percent aluminum, 15 percent iron and 40 percent oxygen. Driggers estimates that the hypothetical plant would require about 500 megawatts to process about 300,000 tons of lunar material per year.

Driggers also describes a space habitat which, as a first attempt, is a "utilitarian" precursor to the more elaborate colonies to be built after accumulating more experience. The proposed habitat accommodates about 6,500 people, most of whom would be involved with constructing the solar power satellites. He advocates a cylindrically shaped habitat annexed to a similarly shaped agricultural station. The living module spins at a slow rate (21 seconds for a 100-meter-diameter cylinder) to simulate earth gravity. The manufacturing facility, also attached to the living quarters, does not spin in order to exploit the naturally weightless environment, in which many plant operations are enormously simplified.

Original toroidal colony designs have been abandoned for various reasons, according to Gerard O'Neill, the Princeton University physicist who has led the repopularization of space colonies. Not only are cylinders and spheres superior in total weight necessary for an identical population capacity, they also reduce the amount of shielding necessary to protect a colony from space-borne radiations.

To minimize the hazards of microwaves, O'Neill says, the SPS beams would be aimed at specific sites on earth selected for their isolation from populated areas. The microwave beams can easily be kept on target by using a "fail-safe" device which shuts the power off any time the beam strays off-target. The energy flux of the beams under study is about one-third that of average sunlight, O'Neill adds.

Driggers proposes that the space colony build 20 10-gigawatt power stations, estimated to cost about $500 million each. This cost compares favorably to that for terrestrial nuclear power stations, O'Neill says. Driggers also estimates that the entire three-stationed complex, including production of the first solar power satellite, would cost about $100 billion to $200 billion and take until at least the late 1980s to complete.

Scientists emphasize their unwillingness to predict the likelihood of a national commitment to the project. However, NASA has already demonstrated more than a casual interest. It has sponsored a great deal of the research, including this summer's study, and high-ranking NASA administrators have personally attended space colony conferences. Furthermore, the proposed space complex has been conceived so as to be compatible with NASA's current pet project, the space shuttle. Commenting on the research's whirlwind progress during the past few years, O'Neill elatedly observed that it would be difficult for him to imagine sustaining an increased workload.

Investigators in this field realize the immaturity of the subject matter and foresee the need for more research. A subject often brought up in current discussions involves the unknown effects of microwave radiation on the atmosphere (including the ionosphere) and its general impact on the earth's ecology. Although they readily acknowledge this lack of information, few scientists believe it represents an insurmountable problem.

The technology for implementing this cosmic enterprise exists or soon will. What loom as the greatest obstacles are political and social ones. In the face of pressing domestic chores—expensive ones—Congress may not be swept away by the grandeur of a scheme costing four times as much as the Apollo program. The social advisability of proliferating our volatile species in space and the international legalistics involved (United Nation representatives have yet to even agree on a suitable definition of "space") will probably prevent the rapid evolution of space colonization. There are as many other reasons to believe, however, that mankind's next "giant leap" into the universe will be collective steps taken onto the carpeted floor of a plush living room in space. □

Michael Guillen, a Ph.D. candidate in physics and astronomy at Cornell University and a weekly science columnist for a chain of California newspapers, has been working on the staff of SCIENCE NEWS this summer.