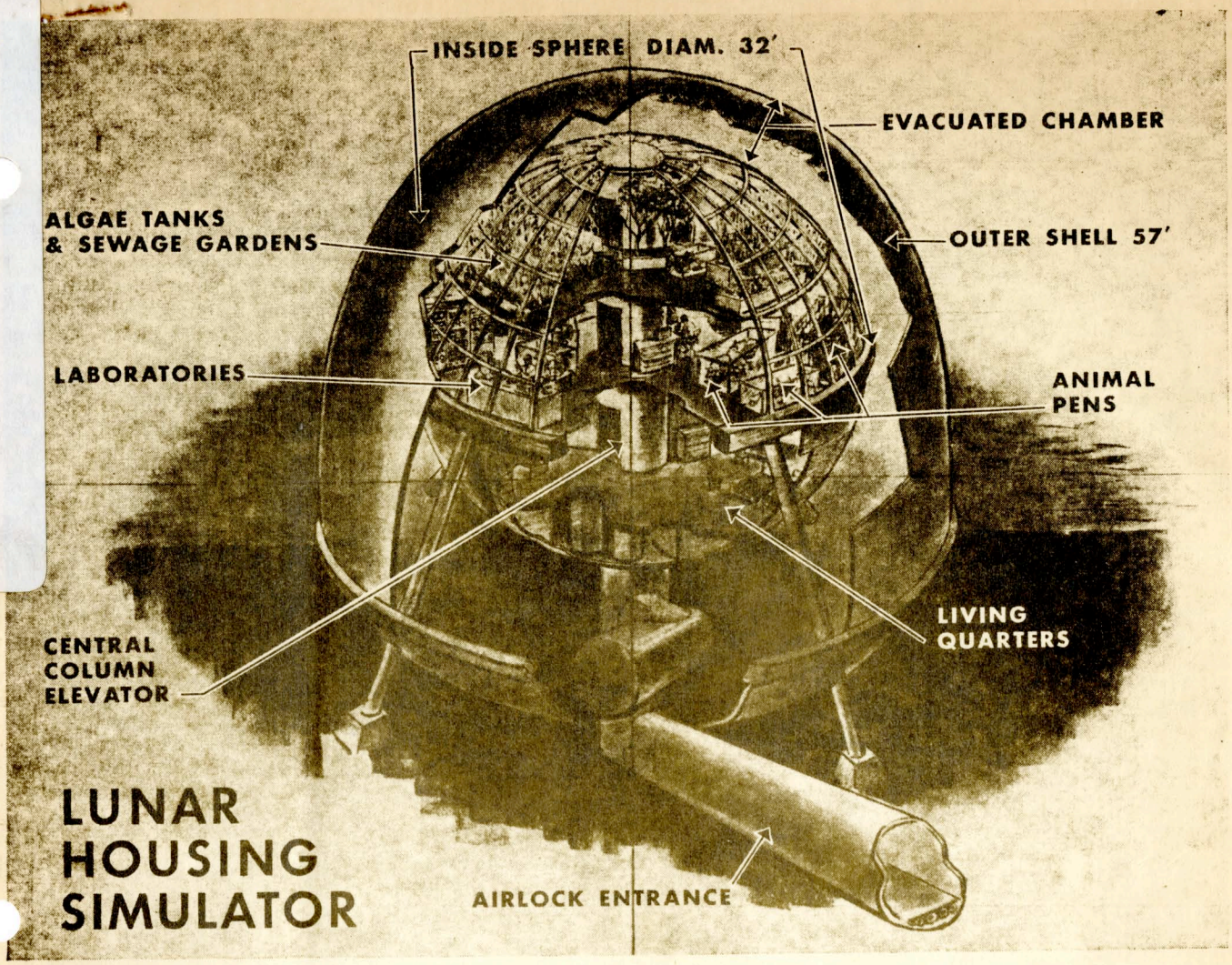

Waste Disposal in the Space Age

Waste conversion techniques have been developed into a balanced total environment system that can handle the problem of disposing of noxious organic materials from sealed space ships by turning them into reusable products.

When the first scientists land on the moon—probably in the 1960s—they will spend a period of weeks living and working in a lunar ship that might look something like the Martin Co.'s space simulator shown above.

Martin's Denver Div. researchers already have started the engineering for the lunar house, which will be a little universe all its own. Since the vehicle will be completely sealed, a "total environment" simulating conditions on earth will have to be created. Plants and animals will be taken along to carry out the same functions as they do on the earth—the plants will provide oxygen necessary for animal and human life, and the animals will eat the plants and release the carbon dioxide needed to produce more plants.

• **New Kind of Garden**—The plants also figure in the sewage gardens—an unusual waste conversion system that was devised especially for use in a space ship—but which also may someday help communities and industry handle their sewage and waste problems more effectively. Since the space ship will be completely sealed, it may not be feasible to discharge waste materials. And they can't be allowed to accumulate in any great quantity, either. So, the only solution was to find a way to convert them into useful, reusable products. In the system envisioned for a lunar ship, the noxious materials will be dumped into tanks of water containing algae and bacteria. Through photosynthesis, the waste solids become algae—which animals can eat—and the waste liquids are changed back into drinkable water.

The process, known as photosynthetic oxygenation, developed out of research begun nine years ago at the University of California. The scientists' initial interest was the improvement of commercial sewage treatment techniques. But, with the dawning of the space age, their interest shifted to working out a complete and balanced system that would eliminate the need for discharging wastes altogether.

• **Early Research**—The earlier research work had led to discovery of methods of converting waste materials to harmless substances that could be dumped into streams without polluting them. Then the researchers started looking for ways to convert the wastes into useful products.

After prolonged experimentation, they were able to convert wastes into high-grade fertilizer; into algae, which have been used experimentally as high-protein fodder for chicks; and into methane, suggesting a new source for gasoline.

Because of their experience with these and other processes, the Uni-

versity of California scientists felt the photosynthesis process for turning the wastes into algae could best be adapted for a balanced sewage disposal system in the small confines of a space ship.

Bulk of the research was handled by Dr. William J. Oswald, a sanitary engineer from the University of California, and Dr. Harold B. Gotaas, now dean of the Technological Institute at Northwestern. Later, Dr. Clarence G. Golueke, a research biologist at Cal, joined the team.

• **How the Process Works**—Essentially what Drs. Oswald and Golueke did was to apply their biologic science to the long-used ponding system of sewage treatment by introducing algae and bacteria. In ordinary ponding, after some solids have been screened out, the wastes are dumped into a pond of water, and the algae normally present in any water consume and grow on the remaining solids and give up oxygen in the process. But this natural process is a slow one and requires a large pond. But by putting more algae into the water and also bacteria, the whole purification process is speeded up and can use a smaller pond. For the needs of the few people on a space ship, a tank would suffice.

The photosynthetic oxygenation process works like this: The algae supply the bacteria with abundant oxygen, while the bacteria supply the carbon dioxide for the conversion of the solids in the sewage into more algae. Sunlight also is necessary for the algae to grow.

• **Test Results**—After the process had been tested under laboratory-controlled conditions—in which algae and bacteria were grown continuously in human wastes in king-size test tubes—a moderate-scale test was conducted at the sewage treatment plant in the small city of Concord, Calif. And, on the basis of these results, Drs. Oswald and Golueke believe that the process is workable for any city that must treat its sewage and has a large amount of not too expensive land available nearby. They estimate that an American city, on the average, produces about 100 gal. of sewage per person per day. At the present stage of development, their process can handle about 100,000 gal. per day on each acre of pond. Each acre then would take care of 1,000 people. This is theoretical, based on the moderate-sized pond operated at Concord. The scientists hope to reduce the land requirement by as much as one-half as they refine the process.

• **Useful Byproducts**—From time to time, some of the algae has to be removed from the pond, and Drs. Oswald and Golueke accomplished this by centrifugation. After it has been dried out, the algae can be ground into meal. The

university researchers found that algae is 40% to 50% protein and contains large amounts of Vitamin A. This makes it useful as a feed supplement. Experiments showed that chicks could get one-fifth of their nutritional requirements from the algae meal without harmful effect. Experiments using the algae as feed for other animals still lie ahead. Since the algae is rich in calcium, nitrogen, magnesium, phosphate, and potassium, it also can be used as fertilizer.

While the decontaminated sewage water would not be harmful for human consumption, most persons, understandably, would rather go thirsty. But the purified water might be used for irrigation, though its mineral deficiency makes this application dubious for extended use. It would be ideal, however, for industrial cooling, and could also be used for other industrial purposes where the water has to go through a purification process anyway.

• **Spaceship System**—For a waste disposal system on a space ship, Dr. Oswald estimates that it will be necessary to carry 30 gal. to 40 gal. of water and algae per man. Again, refinement of the process may cut this volume down. But however much the average person might shrink at drinking purified sewage water, it will be completely potable and palatable. Dr. Oswald figures that the space traveler can get by on a gallon of water a week for drinking, but even through careful use will need as much as 10 gal. to 15 gal. a day for other purposes.

The persons aboard a lunar vehicle, however, will be spared the agony of eating algae meal—except possibly in a case of emergency.

The space ship larder will be stocked with high-energy food prepared on earth and packaged in organic materials that could be ground up with the garbage and introduced into the waste conversion system. The algae would be fed to the animals and used as fertilizer for the plants.

Ingenious though it is, the waste conversion system imposes certain limitations on the space vehicle. Since sunlight is a basic ingredient of the process, trips beyond Mars or Venus would be impossible because the sun's rays are too feeble there.

• **Unsatisfactory Alternatives**—Possible alternatives to the photosynthetic oxygenation process for handling waste disposal are (1) rocketing the wastes toward earth to burn up on entry in the atmosphere (2) or discharging them from the vehicle into space where they would become flying submeteorites. Simple as these methods sound, they involve engineering problems far more difficult than waste conversion since the space vehicle must remain sealed at all times. **END**