Martin Aircraft Conducts Closed Ecology Studies

In a converted ranch house garage on the Martin Company's 7,000-acre site near Denver, Martin scientists are looking for answers to some of the most difficult problems facing man in his efforts to conquer space.

Members of Martin's Space Biotechnology Section, working in laboratories located in former ranch buildings, are searching for means of balancing a closed ecology in which a space traveller may live and work for extended periods away from earth.

Dr. James G. Gaume, chief of the section, says the goal of the research is a self-sustaining system which will regenerate and purify its own atmosphere, produce its own food, and then re-utilize its own wastes in the process of food production.

Essentially, a space vehicle or station designed for extended periods must provide a miniature replica of the earth's closed ecology.

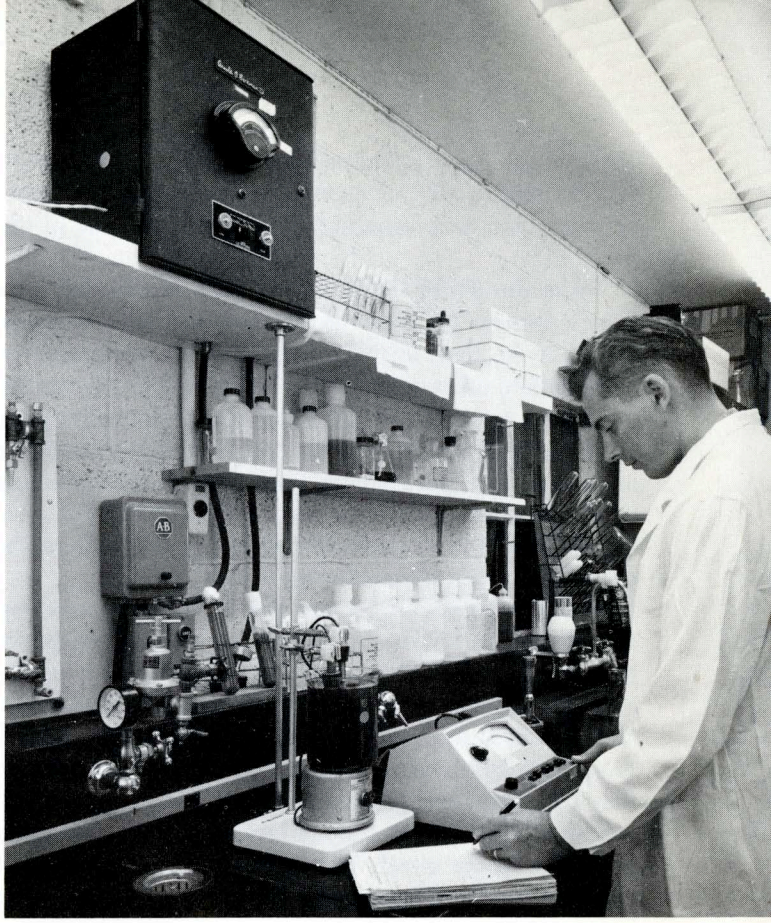
Part of the research in Dr. Gaume's section is centered on the role that microscopic algae may play in a closed ecology. It is hoped that in addition to supplying the breathing atmosphere with oxygen, the algae will also remove carbon dioxide from the air and serve as food for members of the space crew. In turn, human and animal wastes (animals may be present on the space trip) would fertilize the algae, and a cycle would be completed.

Dr. Gaume says one of the problems facing scientists working on the closed ecology project is that of determining the best oxygen-producing algae for the system. Each of the algae under consideration has a certain desirable characteristic; some have several such characteristics. The problem is to select the one that is best suited to produce oxygen, utilize wastes as nutrients, and provide a dietary supplement.

A few other questions for which answers are needed: Will converted waste materials be suitable nutrients for the algae or must other chemical nutrients be used? Can the chemical composition of the nutrient be maintained by automation or must a technician prepare the solution? What source of light energy will be used for photosynthesis?

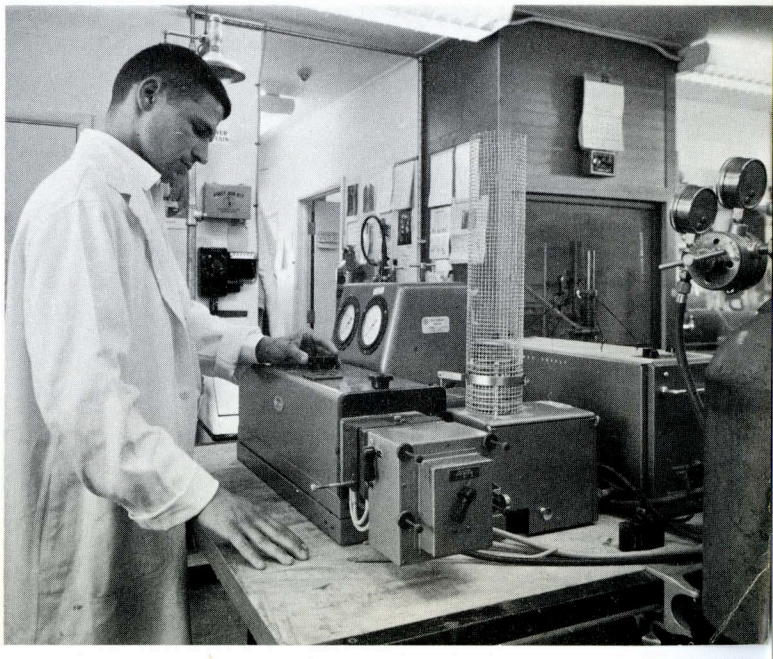
Denzel L. Dyer, Ph.D., directs work on algae at the Denver Division under R. D. Gafford, Ph.D. Current projects involve all of the general problems: atmosphere regeneration, food production, and waste processing.

In several phases of the work, Dr. Dyer uses a Beckman DU Spectrophotometer. With this instrument, he says, "we can easily analyze the nutrient medium and the liquid effluent from a waste digester and determine



Dr. Denzel L. Dyer uses a Beckman Zeromatic pH Meter to check the pH of algae in suspension. Dr. Dyer is interested in establishing the relationship between pH and the algae's growth. A Beckman F-3 Oxygen Analyzer, also used in Martin's closed ecology studies, is located on top shelf above Zeromatic.

Seymour Wildman, analytical chemist at Martin, is shown using a Beckman DU Spectrophotometer with flame to analyze liquid effluent from a waste digester in the Space Medicine Section of Martin's Denver Division.



The Analyzer
Beckman Instruments, Inc.
January 1962

whether the algae are receiving sufficient nourishment. For example, the DU is used to determine whether phosphorous, which is essential to algae, is present in the material."

"With the aid of the DU," Dr. Dyer points out, "We can determine by direct proportion the near accurate weight of the algae by finding their density in suspension. This method takes only a few minutes, but the alternative procedure would involve 24 hours to centrifuge the algae in suspension, to remove salts, and to resuspend in water and evaporate. The volumes we work with are extremely small, of course, and this is another reason why the spectrophotometer is so much faster than gravimetric methods and so much more efficient for us."

Two Beckman Zeromatic pH Meters are used by the Martin scientists in studies aimed at finding the optimum pH for algae growth. Any element in any ecology may react upon other elements to varying degrees. But in a closed life system, operating in the extremely limited space envisioned in the Martin studies, effects may be greatly exaggerated. For example, copper is poisonous to algae, which become sick if they are exposed to contact with the metal. The acidity of all solutions used and their effects upon metal surfaces is of major importance.

Dr. Dyer says present knowledge points to aluminum or certain plastics as the materials best suited for the structural work of the housing for a closed ecology in space. Even some alloys containing copper are incompatible with algae; therefore, such items as pump bearings of copper alloy must be ruled out. Glass, while used widely in laboratories, also would be ruled out due to its weight and fragility.

Since the purpose of the algae is not only to serve as a basic food but also to provide an oxygen supply, work in Martin's Space Medicine Section includes the measurement of oxygen converted by the algae, a factor directly related to their growth.

A Beckman F-3 Oxygen Analyzer is tied into the laboratory's photosynthetic gas exchange system when needed. When a closed system is set up for laboratory purposes, the Oxygen Analyzer, using a measured amount of CO_2, measures the increase in the system's oxygen content.

Animals such as chickens or rabbits may be included in the closed system to serve part of the food needs. This is expected to have a favorable psychological effect upon the crew. In a paper recently authored by Dr. Gaume, he wrote:

"Motivation must be as high as possible, and a diet consisting solely of algae would not sustain or increase motivation."

However, in defense of the lowly algae, he wrote:

"There is no reason why algae, when prepared adequately for the table, cannot be just as acceptable—yes, even as tasty—as spinach, broccoli, and other green vegetables.

"In fact, four years ago, algal research scientists prepared and ate a banquet in which all the courses of the meal were composed partially of algae. The event was a notable success."

The Martin Company opened its Denver facilities about five years ago. Its major project has been the design, fabrication, and testing of the Titan I and II intercontinental ballistic missiles.

Beckman instruments have been applied in the Titan work too. For example, another DU Spectrophotometer is used in research and development on Titan II propellants. A Beckman Infrared Spectrophotometer is used in the measurement of hydrocarbons in recovered helium. A GC-2 Gas Chromatograph determines the purity and moisture content of aerozine-50. And Beckman pH meters are used to check water used in the cleaning of various missile components, such as tubing or valves. The pH meters also are used in the titration of fuels such as aerozine-50 and nitrogen tetroxide.

The Denver Division of Martin is referred to as an "integrated missile facility," the term stemming from the fact that an engineer's line drawing can be transformed at the site into a complete weapon system, including design, fabrication, and captive testing.

U.S. Air Force authorities have mentioned the Denver Division as the only facility of its type in the western world—and probably in the entire world.

This photo shows the photosynthetic gas exchange system at Martin's Space Medicine Section in Denver. The test tubes contain algae, growth of which is promoted by light from fluorescent tubes. Checking the system is Dan Richardson, chief of bio-engineering.