SKYLAB

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Introduction

In the next few days you are going to be overwhelmed with statistics on the myriad of past, present, and future benefits that mankind can expect from operations outside the earth's atmosphere. These benefits are real and offer, in my opinion, the only hope mankind has to perpetuate a habitable earth environment.

The previous speaker described unmanned data-gathering orbital systems and, I am sure, impressed you with the results to date and the potential yet to be exploited.

In my portion of this program I will describe how Skylab will operate, collecting data and using man's indispensable capability to observe, evaluate, make judgments, and adapt to changing situations.

I used the term exploitation a moment ago and want to emphasize that the space program is rapidly being transformed from basic experiments and explorations to useful operational exploitation. A major factor in achieving the necessary knowledge to solve mankind's problems will be the addition of trained scientists, doctors, and engineers as future orbiting working astronauts.

Skylab will be our country's first step in providing a long-term manned orbital capability.

What Exactly Is Skylab?

Skylab is an experimental space station, designed to provide a comfortable shirtsleeve environment for a three-man crew for periods of up to 56 days in earth orbit. Figure 1 shows the Skylab "Cluster" as it will appear circling the earth. I will give you a brief description of the various elements that make up the cluster. Total design life of the cluster is 8 months, encompassing three separate manned visits.

Figure 2 shows the Command and Service Module. It is the ferry vehicle or "taxi," if you will, that takes the crew to and from the workshop. The astronauts will dock their spaceship to the Skylab in much the same manner as on the Apollo program where they docked and undocked with the lunar landing vehicle.

The Multiple Adapter (Fig. 3) provides — as its name implies — the docking port for the Command and Service Module. In addition, it houses the control and display panels for the solar and earth resources experiments, which I will discuss later.

The windmill-like apparatus on top of the cluster is one of the main experiments on Skylab. This telescope mount with its solar array panels is a solar observatory that will give solar physicists a look at the sun's activity free from the distortion caused by the earth's atmosphere. Figure 4 shows a more detailed view. While Skylab is photographing the sun from space, scientists here on earth will use ground-based telescopes to photograph the same areas of the sun for comparison of data.

The Airlock Module (Fig. 5) is the "nerve center" of the cluster. It serves as the Control and Distribution Center for all the electricity, the oxygen and nitrogen that the astronauts breathe, and the equipment for two-way voice communications between the Skylab and the ground control stations. The Airlock Module is equipped with a window or hatch from which the astronauts can exit the spacecraft and walk along a ladder to load and retrieve film used in the solar telescope cameras.

The largest section of the Skylab cluster is the Orbital Workshop (Fig. 6) with space equivalent to a small three-bedroom house. This 10 000 ft^3 two-story laboratory has been converted from the hydrogen tank of the third stage of the Saturn V rocket. It will serve as the primary living quarters and experiment operations area. The old cramped quarters and physical constraints associated with Gemini, Mercury, and Apollo will be a thing of the past. Individual rooms are provided for recreation, eating, bathroom-lavatory facilities, and sleeping. A home-type toilet will be particularly appreciated by the astronauts and will remove what has been one of the most irritating aspects of space travel. A shower that can be used in weightless space has been developed to be used onboard Skylab. A special interest to the ladies in the audience is the large amount of closet space available for storing food, water, clothing, trash bags, personal items, and various experiment equipment. The goal has been to create a very pleasant environment with many of the comforts of home.

There are some aspects of living in space that are unique and quite unusual to any that we find here on earth. For instance, in the weightlessness of space, there is no up or down — one may float around freely — so freely that:

- The astronauts will have to use "holddowns" to stay in position while eating at the dining room table, using the bathroom, and even while sleeping (Fig. 7).

- The normal commode found on the floor in most bathrooms will be located, as shown in Figure 8, on the side of the wall in Skylab for better utilization of available space.

- The bunks or sleeping restraints (Fig. 9) have also been placed on the wall, with the astronauts sleeping in a vertical position. These bag-type restraints merely keep the men from floating around while sleeping.

- Food will come prepackaged and placed on trays which are plugged into electrical outlets on the dining table for heating (Fig. 10). Menus will be very earthlike.

- The trash and waste material will be collected and placed into a large tank below the first floor by means of a special trap door located in the middle of the floor, as shown in Figure 11.

- The shower mentioned earlier is shown in Figure 12. It works on a suction principle drawing water over the body and into a tank.

The main work area is located on the second floor above the astronaut's living compartment (Fig. 13). To get to it, the weightless astronauts simply will float upstairs, using a fireman's pole for a guide rail.

When Will Skylab Be Put in Orbit?

The Skylab is scheduled to be launched into a 270-mile orbit above the earth in 1973. A program mission profile is shown in Figure 14. The Skylab will be launched unmanned on a two-stage Saturn V rocket the same as used on the Apollo Program. The spacecraft will contain all the food, water, and oxygen needed for the entire mission. On the following day, after key systems have been turned on and working, the first three-man crew will ride into space aboard an Apollo Command and Service Module launched by the smaller Saturn IB vehicle. They will rendezvous with the Skylab cluster, transfer inside, and complete activation of all the systems. This first crew will spend 28 days in the workshop area conducting a wide range of medical, scientific, and technical experiments. At the end of the mission, the crew will return to the earth with an ocean landing and recovery, just like the Apollo lunar missions. Some 2 months later the three-man crew will visit the workshop for a 56-day period. After their return, and about a month later, the third three-man crew will visit the Skylab for an additional 56-day period. In all there will be a total of 140 manned days during the 8-month period.

What Is the Skylab for?

I have briefly told you what the Skylab is and how we plan to place it into orbit. Now we get to the real heart of the program — what the Skylab is for.

Although the Skylab program has several objectives, they fall into two major categories. The first is centered around man's spaceflight capabilities over extended periods of time, so we will study and carefully monitor the astronauts. This will involve an assessment of man's operational capabilities as well as extensive biomedical experiments to determine the effect of long-term space activities on the human body (Fig. 15). The second major category is to conduct scientific experiments in which we will monitor and study the sun, the earth, and celestial space.

In all, there are more than 50 experiments onboard to accomplish the many and various objectives, with about one-third of them devoted to studying the biological effects of prolonged weightlessness on man. The astronauts will exercise regularly on a stationary bicycle as their physiological changes are carefully monitored. A reclining chair will whirl them around to determine their sensitivity to motion sickness. Urine samples will be collected and frozen daily for later analysis on earth to determine possible mineral losses from the bones. A device will be used to check out the cardiovascular system with measurements of the heart rate, temperature, and blood pressure being taken.

The important experiments for producing near-term benefits for man here on earth are the earth resources experiments (Fig. 16). Skylab has a number of sensors that are designed to record detailed information about our earth — not just from a scientific standpoint, but from a very practical standpoint. These sensors, for example, were chosen to detect specific information on types of soil and vegetation, crop vigor, and surface water conditions. From these data, inventories can be made of our natural and cultural resources. Skylab will collect and return more of this information than any other space program to date, adding greatly to the data expected from the unmanned Earth Resources Satellite (ERTS-A) to be launched by NASA in 1972.

NASA recently put out an announcement to several thousand potential users of the data that will be collected by Skylab. There were 701 proposals received from scientists, engineers, city planners, etc. They wanted information to solve practical, everyday problems such as city-growth planning, or estimating the snowfall during a winter season over the Rocky Mountains. The National Geological Survey Water Resources Division says that if they can tell the amount of snow 1 percent better than they are now able to — which is by tramping through the woods and pounding a rod in the snow and saying, "it's six feet deep" — If they can do this from Skylab 1 percent better, then the information is worth $10 million a year to them in managing water and electrical power operations. This is just one of many interesting and useful things that will be done with Skylab (Fig. 17).

As you might expect, in the 701 responses there were a few that turned out to be a little silly. One man, for example, requested a census of all of the black pepper in the world. He had a theory that black pepper was the source of all evil. Since he was from California, as I am, I have been intending to look him up to get a few more details on his theory — since I always thought it was women and booze.

What may turn out to have the greatest long-term benefits on Skylab are the solar experiments. Eight major solar instruments will constantly measure the sun in the extreme ultraviolet and X-ray portions of the electromagnetic spectrum and will record data as to the sun's activities (Fig. 18). We study the sun because it is the main source of energy that we have on earth, and we know very little about it. It is a complex thermonuclear reactor that we can observe and treat as a laboratory to unlock the real secrets of nuclear processes: so that those processes can be applied here on earth for development of future power systems. The astronauts will be able to select targets of scientific interest and actually point the telescopes. They will control and monitor the experiment operations in acquiring the data, including retrieval of the film (Fig. 19).

There are a number of other interesting experiments on Skylab:

- A small experimental space "manufacturing" facility is provided where the astronauts will do some casting and welding of dissimilar metals (Fig. 20). The absence of gravity and the high vacuum of space may provide a boon to certain manufacturing processes. Also, some technical or engineering tests will be made on various protective coatings, effects of contamination on parts of the Skylab from its own discharges, and space repair techniques.

- Small semiconductor crystals used today in electronics will be carried aloft (Fig. 21) to see if they grow better in space. If we can grow large crystals without built-in thermal or mechanical stresses, we will be able to build more reliable electronic equipment. This could result in better color television sets for you and me.

- We are also looking at the possibility of developing methods for producing vaccines for the medical community as one of the things that can be done more effectively in the zero gravity of space than we can do here on earth.

- A general objective of our Government's space program is to provide a platform for greater international cooperation and we do have, on Skylab, a French experiment containing an ultraviolet camera that will scan the heavens for new scientific information on the stars (Fig. 22). A second Skylab, if authorized, would be expected to have greater participation by many more foreign countries.

- Special interest to the younger generation is the plan NASA has set up to stimulate interest in science and technology by directly involving high school students in space research (Fig. 23). Information on Skylab has been sent to high schools throughout the country. A selection and awards process has been devised to reduce the total potential proposals to the final six which will actually be flown on Skylab (Fig. 24). Certain specifications (Fig. 25) have been established regarding size, weight, and astronaut time requirements, as well as criteria that will assure that the student's experiment is compatible with Skylab and will not affect the launch schedule. Money has been authorized to complete the selection process and to finance the development and integration of the six selected experiments into the Skylab spacecraft.

This concludes the basic overview of Skylab. I might emphasize that while Skylab is experimental in nature, it is expected to lead to operational systems that will provide a better understanding of the distribution and abundance of earth resources, the solar processes which will affect terrestrial weather and climate, and control of our environment. We can all expect to benefit from improved long-term management of the crucial earth resources required to keep the environment here on earth viable for mankind — now and in the future.

What Will Skylab Cost?

Even though Skylab will cost about $2.5 billion, it will be spent over a 7-year period. Comparisons are dangerous and can be misleading, but I might compare this to a recent announcement in the agricultural area that the U.S. is prepared to spend $2.0 billion in 1972 alone to reduce the output of livestock feed grain. I would submit that the thousands of jobs created by the Skylab program over a 7-year period, plus the environmental and other direct research benefits we will obtain from its operations, make a very positive argument for the dollars expended. Placed in perspective the $2.5 billion does not seem so large. Even Snoopy benefits (Fig. 26).

A last closing thought about costs: our Federal Government is now spending 42 cents out of every tax dollar on human resources and about 1 cent for the Space Program — I am confident that by the end of this conference you will be as positive as I am that the taxpayer is getting more than his money's worth from the 1 cent spent on space programs such as Skylab.

Will There Be a Second Skylab?

This depends on many things — timing, cost, solid requirements for data, and the capability of our astronauts to perform meaningful tasks over extended periods of time. If past experience is any guide, we can be sure that information gained from Skylab-A will produce a deluge of requests for additional information and new experiments.

You will be interested to know that the present Skylab program does contain a complete backup set of hardware. This backup Skylab will be shipped to the Kennedy Space Center in Florida, and readied for final acceptance and launch while Skylab-A is performing its mission.

Yes, there could be a second Skylab using the backup hardware and which would produce at least as much meaningful information as Skylab-A — and for roughly 25 percent of the cost of the first Skylab.

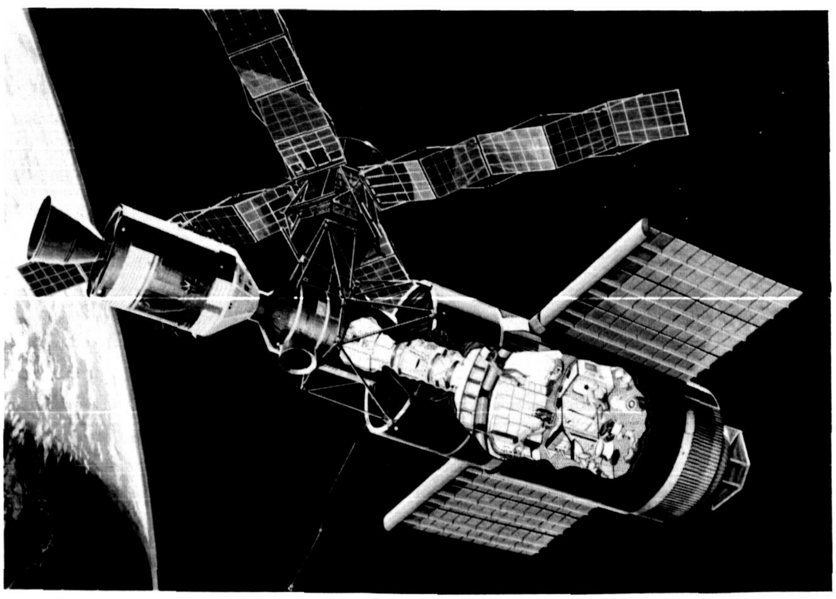

Figure 1. Skylab cluster.

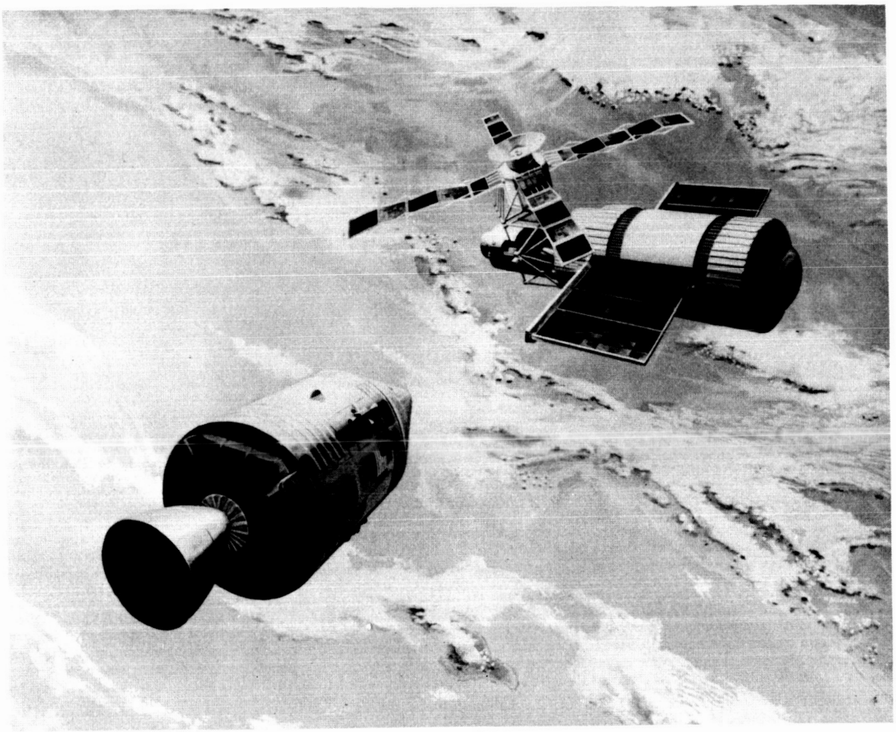

Figure 2. Command and Service Module.

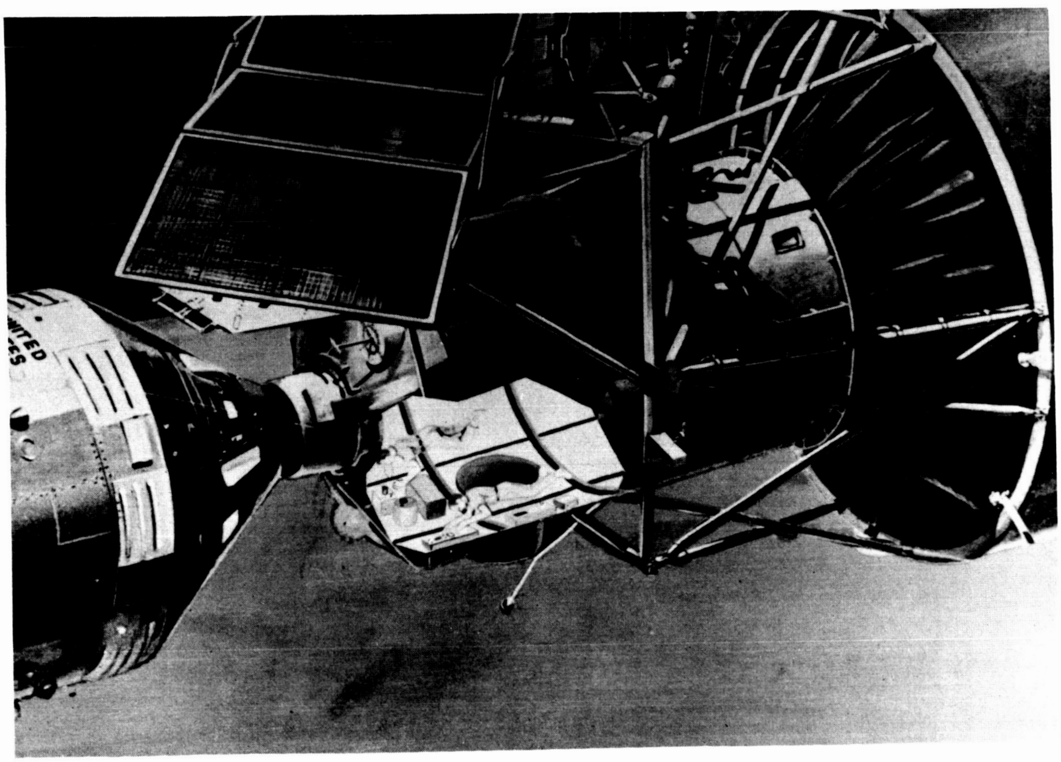

Figure 3. Multiple adapter.

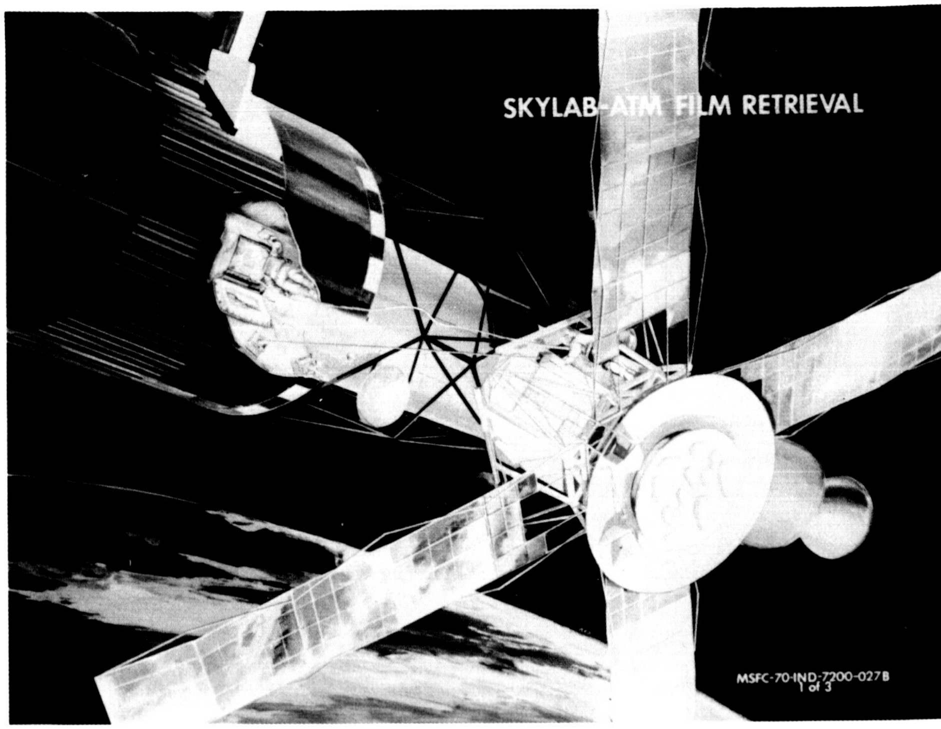

Figure 4. Detailed view of telescope mount.

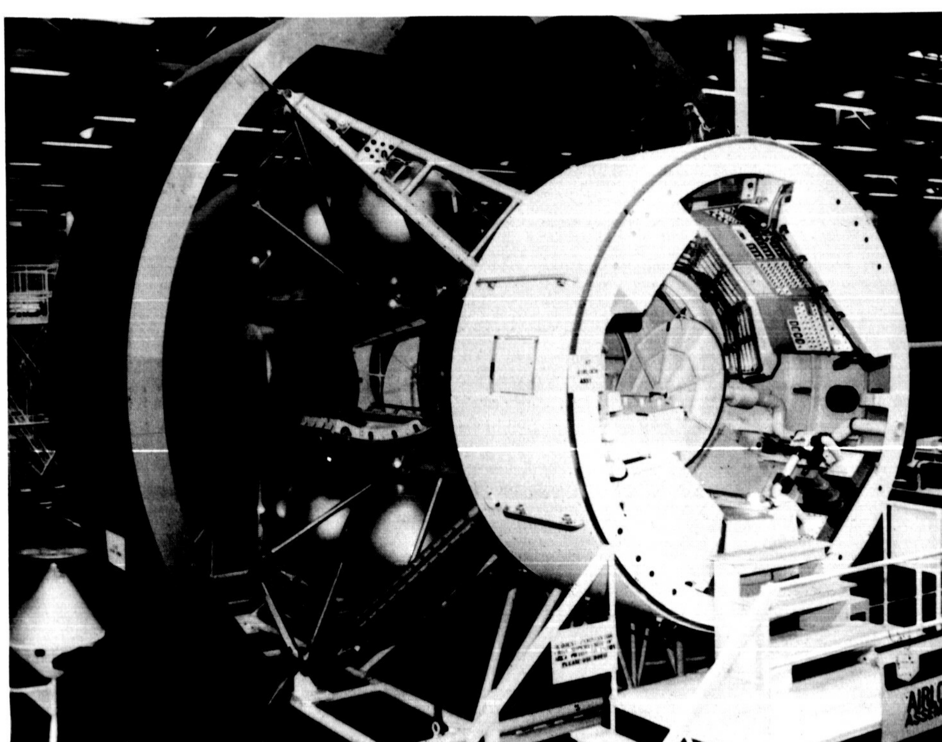

Figure 5. Airlock module.

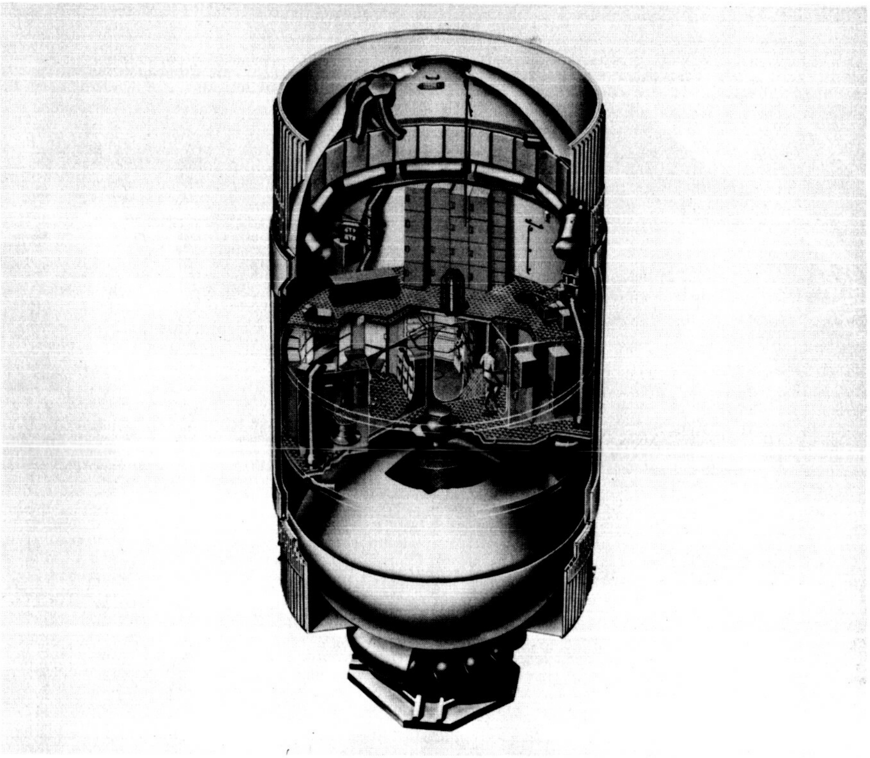

Figure 6. Orbital workshop.

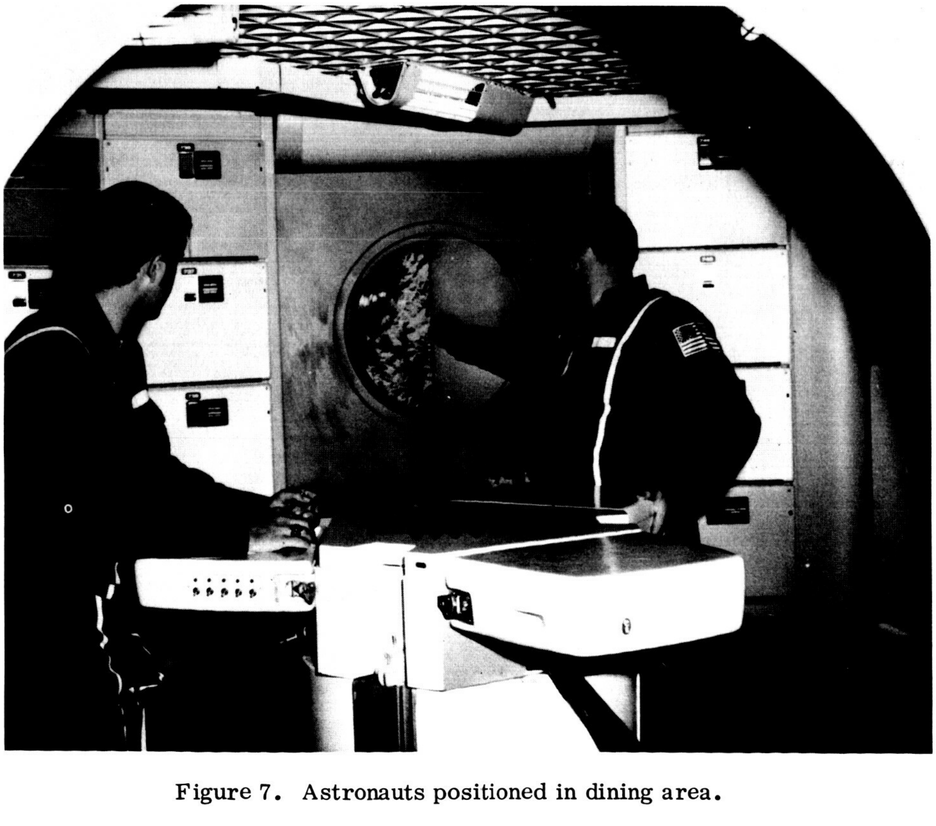

Figure 7. Astronauts positioned in dining area.

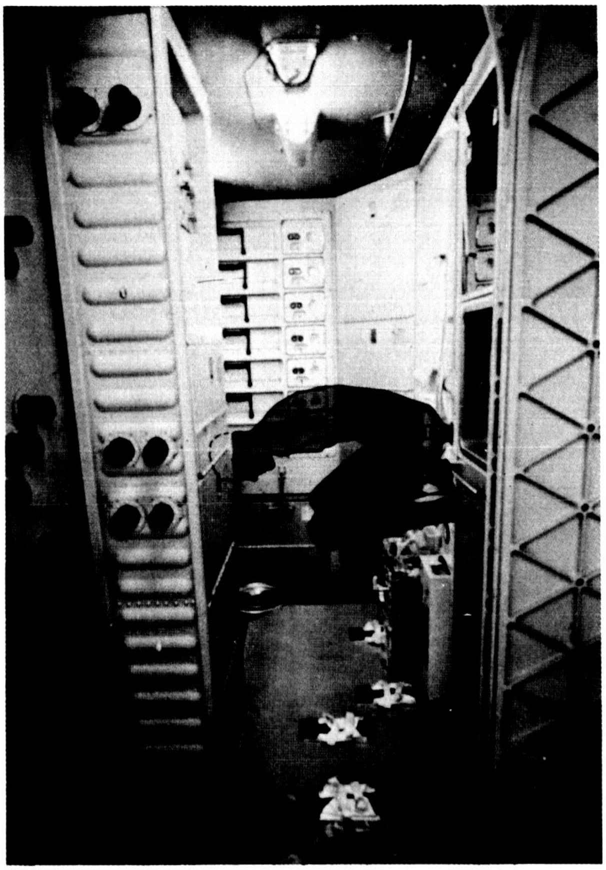

Figure 8. Bathroom.

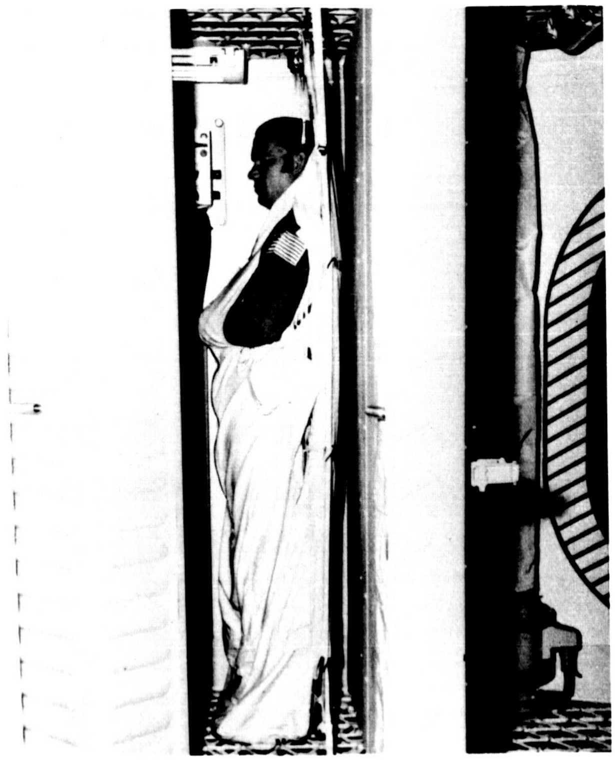

Figure 9. Bunks or sleeping restraints.

Figure 10. Dining area.

Figure 11. Disposal of trash.

Figure 12. Shower.

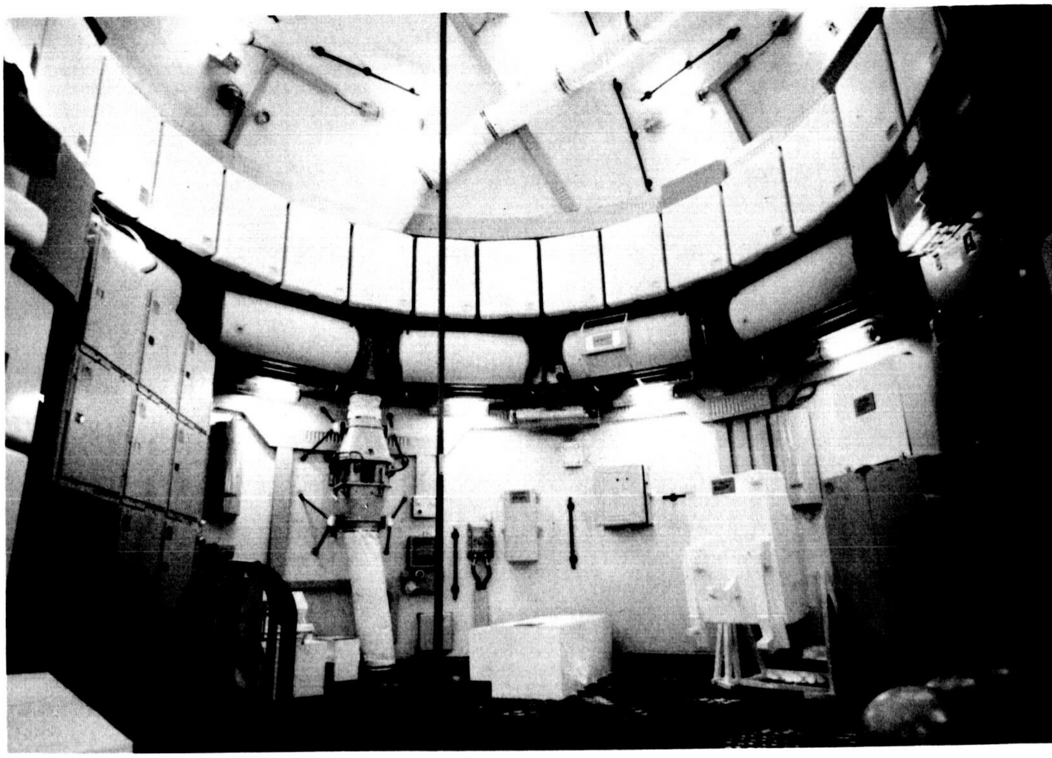

Figure 13. Main work area.

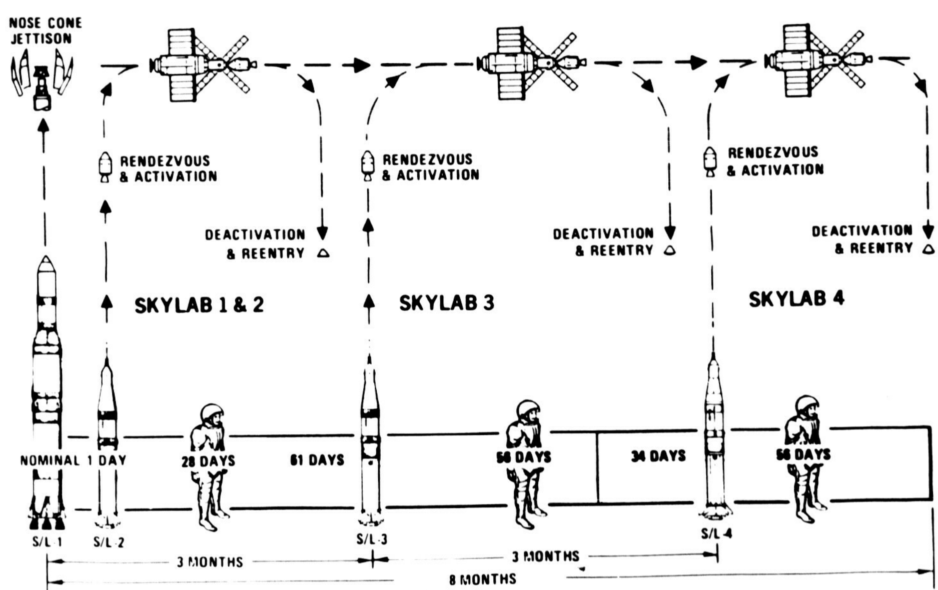

Figure 14. Program mission profile.

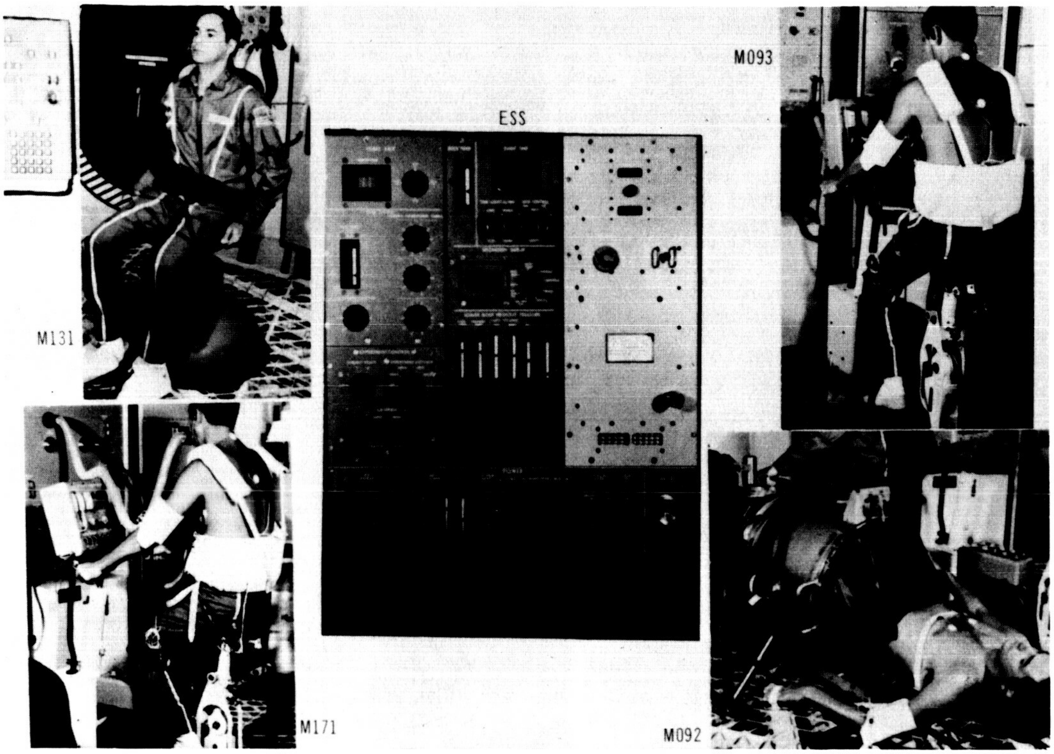

Figure 15. Experiment support system.

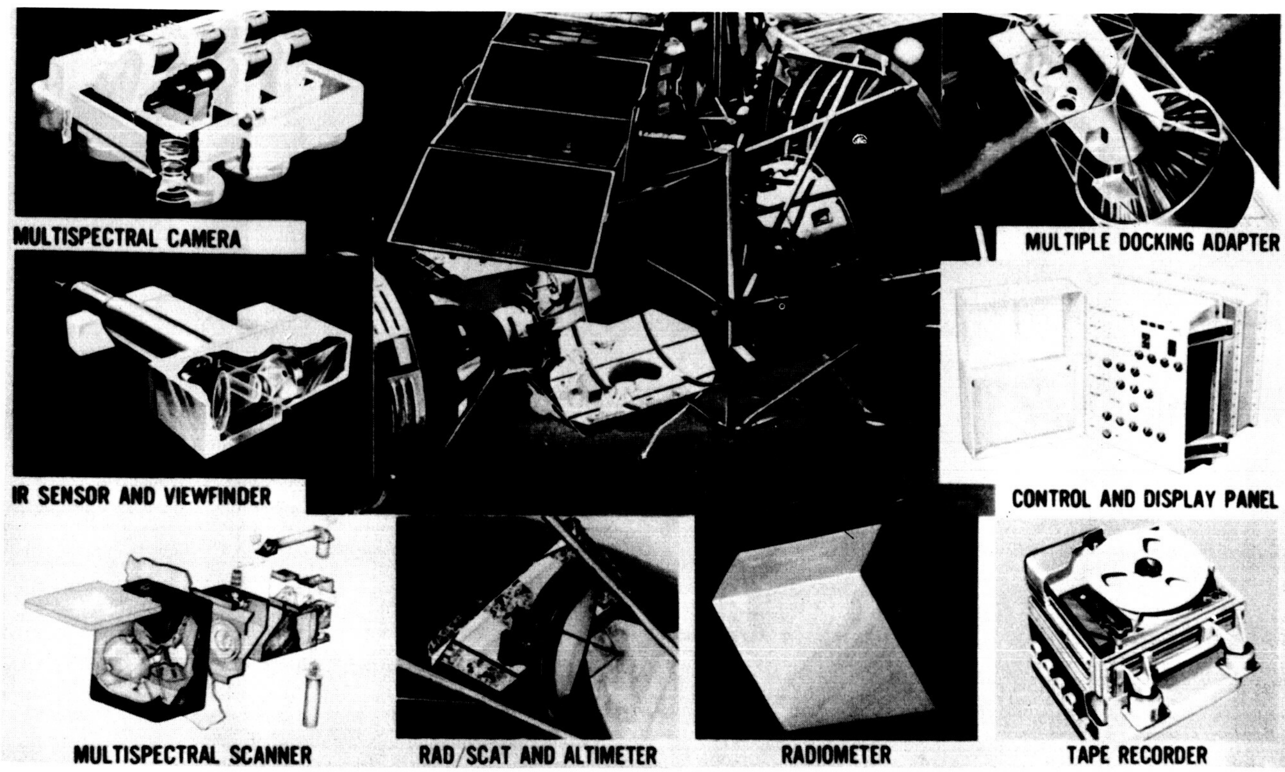

Figure 16. Skylab - Earth Resources Experiment Package (EREP).

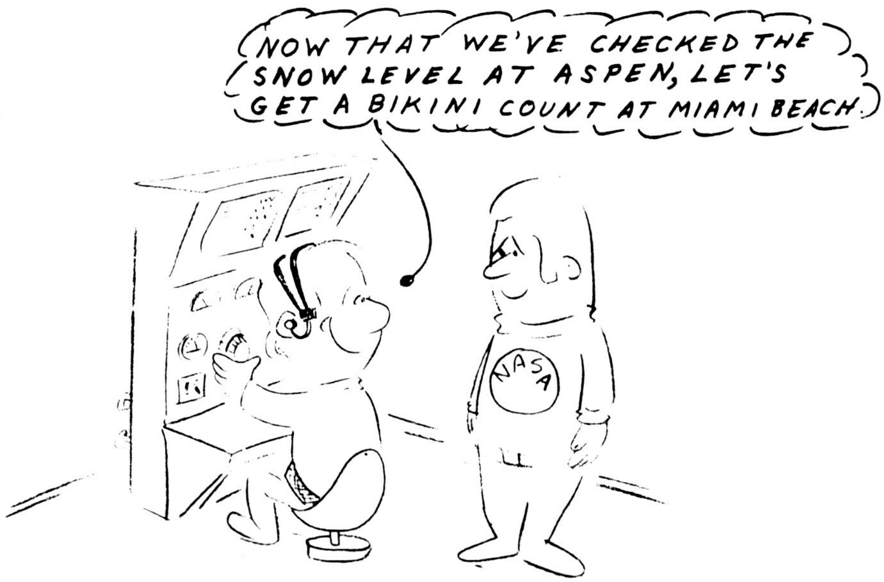

Figure 17. One of Skylab's many uses.

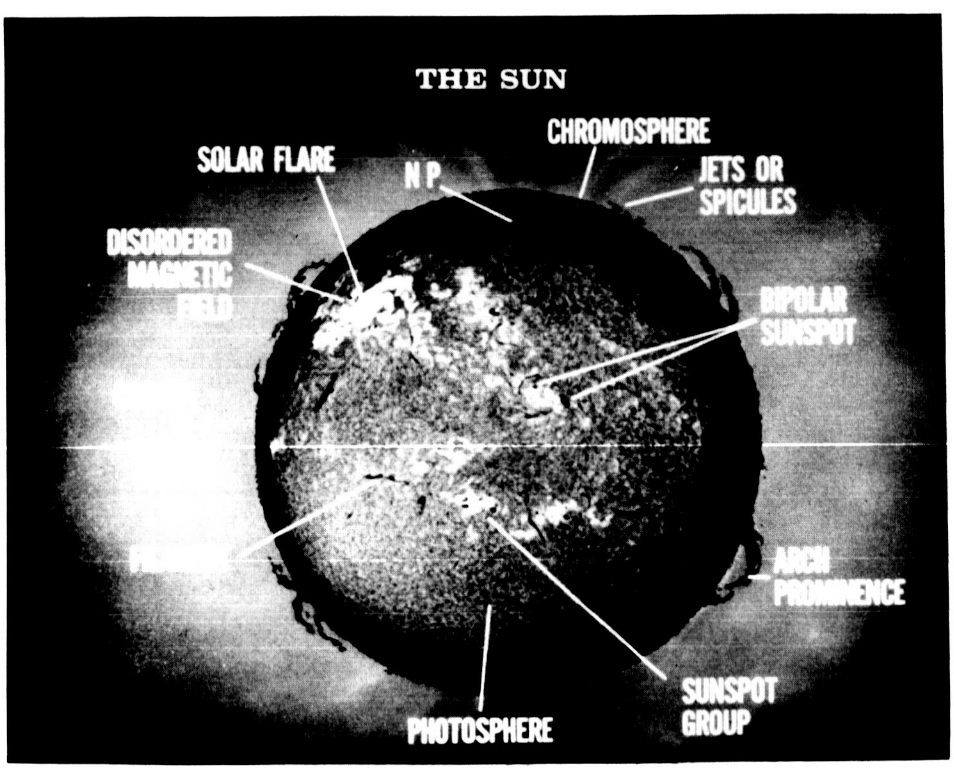

Figure 18. Sun's surface.

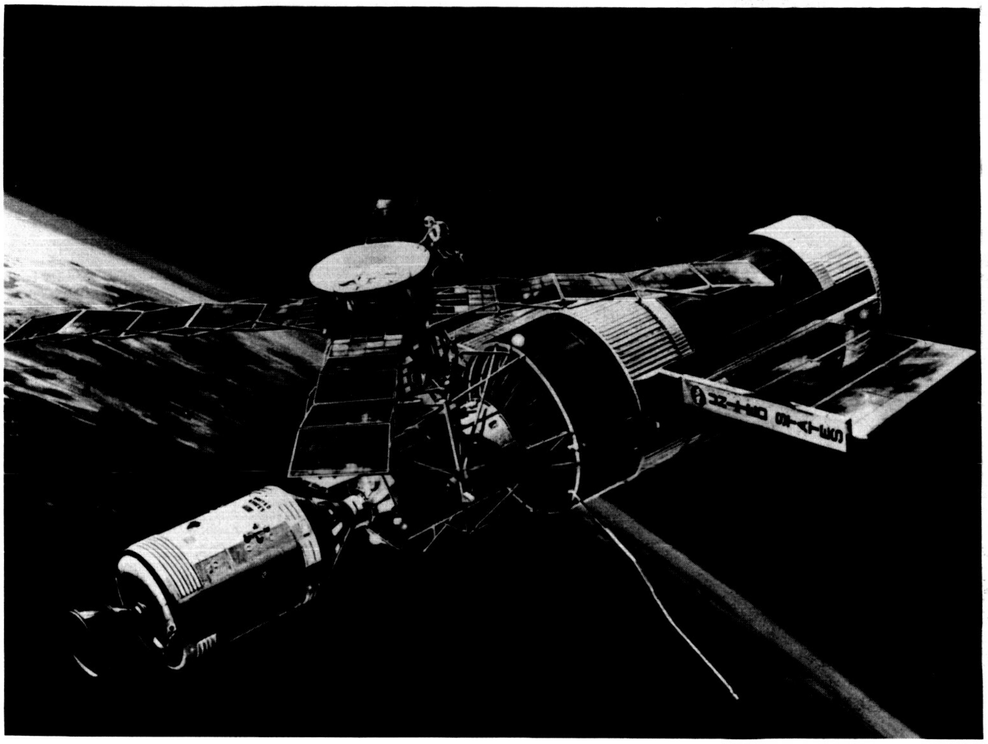

Figure 19. Film retrieval.

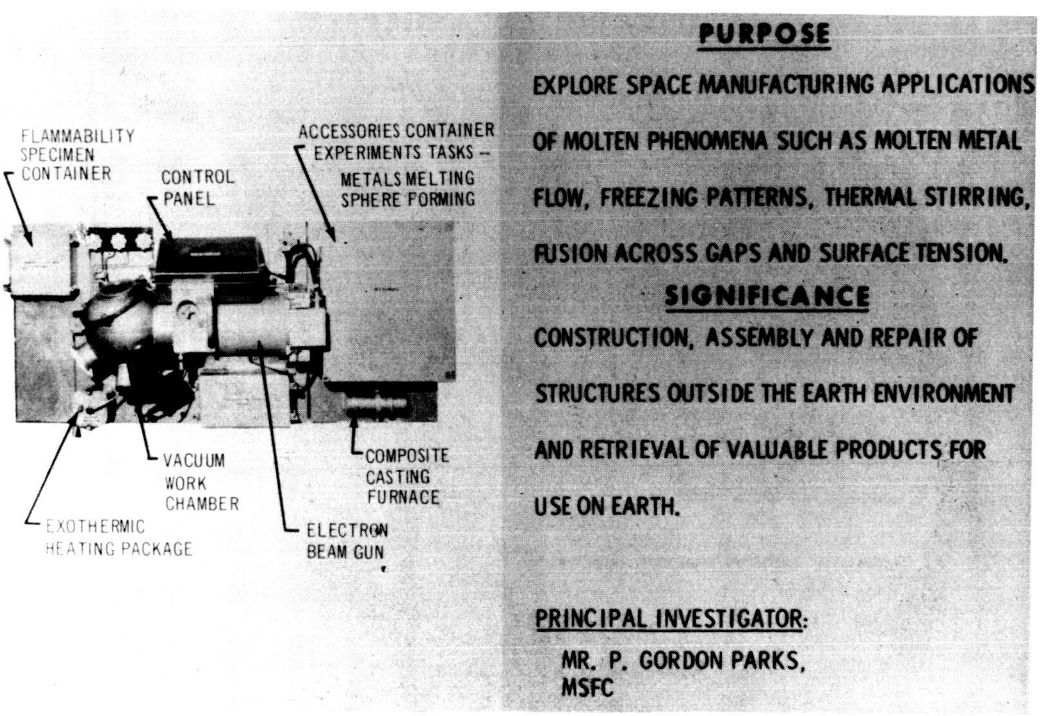

Figure 20. Materials processing in space facility (Skylab experiment M512).

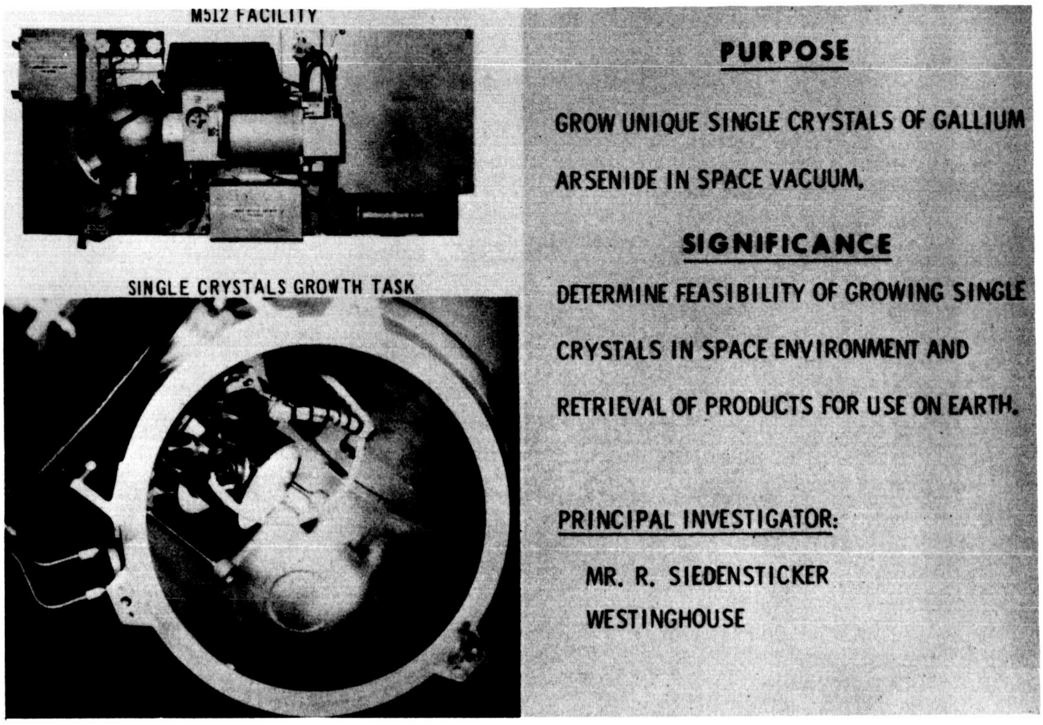

Figure 21. Materials processing in space - single crystals growth task (Skylab experiment M512).

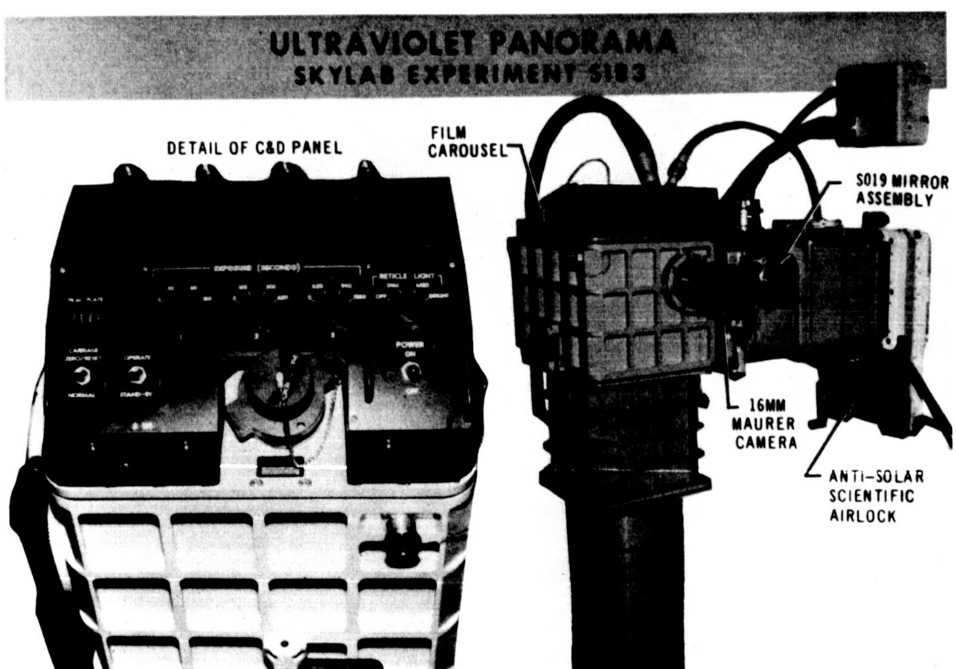

Figure 22. Ultraviolet panorama camera.

PROGRAM OBJECTIVE

STIMULATE INTEREST IN SCIENCE AND TECHNOLOGY BY DIRECTLY INVOLVING STUDENTS IN SPACE RESEARCH

Figure 23. Program objectives.

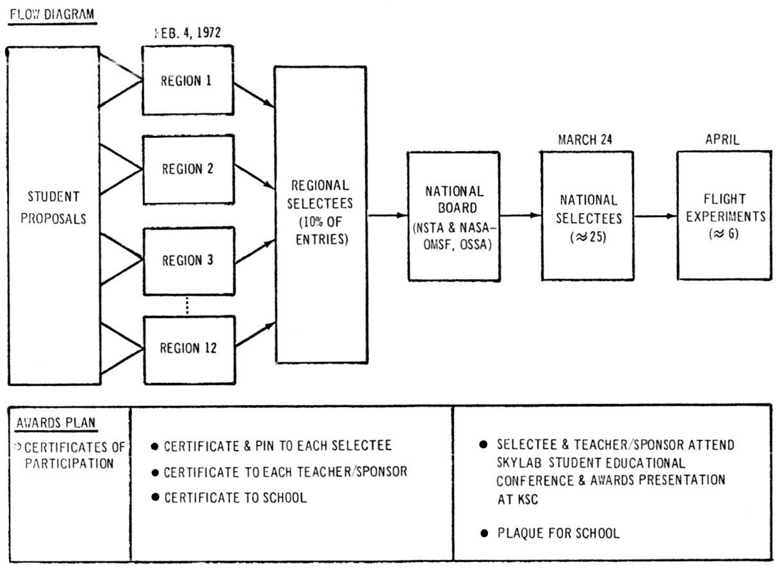

Figure 24. Skylab student program sequence of major events.

(Approved by Administrator)

- SIX EXPERIMENTS
  - TOTAL LAUNCH STOWAGE SPACE — 1 CUBIC FOOT
  - TOTAL WEIGHT — 35 LBS
  - TOTAL CREW TIME — 1-1/2 MAN-HOURS PER WEEK
- CRITERIA FOR EXPERIMENT EQUIPMENT ESTABLISHED
  - COMPATIBILITY
  - PROGRAM IMPACT
- COST ESTABLISHED
  - SELECTION PHASE - 65K
  - DEVELOPMENT & INTEGRATION - 200K

Figure 25. Major features.

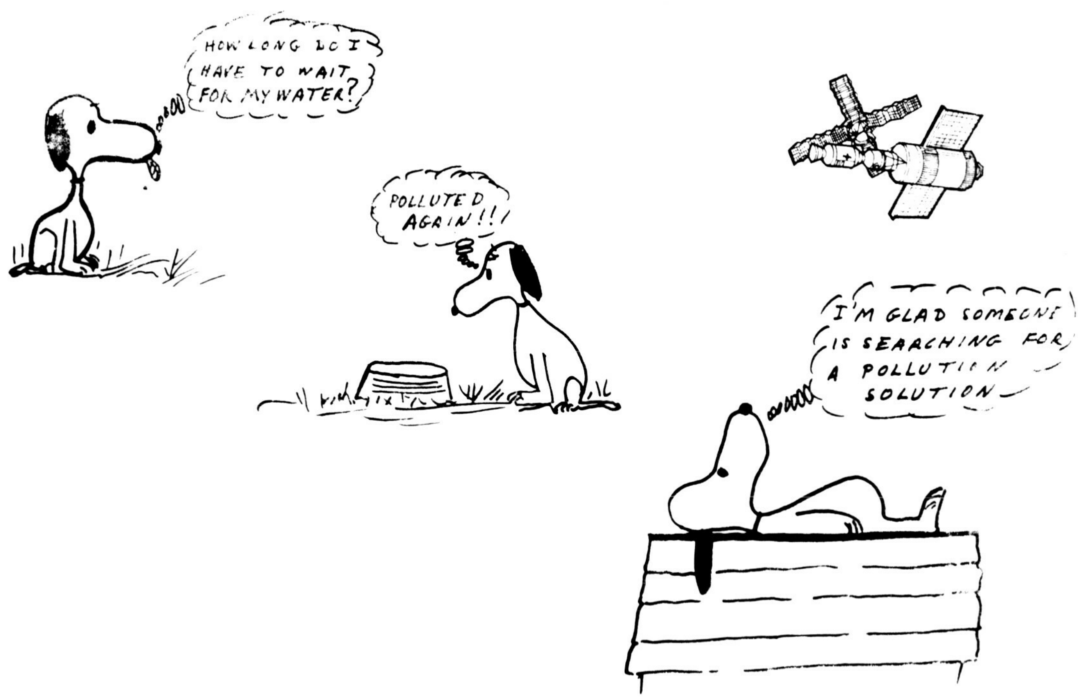

Figure 26. One of Skylab's benefits.