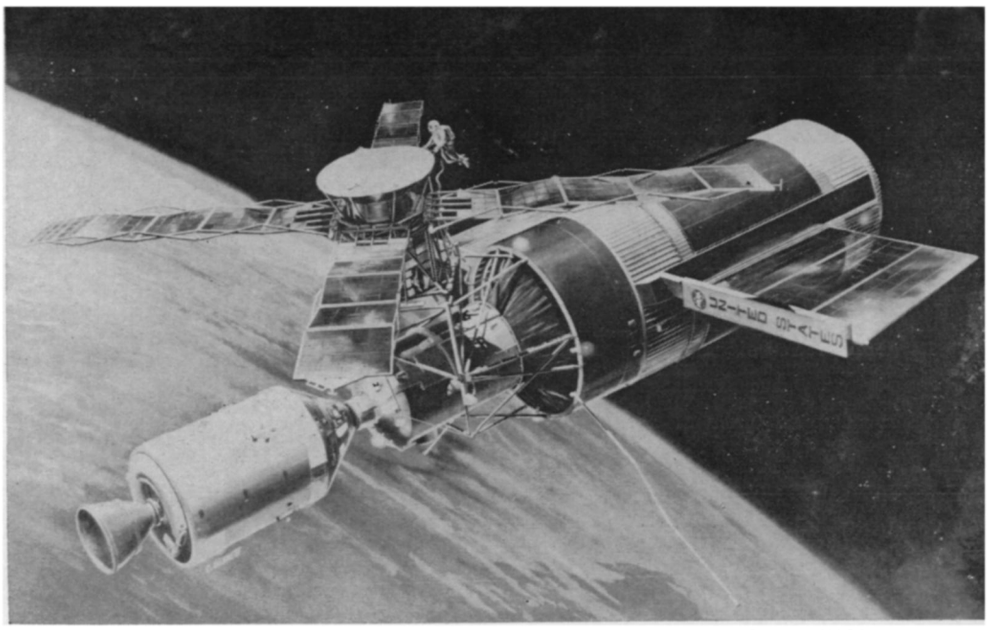
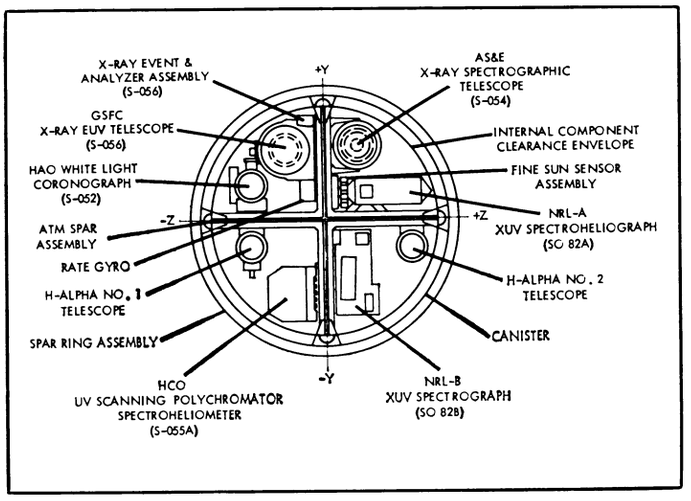
Testing man's value in space

Skylab astronauts will conduct biomedical, solar and earth studies

by Everly Driscoll



Photos: NASA



Skylab's telescope mount will be a major space laboratory, with eight separate instruments.

Like Topsy—it just growed. The concept of a civilian manned earth-orbiting laboratory began developing in the National Aeronautics and Space Administration about the same time as the birth of the Air Force MOL program in the early 1960's. Unlike the Air Force program, which was buried in 1969, the fledgling NASA Apollo Applications Program at least stayed alive through the moon fever and subsequent budget cuts (SN: 1/3, p. 21).

Now sporting a new name—Skylab—it has grown from a rather inexpensive project using leftover Apollo hardware to a full-blown, several billion-dollar science lab. Skylab will have the only manned space flights funded between the end of the lunar missions in the summer of 1972 (SN: 8/29, p. 162) and the advent of space shuttle flights scheduled for 1977–78 (SN: 8/22, p. 178).

One reason for Skylab's viability is that it promises to answer some basic and persistent questions about the sun, about the effect of prolonged space travel on man and about the earth itself. Another is that Skylab will use Apollo technology and hardware—systems already tried and proven. It will thus be relatively inexpensive.

Skylab is scheduled now for launch in November 1972, but scientists and engineers are still somewhat date-shy. The launch has been slipped so often (most recently from March to July to November of 1972) that there is at best only cautious optimism about the current target date.

When launch day does arrive, however, the laboratory itself will be the first to be placed into orbit, by Saturn 5 first and second stage rockets.

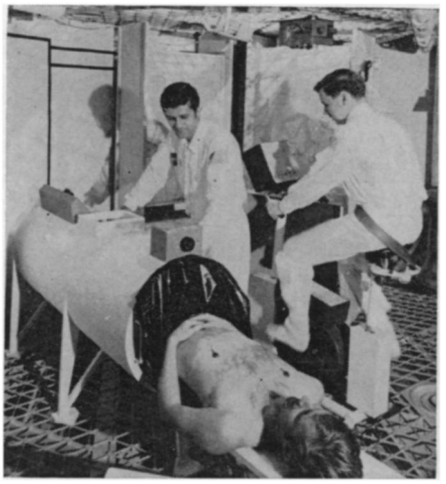
The laboratory array will include an empty Saturn 4-B rocket stage housing the two-story crew quarters and medical lab; an airlock module; a multiple docking adapter, and the Apollo Telescope Mount cluster.

A day later the Apollo command and service modules carrying the first three-man crew will be launched toward rendezvous with the lab by a Saturn 1-B stage. The crew will stay in the laboratory for 28 days, return to earth and be followed two months later by a second three-man crew, which will stay for 56 days. Then a month later, the third and last shift will go up, also for 56 days. This pacing follows the incremental approach used in Mercury and Gemini flights of gradually increasing man's space time.

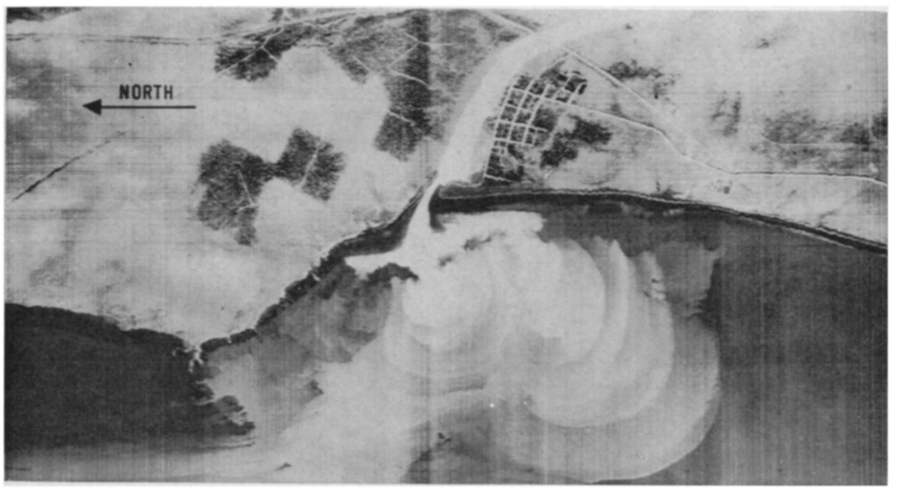
Science is the primary focus of the five-month project, not operational complexities such as lunar landings, and NASA is currently planning to include at least one scientist-astronaut in each mission. Crew announcements are not likely any time soon, since the flights are over two years off, but 13 scientist-astronauts are still in the program. The three most likely to be among the nine Skylabbers, however, are those in the first scientist group chosen: Drs. Owen K. Garriot, an electrical engineer, Edward G. Gibson, an engineer and physicist, and Joseph P. Kerwin, a physician. Geologist Harrison H. Schmitt is also in the first group, and he may take part if he doesn't fly in Apollo.

The agenda of activities for each workday in orbit includes attending to more than 50 experiments in 11 technological and scientific disciplines. Such diversity means that each man must be trained for multiple tasks, ranging from pilot activities to space walks to stellar astronomy.

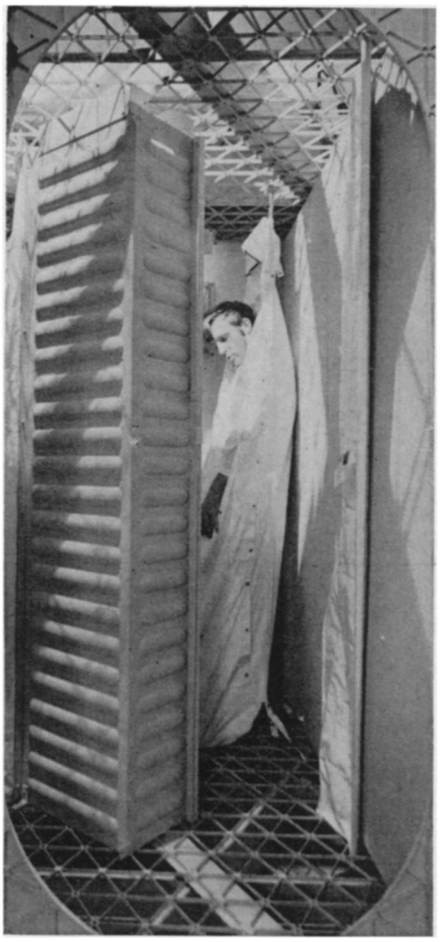
"It is not just a matter of having a physicist spend all of his time in solar or stellar astronomy," explains Astronaut Donald K. Slayton, chief of flight crew operations at the Manned Spacecraft Center in Houston. "He will also have to do biomedical and earth resources experiments." The first mission will focus primarily on biomedical investigations, the second on solar astronomy and the third on earth resources, but each crew will perform some tasks in each of these areas.



Cylinder will measure deconditioning.



Thermal pollution of water can be detected by use of infrared photography.



Space Age sleeping bags for Skylab.

Medical and biological measurements are pivotal to the success of the laboratory's operation. Concurring with recommendations of a report on the biomedical foundations of manned space flight by the President's Science Advisory Committee, NASA will seek to qualify man for space flight—to demonstrate that he can function for relatively extended periods without irreversible damage (SN: 12/13, p. 561). How the astronauts respond psychologically and physiologically to one and two months in space will determine in part what their role will be in future space travel. Previous space flights were limited biomedically by operational constraints of time and capsule room, but Skylab can accommodate large onboard instruments for inflight data. Observed but reversible effects of space flight on astronauts, such as cardiovascular deconditioning, bone mineral and calcium loss, weight loss, red and white blood cell anomalies and measurements of radiation doses, can be examined extensively. Experiments have been designed to measure both man's adaptability to space capsule living and the habitability of the spacecraft itself.

Two such experiments, housed in the empty Saturn two-story crew quarters, will use a bicycle ergometer and the lower body negative pressure test cylinder. Both will be plugged into a control console that displays and records blood pressure, heart beat rate, respiration rate, body temperature and metabolic rate. These readings will be taken on the crew during rest, exercise on the bicycle, and performance of tasks such as space walks outside the spacecraft. Preflight data will be used as a baseline for comparisons.

The negative pressure test will measure in flight the rate of cardiovascular deconditioning. Space physicians know that after extended periods of weightlessness the heart temporarily experiences difficulty in circulating the blood when the astronaut stands up in normal gravity. However, since only pre- and postflight measurements were performed on Apollo flights, it is not known whether the deconditioning continues or levels out as man adapts to his new environment. Physiologists theorize that in zero g, blood tends to concentrate less in the extremities and more in the chest regions. One result of this is an increased ratio of the volume of blood to air in the lungs. The body then tends to compensate by voiding water; thus weight loss occurs. The experiment will subject the astronaut to negative pressure from the waist down, challenging the heart against a calibrated work load. During this time, changes in heart rate, blood pressure, and size of the leg will give real-time data to be compared with preflight measurements.

Biologists participating in a recent National Academy of Sciences' review of NASA's life sciences program (SN: 8/1, p. 93) agreed that Skylab would satisfy biomedically the scientific requirements to qualify man for space. Biologically, however, the scientists expressed great interest in the phenomenon called circadian rhythm—man's biological clock that regulates his normal body cycles.

The space environment offers a unique opportunity to study this mechanism and possibly resolve differences between two schools of thought. One holds that the biological rhythms are dependent on outside cues—stimuli such as daylight and dark; the other believes that it is controlled by an internal mechanism. Three experiments in the lab—with potatoes, pocket mice and vinegar gnats—will supply data to determine whether the biological rhythms of these organisms are affected by removing them from the earth's rhythmic geophysical cycles.

Although these biomedical questions are fundamental, the astronauts will spend at least one-third of their time tending and operating a cluster of experiments to study the earth's sun. The Apollo Telescope Mount, as the cluster is called, is designed to give solar scientists a look at the sun's activities undistorted by the effects of the earth's atmosphere. Five principal investigators have designed experiments for the

ATM flight. The eight instruments used in these five experiments will obtain measurements of the sun in the extreme ultraviolet and X-ray portions of the electromagnetic spectrum and the white light and hydrogen-alpha (6,563-angstrom) bands of the spectrum. The experiments are particularly concerned with active regions on the solar disk or in the corona.

The telescopes are mounted in a seven-foot diameter cylindrical structure. The control and display panel, located in the multiple docking adapter, will be the primary work station. From this point the crew will control and monitor the experiments, the pointing control system, the instrumentation and communications and the power system.

"It is one of the most complex operations that man has ever been called upon to perform in space," says Astronaut Walter Cunningham, an Apollo 7 crewman who is training for Skylab.

Earth resources photography will be the third area of concentration. Skylab will be in an orbit inclined 50 degrees to the earth's equator. This will take the spacecraft over most of the North American continent in daylight. Crops, forests, oceans, water supplies, geological features and land forms can be examined with ultraviolet, infrared and multispectral photography over an eight-month period.

"Earth resources experiments," says Astronaut Cunningham, "may be the greatest single use of space that we are going to see for some time." Skylab will use a multispectral 10 band-scanner to identify contaminated areas in large bodies of water. The microwave radiometer and scatterometer will use radar techniques to penetrate cloud cover. With these methods the astronauts can detect such characteristics as snow cover, recent rainfall and surface roughness. The IR spectrometer will get signatures through spectral characteristics of different types of materials, soil, crops and minerals.

Although Skylab is not the multimodular, resuppliable space station of the future, "it is a precursor to the space station," says William C. Schneider, Skylab program director at NASA headquarters.

If successful it could help seal the idea of a space station, which at one time was the hottest item at NASA, but which in the last 10 months has been usurped by the concept of a reusable space shuttle (SN: 8/29, p. 178). Skylab can promote the space station idea if its contributions to basic scientific research and its usefulness through its data on the sun and the earth's environment are as extensive as those planning the program believe they will be. □