Skylab: a houseful of electronics

NASA's orbiting space lab to be launched next month will look at sun, space, stars—and man's ability to live among them

by William F. Arnold, Aerospace Editor

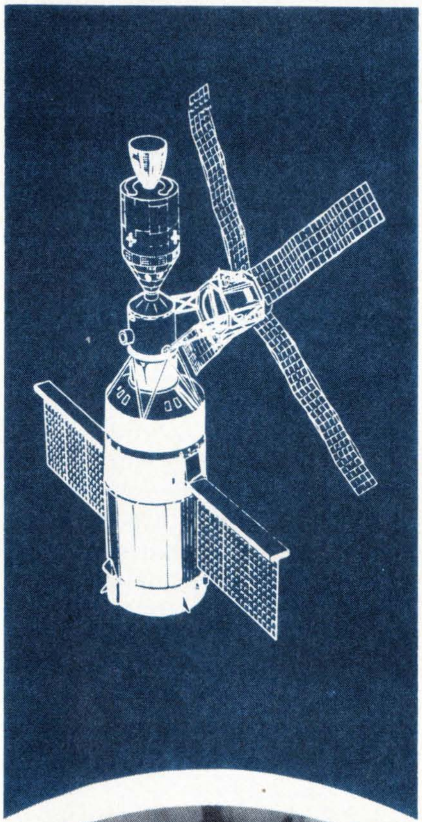
Early in the afternoon of May 14, a Saturn V rocket, made familiar by the Apollo program, is scheduled to blast off from Cape Kennedy. But instead of bearing an Apollo spacecraft toward the moon, the missile will carry NASA's Manned Space Program in a new direction: the launch of Skylab, an earth-orbiting space laboratory the size of a small three-bedroom house. A day later, a smaller Saturn rocket will send the first team of three astronauts to live there for 28 days. In the course of the program, three such teams will take turns at inhabiting the floating laboratory for periods up to 56 days.

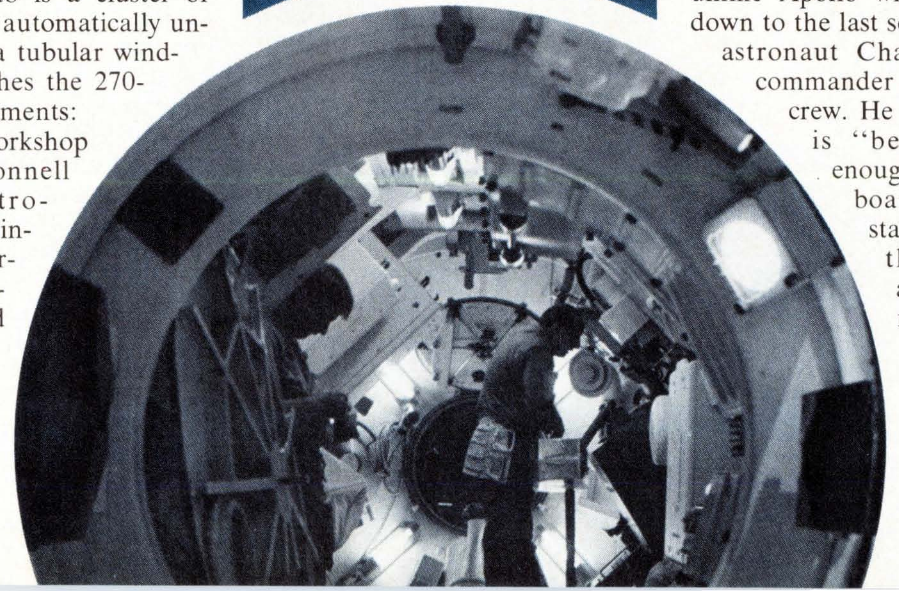
Supported by a load of electronics, Skylab will transport a large mission of solar investigation, earth observation, and medical analysis of the effects of prolonged weightlessness on man. This data will be used to help NASA plan for the permanent space station on the drawing boards for the 1980s. Thus, Skylab carries an impressive array of high-resolution, short-wavelength solar astronomy equipment, earth survey gear, and biomedical monitoring equipment.

Basically, Skylab is a cluster of elements that will automatically unfold to resemble a tubular windmill when it reaches the 270-mile orbit. The elements:

- The orbital workshop (built by McDonnell Douglas Astronautics Co.) containing the crew's quarters, the experiment area, and the structural support for the large solar arrays.

Windmill. Two astronauts, below, work in multiple docking adapter trainer. That's the module to which windmill-like antenna is attached in the drawing above.





- The Apollo telescope mount, including the solar experiments and a solar array providing electric power.
- The airlock module (from McDonnell Douglas) containing an airlock for extravehicular excursions—the NASA term for walking in space—plus the main data and communications links.
- A multiple docking adapter (from Martin Marietta) providing the telescope-mount control panel, a window for earth-resources viewing, and the docking port for the modified Apollo command-service module in which the astronauts will be ferried back and forth.

Overall, the Skylab cluster, an assemblage of modified Apollo and Saturn pieces left over from the truncated Apollo program, will be 118 feet long, 90 feet wide, and weigh 181,300 pounds. Total program costs will be $2.6 billion, about a tenth of the 17-mission Apollo program's cost. Inside the silo-like chambers and tubular passageways of Skylab, the astronauts will have lots of room and plenty to do during their stays in orbit.

"It's not a rigid flight schedule, unlike Apollo which was planned down to the last second," says lunar astronaut Charles P. Conrad, commander of the first Skylab crew. He explains that this is "because we have enough experiments on board that we can stay busy for more than 140 days," adding that a mission-planning computer keeps experiments together.

figure in a good share of the 60 experiments aboard, particularly in the earth-resources experiments package (EREP), and in the equipment for studying solar physics, astrophysics, and the life sciences. Another set of experiments of interest to electronics manufacturers are those concerned with the manufacture in space of such semiconductor materials as gallium arsenide crystals, to determine whether low-cost, high-yield automated production out there is ultimately feasible [*Electronics,* Jan. 18, p. 107].

What next? With the Earth-Resources Experiments Package, "we fly six instruments to find out what we can do and what instruments we should design for future missions," says Arnold Aldrich, deputy manager, Skylab research office at Houston Johnson Space Center. Elaborating, Harold Granger, Earth Resources program officer, says the EREP instruments are in three categories: object detection and pollution monitoring; the surveying of water, mineral, forestry and agricultural objects; and meteorology.

To accomplish those wide objectives, NASA will use complementary infrared and microwave techniques. The infrared gear will "determine and take out atmospheric effects as measured by the sensors to classify and determine things on the ground," explains Granger, while the microwave equipment, not severely attenuated by cloud cover or rain, will provide the only all-weather sensing system. Designed to be complementary with survey data from the Earth Resources Technology Satellite 1 [*Electronics,* July 3, 1972, p. 31], EREP's results will be compared with ground and aircraft sensing "to tell the difference between what we're reading on the ground and what we get from the air," says Granger. A complementary package, the infrared experiments will be loaded, operated, and maintained by the crew.

Sun gazing. But the astronauts will look at the sun and stars, too. Here, they will use the ultraviolet region because the earth's atmosphere attenuates about 80% of ultraviolet radiation and, since Skylab will float above the atmosphere, "we hope to gain information that we're unable to obtain on earth," explains Reg Machell, manager of the orbital assembly office, Skylab program office.

The X-ray/UV solar photography experiment (Naval Research Laboratory with Martin Marietta Corp. as subcontractor) will peer into the 10- to 200-angstrom wavelength, the lower end of ultraviolet and upper end of X ray, to determine the effects of the sun's energy on the earth's environment, ionosphere, and weather, Machell says. A similar UV stellar astronomy experiment (Northwestern University) will use the 14- to 3,000-angstrom wavelength to look at the stars because stars emit "a large amount of energy in the UV but we can't see it from earth," he says.

Horizon photo. The UV experiments also include an airglow horizon photograph (also WRL-Martin) to look at the earth's ozone; a UV panorama, a French experiment to measure the UV brightness of stars; a UV scanning polychrometer spectroheliometer (from Harvard College Observatory with Ball Brothers Research Corp.) which will be used to observe changes in the sun's environment by measuring the extreme UV region of 300- to 1,350-angstrom wavelengths, and a similar experiment by NRL and Ball Brothers for 150 to 650 angstroms.

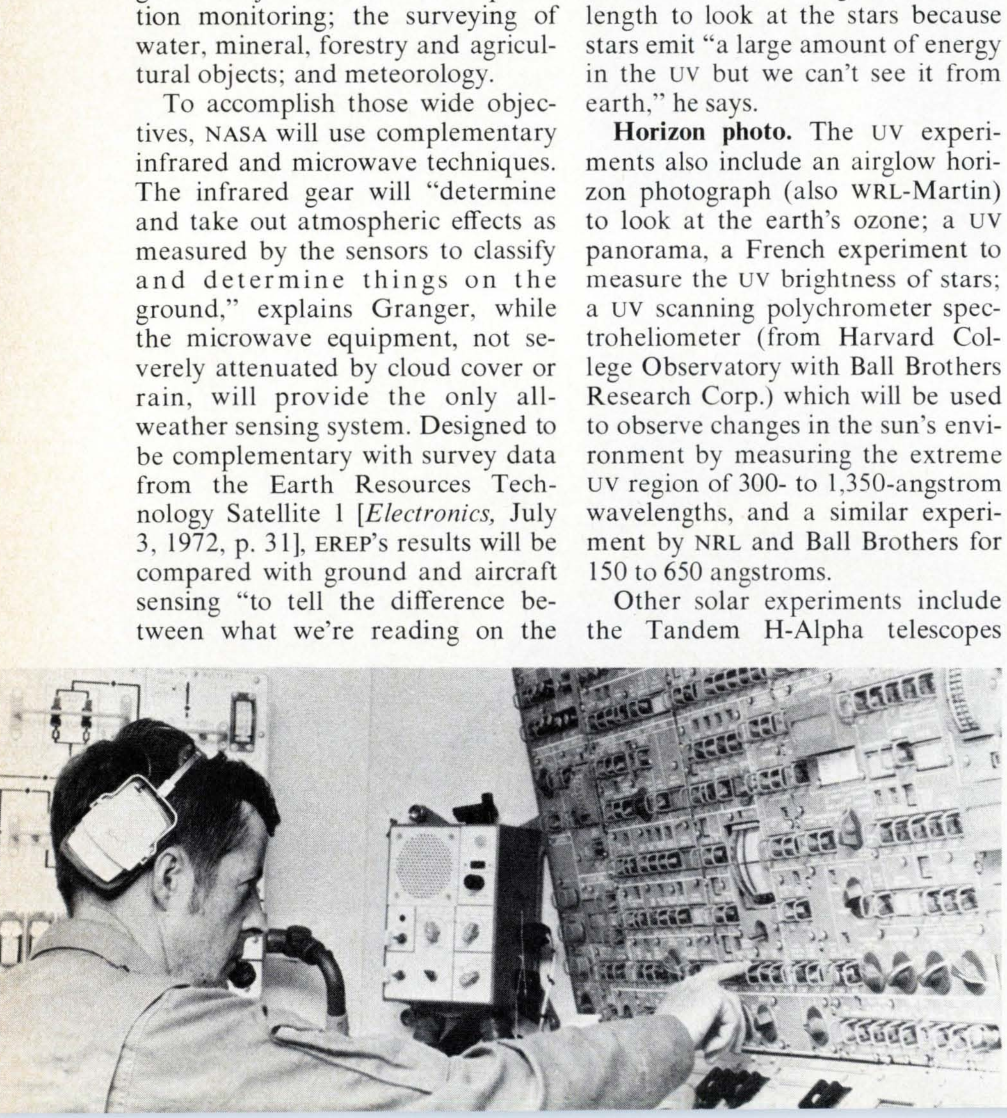
Other solar experiments include the Tandem H-Alpha telescopes (from Perkin-Elmer) which will measure solar UV and X-ray phenomena with vidicon and photographic techniques; a TV-movie camera system (from High Altitude Observatory and Ball Brothers) to view the corona; and two X-ray telescope systems by American Science and Engineering and NASA's Marshall Space Flight Center.

Life in space. Of the 30-odd experiments on crew health and performance in prolonged zero-gravity living and the habitability of the quarters, the most interesting electronically is the one monitoring the crew's sleep. Here, "a small computer sorts out signals into seven categories to monitor sleep patterns," explains Richard S. Johnston, life sciences director.

To do this, the drowsy astronaut will enter a cocoon, don a special cap containing monitoring electrodes, and doze off. A preamplifier will transmit the signals to the panel assembly containing the computer, which will convert the analog signals to 3-bit binary codes for near-real-time telemetry, sampled every 10 seconds, to mission control. There the data will be shown as: the astronaut's current sleep state, cumulative time in each of the seven stages of sleep, and a continuous graphic display of his sleep profile. The analog signals will be recorded for later analysis.

Two channels. Communications among the crew and between them and the ground are handled by a two-channel setup, in which one channel is for internal communications and not recorded and the second is recorded for "experiment debriefing" to the ground, explains Conrad. There's also TV in the command module in which selected segments can be recorded up to 25 minutes.

Early in April, the Russians orbited a Salyut spacecraft, which would become a manned orbital space station when they send a crew up to man it. Two years ago, a record 26-day mission aboard Salyut 1 met diaster when the cosmonaut crew died during re-entry. Another Salyut launching attempt last year was unsuccessful. □



Looking. Astronaut Joseph P. Kerwin at the console of Apollo telescope mount.