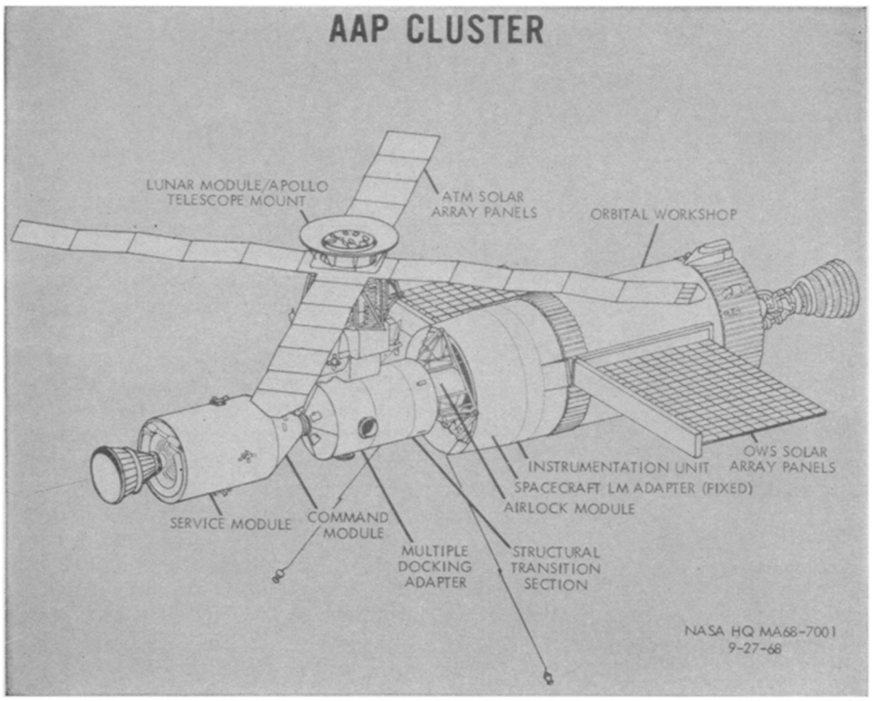
The space station is 'Go'

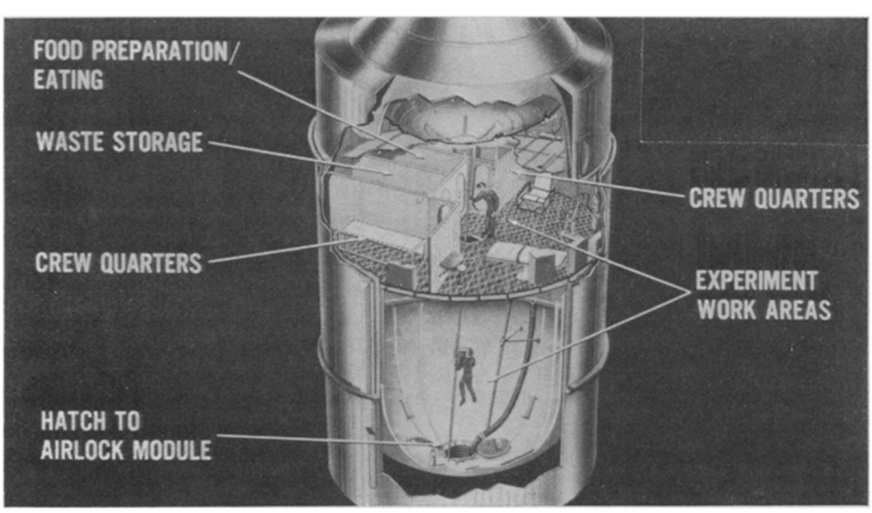
A converted rocket stage will house astronauts for months of space research

by Jonathan Eberhart



Photos: NASA

Solar panels, telescopes and a spacecraft festoon the complicated workshop.



Crew quarters and most experimental equipment will be installed on the ground.

Space stations have been an assumed part of a manned space program since before the United States even had a manned space program. They are invariably part of advisory reports on the future in space, including that of the Space Task Group, headed by Vice President Spiro Agnew, which has been a major influence in President Nixon's long-range planning. Soviet interest has before the United States even had a it took man's first landing on the moon (SN: 7/26, p. 73) to assure the first American station its place in the sun: a 240-mile-high, circular orbit in 1972.

This first station will be centered around a large workshop-laboratory, heart of the Apollo Applications Program, with a series of three-astronaut crews spending from one to two months each living and working inside an empty rocket stage. The empty-booster idea is as old as the AAP itself, the basic philosophy of which is to get the maximum use from the costly Apollo hardware. Individual Apollo spacecraft for each AAP crew permit the station to be resupplied without the time and cost of developing a reusable shuttle vehicle, while the booster gets around the immediate need for designing an overall structure for the station itself.

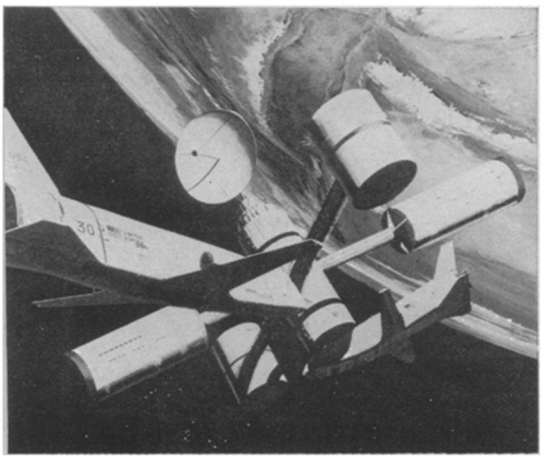
The plans for it have long been laid out; some details haven't changed in years. But the Apollo program had to do its big job first, before the orbiting workshop-laboratory of the Apollo Applications Program could be assembled and fired into space.

Along with everything else in the United States' manned space effort, the AAP workshop could have come along more than a year earlier, had it not been for the launch-pad fire that killed three astronauts and rocked the whole Apollo program on Jan. 27, 1967. The fire, and Vietnam-tightened budgets, took a serious toll. Until late 1966, in fact, NASA planned to launch the workshop in 1969, says Philip E. Culbertson, who is in charge of integrating the entire AAP.

Now, three years behind its original schedule, the fledgeling space station is on the track, primarily because the Apollo equipment, which was an unknown when the workshop was conceived, has proved itself.

At Marshall Space Flight Center in Huntsville, Ala., engineers are fitting out the booster for its new job. Equipment for almost two dozen scientific experiments will be installed inside the fuel tank (which is virtually the whole booster—its rocket engine is being removed), while other devices, including an elaborate array of solar and stellar telescopes, will be coupled outside to a multi-socket docking collar.

Until this summer, the plan was to launch the workshop stage, empty of instruments but full of fuel and with a working rocket engine installed, as the second stage of an S-1B booster, smaller than the Saturn 5. Once it had put itself into orbit, by its own bootstraps, so to speak, any remaining fuel was to be dumped, and the first crew of astronauts would enter to set up



Shuttle will serve future stations.

housekeeping. With this so-called wet-launch approach, setting up would be a major task, taking the three crewmen as long as a full week to bring in most of their equipment from storage space in the external docking collar.

Early in July, however, the plan was changed from wet launch to dry. Now the workshop is to be carried aloft, empty of fuel, but full of instruments and equipment, by two stages of the much more powerful Saturn 5. The S-4B will therefore not be doing double duty as a rocket stage, but program officials point out that it will still be fulfilling its main advantage of saving development cost and time.

Dry launching has numerous advantages, and Culbertson agrees with Harold Gould of the House space committee staff that one has been to boost confidence in the workshop's reliability. Besides permitting more secure, permanent installations, it greatly simplifies checkout procedures; Culbertson estimates that this alone will save engineers a good four months to work on the workshop structure itself. It will also let NASA delay some of its spending on the project by not having to check the equipment out independently, then try it inside the workshop, then take it out again for launch.

Delayed spending has already been a part of the Apollo Applications Program. Funding for the program began in fiscal 1966 at a modest $26.4 million, and by fiscal 1968 was up to $253.2 million. With the 1968 budget all but secure, however, along came the launch-pad fire, with the result that the slowed-down programs often spent less than their appropriations. Funding for 1969 thus dropped more than $100 million.

Fiscal 1970 is the first year in which the budget is paying big bills for heavy hardware, so NASA expects its AAP expenditures to go back up past the $250 million mark again. The fact that the space agency seems to be getting Congress and the White House to go along, despite the program's slow beginnings, is a fair index of the solidarity of the workshop's future.

Before the Apollo moon-orbiting and landing missions proved the capabilities of the hardware, says James Gehrig, staff director of the Senate Committee on Aeronautical and Space Sciences, Congress was reluctant to make heavy commitments to another major effort. Culbertson adds, "It was just hard for people in NASA and Congress to think beyond the lunar landing, since the effort was so great on that."

Several factors besides the landing itself, however, are helping the workshop gain acceptance. The photos of earth taken by Apollo astronauts from earth orbit, suggests Culbertson, have demonstrated the value of observations from space, whether of crops, natural resources or Russians. One of the workshop's main experiments is multispectral terrain photography, using cameras with as many as six different film-and-filter combinations to record images below, much as was done in simpler fashion during the flight of Apollo 9 (SN: 3/15, p. 255).

Another influence is the unexpected and controversial death of Bonnie (SN: 7/19, p. 46), the monkey who died on the ground after being brought back following only 9 of a planned 30 days in space aboard Biosatellite 3. Chief Biosatellite scientist Dr. Ross Adey says weightlessness was primarily to blame; others, including NASA medical research director Dr. Charles Berry, believe that Bonnie's extensive implanted instrumentation and other factors lay the base for no such firm conclusion.

The AAP workshop will provide the first opportunity to investigate the effects of weightlessness on man for extended periods of time. The present record for man's exposure to space is the flight of Gemini 7 in Dec., 1965, when Frank Borman and James Lovell, who later became two-thirds of the Apollo 8 moon-orbiting crew, spent less than 14 days circling the earth. AAP is to quadruple that.

In addition, all U.S. manned space flights so far have been carried out with only minimal biomedical data. The workshop crews will undergo 10 biomedical experiments during their missions, some of which—measurements of body fluid loss, mineral balance, metabolic rate, cardiovascular functions—bear directly on the symptoms exhibited by Bonnie.

Other experiments in the workshop's exhaustive schedule include studies of the sun, stars, earth's airglow and zodiacal light, and cosmic rays. With a sharp eye toward permanent space stations of the future, the astronauts will perform at least half a dozen engineering studies, including welding, brazing, evaluation of thermal control paints and coatings and measurements of contamination of scientific instruments by the workshop's atmosphere. Some researchers anticipate that the gravity-free environment may enable such engineering accomplishments as perfectly spherical ball bearings; lightweight, lowdensity steels that cannot be produced on earth might be possible in orbit, getting the most from materials. Jet-propelled boots, backpacks and hand-controllers, along with several types of sleeping accommodations are all on the agenda to help make life more livable in space.

Among the experiments are two being carried out for the Air Force are tests of an expandable airlock and the thermal coating study. There once were three more, including a test of the Air Force's space suit design, but these were canceled when the Air Force Manned Orbiting Laboratory was scuttled (SN: 6/21, p. 595).

At present, which means as far as Congress is expecting to pay, the Apollo Applications Program consists of four launchings. The first will put the workshop itself into its orbit. Two or three days later, the first three-man crew will lift off from Cape Kennedy, rendezvous with the dormant workshop and dock its Apollo spacecraft to it for a 28-day stay.

A few days before returning to earth, they will prepare the workshop for storage, then leave in their spacecraft, to be replaced a month later by a second crew in a second command module. This crew will remain in orbit for up to 56 days. Though many of the experiments will be conducted by all three crews, much of the second crew's time will be devoted to astronomy, using the workshop's external telescope mount and its host of instruments. After another month's hiatus, a third and final crew will come up for another 56 days.

The space agency is officially planning to orbit the workshop in July of 1972. Program officials, however, are aiming for March; the dry-launch plan now makes it seem possible, and saving time saves money.

Plans already extend past AAP. By the mid-to-late 1970's NASA hopes to orbit a huge station capable of supporting as many as 50 men, served by reusable surface-to-orbit shuttlecraft. Such stations would be carrying on massive research and manufacturing projects, and someday are likely to replace the earth as the launch pad for space flights to other planets. □