ANOTHER GIANT STEP TOWARD THE PLANETS

Three Soviet Soyuz craft are the forerunners for future permanent orbital stations

For nearly nine months all had been quiet from the Soviet Union's manned space program. Since the January flights of Soyuz 4 and Soyuz 5, in which the two spacecraft docked and two cosmonauts transferred from one space cabin to another, no manned launchings had been attempted.

The ensuing months were a time of glory for the United States space program, as the world followed first the Apollo 9 test of the lunar module in earth orbit, then the Apollo 10 test of the module in lunar orbit, and finally the Apollo 11 manned landing on the moon.

This week the Soviets confirmed that they are still very much in the man-in-space business. With a burst of activity unprecedented in the short history of manned space flight, they launched into similar earth orbits three spacecraft carrying a total of seven men—three more than had ever been in space at the same time before.

Aboard Soyuz 6, launched last Saturday, were Georgy Shonin and Valery Kubasov. In Soyuz 7, launched Sunday, were Anatoly V. Filipchenko, Vladislav N. Volkov and Victor V. Gorbatko. And in Soyuz 8, launched Monday, were Vladimir Shatalov and Alexei Yeliseyev, both veterans of the January Soyuz flights. The flights appeared to be a preliminary test of techniques necessary for establishing a permanent manned orbital space station. From space Dr. Yeliseyev said, "We will conduct experiments which will lead to the creation of still more powerful orbiting stations and we will have a number of experiments useful for building different kinds of orbiting stations." An official Soviet announcement said the mission goal was to improve spacecraft systems and methods of controlling them. A secondary task was to determine new potentialities of the three spacecraft and to test plloting skills.

On its second day in space Soyuz 8 rendezvoused with Soyuz 7 and they performed close orbital maneuvers, apparently testing docking techniques. Joint operations continued during the third day. Soyuz 6, not equipped for docking, was expected to carry out welding experiments. During the early phase of the flights photographic and biomedical studies were conducted.

Evidence seemed to argue against suggestions that the Soyuz flights were actually intended to establish a permanent orbital station. All three craft were circling the earth in relatively low orbits, ranging from 121 to 143 miles, where they would eventually be slowed by atmospheric drag and fall back to earth. The craft could maneuver into higher orbits, of about 300 miles, but they could not be expected to stay there indefinitely unless they were joined soon by a fourth craft, a larger unmanned core vehicle sent up with long-term oxygen and power supplies.

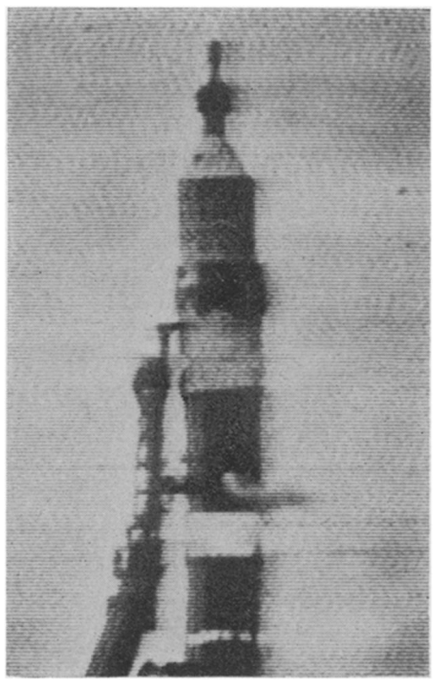
The Soyuz life-support systems are designed to operate 30 man-days per capsule, or about 10 days to the man. And it is not desirable to get too close to that limit.

"All these factors tend to support the rumors from Moscow that the Soyuz craft will be up about a week," said Dr. Charles Sheldon, the Library of Congress specialist on the Soviet space program. Information from Moscow provided no more positive indication of long-range plans.

From the beginning of the missions the Soviets cited the experimental welding equipment carried into orbit and the value of welding metals in space. Tests of welding techniques are one of many preludes to any eventual assembling of vehicles in orbit for large permanent space stations. A method known as electron-beam welding is planned for testing during a 1973 earth-orbital mission of a U.S. Apollo Workshop.

The Soviet multiple-craft mission comes as no particular surprise to American space officials. For some time the Soviets have been saying they intend to stress the development of manned earth-orbital stations more heavily than manned flights to the lunar surface (SN: 2/1, p. 14).

Both countries have been developing ideas for space stations of various sizes. But in the United States the bulk of the attention for several years has been given to the Apollo lunar landing program. In the debate on post-Apollo goals many scientists have expressed hope that the focus of the manned program for some years to come would be directed toward establishing permanent orbital stations rather than making further exploratory steps out into the solar system.



Photos: Novosti

Soyuz 6 at blastoff: First of three.

Last month the report of the President's Space Task Group (SN: 9/20, p. 233) endorsed the concept of a space station module as the basic element of future manned activities in earth orbit, of continued manned exploration of the moon, and of manned expeditions to the planets.

The basic unit in the American program would be a permanent structure capable of supporting 6 to 12 occupants, who would be replaced at regular intervals via reusable shuttle craft that are still to be developed. This module, which might be placed in orbit as early as 1976, would also provide a permanent manned station in lunar orbit, the task group said.

Joining the modules to each other would create a space base, which could be occupied by 50 to 100 men. The space station module, the task group said, would also be the prototype of a mission module for manned planetary expeditions.

The orbital stations are seen as a base where astronauts can work for extended periods, gaining the experience and capabilities needed for that critical time in the future when men can set off for a two-year mission to Mars. The stations would be used to

Docking of Soyuz 4 and 5 in January.

carry out scientific experiments, engineering studies and applications work. They would serve as laboratories for long-term biomedical studies, for instance, observing the effects on man and animals of long exposure to orbital conditions.

Not all scientists are convinced of the efficacy of conducting scientific studies from manned orbital stations. Between sessions this week at a symposium on the space program at the National Academy of Sciences' fall meeting at Hanover, N.H., Dr. John W. Findley of the National Radio Astronomy Observatory confessed to having mixed emotions about using manned space stations as scientific tools.

Their use as vehicle assembly points and way stations for longer expeditions is sensible, he said, but the inevitable small wobbles in the orientation of the station due to the crew's activity would be likely to make certain precise kinds of physical observations difficult.

The first launch of a small U.S. orbital station, in the Apollo Applications Project, is now scheduled for July 1972. A 60-ton station will support three men for four weeks and then be revisited twice by three-man crews who might stay up to two months at a time. The AAP station will be established inside the empty fuel tank of a giant Saturn 5 rocket stage which will be outfitted with scientific equipment, two decks, several compartments and an airlock and docking module.

The AAP program, which has met many funding delays, has now had its financing restrictions lifted, and, says its director, William C. Schneider, "We're moving full bore ahead." As for the three Soviet Soyuz craft orbited this week, Schneider observes that they are smaller than the planned initial U.S. station. "But if you dock enough of them together you get a very respectable hunk of hardware in orbit." □

THYMINE DIMERS

Repairing the DNA

An abnormal bulge in a strand of DNA has become a unique link between geneticists studying the molecular biology of genes and researchers more directly concerned with clinical effects of inherited disease.

The bulge occurs when two adjacent chemical components of DNA—thymine bases—are struck by ultraviolet light, causing them to fuse into what is called a thymine dimer (see p. 352). This double molecule causes unusual rigidity in the DNA strand, twisting the DNA helix out of shape and preventing the normal process of replication.

Using mutations of this kind in laboratory experiments, Dr. Arthur Kornberg and his co-workers at Stanford University in Palo Alto have formulated a hypothesis to explain the way cells repair defects in DNA.

Simultaneously, Dr. James E. Cleaver of the University of California Medical Center in San Francisco is exploring the possibility of genetic engineering as a cure for a rare genetic defect called xeroderma pigmentosum. The condition is marked by an extreme sensitivity to the ultraviolet light in sunlight, leading almost inevitably to fatal skin cancer. The defect, Dr. Cleaver finds, lies in the patient's inability to repair thymine dimers when they occur, thus allowing the undesirable mutations in DNA to persist.

To understand how cells proliferate, how viruses reproduce and how to promote or suppress these events, Dr. Kornberg says, it is essential to know the mechanism by which DNA is copied and how healthy cells repair it when it is defective. Addressing the annual meeting of the American College of Surgeons in San Francisco last week, the Nobel laureate explained his hypothesis of DNA repair which he calls a cut, paste and seal operation.

The system depends on the activity of three enzymes, studied in Psi x 174 viruses because of their genetic simplicity. The first, as yet unidentified specifically, belongs to a class of proteins called endonucleases. Theoretically, an endonuclease is constantly at work, patrolling strands of DNA, looking for chemical errors. When it finds a bulging thymine dimer, introduced by ultraviolet light, it nicks the DNA strand, thereby signaling another enzyme that something is awry. This second molecule, DNA polymerase, then excises the mutant segment, replacing it with a normal unit of DNA. Finally, a joining enzyme, ligase, pastes the new segment into place, restoring the strand of DNA to a normal state.

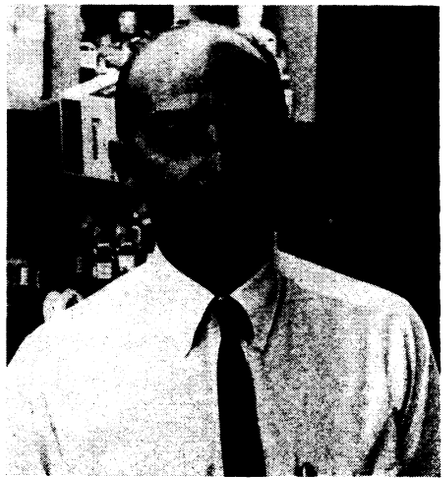
Previously, Dr. Kornberg, who won the Nobel Prize for his work on DNA polymerase, theorized that this enzyme is vital to the process of DNA replication. And, by understanding of the joining properties of ligase, he was able, in 1967, to synthesize the first biologically active molecule of viral DNA (SN: 12/30/67, p. 629).

The role of DNA polymerase in repair, he declares, was unexpected. "I'm really surprised at how much more work this enzyme can do than we ever knew when we started working with it. It is absolutely essential for the survival of life . . . governing the reproduction of genes and repairing them when they are damaged." He concedes that it might perform other tasks as well, but if so, they remain to be identified.

While emphasizing that this explanation of biochemical events surrounding the synthesis of DNA is conjectural, Dr. Kornberg believes the preliminary evidence is strong. In addition to test-tube experiments and chemical analyses, an electron micrograph showing DNA polymerase actually sitting on a strand of DNA clearly confirmed the relationship between the two.

The coincidental result of Dr. Kornberg's and Dr. Cleaver's work is a rare example of basic research developing information needed by a clinical researcher, at the time the need develops.

In the human disease related to Dr. Kornberg's line of research, the inability to excise and repair thymine dimers apparently results from the absence of one of the enzymes active in the repair process. It is most probably the endonuclease, though Dr. Cleaver says he cannot be certain yet. He is sure, however, that the inherited deficiency specifically involves the repair of thymine dimers, because tests



Stanford University

Dr. Kornberg: Cut, paste and seal.