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ASSEMBLER--THE FUTURE PROFESSION OF AN ASTRONAUT

By Col. A. Nikolayev, Pilot-Cosmonaut, USSR

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By Joseph L. Zygielbaum
Terra-Space Corporation, Malibu, California

The progress of space flights will inevitably lead to the broadening of the activities of man in cosmic space. The historic extravehicular activities in open space by Aleksei Leonov and the experiments conducted outside the spaceship by American cosmonauts in accordance with the Gemini project will undoubtedly be followed by more complex and prolonged flights during which cosmonauts will be scheduled to engage in quite a few extravehicular activities. From experiments they will proceed to the assembly of orbiting stations and laboratories. This type of effort requires a highly professional ans specialized preparation on the part of the cosmonauts.

We may therefore safely claim at this time that one of the first related professions which we as cosmonauts will have to acquire will be the profession of orbital assemblers. We will have to carry out operations in respect to docking, leave our spaceships, move about in open space, join together spaceships, and then assemble separate details into large structures.

The design of an orbiting station and its assembly in space represent an extremely complex problem. In order to cope with this problem we still have a lot to learn. The most important step on the road to the solution of this problem is unquestionably the docking of two spaceships and the placing of spaceships into close orbits with a minimum possibility that they will drift apart. We have a certain amount of experience in this respect.

The moments when the tandem flight of the spaceships "Vostok-3" and "Vostok-4" began are still fresh in my memory. By that time I had already spent one day in space. The next orbital revolution took me over the region of the Baykonur Cosmodrome. At that moment "Vostok-4" was launched. The spaceship entered an orbit in direct proximity to my spaceship. I could distinguish a bright star moving slowly on the background of the dark sky. This was the spaceship piloted by Pavel Popovich. The distance between our spaceships at that moment did not exceed six and one-half kilometers.

Thus, for the first time in history, two spaceships approached each other. I would like to mention the fact that at that time we had no available means for maneuvering. During our flight we demonstrated only the possibility of placing spaceships in orbit at close proximity to each other. This was of great importance because it represented a necessary step toward a subsequent docking operation. The capability of precise orbital rendezvous between spacecraft is a must before a docking operation can be successfully undertaken.

All future operations related to docking and joining spacecraft in orbit will begin with a controlled approach and rendezvous. Special techniques and facilities are already developed or are being developed for this purpose. Some of these techniques have been demonstrated by the Soviet Union as well as by the United States.

We will try to visualize what work in space will be like: "Attention! An artificial object is in front of us. I am observing this object in the area of the constellation of Orion as a star of the second magnitude. I am beginning my approach to the object. . ." Obviously such a report will be transmitted to Earth by the commander of a spaceship.

The point is that spaceships, artificial satellites and other objects in cosmic space are seen in the form of stars at a distance of several kilometers. The brightness of these man-made celestial bodies varies with distance.

I remember Pavel Belyayev's report about a meeting with a satellite. During the flight of "Voskhod-2," one of the "Kosmos" satellites, which was launched into an orbit with an inclination toward the equator of about 65°, passed presumably at a distance of about 800 meters from the spaceship. This satellite was seen as a bright star standing out sharply on the background of the sky.

Thus, our cosmonauts have a certain amount of experience in the detection and recognition of spaceships. This experience will be of great help in the future during the construction of orbiting stations.

What is required of a cosmonaut during the various stages of such a complex operation as the assembly of orbiting stations?

First of all, it is necessary to work out the methods for stepping out-

side a spaceship to the last detail. It is known that the first experiment to step out from a spaceship into open space was accomplished by means of an airlock. This special installation on board the spaceship "Voskhod-2" made it possible to leave the cabin first and then to gradually "get used" to the conditions of space.

We have learned from Aleksei Leonov's reports that the exit from the airlock and the return to it require specific practice and skills on the part of the cosmonaut. This is being confirmed by the results of various training sessions. Therefore, the training program should include not only "making oneself at home" in a spaceship, but also detailed knowledge of the airlock, detailed study of all its parts, and testing of all operations in strict order.

When one enters an airlock under normal conditions on Earth, the first impression is that, in spite of the small confinement, all necessary operations can be carried out without difficulty. However, we all know by now that factors of spaceflight, especially weightlessness, hamper the activities of a cosmonaut and require of him special preliminary training. Aleksei Leonov spent a lot of effort on bringing the movie camera back into the airlock. In the future, cosmonauts will have to take with them for a "space walk" not only a movie camera but also scientific instruments, tools, oxygen supplies, and fuel for the orientation and transportation systems.

The airlock method is not the only method used for an exit into space. It is known, for instance, that the Americans have used the method of cabin decompression for this purpose. The preparation of a cosmonaut for a similar method of "stepping out into space" has its advantages and difficulties, and the method itself has its pluses and minuses. However, in my opinion the airlock method is more feasible in the long run, because with the appearance of larger spaceships occupied by large crews it would not be expedient to decompress the cabin for the purpose of leaving the spaceship.

Let us follow the work of a cosmonaut after he leaves the spaceship. After the spacecraft approach each other and the docking couplings are interlocked carefully, the cosmonaut will approach the junction of the two spacecraft in order to fasten the flanges together, i.e. to fasten the nuts and clamps. Similar operations have already been tested in cosmic space simulators. The

results of some of these tests were reported in October of 1966 at Madrid at the Congress of the International Astronautical Federation. In the course of the discussions, the scientists voiced their opinions on the fact that in order to carry out many practical operations in space, considerably more effort and knowledge is required of the cosmonauts than in Earth conditions.

Many practical operations which are common in Earth conditions, such as screwing on and tightening bolts and clamps, welding, soldering, etc., will present entirely different problems in orbit. It is most likely that special instruments and all sorts of devices will be necessary in order to carry out these tasks.

The first extravehicular activities were quite short, and the paths along which the cosmonauts took their first "space walks" did not exceed a dozen meters in length. Nevertheless, it is possible to foresee a considerable increase in the duration and distance of such "walks." Furthermore, in order not to be literally tied to the spaceship (I have in mind here the umbilical cord which connected the cosmonauts to the spaceship during the first experiments), it is necessary to learn how to make use of the individual maneuvering devices and the automatic life support system.

After mastering the new technology, pilot-cosmonauts will be able to move about more freely in space, which in turn will eliminate in a number of cases the necessity of bringing cosmic objects very clost together, and this, by the way, is not a simple task and not without danger. In the beginning, a cosmonaut, after leaving the spaceship, will be able to connect the two spaceships by means of a cable, after which the two spaceships will be joined solidly with the help of a hoist or other device.

Docking or, using the naval terminology, mooring will also remain a necessary factor after the construction of orbiting stations. During the approach of a spaceship to the station and before entering the special docking area inside that station, the crew will have to "moor" the spaceship to the station. This is why the training of cosmonauts for the execution in open space of operations related to docking, joining, and assembly is an important factor in their preparation for new flights.

So far we have discussed only one side of the extravehicular activities of a cosmonaut. Of course, the rendezvous and docking will be conducted by the commanders of the spaceships and other crewmembers who will remain on board. The perfect radar technology, instruments for observation and distance measurement, means for communication and signaling, computers, and other equipment will make it possible for people to work more reliably and constructively in open space. Many of the enumerated instruments and devices are already installed on board manned spacecraft. At the present time only ship commanders are using these instruments, but it is certain that in the future even navigators will use them.

The success of extravehicular activities depends considerably on the faultless operation of the facilities of the ground-based measurement control complex. We have a lot of respect for the specialists who assure the success of our flight.

Before giving the "okay" for a docking, the flight leaders receive from the ground-based stations data on the orbital parameters and reciprocal positions of the spaceships. If these correspond to the calculations, then the command for docking will be issued.

Ground-based stations will execute, if necessary, the rough rendezvous approach of the spaceships. As far as the subsequent operations are concerned, these will be carried out by the crewmembers of the spaceship, of course, under continuous control of the ground stations. This means that a cosmonaut will have to be able to work in close cooperation with the ground stations.

The described docking method is by far not the only possible method. We do not exclude the possibility of docking two spaceships by means of automatic systems only. Nevertheless, it will not be possible to do away with the direct participation of man in orbital constructions. There are no instruments or devices capable of replacing a man during the construction of such objects as orbiting stations or laboratories. In these cases the experience, knowledge, and skills of man are absolutely necessary.