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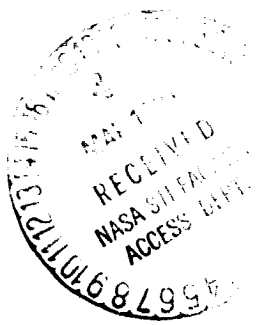

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16. Abstract

The necessity for the cosmonaut to receive broad training in many fields in order to carry out his multifaceted work is discussed.

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WORK OF THE COSMONAUT

L. S. Demin
Hero of the Soviet Union, USSR pilot-cosmonaut,
candidate of technical sciences

On April 12, 1961 Yuriy Gagarin, citizen of the Union of Soviet /4* Socialist Republics, completed the first space voyage. The exclamation "Let's go!", poorly distinguished through the radio interference, announced the beginning of a new stage in the mastery of space, man's direct invasion into a mysterious and unknown world.

In 16 years more than 80 cosmonauts and astronauts have taken the "path" trodden by Yu. A. Gagarin. Space flights became systematic.

If the first space flight is compared with subsequent ones, it is not difficult to see striking changes. With each flight space technology is perfected, the volume of work is increased and the subjects of the tasks solved by the cosmonauts are expanded, and the length of their stay in space grows. The demands on the cosmonauts increase, and the preparation for flight changes and becomes more complex. In the first flights the possibility of living and working in space was verified. At that time it was still not clear in what state would be the cosmonaut's nervous system and emotional sphere during the flight, his physical and mental activity, and the possibility of directing the ship and conducting scientific experiments.

It was suggested that man would not withstand the unknown nervous-emotional overloads and would not be able to act rationally during a space flight. To exclude the proposed "irrational" intervention of the cosmonaut in the direction of the ship, a "logic lock" was put on board the first "Vostoks." The six-button device gave access to the ship's manual control if the cosmonaut punched in the three-digit number written in the ship's documentation.

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* Numbers in the margin indicate pagination in the foreign text.

Then about 90% of Yu. A. Gagarin's flight time was spent on medical experiments. In the space flights on the "Soyuz" series ships this number was reduced to 15-18%. Now, when the major, pressing medical-biological problems are solved, preference is given to scientific and technical tasks and to tasks pertaining to the national economy. For example, the crew of the first expedition on the "Salyut-4" orbital station, consisting of A. A. Gubarev and G. M. Grechko, completed more than 100 scientific, technical, astrophysical, geophysical and medical-biological experiments and investigations; and the crew of the second expedition, consisting of P. I. Klimuk and V. I. Sevast'yanov, more than 200. The "Salyut-4" orbital station was a space scientific-research laboratory, a type of scientific outpost, from which the cosmonauts did various investigations of space, the Earth, and its surrounding area. It was equipped with modern scientific-research equipment (more than 2.5 tons). Mounted on the station were about 90 different installations with many (up to 100) individual devices and aggregates. On board the station were 43 control panels. It is evident that only qualified specialists can work with such manifold and varied equipment. What is characteristic for the activity of a cosmonaut?

Primarily, multifaceted work: scientific-research, experimental, engineering, flight, operator's work, participation in technical commissions and councils, training on simulators, study of technology and sports.

Scientific-research work is taking up a more and more solid and extensive position in the cosmonaut's activity both on the earth and in space. The range of sciences and branches of the national economy interested in space experiments is extremely broad. Even in such earth branches as agriculture or metallurgy the results of space investigations find direct use.

It is not yet possible to send scientific workers from different fields into space; therefore members of the crew are prepared for scientific work and carry it out during the flight. A feature of the cosmonaut's activity in this is that he must have a certain amount of scientific knowledge and must understand the sense and the goal of the

conducted experiments. And the better he is prepared, the more information he will relay from space and bring back with him.

The quantity, volume and variety of the scientific-research tasks are increased from flight to flight. The requirements for the scientific preparation of the cosmonauts also grow steadily.

Experimental work is one of the important elements of the cosmonaut's profession. For a long time yet it will be the core of all his /5
activity. At present all space flights are experimental. The cosmonaut tests the space ship and its systems, instrumentation and equipment, and at the same time he himself is the object of research. In the conditions of a real space flight different systems, devices, aggregates, and the quality of the engineering-psychologic development of the panels, control organs, signals and incicators--all that the cosmo-

Twice Hero of the Soviet Union, USSR pilot-cosmonaut V. F. Bykovskiy before training on the centrifuge.
Photograph by V. L. Zhikharenko

Twice Hero of the Soviet Union, USSR pilot-cosmonaut V. N. Kubasov tells a physician about his sensations after routine training.
Photograph by V. L. Zhikharenko

naut is connected to during the flight--are tested and verified. The equipment is evaluated with respect to the convenience of working with it. Simultaneously the effect of factors of the space flight on the human organism is determined. The experimental work requires knowledge of the theory and construction of the experimental equipment, ability to work with it, and familiarity with the experimental method. It is for this reason that the cosmonauts extensively and carefully prepare for the upcoming real space flights even before the flight.

The contemporary space ship is a "cluster" of varied equipment that /6 the cosmonaut uses and that is necessary for preventive maintenance and, if required, for repairs. To study and master this equipment, the cosmonaut must know many engineering professions. In fact, the cosmonaut must deal with different motors and telemetric, radiotechnical and

radio communications equipment; service air and water regenerators and the energy system; and use different optical devices, numerous automatic machines, nutrient and water supply systems, scientific-research instrumentation and aggregates, and medical equipment. The cosmonaut must be not only well "grounded" in many engineering professions, he must also be a qualified practitioner.

For the cosmonaut an airplane is a natural and multifunctional simulator. In it the cosmonaut experiences conditions that imitate those which he will encounter in space flight. Flight preparation is necessary for cosmonauts also for the development and reinforcement of professional qualities--the ability to work efficiently with control units and equipment. It develops habits of acute observation, discretion and attentiveness and develops instantaneous reaction to a suddenly changing environment. Finally, flight training and parachute jumps teach and support high moral-volitional qualities in the future members of space crews.

Operator's activity, the ability quickly and accurately to work with control devices, indicators and signals, occupies an important place in the cosmonaut's training. The great number and variety of the equipment that the cosmonaut directs and controls creates the most varied and at times strained situations in the operator's activity of the cosmonaut. For example, work with one system or device with free or nonstrained graphics alternates with simultaneous or subsequent work with several systems, when the astronaut must direct his attention to different processes.

The completion of modern requirements of engineering psychology has great significance for operator's activity. This is the creation of the ship with account taken for the psychologic characteristics of man, and the construction, distribution of control devices and equipment on panels, formation of the working place and the interior; this is even distribution of the flight program in time and of received information among crew members, and of the load on their sense organs; this is the psychologic preparation of the cosmonauts for possible

stress situations.

The psychologic preparation achieves all the more solid and extensive positions penetrating all those areas which are related to the preparation for the flight, its occurrence and the postflight period.

A special place in the cosmonaut's activity is occupied by simulators, devices, the work on which permits the attainment of the necessary practical experience in controlling the ship, its systems and devices. Knowledge of the ship alone, even the most fundamental, is not enough for quick, clear, accurate work during a space flight. Practice, experience, habits and familiarity with the features of the systems and the details of their use are also necessary. All this is achieved by regular training on the simulator. The driver-trainee or pilot-trainee has the possibility of mastering the control of an automobile or airplane in real conditions under the direction of an instructor. On the ground the cosmonauts not only master the systems and instruments of the ship, but also "play out" more complex and important steps of the flight and even individual "pieces" of the flight task.

Every space flight enriches astronautics with a unique experiment and scientific results. Thus, the flight of Yu. A. Gagarin made it possible to determine the psychologic, engineering-psychologic, and medical-biologic barriers of weightlessness. Beginning with this flight, changes and modifications have been regularly introduced into the construction of the space ships and their systems; they reflect the information and accumulated experience of the cosmonauts. Therefore the cosmonauts actively participate in technical commissions and conferences and are in close contact with the designers. Only by joint efforts can a "machine" that is well "adapted" to man be created.

As long as there are overloads, weightlessness and stress responses /8
in space flight, the cosmonaut must be well prepared physically. The cosmonaut needs physical training in order to become strong, agile and tolerant; the preparation develops stamina and will, trains the vestib-

ular apparatus, expands the physical and psychologic capabilities of the human body, makes it resistant to diseases, and strengthens and maintains health. Several times a week the cosmonauts work out on sports fields.

/7

The cosmonauts verify instrument readings. Left to right: Twice Hero of the Soviet Union, USSR pilot-cosmonaut V. N. Kubasov; Twice Hero of the Soviet Union, USSR pilot-cosmonaut A. A. Leonov; Twice Hero of the Soviet Union, USSR pilot-cosmonaut N. N. Rukavishkikov.
Photograph by O. B. Savin

/8

The cosmonauts give not a little time to medical preparation. First, there is a periodic, strict check of the state of health, done by physicians who know their "wards" well. Second, the cosmonauts study independently the fundamentals of medicine and master different medical

Twice Hero of the Soviet Union, USSR pilot-cosmonaut V. I. Sevast'yanov verifies a time reading. Photograph by V. L. Zhikharenko

instruments and equipment that must be used during the space flight. And, finally, there is varied training, which increases the functional capabilities of the organism.

The work of the cosmonaut requires systematic shifting from scientific to physical work, from experimental to academic, from flight to simulator, and, if necessary, to repair work.... Georgiy Mikhaylovich Grechko told me an interesting incident from the experience of the crew of "Salyut-4." /2

According to the flight program, it was necessary to study the sun with the aid of a sun telescope, but at the needed moment the reflection of the sun did not appear in the telescope's eye-piece. Different hypotheses about the disrepair of the telescope were put forward, but none were confirmed. It was decided to turn the station perpendicular to the flow of sun beams in order that the rays, entering the telescope, would fall on the mirror. The mirror (it could rotate in two planes for automatic tracking of the sun) had to be placed in the middle position. Then the sun beams reflected from the mirror will fall in the optic system and the telescope will work. But how to place the mirror in the middle position? Since the mirror is moved from one end position to the other by an electric motor, it was decided to determine by ear the time of its work in transferring the mirror from support to support. (In the end positions the motor is turned off automatically.) After a time interval equal to half the duration of the motor's work the mirror is in the middle position. From one of the channels the work of the electric motor was audible, and from the other channel it was not heard, although it was clear that the motor was working. It was necessary to dismantle one degree of hermetic sealing on the telescope, but the sound of the working motor was again not heard. Mother wit prompted: take the medical stethescope and try to hear the work of the motor through the body of the telescope. The success was complete. The time of work for placement of the mirror was determined, and when the telescope was turned on, the sun appeared in its eye-piece. In the end the scientific investigations were conducted and they received high appraisal.