NEW TECHNOLOGY AND THE PROFESSIONAL HEALTHY MAN

Dr. Yuri I. Voronkov
Head, Department of Cosmonaut Selection
Ministry of Health
Russia

More than thirty years of experience in maintaining the safety of manned space missions, has highlighted the validity of a tried and trusted, Russian method of cosmonaut selection and training. The medical selection was based on observations made in clinical medicine, the medical expertise of the flying personnel and experimental investigations concerning space flight effects on living systems. Between 1948 and 1961, information on animal exposure to space flight factors was provisionally obtained from vertical missile flights, which made it possible to validate the feasibility of manned space missions.

The first cosmonauts were selected from flying personnel who were in good health and familiar with the conditions and effects of factors, similar to those to found in space missions. After that, because of the complicated tasks undertaken during space missions, the in-flight use and testing of sophisticated space technology, and the completion of a broad spectrum of studies, the need arose to include cosmonauts, among the flight crew, who were researchers and highly qualified representatives of various scientific specialities. Because of this, it became necessary to change some evaluation criteria for assessing the health status of the chosen candidates, taking into consideration their age and physical fitness. In specific cases, during the selection process, some health-improving measures, related to the professional importance of the candidates for the position of cosmonaut-researcher, were also carried out.

The primary goal of cosmonaut selection is to predict their peak tolerance of a particular space mission, while maintaining good health and adequate performance throughout the flight, completing the flight tasks, and assuring a successful return to earth. The inclusion of cosmonaut researchers in space crews, meant studying the effect of space flight factors on the reactions of subjects, in simulated ground-based investigation.

An improved system of medical selection for cosmonauts, was also based on generalisations taken from the findings of in-flight medical examinations and data obtained during post-flight assessments. All this made it possible to develop a profile for the medical requirements of a candidate's state of health. In this case, the requirements for the commander and flight-engineer were more stringent than those for other crew-members. More rigorous requirements were also asked of cosmonauts who were to be involved in long-term space missions. The adapted system of medical selection consists of the following stages:

- Primary selection is carried out on an out-patient basis and directed towards excluding diseases associated with functional disorders, which are absolute contra-indications to participation in space missions.
- Selection was conducted in a hospital to determine latent pathologies, early pre-clinical forms of disease, as well as, the functional potential of the body.
- Selection in the process of space training of cosmonauts, makes it possible to evaluate the adaptational reactions of each cosmonaut and make a more accurate choice. Training conditions are often characterised by, for example, stress, acting as a stimulus, providing another method for developing and detecting additional health abnormalities.
- Immediate pre-flight selection occurs when the cosmonaut is pronounced fit for participation in a space mission. Naturally, as a result of accumulating knowledge about, and the improvement of, spacecraft environments and onboard conditions for work, the requirements for candidate health levels have been lowered, in particular those for cosmonaut-researchers. Needless to say, up to the present, candidates for cosmonaut-research must enjoy a good functional body state, must not have chronic diseases and must have a psychological state which will not adversely affect the accomplishment of flight tasks.

Experience in the medical selection of cosmonauts indicates that for medical reasons, from every 100 candidates, approximately 2 to 10 individuals will be pronounced fit for training.

The further advancement of space science imposes new requirements for developing the medical selection system. This requires, among other things, looking at the prospect of repeated space missions and determining the optimal length of intervals between missions. Russian ground-based experimental investigations indicate that a repeated exposure to 30-day head-down tilt, in the case of incomplete re-adaptation, leads to an increased "acute" adaptation, repeated hypo-kinesia and impaired subjective feeling in test subjects. In this case, the signs of astenisation and vegetative-vascular instability develop earlier and need a longer time for recovery in the re-adaptation period; mental work capacity is markedly decreased.

In conclusion, it should be noted that efforts are necessary to improve the medical selection of cosmonauts, specifically with regard to
Cosmonaut Biomedical Training

At present, the preparation (training) of cosmonauts can be defined as a continuous purposeful process of training, forming and maintaining operational skills, enabling crew members to acquire the professionally-significant psychological and physical features essential, if effective work is to be done in space missions.

The preparation of cosmonauts consists mainly of technical, aviation and space, medical, biological and other scientific training. An early cosmonaut training concept was based on the assumption of a definite analogy between stratospheric flights and space missions. Because of this, the early Soviet cosmonauts were recruited from among fighter pilots who enjoyed excellent health.

This was based on the fact that the fighter pilot's activity is very similar to that of a cosmonaut piloting a single-man spacecraft. During the training of the first cosmonauts, a considerable portion of the programme was dedicated to the medical aspects, essentially because the aim was to substantiate the principal question of survival and work, in space. The familiarisation of cosmonauts with exposure to space-flight factors, thereby, gaining an increase in their tolerance, as a result of conducting appropriate exercises, constituted a component of the biomedical training and preparation of cosmonauts. Training and testing consisted of the following components: flights in aircraft equipped to simulate weightlessness; prolonged stays in specially equipped isolation chambers; testing and training in a thermal chamber, by applying thermal loading; centrifuge testing and training; vibrostand testing; parachute jumps; physical training; training in the Vostok space cabin mock-up.

The first space flights of cosmonauts in the Vostok spacecraft, demonstrated, not only that humans can stay in space-flight environments, but also that they can perform in-flight, completing various kinds of work. In this case the training programme was improved during the course of the flight. Thus, for instance, the motion sickness symptoms, exhibited by G. Titov during the Vostok-2 flight, drew great attention to vestibular training.

After cosmonaut researchers were included in the space crew, the so-called non-specific methods of training, a part of biomedical training routines, were considerably extended. In particular, staying at a moderate altitude is also stressed, because acclimatisation to moderate altitudes increases human tolerance to acceleration and hypoxia, as well as raising physical performance. The fact that the extensive use of specific methods of dynamic bench-test training has an effect on the body was not ignored. After systematic tests during repeated specific exposures, functional overstrain and neurotic states can develop, as a result of cumulative stimuli. Because of this, while designing a biomedical training system, preference was mainly given either to non-specific methods, during a prolonged time of cosmonaut training, or to an optimal combination of specific and non-specific ones. The general structure of cosmonauts' training changed because of the increase in the length and sophistication of space flights. Training routines were considerably extended in time and content. One development of this concept was that during initial cosmonaut training - preparing for the first space flights - media aspects greatly predominated. In this case, the length of biomedical training and preparation of cosmonauts amounted to 50% of the total time of the training process, and to a greater extent was directed toward increasing body resistance to the numerous stresses of the space mission. With the increased length of orbital missions, the approach to cosmonaut training became more differentiated, its most important tasks being: extensive studies of human body potential, development of methods to use this potential and solutions to counteract problems, aimed at optimising physical working capacity and the professional longevity of the cosmonauts.

An important distinguishing feature of cosmonaut training became individualisation, developing the training routines for each cosmonaut and for the crew, as a whole, while revealing and taking into account psycho-physiological features. In this case the length of biomedical training consisted of approximately one third of the total training time.

The preparation of cosmonauts for long-term orbital space station missions was characterised by the marked priority given to training, based on the use of methods and measures to prevent adverse effects of space-flight factors on the body.

The results of training-concept analysis and its evolution, during the progress of manned space science, make it possible to single out, as its generalised element, the idea that the cosmonaut should, not only be an operator who must control spacecraft systems, but also a biological object, characterised by individual psycho-physiological features and potentialities. As well as providing cosmonauts with stable professional skills, the ability to be ready to perform more responsible activities, having a complex dynamic structure, is relevant.

Within the framework of biomedical preparation, sensory, anti-orthostatic, physical, psychological and medical training is carried out. Within the context of aerospace preparation, simulator, parachute and altitude training, as well as rescue and survival methods, are carried out. At present, simulator training accounts for 70 to 80% of a cosmonauts time during the immediate pre-flight preparation for a mission crew. From the socio-psychological point of view, simulator-training can improve relationships among crew members and form a cohesive crew. During simulator-training the interaction of the crew with ground flight control services is also mastered. From the psychological-pedagogical point of view, simulator training, as well as a broad spectrum of possibilities for controlling the course of the training process itself, creates sufficiently good conditions for studying the behaviour and activity of cosmonauts carrying out training tasks, including the observation, recording and
analysis of their actions and physiological data readouts.

Next, and perhaps the most important trend in using professional simulators to train cosmonauts psychologically, is the creation of a cosmonaut's preparedness to perform the most responsible activities, such as orbital docking operations. In the process of simulator mastery of actions, under various emergency situations, cosmonauts develop professionally important psychological features, such as quick thinking. The use of simulators, with the aim of medical and psychological monitoring, should be considered separately in order to solve the following tasks:

- revealing dangerous states requiring the cessation of training and application of corrective measures, including medical ones
- diagnosing such undesirable states as overstrain, astenisation, apathy, decreased performance etc.

In these ways, existing systems for the selection and biomedical training of cosmonauts make it possible to provide for the safety of long-term space expeditions, lasting up to a year. In conclusion, it should be noted that the development of future cosmonaut training programmes, related to interplanetary flight, when flight duration could be significantly increased, and the feasibility of a rapid return to earth would be excluded, will reflect a significant shift in biomedical aspects.

References