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SOVIET ASTRONAUTS IN THE NEAR COSMOS

G. V. Petrovich

The start of the second half of the 20th century saw the advent of a new era in the history of the development of mankind - the mastery of the cosmic space around our planet. A great new era in the history of the world began. In 1957, with the automatically controlled artificial earth satellite, and in 1961, with the first manned space flight.

April 12, 1961, will remain forever in our memories; on this date, the spaceship "Vostok," containing astronaut Yuri Gagarin, gleaming in the rays of the early-morning sun, was successfully launched from its space-port and made an orbital flight around the earth with a velocity exceeding circular velocity. The maximum altitude (apogee) was 327 km; the weight of the ship, including Gagarin, was 4725 kg, not counting the last stage of the carrier rocket. After one revolution of the earth, lasting 1 hour and 48 minutes, according to program, the spaceship and the astronaut landed successfully at a pre-selected site in the Soviet Union.

The landing site, located on the left bank of the Volga, in the picturesque highlands near the village of Smelovka in the

Ternovka region of the Saratov district, would be a perfect place for an obelisk in memory of this great accomplishment of our era.

The spaceship was placed in orbit by a powerful multistage carrier rocket. In describing it, let us merely say that the total maximum useful power of all stages of the carrier rocket was 20 million horsepower. The high specific thrust of the six liquid propellant rocket engines on the Vostok made it possible to obtain enormous power with relatively moderate fuel expenditure. The creation of such engines is one of the basic achievements which has made it possible for the Soviet Union to occupy first place in the mastery of space.

The combination of high-quality engine design, control systems, and launching equipment made it possible to create and launch such a carrier rocket.

One of the most complex problems was to create a spaceship which could be separated from the carrier rocket. The most important thing was to assure that the living conditions for the astronaut aboard the craft would allow him to fulfill the program, and to assure that the landing system would operate without a hitch. Particular attention was devoted to the training of the astronaut, taking into account the specific conditions of flight into the near cosmos.

How successfully all these problems were solved can be seen from the excellent results of the unprecedented space flight of April 12.

This first manned space flight is of exceptional significance. Practical proof has been given of the possibility of manned space flight and the fact that we have the necessary equipment. This flight has opened a new chapter in the history book of mankind - a

new, cosmic, era. From this day forward, man is no longer bound to his planet by the bonds of gravity, and soon the entire solar system will become his home.

Two-hundred and seventy years have elapsed between Newton's discovery of the law of gravitation and the overcoming of these forces by the first Soviet sputniks. Man has developed enormously in this time. Sixty years have elapsed since Tsiolkovskiy advanced the theory of rocket space-flight, opening the way to the cosmos.

Even if the nature of the force of gravity had not been discovered, spaceships devised by the mind and hands of man, overcoming this force, would still have attained trans-atmospheric heights, making orbital flights at cosmic velocities.

Man has always dreamed of flying like birds. Fantasies have given way to reality, and one remembers the ancient legends of man's flight not only upward but also to other heavenly bodies. Men of many nations have attempted to fly for many hundreds of years. But these attempts were not founded on experience, and the available descriptions of these timid attempts, often not completely reliable, attest to their inglorious end.

But years went by, experience was gained, science and industry developed, and man's age-old dreams of flight began to come true. The first officially recorded air flight was made on November 21, 1783, by two French pilots (Pilatre de Rozier and d'Arland) in a smoke-filled air balloon designed by the Montgolfier brothers; the flight lasted for 20 minutes and covered a distance of 9 km. Ten days later the flight was successfully repeated in a much-improved air balloon, filled with hydrogen, and piloted by the talented designer Charles and the mechanic Robert. Thus began air navigation,

and from then on it developed rapidly.

The creation of a heavier-than-air craft, a plane with a motor, was a long and difficult process. History has recorded numerous painful creative attempts, but only in rare cases were the planes able to get off the ground, and then for only brief periods (Mozhayskiy, Adzir, Maxim). An airplane with a motor, capable of practical flight, was created in America by the Wright brothers who, on December 17, 1903, made the first four successful flights, lasting up to one minute. France, Germany, Russia, England, and other countries all contributed considerably to the rapid development of aviation.

The Soviet Union has paved the way for penetrating into the cosmos, and in the creation of rocketry, making history along the way. The basic landmarks of the glowing path of the Soviet Union along these lines include the following: the launching of the first artificial earth satellites (October 4 and November 3, 1957, the latter with an animal on board) and the first solar satellite (January 2, 1959, with a close lunar passage), the reaching of the surface of the moon (September 12, 1959), the flight around the moon and photography of the far side (October 4, 1959), the launching of increasingly heavier artificial earth satellites (1327 kg - 1958; 4540, 4600, 4563 kg - 1960; 4700, 4695, 6483 kg - 1961), the placing of a heavy automatic interplanetary station into an Earth-Venus orbit; this was launched from a satellite orbiting the earth (March 12, 1961) and, finally, the launching and safe recovery of the Vostok and astronaut Gagarin (April 12, 1961).

October 4, 1957 and April 12, 1961 will go down in history as the dates of man's triumph, the opening of the space age. Only

3-1/2 years separate these great events. Much has been done in this surprisingly short time. The creation of the Vostok was preceded by much scientific research and experimental-design operations, as a result of which it was possible to turn to the program of the summer* testing of spaceships. The attached table gives a summary of the flight tests of six spaceships, culminating in the flight by astronaut Gagarin.

In fulfilling this program, all systems were thoroughly tested. After each flight all noticeable deficiencies were eliminated, the effectiveness of the various measures was verified under laboratory, stand-test, and sometimes flight conditions, and only after this had been done was the next ship launched. As a result we obtained reliable results when spaceships with dummies on board were prepared for launching, flown, and landed without incident. Only then was the decision made for a manned flight.

Gagarin's flight was the first manned rocket flight in the Soviet Union. This flight, carefully prepared, was a glowing success.

Former military fighter-pilot Gagarin (born in 1934), as a result of extensive clinical and physiological tests, was selected with a group of fliers who had expressed the desire to become astronauts.

On the basis of many tests, the candidates most suitable for space flights were selected; they formed the group of highly-trained astronauts, with knowledge of space and rocket technology, astronomy, geophysics and space medicine. Gagarin was one of the best of the astronauts.

Gagarin justified the faith placed in him. All the systems of the carrier rocket and the ship operated excellently, and after

* Translator's note: As in original. "Summer" here is apparently a misprint for "flight".

orbiting the earth Gagarin was safely landed at the pre-selected site. After his flight he felt fine.

Mankind will always remember the name of the son of the Soviet people, now Hero of the Soviet Union, the first astronaut, Yuri A. Gagarin.

Approximately ten years ago the Soviet Union began studying the question of the advantages of manned flight in a rocket on a ballistic trajectory. Even at that time the Soviet Union had ICBM's which were so reliable that there was no doubt but what they could be used for manned flight to 100 km and higher. However it was decided that such flights were of no advantage. Actually, a ballistic flight is not a space flight in the true sense of the word since the minimum, i.e., circular, velocity is not reached. Under such conditions, weightlessness lasts only several minutes; this same thing can be attained using specially equipped airplanes. It is much easier to make a manned ballistic flight than a manned space flight. At the same time, much time and effort would be expended on perfecting a manned ballistic flight.

A manned ballistic flight would not assure the accomplishment of a space flight but, rather, would postpone space flights, since all attention would be devoted to something which holds no promise.

Therefore, Soviet scientists and designers worked on the creation of spaceships designed for orbital flights.

The spaceships, placed in orbit around the earth and separated from the last stage of the carrier rocket after a velocity greater than circular had been attained, consisted of hermetically sealed cabins attached to instrument compartments, which also contained the braking devices.

The hermetically-sealed cabin maintained normal atmospheric pressure, humidity and temperature. But as added insurance the first astronaut wore a spacesuit. The cabin contained life-support equipment, automatic and manual flight control systems, automatic solar orientation and manual ground orientation systems (optic orientor), a landing system, autonomous and radio telemeter apparatus for controlling and recording various parameters, a USW and SW radio apparatus for two-way telephone communication between the astronaut and the surface stations, radio telegraph communication with the ground, radiosystems for controlling the orbital elements and orienting the spaceship, and a number of other devices.

The astronaut's cabin is much more roomy than that of a single-seat plane.

The outside of the cabin contained radio antennas and an insulating system to prevent the ship's burning up in the dense atmospheric layers during the descent.

The cabin contains three heat-resistant portholes and two automatic rapid-opening hermetically-sealed escape hatches.

The outer surface of the instrument compartment contained spherical cylinders with compressed gas and the guidance nozzles of the orientation system, the orientation elements, and the shutters for the temperature-control system. The hermetically-sealed instrument compartment, filled with gas, contained flight control apparatus, radio telemeter apparatus, and the temperature control system.

The silver spaceship Vostok is girded, at the point where the cabin and the instrument compartment meet, by a green band, a covering with specific optical properties capable of maintaing the required temperature on board the ship during space flight.

Several of the systems, including the landing system, are duplicated for increased reliability. For example, the astronaut can land with the ship or by parachute, ejecting himself from the cabin. If the braking device malfunctions, the ship can land using natural atmospheric deceleration. Although the orbital flight, according to the program, called for only one revolution, the flight could have lasted longer. The ship contained a ten-day supply of all necessary items.

The astronaut's safety during space flight is of particular importance. Turning to more conventional methods of transportation, let us recall that many lives were lost in the development of water transportation throughout history. Many lives were also lost during the first stages of air navigation and aviation. These people perished because not enough study was made of the various factors involved. The direct mastery of the cosmos involves many difficulties heretofore unencountered. Ships and planes are more conventional technical means, and were easier to develop and operate than are rocket devices. Therefore it would be naive to consider that no lives will be lost in the mastery of the cosmos. However, our task is to reduce these losses to a minimum, taking all measures necessary to insure this.

The Vostok had systems which the astronaut could operate under practically any emergency which might have arisen, from the very start to the landing on earth.

It is worth mentioning that the astronaut cabins from all four successful flights could be re-used, after slight repairs were made in the outer covering. Evidently, in the near future, we can expect that not only astronauts, but also the cabins of spaceships, will be repeatedly launched into space.

The least-known factor had to do with weightlessness. In laboratory tests, only very short periods, of the order of seconds, of weightlessness can be simulated. It was unknown how man would react to prolonged periods of weightlessness, of the order of minutes or hours, and how he would withstand the g-forces upon descent. This was why the first manned space flight was only one revolution, during which Gagarin was weightless for 67 minutes.

Gagarin's flight produced valuable information. In particular, he withstood this weightlessness very well, and was able to perform all functions satisfactorily. This will help pave the way for future, longer, manned space flights.

Possibly, not everyone would be able to withstand this weightlessness. Possibly, something akin to sea-sickness would result; only future flights can answer these questions.

The next problem, after the one of weightlessness has been dispensed with, has to do with shielding from ionizing cosmic radiation. At 327 km (apogee) the atmospheric density is only a fraction of that at sea level. The protective properties of the atmosphere at this altitude and higher cannot protect man from increased cosmic radiation. During solar storms the intensity of irradiation in interplanetary space can be thousands of times greater than normal cosmic radiation. Such intense radiation is a danger for astronauts and protective measures must be taken.

The danger of meteor collisions and the influence of weightlessness were initially clearly overestimated; however, until recently the dangers of over-exposure were not even imagined. This serious problem can be solved only by organizing a more active sun service, constant round-the-clock check of solar activity, develop-

ing an effective method of forecasting solar activity, and producing a practical shield for astronauts aboard spaceships. This shield may weigh tons, and therefore a long-flying spaceship must be heavy if it cannot, at the first signal, take refuge in the earth's atmosphere.

It has been shown repeatedly that the effective penetration of man into the cosmos requires powerful rockets capable of imparting cosmic velocities to heavy ships carrying the necessary equipment and some payload.

In the three-and-one-half years since the first sputnik was launched, the Soviet Union has orbited 11 sputniks with a total payload of 42.7 tons, not counting the weight of the last stages of the carrier rockets. This includes the weight of the heavy sputnik used to initiate the Earth-Venus flight. In addition, four automatic interplanetary stations with a total weight of 1830 kg attained escape velocity. The maximum weight of the earth satellite at the beginning of 1961 was 6.5 tons. Because the payloads are increasing, within the next decade the tonnage of spaceships will have increased tens of times. The launch weight of future spaceships will be commensurate with that of present-day ocean liners.

The next stages will be more prolonged and higher orbital flights and then manned orbital stations for various observations - meteorological, geophysical, astronomical, radioastronomical, telecommunication, navigational, observations of meteors, solar activity, and other scientific stations having great significance to the national economy.

The orbital altitudes of these stations will, at first, be only several hundreds of kilometers, in order to make use of the protec-

protective action of the earth's atmosphere, and in order not to enter the earth's radiation belts. These stations will be used to send cosmic rockets to the moon and other planets of our solar system.

TABLE

Number of Soviet space-ship	Launch date	Weight (kg)*	Orbital elements: Altitude (km) Perigee	Apogee	Rotation period (minutes)	Landing Date	Flight time	Number of revolutions	Data investigations
First Soviet space-ship	May 15, 1960	4540	312	369	91.2	Not destroyed on land	3 days, until [illegible] command given	64 until deanent command given	(see 1 page 13
Second Soviet space-ship	August 19, 1960	4600	306	339	90.72	August 20, [illegible]	1 day	17	(see 2 page 13)
Third Soviet space-ship	Decem-ber 1, 1960	4563	160	249	88.47	Decem-ber 2, 1960	1 day	17	(see 3 page 13)
Fourth Soviet space-ship	March 9, 1961	4700	183	249	88.5	March 9, 1961	1 hour 46 min-utes	1	(see 4 page 13)
Fifth Soviet space-ship	March 25, 1961	4695	178	247	88.42	March 25, 1961	1 hour 45 min-utes	1	(see 5 page 13)
Space-ship "Vos-tok"	April 12, 1961	4725	181	327	89,34	April 12, 1961	1 hour 48 min-utes	1	(see 6 page 13)

* Not counting the weight of the last stage of the carrier rocket.
** Angle of inclination of the sputnik orbits to the equatorial plane - 65°.

TABLE (continued)

1.	Ship placed in orbit; assurance of normal functioning of conditioning in astronaut's cabin; radio communication with the ground; checking of command radio lines, orbital radio control elements, transmission of telemetric information from the ship; check on the functioning of the self-orienting solar batteries, astronaut cabin stabilization system, orientation system, braking system; descent from orbit. All systems operated normally, but due to a malfunction of the orientation system data units the ship ascended instead of descending (perigee – 306.5 km, apogee - 690 km, rotation period - 94.25 minutes).
2.	Check of all systems for life support of a man in the cabin, his safe flight, and return to earth. Cabin contained numerous test animals (2 dogs, 28 mice, 2 rats, several hundred insects), plants and other biological specimens, an apparatus for studying cosmic space, and also telemetric and television systems, a radio system for trajectory measurements, and a radio communication device. All systems operated normally. The ship landed at the precise landing site. The animals, all the biological specimens, and the scientific apparatus were recovered intact.
3.	Repeat of the program of the second spaceship. All systems operated normally, except for one - this resulted in an incorrect descent trajectory and the ship burned up on entering the dense layers of the atmosphere.
4.	Further development of the design of the ship and its system, to insure the necessary conditions for manned flight. The cabin contained animals (a dog, mice, guinea pigs, frogs, insects), seeds, and other biological specimens. All systems operated normally. After the research program had been fulfilled the ship with the animals and dummy astronaut landed, on command, at the pre-selected site.
5.	Repeat of the studies of the fourth ship. All systems operated normally and the cabin with the animals and dummy astronaut landed successfully, on command, at the pre-selected site.
6.	First manned orbital space flight; check of the influence of all factors of flight in the near cosmos and return to earth of the human organism. All systems operated perfectly, astronaut Gagarin withstood the flight exceptionally well, fulfilled all the tasks required by the program, and successfully landed at the pre-selected site.