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The Start of the Manned Space Race

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Introduction

At the same time NACA and the USAF were studying manned spaceflight (see **The Beginnings of America's Man in Space Program** in the October 1998 issue of *SpaceViews*), comparable efforts were quietly taking place independently in the Soviet Union . As with virtually every other aspect of the Soviet Union's early space program, Chief Designer Sergei P. Korolev and his OKB-1 (Experimental Design Bureau No. 1) lead the way. All during the 1950s when Korolev and his colleague, Mikhail K. Tikhonravov of NII-4 (Scientific Research Institute No. 4), were pushing their original Earth satellite proposal, it also included plans to send probes to the Moon and men into orbit. When the satellite proposal was finally adopted by the Soviet government on January 30, 1956, the lunar probe and manned satellite projects were also given the green light.

Initially the bulk of the resources at OKB-1 were poured into building Object D (which would eventually become Sputnik 3) as well as continuing development of the R-7 as both an ICBM and the basis of a launch vehicle. Work on more advanced space missions did not begin until after November of 1956 when Tikhonravov and his group were officially transferred from NII-4 to Korolev's OKB-1 to become Project Department No. 9. On March 8, 1957 the group was reorganized to focus exclusively on the planning and development of spacecraft. Within a month the group released their first preliminary plan for lunar and manned spaceflights.

As these efforts began, Korolev envisioned the need for short suborbital manned flights comparable to the existing program to launch dogs on high altitude ballistic flights using "geophysical" rockets. At this time manned missions into orbit were not anticipated until the 1964 to 1967 time frame. But the launches of Sputnik 1 and 2 in October and November of 1957 changed everything.

The first Sputnik launches were to affect the manned space program in several ways. The impact the launch of Sputnik 1 had on the West led Soviet Primer Nikita Khrushchev to exploit space missions for their propaganda value. Development of more advanced and spectacular missions like the manned satellite program were immediately approved and placed on the fast track. Also at the insistence of Khrushchev, Sputnik 2 was launched with a dog on board. While thermal control problems marred the mission, it did demonstrate that weightlessness would not be a major hazard for a human (see **Sputnik 2: The First Animal in Space** in the November 1997 issue of *SpaceViews*). As a result, Korolev scrapped his initial, more conservative approach and moved ahead with a much more aggressive plan. In December of 1957 Korolev established three new design groups under Tikhonravov: The first group would design automatic lunar probes, another group communication satellites, and the last would work on piloted spacecraft using the designs of the successors of Object D as a starting point.

Moving Towards a Manned Satellite

As work was moving forward during 1956 and 1957 on Object D, a group at Department No. 9 under Eugeniy F. Ryazanov was already performing preliminary studies on a series of successors designated Object OD (with "OD" standing for "Oriented D"). Unlike Object D whose orientation was not controlled, Object OD would be equipped with an attitude control system to point its payload of photo-reconnaissance cameras. Object OD-1 would use a lightweight, passive attitude control system and be equipped with a cone-shaped reentry module to return its payload of exposed film. Unfortunately early studies quickly showed that the mass of Object OD-1 would exceed the 1,400 kilogram (3,100

pound) payload capability of the R-7-based 8A91 being developed to launch Object D. A more powerful rocket would be needed.

Based on experience with the 8K71 ICBM as well as the 8K71PS and 8A91 satellite launch vehicle versions of the R-7, development of an improved ICBM called the R-7A (also known by the designation 8K74) was begun. Many of the R-7A upgrades could be incorporated into a new family of satellite launch vehicles to increase their reliability and payload performance. One of the designs to result from these studies was the 8A92. Like the 8A91, the 8A92 was initially envisioned as a two-stage launch vehicle consisting of four strapon boosters surrounding a sustainer core. Its increased performance promised to orbit a payload of as much as 1,700 kilograms (3,700 pounds). But even this enhanced lift capability would prove to be insufficient. By the end of 1957, the Object OD-1 design was still 400 kilograms (880 pounds) overweight.

With continuing development problems and the change in goals in December of 1957, work on Object OD-1 was ended. Resources were instead shifted to the development of the larger and more advanced Object OD-2. In its reconnaissance configuration, this spacecraft retained the basic cone-shaped reentry module of Object OD-1 but it was now mated to a large cylindrical service module containing an active attitude control and other support systems not required for the return to Earth.

The 4,900 kilogram (10,800 pound) mass of Object OD-2 required the development of a larger launch vehicle called the 8A93. The 8A93 would be a three-stage rocket using a stripped down R-7A for the first two stages and a third stage based on the Blok E being developed for the 8K73 Moon rocket (see **The Soviets Reach for the Moon** in the May 1998 issue of *SpaceViews*). With a third stage built around the powerful RD-109 engine being developed by OKB-456 under Valentin P. Glushko, this much more powerful rocket promised to deliver a payload as great as 5,300 kilogram (11,700 pounds) into orbit.

A Manned Spacecraft Design

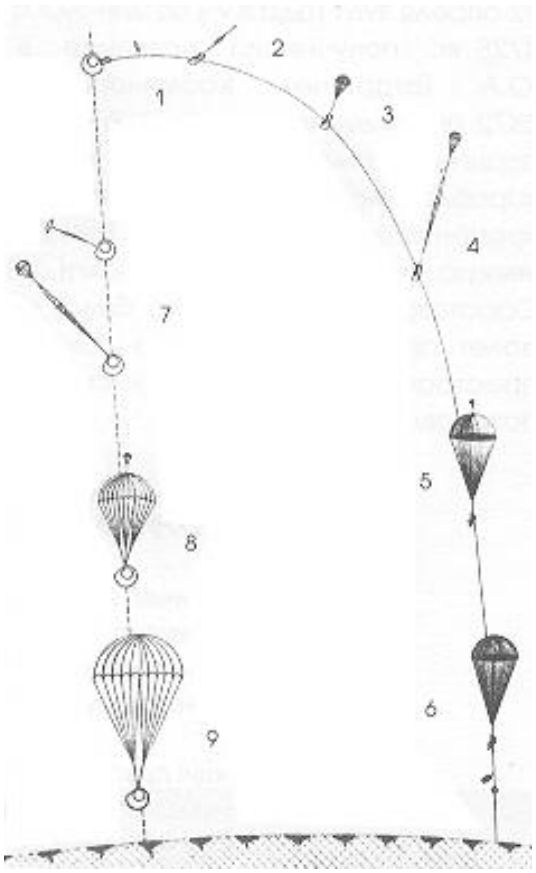
A team of engineers from Project Department No. 9 under Konstantin P. Feoktistov were assigned the task of designing a manned version of Object OD-2. While this team retained the original concept of employing separate service and reentry modules to minimize the total spacecraft mass, they ultimately designed a spacecraft totally different from the original OD-2 concept. As would be the case with its sister the 8K73, this team anticipated that the development of the Blok E stage of the 8A93 would drag on far longer than anticipated. Instead they opted to use the 8K72K. Based on the 8K72 launch vehicle then under development to launch the E-1 lunar probes, the 8K72K would incorporate a number of modifications to improve its performance and reliability. This included an improved Blok E third stage that replaced the RO-5 engine used in the 8K72 with an upgraded RO-7 being developed by OKB-154 under Semyin A. Kosberg. For later flights, the original two-stage 8A92 concept would be upgraded to include an improved Blok E stage. The orbital payload of the 8K72K and 8A92 would be no more than 4,700 kilograms (10,300 pounds) but it was felt that these rockets would be available at a sooner date than the more powerful 8A93.

The 8K72K launch vehicle designed to launch the Soviet's first manned spacecraft. (Energia RSC)

Presented with more stringent payload limits, Feoktistov's team had to make every effort to minimize the mass of the manned OD-2. While a variety of shapes for the reentry module were considered, the original conical shape was ultimately abandoned in favor of a 2.3 meter (7.5 foot) in diameter sphere. Such a simple shape had many advantages. First the aerodynamics of a sphere were well understood and it promised to be stable. This shape also maximized the interior volume for the passenger and critical recovery systems while at the same time minimizing the mass of the required heat shielding. By offsetting its center of mass from its center of figure, the reentry module would automatically keep itself oriented during its return to Earth without the weight penalty of an active attitude control system. This approach did result in a more punishing ballistic reentry but peak braking loads would still be limited to a tolerable 10 Gs. This design also promised to keep the landing target errors to an acceptable 200 to 300 kilometers (125 to 190 miles). While a lightweight, unpressurized service module was studied, ultimately Korolev's wish to use a pressurized one was adopted despite the weight penalty. This helped to simplify thermal control problems, offered a more benign environment for the onboard systems, and would speed development.

The group in Department No. 9 at OKB-1 responsible for the design of the first Soviet manned spacecraft. Their leader, Konstantin Feoktistov, is the third person from the right seated in the front. (Energia RSC)

The final hurdle to a successful manned mission was the landing. American efforts centered on a parachute-assisted water landing that would take advantage of their large naval surface fleet. Soviet designers opted for a touchdown on land to take advantage of the Soviet Union's vast territory. A variety of systems including a helicopter-like rotor favored by Korolev were considered for the final braking but ultimately it was decided to use a simple a parachute. Unfortunately a parachute large enough to guarantee a survivable landing for the passenger-laden reentry module would be prohibitively heavy. In April of 1958 Feoktistov's design team came up with an ingenious solution which they called "the forced landing procedure". The cosmonaut would ride inside the reentry module until after the worse of the reentry was completed. At an altitude of 7 kilometers (23,000 feet) the cosmonaut would use an ejection seat to blast clear and make a final descent using his own parachute. The descending reentry module would then be free to make a rough landing at a final speed of 10 meters per second (22 miles per hour) using a small parachute. This ejection seat could also double as a launch escape system to pull the cosmonaut clear of his craft in case of a catastrophic failure during ascent.



A diagram showing the "forced landing procedure" developed by Feoktistov's team to minimize landing weight. (Energia RSC)

While the manned Object OD-2 concept was much different than the original Object OD-2 design, Feoktistov's team broadened its appeal further by designing a reconnaissance variant. In this second version, all the systems needed to support a passenger were removed and a photo-reconnaissance package

installed. This approach only made sense since both manned and reconnaissance orbital missions involved the return of a payload from orbit. This new Object OD-2 proposal was presented to Korolev in June of 1958. He approved the manned design and the cone-shaped reconnaissance configuration of the OD-2 was eventually dropped in favor of Feokstitov's unified spacecraft design concept. But while Korolev was convinced that this was the best way to proceed, he still had powerful critics that needed to be swayed.

Seeking Approval

At this time there was much debate among the various Chief Designers and officials in the Soviet government on which path their space program should take. Echoing concerns that are still voiced today, one group insisted that manned spaceflight was too expensive and would yield few if any tangible benefits. They felt that the country's limited resources were better spent on the development of unmanned spacecraft to perform various useful tasks. While a valid argument could be made on this point, Khrushchev clearly preferred a manned flight for its potential propaganda value. In addition, because of the amount of hardware shared between the manned and unmanned reconnaissance versions of Object OD-2 that Feoktistov group had designed, development efforts for a manned spacecraft could have direct applications towards a highly useful photo-reconnaissance satellite.

Others thought that suborbital flights should be a prerequisite for a full blown manned orbital flight. But by May of 1958 even Korolev had become convinced that manned suborbital flights, even suborbital test flights, were superfluous. This was in part due to the relative success of Sputnik 2 and a continuing series of canine suborbital test flights. Korolev also argued that the development of hardware needed for a manned suborbital flight would not add as much to the art as an orbital mission would. This despite the small additional effort required to achieve the latter. In the end Korolev had decided that a manned suborbital flight would be a meaningless stunt. He felt that moving directly to the development of a manned satellite would be of much greater value given the growing competition with the United States and the resources he had available.

In the end Korolev won the argument and the Council of Chief Designers approved his plan for a manned orbital spaceflight in November of 1958. Work to design and manufacture this new spacecraft began in earnest in early 1959 as the Soviet government issued a series of secret decrees on the matter. By the summer of that year the spacecraft officially received the name the world would know it by: Vostok.

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