A History of Human Space Exploration

FOOTHOLD IN THE HEAVENS

The Seventies

Ben Evans

Springer

PRAXIS

Foothold in the Heavens

The Seventies

Ben Evans

Foothold in the Heavens

The Seventies

Springer

Published in association with
Praxis Publishing
Chichester, UK

PRAXIS

Ben Evans
Space Writer
Atherstone
Warwickshire
UK

SPRINGER–PRAXIS BOOKS IN SPACE EXPLORATION
SUBJECT *ADVISORY EDITOR*: John Mason, M.B.E., B.Sc., M.Sc., Ph.D.

ISBN 978-1-4419-6341-3 e-ISBN 978-1-4419-6342-0
DOI 10.1007/978-1-4419-6342-0

Springer Dordrecht Heidelberg London New York

Library of Congress Control Number: 2010925487

Cover design: Jim Wilkie
Copy editor: David M. Harland
Typesetting: BookEns, Royston, Herts., UK

Printed on acid-free paper

Springer is a part of Springer Science + Business Media (www.springer.com)

Contents

Illustrations

Author's preface

When I set out to write a five-volume history of humanity's exploration of space, it seemed a big project, though fairly straightforward. Starting with Yuri Gagarin's pioneering voyage in April 1961, the journey through five dramatic decades promised to be an exciting one, with specific breakpoints between the volumes: the resumption of manned lunar landings in the Seventies, the arrival of the Shuttle in the Eighties, the development of the International Space Station in the Nineties and the increasing 'privatisation' of getting people into orbit and the first fee-paying 'tourists' in the Noughties. My intention was for something a little more detailed than a basic log of manned expeditions into space, but as time has rolled on, the project evolved into a far larger and more complex task than envisaged.

I must, therefore, ask the reader to forgive me for failing to strictly track an *entire* decade with each volume. The first volume, *Escaping the Bonds of Earth*, had to take into account some of the advancements of the Fifties as a prerequisite to focusing on 'its' decade, the Sixties. In this second volume, *Foothold in the Heavens*, I had to focus on particular episodes in considerable depth – the historic flight of Apollo 11 being a notable example – at the expense of covering an entire decade. Furthermore, I realised that spaceflight was not, and *is* not, a unique phenomenon, outside of public or political control. Rather, it has been an integral part of our social, economic and cultural fabric, and the lightning speed or snail's-pace slowness of its progress through the decades has been increasingly dictated by outside influences: the Bay of Pigs, the mythical 'missile gap' between the United States and the Soviet Union and the Cuban Crisis of 1962 were all instrumental in determining space policy. In the early Seventies, the progressive thawing of relations between the United States and the Soviet Union similarly impacted their respective space programmes. I feel it would be unconscionable to discuss our progress in space without paying tribute to *why* we were doing so, the obstacles we had to overcome in order to get there and the opinions, attitudes and feelings of the people whose dollars and roubles were paying for such endeavours.

By the last year of the Sixties, almost three dozen astronauts and cosmonauts had journeyed into space. They had circled the globe in their pressurised ships, they had ventured outside in bulky, life-sustaining suits and they had embarked on the first mission to the Moon. Culturally, socially and technologically, the world around them had changed in a thousand ways. Against the backdrop of a deepening crisis in Vietnam, floodlit by the problems of the United States at war with itself over issues of racial and social inequality and with an increasingly disaffected youth struggling to make its voice heard, the American programme lost much of the popular appeal that it had once enjoyed. In the Soviet Union, the increasing regression and repression of Leonid Brezhnev's regime led to widespread condemnation and mass emigrations from a country that considered itself the embodiment of the beauties of the communist state. Yet, ironically, it was actually the steady thaw of relations between these bitter foes which spelled the end of limitless budgets for human space exploration.

By the early Seventies, men had walked on the Moon and had occupied space stations in orbit around Earth and both the Soviets and the Americans *could* still take pride in their achievements. Astronauts, managers, scientists and even some politicians could see no reason why a manned expedition to Mars and a permanently-occupied lunar base should *not* be achieved before the end of the century. It might not be on the scale of Arthur C. Clarke's imaginings, but it was certainly more than a mere dream. However, for an increasingly apathetic public, the cost was excessive. The race to reach the lunar surface in the Sixties would be superseded by a considerably more frugal attack on the heavens in the Seventies. As Apollo wound down, America's efforts switched to developing a cheaper means of accessing space: the Space Shuttle, which would bring both tragedy and triumph and effectively confine the nation to low-Earth orbit for the next several decades. Similarly, the Soviet leadership lost interest: its practice of signing blank cheques for Chief Designers to score major propaganda victories against the capitalist West declined markedly. Its ambitious effort to put men on the Moon fell apart and it, too, adopted a more conservative, gradual system of mastering the new frontier of space.

My intention in writing this second volume has been to briefly explore some of the reasons why the political, social, cultural and economic climate changed so significantly for both superpowers in the final years of the Sixties and those first few pivotal years of the Seventies and how this impacted our aspirations in space. For as Westerners grew their hair and sideburns steadily longer, so the budgets for space exploration steadily shortened and steadily thinned.

Four decades later, we continue to live with the consequences of those frugal times, for our species remains chained in low-Earth orbit. Today, we are further away from having our representatives return to the Moon than John Kennedy was when he made his famous speech in May 1961. The establishment of Earth-circling space stations, although ever larger, more advanced, more sophisticated and more 'international', has done little to escape what Konstantin Tsiolkovski once called the cradle of humanity. In a sense, therefore, the early portion of the Seventies was juxtaposed by two ironic, opposing themes, for as the last Apollo crew left the Moon our species reached the zenith of its accomplishments – and abruptly *stopped.* Four decades later, though we have had, and continue to have, a secure foothold in the heavens, we are still waiting for the next team of intrepid explorers to carry us deeper into the Universe around us.

Ben Evans,
Atherstone, February 2010

Acknowledgements

This book would not have been possible without the support of a number of individuals to whom I am enormously indebted. I must firstly thank my wife, Michelle, for her constant love, support and encouragement throughout the time it has taken to plan, research and write this manuscript. As always, she has been uncomplaining during the weekends and holidays when I sat up late typing on the laptop or poring through piles of books, old newspaper cuttings, magazines, interview transcripts, press kits or websites. It is to her, with all my love, that I would like to dedicate this book. My thanks also go to Clive Horwood of Praxis for his enthusiastic support and to David Harland for reviewing the manuscript; I appreciate not only their advice, but also their patience in what has been an overdue project which proved more difficult to write than I had envisaged. I must once again thank Ed Hengeveld for supplying many of the illustrations. Others to whom I owe a debt of gratitude include Sandie Dearn, Ken, Alex and Jonathan Jackson and Malcolm and Helen Chawner. To those friends who have encouraged my fascination with all things 'space' over the years, many thanks: to Andy Salmon and Andy Rowlands, Dave Evetts and Mike Bryce and Rob and Jill Wood. Our two golden retrievers – the ever-hungry Rosie and the the attention-seeking Milly – have provided a ready source of light relief. Lastly, there are two others that I would like to mention as having played a great role in my life in the last year. Firstly, my friend Roy Lane, who tragically lost his battle with cancer in March 2009, and secondly, our beautiful nephew, Callum Jay Hooper, born on St George's Day, 23 April 2009, whose never-ending smile and chuckling laugh are a joy to behold.

1

New directions

A DIFFERENT PATH

As the Sixties entered their final year, humanity stood on the brink of an event which, in Richard Nixon's words, would come to be known as "the greatest since the Creation". By the end of 1969, not one, but four Americans would have trodden the Moon's dusty surface, fulfilling a bold promise made by President John Kennedy eight years earlier. The Soviet Union, whose own tally of celestial successes included the world's first artificial satellite, the first man in space and the first spacewalk, was forced to watch dumbstruck from the sidelines. To be fair, the writing had been on the wall for some time: that all hopes of beating the United States to the Moon and planting a flag bearing the Hammer and Sickle into the lunar soil had been irretrievably lost.

Still, the Soviet dream of reaching our nearest celestial neighbour would not evaporate for some years: in the early Seventies they would land a pair of automated rovers, the Lunokhods, on the Sea of Rains and in Le Monnier Crater, and would test, albeit unsuccessfully, their own enormous N-1 Moon rocket. As impressive as these feats were, in the public eye they represented little more than a diversion from what had actually been a breathtaking triumph for the United States and its ideals of liberal democracy and freedom of speech. The Lunokhods gathered a wealth of valuable scientific data, it is true, but the sight of astronauts – *real* human beings – bouncing around in one-sixth of terrestrial gravity garnered far more popular appeal. At least, that is, in the early days. Moreover, the N-1 itself, despite being more powerful than America's Saturn V, would fail repeatedly even to attain Earth orbit. The last of its kind vanished in a fireball shortly after launch one morning in November 1972.

It seemed obvious that, after denying for some years that they even *had* plans to put a man on the Moon, the Soviets needed to fundamentally shift the paradigm of their spacegoing philosophy in a quite different direction. By the spring of 1969, they finally had the means to do so. It came in the form of a three-part spacecraft known as 'Soyuz' ('Union') and, late the previous year, an ebullient cosmonaut named Georgi Beregovoi had nursed it through a four-day shakedown cruise. He had tested its ability to manoeuvre in space and rendezvous with an unmanned Soyuz, but failed to dock the pair together.

In time, Soyuz would become the most-used manned spacecraft in history. As of 2009, variants of its original design have ferried over a hundred crews of different nationalities into orbit and supported more than half a dozen space stations. The goal of establishing a long-term human presence in Earth orbit would supersede and effectively replace the Soviets' failed lunar dream. On 14 January 1969, the first steps of this 'new' dream would be taken, when two Soyuz rendezvoused and docked and a pair of cosmonauts spacewalked from one craft to the other. On the face of it, the exercise, though risky, was highly successful, but not for almost three decades would the outside world learn of its close brush with disaster.

Disaster and tragedy had become virtual bywords for Soyuz since its conception, particularly in the wake of its first manned flight. In April 1967, cosmonaut Vladimir Komarov was launched aboard Soyuz 1, in the expectation that he would rendezvous and dock with Soyuz 2, crewed by Valeri Bykovsky, Alexei Yeliseyev and Yevgeni Khrunov. During the joint flight, Yeliseyev and Khrunov would don pressurised suits and clamber from Soyuz 2 over to Soyuz 1. They would then return to Earth with Komarov, leaving Bykovsky to land alone in Soyuz 2.

Unfortunately, only hours after Soyuz 1 and Komarov reached orbit, the first problems reared their heads. A solar array failed to unfurl, knocking out more than half of the spacecraft's electrical supply; then glitches with orientation and other sensors rendered the planned mission impossible. Soyuz 2 was cancelled and the focus shifted to bringing Komarov home safely, but this failed when the parachute lines became entangled during descent. The spacecraft hit the ground with all the force of an unrestrained meteorite, killing its occupant instantly. Not until October 1968 and the flight of Beregovoi would the much-improved Soyuz finally show what it could do.

A rendezvous between Beregovoi's Soyuz 3 and the unmanned Soyuz 2 went well, but was dramatically upstaged by the American flight of Apollo 8 in December, during which astronauts Frank Borman, Jim Lovell and Bill Anders became the first men to orbit the Moon. Less than three weeks later, the next stage of the Soviet plan to establish an Earth-circling space station was ready: the ambitious docking and spacewalking extravaganza, thwarted in 1967, would finally become reality. It would not have the same impact as a lunar mission, admittedly, but during the joint flight cosmonauts Yeliseyev and Khrunov would seize a couple of impressive 'firsts'. They would become the world's first two-man spacewalking team and complete the first-ever transfer of crew members from one craft to another, landing in a different vehicle from the one in which they were launched. Ironically, for one of the other cosmonauts, the mission would also entail a hazardous re-entry and he would come within a whisker of losing his own life.

UNION IN SPACE

Soyuz was the brainchild of Sergei Korolev, the famous 'Chief Designer' of early Soviet spacecraft and rockets, with the original intention of undertaking both Earth-orbiting missions and an ambitious series of lunar ventures to rival the United States' Apollo effort. As early as 1964, the design and definition of Soyuz was well underway and technical documentation and a 'boilerplate' mockup revealed it to be a craft capable of lofting two, and later three, cosmonauts. In his seminal work *Challenge to Apollo*, Asif Siddiqi noted that when Korolev saw the mockup for the first time, he is said to have declared proudly that Soyuz was "the machine of the future".

With the exception of his vague moniker, not until long after his death on a hospital operating table would the outside world learn anything of substance concerning Sergei Pavlovich Korolev. Yet this man of outstanding engineering genius had masterminded some of the most remarkable triumphs in the exploration of space. It was he who designed the R-7 missile which launched first Sputnik and then Yuri Gagarin, it was his design bureau which assembled Vostok – the world's first piloted spacecraft – and it was he who oversaw and orchestrated the first three-man orbital mission, the first spacewalk and his nation's first faltering steps towards the Moon. His brilliance and unwavering devotion to a lifelong dream of exploring the heavens was balanced by an all-or-nothing obstinacy which often manifested itself in a violent temper, capable of exploding without warning. He had lived a hard, driven and thankless life of service to the Soviet state and it was this, ultimately, which consumed him.

Born in 1907 in the central Ukraine, his interest in aviation and rocketry emerged at a young age. Under Joseph Stalin's regime, with its ingrained fear of the power of the individual, there had been little opportunity for the *intelligentsia* to prosper and, as a highly regarded engineer, Korolev quickly found himself arrested and sentenced to ten years of hard labour in the notorious Kolyma gulag. The Nazi invasion of the Soviet Union in 1941 prompted his release in support of the war effort. Later, he set to work developing an arsenal of rockets and missiles, which he hoped could someday transport instruments into the high atmosphere and, finally, into space. His masterpiece, the R-7, though principally intended for the Soviet military as an intercontinental ballistic missile, would be used to put satellites and humans into orbit. By giving it a dual-purpose use, he displayed a trait of his canny character, keeping his military critics quiet by satisfying their needs in parallel with his own.

In the early Sixties, the regime of Stalin's successor, Nikita Khrushchev, was generally supportive of Korolev and his projects, which yielded a regular delivery of space 'firsts' that the feisty and erratic Soviet premier could use to enforce an ideological advantage over the United States. The boorish Khrushchev was far more interested in the glamour, political and military impact of spacegoing rocketry and, to an extent, that was fine with Korolev because it provided him with ready supplies of manpower and funding to pursue his space ambitions. It remains a pity, though, that he never truly received the recognition that he deserved in life. After Gagarin's triumphant orbit of the Earth in April 1961, the Chief Designer had been barred from publicly wearing his medals and even had to thumb a lift into Moscow when his car broke down. Efforts by the Nobel Prize Committee to establish an award for this unknown man fell on deaf ears.

It is bitterly ironic, therefore, that his untimely death during a routine stomach operation in January 1966 should have finally opened a chink in the Soviet armour and uncovered something of the mysterious Chief Designer as a real person for the first time. Within the cosmonaut corps, his death was immediately recognised for the calamity that it was: Yuri Gagarin, in a solemn eulogy, described Korolev as being "synonymous with one entire chapter in the history of mankind" and Khrushchev's successor, First Secretary Leonid Brezhnev, was one of the pallbearers who carried the ashes for interment in the Kremlin Wall.

Many cosmonauts felt that the men who followed Korolev – his deputy, Vasili Mishin, together with Georgi Babakin, Vladimir Chelomei and the famous rocket engine designer Valentin Glushko – exhibited entirely different personalities which damaged the Soviet Union's chances of beating the Americans to the lunar surface. Had Korolev lived just a few years longer, wrote cosmonaut Alexei Leonov, "we would have been the first to circumnavigate the Moon".

Korolev had always described Voskhod 2 – the March 1965 mission during which Leonov became the first man to walk in space – as his life's last great work. However, remarkable as that achievement was, it was perhaps the development of Soyuz which has had the most long-lasting impact on the world. Since its first manned flight, a year after Korolev's death, Soyuz and a heavily modified version of the original R-7 continue to be used operationally today; a fitting legacy to an enduring talent.

In his 1988 book, Phillip Clark traced its history back to a three-part 'Soyuz complex' – a manned craft, a 'dry' rocket block and a propellant-carrying tanker – which Korolev had envisaged in the early Sixties being assembled in low-Earth orbit to fly circumlunar missions. The first part, which Clark identified as 'Soyuz-A', but which the Soviets catalogued as 'Soyuz-7K', was closest in physical appearance to the spacecraft which actually flew and it was to this that Korolev committed himself and his Kaliningrad-based OKB-1 design bureau in March 1963. Measuring 7.7 m long, Soyuz-7K had three components: a cylindrical 'orbital module', a bell-shaped 'descent module' for the crew and a cylindrical 'instrument module' for manoeuvring equipment, propellant and electrical power. According to Korolev's earliest blueprints, it weighed around 6,450 kg, but, unlike the final design, was not equipped with solar panels.

Supporting Soyuz-7K were the 'dry' Soyuz-B rocket block and the Soyuz-V propellant tanker, known to the Soviets by the designations of '9K' and '11K', respectively. Clark hinted that a typical flight profile would have begun with the launch of a 9K, followed, at 24-hour intervals, by as many as four 11Ks, which would dock, transfer their propellant loads and then separate. When the 9K had been fully fuelled, a manned 7K would be despatched to dock with the rocket block. "Mastering rendezvous and docking operations in Earth orbit may have been one of the primary objectives of the Soyuz complex," wrote Asif Siddiqi, "but the incorporation of five consecutive dockings in Earth orbit to carry out a circumlunar mission was purely because of a lack of rocket-lifting power in the Soviet space programme." In fact, it was the sheer 'complexity' of the Soyuz complex which seems to have foreshadowed its restructuring sometime in 1964 and effected a delay of its maiden voyage until at least the spring of 1966.

By the end of the decade, seven manned Soyuz spacecraft would have rocketed into orbit. However, a key physical difference between these vehicles and the original 7K was that they employed a pair of rectangular solar panels, mounted on the instrument module, to generate electrical power. The total surface area of these wing-like appendages was 14 m^2, with each wing measuring 3.6 m long and 1.9 m wide. The rest of the craft's design was strikingly similar to the 7K: a spheroidal orbital module, 2.65 m long and 2.25 m wide, the bell-shaped descent module, itself 2.2 m long and 2.3 m wide at the base, and the instrument module, a cylinder 2.3 m long and 2.3 m wide.

This shape emerged at the end of almost a decade of planning, theoretical work and aerodynamic modelling. As early as 1958, Mikhail Tikhonravov and Konstantin Feoktistov, engineers at Korolev's bureau, envisaged a multi-purpose spacecraft capable of both Earth-circling and circumlunar missions. As has been written by Rex Hall and Dave Shayler, the shape of the descent module was decided at least partly by a desire to touch down on land, rather than in water, and several designs were sketched out. The first utilised aerodynamic surfaces, facilitating an aircraft-like return to a runway, whilst the second adopted a 'missile principle', entering space in a ballistic manner and descending beneath parachutes.

By 1961, concerns about mass and the need for adequate thermal protection during re-entry had effectively eliminated the winged design from consideration. The missile principle, though, needed further work in order to man-rate it: a ballistic re-entry would impose significant duress on both the vehicle and its occupants and Tikhonravov and Feoktistov moved instead toward the concept of a 'glancing' re-entry in order to reduce stress. If the new craft was ever to undertake lunar flights, its return trajectory from the Moon would produce correspondingly higher re-entry speeds of perhaps 40,000 km/h, prompting the engineers to design a 'double-dip' profile which, by reducing the velocity in stages, would lessen the G loads on the cosmonauts and thermal stress on the vehicle.

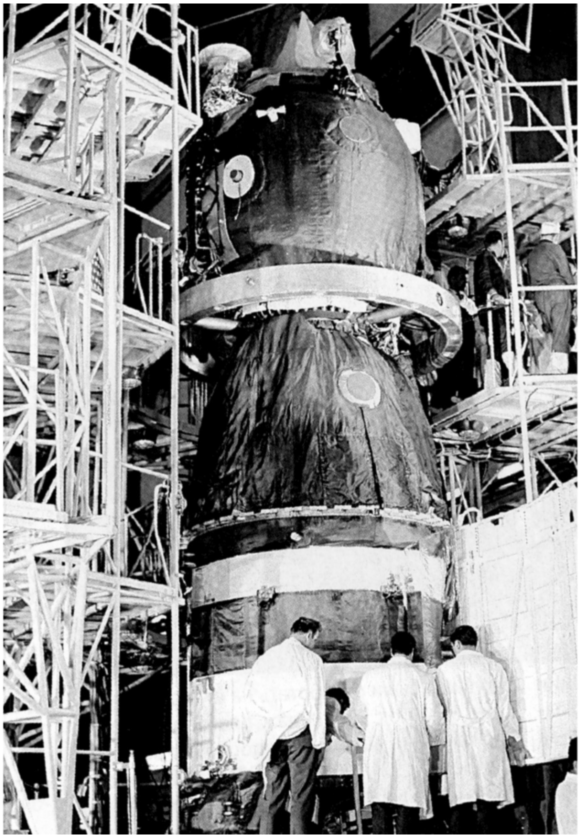
When consensus had been reached on the method of re-entry, a trio of designs were explored by OKB-1 engineers and researchers at the NII-1 and NII-88 aerodynamic institutes: one nicknamed the 'segmented sphere', another called the 'sphere with a needle' and a third dubbed the 'sliced sphere'. The segmented version emerged as the most promising design, with Vladimir Roshchin's group at OKB-1 promoting a descent module with a displaced centre of gravity as a means of generating aerodynamic lift. By 1962, this had evolved into a shape approximating a car's headlamp or a beehive, which aerodynamic simulations predicted would avoid the high deceleration and thermal loads of a ballistic descent and have sufficient lift to be able to steer towards a given landing site. A plethora of proposals also surrounded Soyuz' means of landing, with helicopter-like rotors, fan-jet or liquid-propelled engines, controlled parachutes, ejection seats and shock-absorbing inflatable balloons all being considered. By 1963, however, Korolev approved the design which remains in use today: a combination of braking parachutes and a soft-landing apparatus of solid-fuelled rockets.

Even with these important decisions made, the appearance and layout of the spacecraft remained somewhat fluid, with early designs for a space station ferry called 'Sever' and a lunargoing concept known as 'L-1' both adopting its concept of a descent module for the crew, attached to an instrument module for propulsion and power. Already, though, the design was expanding further to encompass a habitable orbital module and there was disagreement about where this should be located. In some initial drawings it appeared between the instrument module and the descent module and in others it was above the descent module. The idea of placing the orbital module *below* the descent module was soon rejected since it would necessitate cutting a hatch into the descent module's base, potentially compromising its heat shield. The final layout, with the descent module in the middle, was in place by the end of 1962. By this time, it had also received the name of 'Soyuz'.

In spite of Korolev's assertion that it was the machine of the future, Soyuz had been mired for some years in technical and bureaucratic problems, to such an extent that by 1964 its development was virtually paralysed by the Soviet drive for the Moon. Early plans called for it to carry one or two cosmonauts, but by December 1963 the basic design of the Earth-circling version, known as 'Soyuz-7K-OK' ('Orbitalny Korabl' or 'Orbital Ship'), had grown to accommodate a three-member crew. Its purpose would be to support automated rendezvous and docking, spacewalking, manoeuvring and scientific research, thereby fulfilling a number of key requirements for its eventual use as a space station ferry.

During 1964, Korolev directed a small group under Boris Chertok, one of the deputy chief designers at OKB-1, to explore alternative uses for the basic 7K-OK craft. One proposal called for docking two Soyuz together in orbit, thus demonstrating their rendezvous capabilities, and having a cosmonaut spacewalk from one ship to the other. Not only would this ambitious plan offer valuable engineering experience in its own right, but it would also support early ideas for a Soyuz-based Moon mission in which a cosmonaut would transfer from the command ship to the landing craft in lunar orbit by 'extravehicular activity' (EVA). In February 1965, Korolev presented this 'new' version of Soyuz, with an emphasis on near-Earth operations, to the Scientific-Technical Council of the State Committee for Defence Technology and received the approval he needed.

Beginning at its base, the instrument module, also known as the 'service module', carried chemical batteries and two large solar panels to charge them, together with a thermo-regulation radiator and an integrated propulsion and attitude-control system. The latter, designated 'KTDU-35', comprised a pair of engines, one primary and the other backup, sharing the same oxidiser and fuel supply. The primary engine had a thrust of 417 kg and was capable of a change in velocity of some 2,750 m/sec, equivalent to a specific impulse of around 280 seconds. On the basis of early reports which speculated that this engine could boost Soyuz to an altitude of 1,300 km, Phillip Clark suggested that the spacecraft must have a propellant capacity of 755 kg. The propellants took the form of unsymmetrical dimethyl hydrazine and an oxidiser of nitric acid, carried in spherical tanks inside the instrument module. Attitude



A Soyuz spacecraft is prepared for launch at Tyuratam. Note the spheroidal orbital module at the top and the beehive-shaped descent module beneath. Part of the cylindrical instrument module is also visible.

control was by a set of 22 primary and eight backup hydrogen peroxide thrusters. Guidance, rendezvous, communications and environmental equipment occupied the remainder of the cylindrical compartment.

The descent module, whose shape has variously been likened to a bell, a beehive or a car's headlamp, sat directly above the instrument module and housed the crew during ascent and re-entry. It had a habitable volume of some 2.5 m^3. The commander's seat was located in the centre, flanked by a flight engineer and a research or 'test' engineer. Many of the Soyuz' flight regimes would be pre-programmed from the ground. Consequently the main instrument panel presented the crew with readouts and visual displays of the performance of on-board systems, together with a monitor for the external television camera, an optical orientation viewfinder called 'Vzor' for attitude manoeuvres and the Globus device to show the spacecraft's position above Earth. In the event of a failure of the automatic systems, and to facilitate rendezvous and docking, it was expected that the commander could assume manual control. As a result, a pair of joystick-like hand controllers – one for changing the vehicle's velocity and the other for its attitude in space – were located directly beneath the instrument panel in front of the commander.

Rendezvous and docking were supported by the Vzor, together with a system of gyroscopes, attitude-control sensors and thrusters and the 'Igla' ('Needle') radar. The latter would automatically navigate the spacecraft to its target and draw to a halt at a range of 200–300 m, after which the crew would take charge and accomplish the final approach and docking. The systems needed to enable physical contact had undergone extensive development since 1962. At first, OKB-1 engineers Viktor Legostayev and Vladimir Syromiatnikov advocated a 'pin-cone' device to allow two vehicles (one in a 'passive' role, the other 'active') to dock. At this stage, however, there was no provision for the internal, 'shirt-sleeves' transfer of cosmonauts from one craft to the other and, sometime in 1965, Korolev's proposal to change this was rejected by Feoktistov on the basis that a significant amount of work had already been done and additional revisions would put the development further behind schedule. The docking system featured a pin on the active spacecraft, which would be captured by a cone-like funnel on the passive one, essentially cancelling any remaining velocity or angular displacement.

The descent module would be the only component capable of surviving the intense heat of atmospheric re-entry and bringing the cosmonauts back to Earth. Towards the end of a mission, the instrument and orbital modules would be jettisoned and the descent module would employ half a dozen hydrogen peroxide engines, each producing a thrust of 10 kg, to provide roll, pitch and yaw controllability prior to and during the early portions of re-entry. To protect its occupants, it was coated with a heat-resistant ablator, together with a thermal shield at its base that would detach shortly before touchdown to reveal the four solid-propellant landing rockets. A 14 m^2 drogue parachute would automatically deploy 9.5 km above the ground, followed by a main canopy. Seconds before hitting the ground, an altimeter would command the landing rockets to fire to cushion the impact.

Atop the descent module, the spheroidal orbital module contained a bunk, a cupboard for food and water supplies, life-support gear, controls for experiments, cameras and a variety of other equipment appropriate to each individual mission. It was, wrote Boris Mandrovsky in January 1970, "intended for rest, recreation and sleep, as well as for scientific research". For the first, and only, independent mission involving a spacewalk (Soyuz 4/5), the space suits would be stored in the orbital module. However, in view of the fact that its internal volume was barely 6.5 m^3, the difficulty of this task should not be underestimated. Indeed, in May 1968 cosmonaut Boris Volynov, clad in a training version of the suit, was brought face to face with these difficulties: it was hard – unsafe, even – to squeeze through the hatches between the descent and orbital modules and then get outside.

Difficulties aside, Soyuz promised to be one of the safest manned spacecraft ever built, possessing as it did the Soviets' first 'true' launch escape system. This consisted of a tower atop the R-7's payload shroud and a multiple-nozzle rocket engine. In the event of an emergency during the period from 20 minutes before launch until about 160 seconds into the ascent, the shroud would split at the base of the descent module and the escape tower's engine would lift the descent and orbital modules to safety. At the top of the arc, the descent module would be released to parachute back a couple of kilometres from the pad. Early predictions estimated that the crew could be exposed to gravitational loads as high as 10 G during such a scenario.

Launching Soyuz, which was considerably heavier and more complex than the earlier Vostok and Voskhod craft, demanded further improvement of Korolev's original R-7. The basic design of the missile remained physically the same: a two-stage behemoth, fed by liquid oxygen and a refined form of kerosene known as 'Rocket Propellant-1' (RP-1). Strapped around its lower stage were four tapering boosters, each 19.6 m long. The upper stage had an uprated engine which enhanced its thrust from 27,210 kg to 27,573 kg. This 'new' rocket, wrote Asif Siddiqi, was "an extremely rare case of a Soviet launch vehicle developed first for civilian goals". With the escape tower in place, the upgraded R-7 stood 49.3 m tall, produced 411,650 kg of thrust at liftoff – a 3 percent increase over the earlier Vostok version – and could insert a 6,900 kg payload into a 200 x 450 km orbit.

Like Vostok and Voskhod before it, the R-7 was rolled to the launch pad horizontally on a railcar. It is the method still used today. The spacecraft's propellants were loaded prior to its attachment to the rocket's upper stage, after which the shroud was installed and, following rollout, the entire stack was tilted upright. Four cradling arms, known as the 'tulip', supported the R-7 and a pair of towering gantries provided pre-launch access. Cosmonauts entered the Soyuz through a side hatch in the orbital module and dropped into their seats in the descent module. On 14 January 1969, Vladimir Alexandrovich Shatalov would become only the third cosmonaut to ride a Soyuz into orbit. Like his predecessors, he would launch alone. Unlike them, however, he would return to Earth with company.

MAN OF GRANITE

It was the dead of winter in Tyuratam – a time of bitter snow and hurricane-strength blizzards – when Shatalov, clad in fur boots, arrived at the launch pad on 13 January for his first flight into space. He would begin his momentous journey as all previous cosmonauts had done: from a bleak, featureless expanse of steppe, some 200 km east of the Aral Sea. In the local Kazakh tongue, the name of the place, 'Tyuratam', roughly translates as the gravesite of Tyura, beloved son of the great Mongol conqueror Genghis Khan, whose medieval empire spanned much of Asia. According to some sources, it began as an ancient cattle-rearing settlement on the north bank of the Syr Darya River, although at least one Soviet-era journalist has given it a more modern origin, hinting at its foundation as recently as 1901 as an outpost to replenish steam engines passing between Orenburg and Tashkent.

Tyuratam's importance over the past half a century, though, cannot be disputed. It was from this sparsely populated region, five decades ago, that the first steps of a journey far more audacious, much longer and considerably more difficult than any the Great Khan could have envisaged were taken. It was from this place that Yuri Gagarin, the first man in space, began his historic flight. It was from here that

Valentina Tereshkova became the first woman to travel into orbit and Alexei Leonov became the first person to 'walk' in space; and it is from here, indeed, that manned missions continue to be launched each year. It was to this remote corner of old Soviet Central Asia – a region swarming with scorpions, snakes and poisonous spiders, whose climate is characterised by vicious dust storms, soaring summertime highs of 50°C and plummeting wintertime lows of -25°C – that Lieutenant-Colonel Shatalov of the Soviet Air Force came to secure his unenviable place as Russia's 13th man in space.

Shatalov was born in Petropavlovsk in northern Kazakhstan on 8 December 1927. His father worked as a locomotive driver and the young boy grew up listening to the clang of carriages and the whistles of the brakemen. Yet it was not his father's stories of promotion from stoker to driver's assistant to driver and, finally, to office-based dispatcher that filled Shatalov with such pride. Rather, it was Alexander Shatalov's tales from the Great Patriotic War against the Nazis, when he drove trains to mend damaged communication lines and signalling equipment and helped lay the 'Road of Life' across frozen Lake Ladoga to link besieged Leningrad with the mainland. Even more exciting for the young Shatalov were his father's memories of seeing the very first Soviet pilots.

After secondary education, the boy studied and graduated from Kachinsk Military Pilot School and Monino Military Academy. He then worked as an instructor for some years and moved into the world of experimental test flight. One interesting anecdote from this time concerns Shatalov and his friend Valentin Mukhin, who approached the chief of the test pilot school to apply for admission ... and to recommend their comrade, Yevgeni Kukushev, too. The chief smiled and told them that Kukushev had come to see him a few days earlier with a similar request for all three of them! "I already have your names on my list," he concluded, and all three were eventually selected.

After several more years flying for a number of Soviet Air Force units and meeting and marrying his wife, Muza, Shatalov was chosen as a cosmonaut in January 1963. By this time, the requirements for these 'star sailors' had changed. When the first group, which included Yuri Gagarin, was selected in 1960, the focus was exclusively upon Soviet Air Force pilots who had proven themselves under exposure to hypoxia, high pressures and varying G loads and had undergone rigorous ejection-seat and parachute training. That requirement remained very much the same when Shatalov was picked, but with the exception that military engineers and navigators were also considered and university credentials were mandatory. Further, the age limit was lifted: instead of the 25–30 range in the first cosmonaut intake, the new class had to be 40 or younger. Aged 35 at the time of his selection, Shatalov made the cut. Consequently, unlike the cadre of relatively inexperienced fliers of the first group, Shatalov's class were far more accomplished pilots and also held advanced engineering degrees.

This second class of cosmonauts was interesting because Shatalov himself, then a senior instructor and pilot of the new Su-7 aircraft, had been approached by his commanding officer to select his five best fliers for consideration. When Shatalov saw the list of requirements, he realised that "the selection criteria apply to me".

Despite the commander's admonition that he was insane to apply – he had a comfortable position and rank, a bright future and probably would not make the final cut anyway – Shatalov persevered. (So too did one of his 'recommendees', a pilot named Anatoli Filipchenko.) At the time of selection, Shatalov had piloted 17 different types of aircraft, including helicopters, and had accrued 2,500 hours of flying time; ten times more than many of the 1960 cosmonauts.

Described by others as a man of impeccable reliability and a person capable of carrying heavy physical and moral burdens, the light-haired and powerfully built Shatalov would adopt as one of his radio callsigns the word 'Granit' ('Granite'), indicative of his steely and hard-as-nails disposition. That disposition, and the respect in which he was held, were recognised as early as June 1964, when he was recommended to lead one of the early Soyuz flights. Nikolai Kamanin, the Soviet Air Force general in command of the cosmonaut corps, considered but ultimately rejected Shatalov, preferring veterans to rookies on the first few missions. A few months later, following exams, Shatalov was rated as one of the most outstanding of his 15-strong group. By March 1965, Kamanin had named him as part of the team to fly Voskhod 3 and, following the cancellation of this mission, assigned him to Soyuz. When Georgi Beregovoi headed into orbit aboard Soyuz 3 in October 1968, Shatalov served as his backup.

A month before his own launch, on 17 December, he passed his final exams in support of the joint Soyuz 4/5 mission, once again scoring outstanding marks. The excitement of those final days, however, was tinged with disappointment. When Shatalov and the Soyuz 5 crew – cosmonauts Boris Volynov, Alexei Yeliseyev and Yevgeni Khrunov – arrived at Tyuratam on Christmas Eve, they received the grim news that Apollo 8 had just entered lunar orbit. Working until late that night, for Shatalov the pot boiled over when Kamanin told him that a 'recommendation' had been received, calling for Soyuz 4 and 5 to dock automatically, not manually. The four cosmonauts objected, arguing that, as pilots, they had the skills and training and ought to be permitted to execute a manual linkup. Finally, Shatalov exploded with fury. "Here we are debating this for the tenth time," he yelled, "while the Americans are orbiting the Moon!"

A DOCKING AND A TRANSFER

Despite the excitement of the impending mission, Apollo 8's success placed morale within the cosmonaut corps at a very low ebb. The question of whether to give cosmonauts active control of their machines had been hotly disputed since the early days of the Soviet space programme. Kamanin had frequently locked horns with Korolev over the issue and his memoirs, preserved in a series of quite remarkable diary entries, first published in 1995, reveal a tough, bitter military man who blamed his country's loss of the Moon race on Soviet engineers' unwillingness to yield control of a spacecraft to its crew. The argument over the role of the cosmonauts in the Soyuz 4/5 docking proved a perfect case in point.

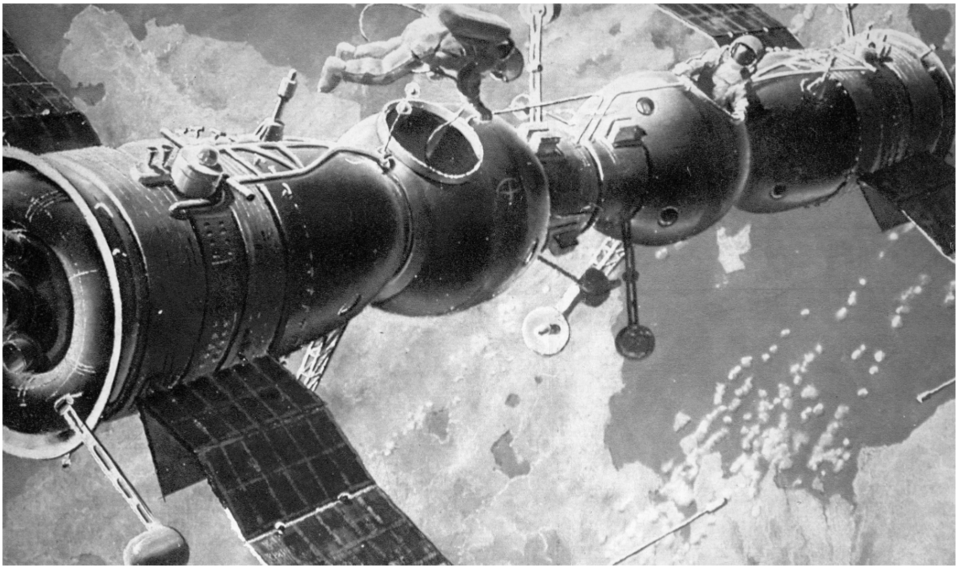
Over the years, Kamanin's diaries have been interpreted and used to paint a portrait of a man who fought fiercely for 'his' cosmonauts and to illustrate the close relationship that he had with them during their time together on the isolated Kazakh steppe. Others have seen him quite differently: he has been described by space analyst Jim Oberg as "an authoritarian space tsar, a martinet" and by Soviet journalist Yaroslav Golovanov as "a malevolent person ... a complete Stalinist bastard". Still others, including Alexei Leonov, have proven more complimentary, seeing Kamanin as "very approachable" with a keen love of sports, especially tennis. Nonetheless, his brand of military leadership, in most cases, successfully prepared the first generation of space explorers for their ventures into the heavens.

Automation, though, remained a key operating principle. Under the cover names of Cosmos 186 and 188, a pair of unmanned Soyuz spacecraft had satisfactorily performed a rendezvous and docking exercise in October 1967. Although they did not achieve a 'hard' link-up – there remained an 8.5 cm gap between them, which prohibited full electrical connections – their mission underlined the reality that the Soviets now had a grasp of rendezvous and docking with exciting possibilities for the future. Unfortunately, these flights did not end well. Cosmos 186 suffered a failure of its solar-stellar sensor, which altered its descent trajectory into a purely ballistic fall from orbit. It landed hard, but in one piece, on Soviet soil. Cosmos 188, on the other hand, re-entered the atmosphere at too steep an angle; so steep, in fact, that its self-destruct package had to be remotely triggered, spraying debris close to the Soviet-Mongolian border.

Success finally came the following April, when two more Soyuz craft, this time under the cover names of Cosmos 212 and 213, rendezvoused automatically and successfully 'hard' docked. In the eyes of many cosmonauts and engineers, this cleared the way for a manned rendezvous, docking and spacewalking flight later in 1968, involving Georgi Beregovoi aboard the 'active' Soyuz 2 and Boris Volynov, Alexei Yeliseyev and Yevgeni Khrunov aboard the 'passive' Soyuz 3. Sadly, it was not to be.

Trials of the spacecraft's backup parachute were not deemed good enough to assign a human pilot and it was considered likely to rip during deployment with a crew of three and a total weight of up to 1,300 kg. Vasili Mishin, who had assumed Korolev's mantle as Chief Designer of OKB-1 in May 1966, proposed reducing the Soyuz 3 crew to just two men to circumvent this risk and suggested postponing the risky spacewalk to a later mission. Others, including Mstislav Keldysh, head of the Soviet Academy of Sciences, were even more cautious, refusing to endorse *any* manned flights until another automated test had been successfully performed. Their reluctance was understandable. The previous year, Soyuz 1 had been lost and its pilot Vladimir Komarov killed when both the primary and backup parachutes failed ...

By the end of May 1968, a compromise was suggested by Mishin: two Soyuz would dock in orbit, one of them unmanned, the other carrying a single cosmonaut. Assuming the success of that flight, the next crews would attempt the transfer mission, perhaps as early as September. Dmitri Ustinov, chair of the Military-Industrial Commission and *de facto* head of all Soviet missile and space projects during this period, demanded a wholly automated flight. This would slip the



Artist's concept of the Soyuz-to-Soyuz extravehicular transfer, performed by cosmonauts Yevgeni Khrunov and Alexei Yeliseyev in January 1969. Originally intended as a key stepping stone toward manned lunar flights, by the time it was eventually undertaken, it was two years overdue, virtually obsolete and far too late to beat the Americans to the Moon.

intended August date for the manned mission until October at the earliest. On 10 June, the Soyuz State Commission convened and decided to launch the automated flight in July, followed by the joint mission with Beregovoi in September and the full-scale docking and spacewalk transfer in November or December.

To this, Ustinov added a proviso that the spacewalk should transfer not one, but two cosmonauts between craft. Although this had been the original plan for Komarov and Bykovsky's joint flight back in April 1967, concerns over the backup parachute led to a call to fly a crew of two, with just one spacewalker. Ustinov's request was borne out by Boris Volynov, whose work in a training version of the bulky space suit had revealed a major obstacle: a single spacewalker risked getting stuck in the hatchway between the descent and orbital modules. Moreover, if he then experienced difficulties getting outside, there would be no one to help him. The commander, in the sealed-off descent module, would be unable to assist, making a *pair* of spacewalkers – capable of supporting each other – the only safe and practical option.

For a time, it had been thought prudent to adopt a so-called '2 + 2' profile, whereby only one of the spacewalkers would actually perform the external transfer and both missions would return to Earth with crews of two. This neatly avoided the risk of bringing a Soyuz back to Earth with three men and a potentially dangerous parachute situation. By the end of September 1968, however, it seemed that the parachute woes had been resolved and the original, pre-Komarov plan for both Yeliseyev and Khrunov to spacewalk over to the other craft was reinstated.

In the meantime, Cosmos 238 had been launched late in August (a month behind the schedule agreed on 10 June) and apparently conducted at least one major manoeuvre before touching down after a near-flawless four-day flight. Finally, on 25 October, the unmanned Soyuz 2 was launched, followed by Beregovoi aboard Soyuz 3 the next day. During his mission, the cosmonaut managed to rendezvous with his automated target, but did not physically dock with it; a peculiarity which perplexed western observers for many years. The Soviets explained that on their first manned flight after the Soyuz 1 disaster, they did not want to subject Beregovoi to any undue risk. However, in a 2002 interview, quoted by Hall and Shayler, Konstantin Feoktistov accused Beregovoi of committing "the grossest error" by failing to notice that Soyuz 2's orientation was mismatched with that of his own craft. This caused Soyuz 3 to inexplicably bank 180 degrees relative to the target, despite the cosmonaut's best efforts to counter it.

Suspicion that the Igla rendezvous device might have been to blame was vigorously denied by its designer, Armen Mnatsakanyan, and Feoktistov agreed that it was simply a classic case of pilot error. Beregovoi's failure to notice the orientation mismatch with Soyuz 2 caused him to waste "all the fuel intended for the ship docking" and forced managers to cancel the remainder of the rendezvous. Years later, Siddiqi postulated that if the cosmonaut had recognised the problem and managed to stabilise Soyuz 3 along a direct axis to the target, he might still have achieved a successful docking. To be fair, though, Beregovoi was a rookie, obliged to perform the tricky exercise very soon after launch, whilst out of direct contact with the ground and during orbital darkness. It has also been reported that he suffered from a bout of disorientating space sickness early in his flight.

Lessons clearly would need to be learned before the docking between Soyuz 4 and 5. Indeed, it was decided that when Shatalov guided his spacecraft to link up with that of Volynov, Yeliseyev and Khrunov, he would do so a full 48 hours after launch, to allow him time to fully adapt to the strange 'microgravity' environment of space. He would also complete his docking during orbital daylight and within range of Soviet ground stations. Furthermore, this plan gave the Soyuz 5 crew, upon whose shoulders lay the burden of the hazardous spacewalk, a full day to acclimatise themselves.

During the docking, Shatalov would rely heavily upon the Igla. This system would later be used to enable a docking between Soyuz and the first Salyut orbital station. Broadly, its goal was to control the relative motion and attitude of two vehicles, the 'passive' of which carried a radio beacon for use as a homing aid by its 'active' counterpart. Firstly, the passive craft (Soyuz 5 in this case) would transmit a continuous-wave beam signal, which the active craft (Soyuz 4) would use to orientate itself to acquire its 'target' in a similar manner to the Cosmos 186 and 188 rendezvous. Next, Soyuz 4 would start to transmit an 'interrogation' signal to Soyuz 5 through its narrow beam antenna. Finally, Soyuz 5 would switch off its continuous-wave beacon and retransmit the interrogation signals through its own narrow beam antenna to establish a secure 'lock' between the pair.

Bearing as he did the unenviable reputation of becoming the Soviet Union's 13th spacefarer, Shatalov could perhaps have anticipated a run of bad luck during the days preceding his mission. Matters were not aided by the fact that his home telephone number ended in '13' and the launch itself was set for 1:00 pm Moscow Time – 13:00 hours – on 13 January, which also happened to be a Monday, traditionally regarded by the Russians to be a most difficult day ...

As it happened, Shatalov's only real bad luck transpired shortly after clambering into Soyuz 4 on the morning of 13 January, when he fell victim to the first launch scrub in Soviet space history. Despite temperatures of -24°C and winds gusting at 8–10 m/sec, the fuelling of the R-7 proceeded normally and the cosmonaut settled into the spacecraft and began running through his pre-launch system checks. Minor irritations came in the form of voice communication dropouts whenever Soyuz 4's television camera was in use, prompting it to be switched off. Then, with nine minutes to go, a problem was detected within the R-7's gyroscopes, apparently related to the ambient temperature and humidity.

By the time this problem was resolved, the launch time had slipped to mid-afternoon and Shatalov had been lying on his back for over two hours. Moreover, with a mission whose planned duration was almost exactly three days, to launch at this time of the day would produce a landing in the half-light of a gloomy midwinter's afternoon. This was considered far from ideal on such a complex flight. Ultimately, mission rules decided the outcome: fuel temperatures could not fall below -2°C at night; otherwise the loss of specific impulse would reduce the R-7's thrust by more than 5 percent. The managers therefore opted to postpone the launch.

Shatalov concealed his disappointment well and as he was extracted from his couch he declared that he had just set a new record for the world's shortest space flight and the very first to return to its exact point of liftoff! Years later, he would admit to an interviewer that, despite the run of thirteens, he was not an overly superstitious man. Still, he said, the decision to scrub the launch "hit me like a sledgehammer ... I had been waiting for the day [for] six years; dreamed, worked and trained hard".

His quick wit, superstition and disappointment aside, a number of potentially serious challenges remained. Although Soyuz had been designed to touch down on solid ground and was capable of performing a water landing, unmanned experience had shown that it might not be totally waterproof and, indeed, could sink. The chances of either Soyuz 4 or 5 splashing down somewhere in the ice-covered Aral Sea were estimated at only 0.003 percent, but, erring on the side of caution, recovery forces despatched rescue helicopters and a trio of B-12 seaplanes in readiness for such an eventuality.

In addition, the debate continued about how to conduct the rendezvous, with Dmitri Ustinov and Space Minister Sergei Afanasyev pressing Vasili Mishin for an automated flight profile. Both were aware of how flawlessly this had been executed by Cosmos 186/188 and 212/213 and remained mindful of Beregovoi's difficulties the previous October. The matter was decided the day before launch by Mishin, who, though he normally favoured automated systems, ruled in favour of the cosmonauts. Nevertheless, on the evening before launch, Nikolai Kamanin took Shatalov aside and told him that if he encountered difficulties then he should revert immediately to the automatic systems.

Shatalov's mission finally got underway at 10:30 am Moscow Time on 14 January with a perfect launch and insertion into a 173 × 225 km orbit, inclined at 51.7 degrees to the equator. For a time it had looked as if another scrub was on the cards, when a fault was detected in the R-7 which could normally only be resolved by lowering the rocket into a horizontal position. According to Hall and Shayler, a young pad technician saved the day by volunteering to strip off most of his clothes and, in freezing temperatures, managed to squeeze through a narrow hatch into the rocket's bowels to correct the problem.

For Shatalov, a veteran, 41-year-old test pilot, the experience of rocket launch, the weightlessness of space and the mesmerising view of Earth, was profound. "When we look into the sky," he explained later, "it seems to us to be endless. We breathe without thinking about it, as is natural ... and then you sit in a spacecraft, you tear away from Earth and within ten minutes you have been carried straight through the layer of air and beyond there is nothing. The 'boundless' blue sky, the ocean which gives us breath and protects us from endless black ... is but an infinitesimally thin film." Shatalov was not the first spacefarer, nor would he be the last, to remark upon the fragility of the world from which he came. Weightlessness, he recounted at the post-flight press conference at Moscow State University, "took me about three to four hours to master". (The fact that he spoke of adaptation lent some credence to the rumours that Beregovoi had experienced difficulties.)

Back on Earth, watching the launch from Tyuratam's Site 17, were a trio of cosmonauts who undoubtedly wished that they could be in his place. Their turn would come the very next morning, 15 January, when they were destined to blast off aboard Soyuz 5 and adopt a passive role as Shatalov performed the world's first-ever link-up between two manned spacecraft. For Lieutenant-Colonel Boris Valentinovich Volynov, who had overcome a string of obstacles in his 34 years of life to reach the point of commanding a spacecraft, his first flight into orbit would almost become his last.

THE MAN WHO ROCKED THE BOAT

Volynov's journey to the launch pad had already been thwarted several years earlier, a fact which many observers have attributed, at least partly, to his Jewish heritage; for he would become the first Jew in space. Selected as one of the original cosmonauts in March 1960, Volynov served as Valeri Bykovsky's backup on the Vostok 5 mission and was widely expected to receive assignment to a later flight or perhaps command of the first Voskhod. By January 1964, however, Marshal Sergei Rudenko, the Soviet Air Force's deputy commander-in-chief, requested Volynov's transfer from the Voskhod to the Soyuz training group. This apparent 'downgrading' was vetoed by Nikolai Kamanin, who, in July of that year, named Volynov along with Vladimir Komarov to train for the Voskhod 1 command.

Despite receiving formal certification to fly in August and seeming to be a strong contender to lead a crew, Volynov was dropped from the mission only days before its launch. So too was fellow cosmonaut Georgi Katys, whose father had been executed in one of Stalin's purges and who had a pair of half-siblings living in Paris. In spite of the solid support of Mstislav Keldysh and the Soviet Academy of Sciences, Katys was cast aside, with Kamanin noting in his diary that an "unfavourable background ... spoils the candidate for flight".

When Sergei Korolev heard of the decision to drop Volynov purely on the basis of his Jewish heritage, he was reportedly furious, but was advised by Nikita Khrushchev not to "rock the boat ... it's not worth it!" Unperturbed, Volynov next trained to lead the long-duration Voskhod 3 mission and, after its cancellation, moved over to Soyuz. In May 1968, he was assigned to command the passive rendezvous flight and, despite passing all of his exams in September and being commended for his "mastery" of the systems, almost lost this assignment too. When the Central Committee of the Communist Party met on 20 December to discuss the crew selections, further 'unhappiness' was expressed over Volynov's background. On this occasion, however, good fortune smiled upon him and his position on Soyuz 5 was accepted.

The man who aroused all this debate was born in Irkutsk in southern Siberia on 18 December 1934. He received schooling in Prokopyevsk and developed a love for the wildness of the taiga which would remain with him throughout his life. He moved to Prokopyevsk before the Great Patriotic War, where his mother, a paediatrician, surgeon and traumatologist, raised him on her own. After graduation, Volynov applied to his local Komsomol Committee for a letter of recommendation to a pilots' school and, with this in hand, experienced a taste of military life: endless drilling, guard duty and kitchen detail. His first solo flight, it is said, gave him little satisfaction, but, thanks to his instructor, Veniamin Reshetov, and his air force squadron commander, Major Ivanov, eventually developed a love of aviation.

Completion of the military pilots' school in Novosibirsk in 1955 was followed by marriage to his childhood sweetheart, Tamara, and the birth of their first son, Alexei. Then, in the closing months of 1959, with a glowing reference from Major Ivanov, he was one of hundreds of young Soviet Air Force pilots to be interviewed about flying a quite different machine: the Vostok spacecraft. Acceptance in March of the following year marked the beginning of his long wait for a mission into space. It also marked the end of a long and difficult selection process.

The search for the world's first spacefarers had begun in earnest in May 1959, when representatives of the armed forces, the scientific community and the design bureaux met at the Soviet Academy of Sciences in Moscow, under the auspices of Mstislav Keldysh, to discuss methods of choosing the most suitable candidates for Earth-orbital missions. Aviators, rocketeers and even car racers were considered, but at length, bowing to the Soviet Air Force, Keldysh agreed to narrow the criteria to pilots from this branch of the military.

Despite an obvious vested interest in wanting to have 'its' fliers take the first manned spacecraft beyond the atmosphere, the logic was inescapable: as already noted, military pilots had proven themselves under exposure to hypoxia, high pressures and varying G loads and had undergone rigorous ejection-seat and parachute training. In addition to their flying experience, candidates would only be