

Escaping the Bonds of Earth

The Fifties and the Sixties

Ben Evans

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To Michelle

Contents

Illustrations	xi
Author's preface	xv
Acknowledgements	xvii
1. From the East	1
Contrasts	1
Veil of secrecy	3
'Star sailors'	14
Farmboy	16
"Let's go!"	18
Reaction	24
The Bay of Pigs	27
A day in orbit	29
Teacher's son	32
Space sickness	33
The Wall rises	36
Space duet	38
Starfish Prime	40
An iron man and "a puzzle"	41
Flying falcon, soaring eagle	43
October crisis	46
A woman in space	49
The perfect candidate?	51
"Romanov and Juliet"	53
Return to Earth	56
2. Monkeys to Men	59
Heroes	59
A man in space	61
The competitor	69

Different world	71
“We gave it away”	72
“Light this candle!”	85
To go to the Moon	95
Gruff Gus	98
Room with a (better) view	100
“The first thing I had ever lost”	104
‘Gas bag’	108
The all-American	113
Spy swap	116
The best . . . at last	117
An American in orbit	122
“Leave the retro package on”	125
Euphoria, disappointment . . . and a boss	129
‘Black-shoe’ Carpenter	134
Science flight	136
Rise and fall of the Aurora	140
Pushing the envelope	149
The joker	151
The six circuits of Sigma 7	154
Fire hoses and police dogs	161
The end	163
Hotshot	167
Last Mercury out	170
 3. Space Spectaculars	 179
Journey to space	179
Sardines	183
“The world’s first passenger spaceship”	188
From thaw to stagnation	191
Risky endeavour	192
A walk outside	197
Near-disaster	201
Decline	206
 4. Pushing the Envelope	 211
Men with missions	211
Grounded	218
A new spacecraft	220
Assassination	233
Crewless successes	235
All aboard the ‘Molly Brown’	237
The astronaut	243
Bloodshed in Alabama	245
Corned beef sandwich	246

Onward, upward ... and outside	248
Discipline, persistence, dedication	253
False start	255
Inside man	257
Outside man	258
Record breakers	261
“How many boys, LBJ?”	264
Wiseguy	266
“Eight days or bust”	268
Changed plans	277
Twins?	285
Three hundred hours in space	288
Long haul	289
“Sittin’ here breathing”	293
Firecrackers, footballing and the F-86	295
Rendezvous!	297
5. Onward and Upward	305
Tragedy	305
Demise of the Dyna-Soar	309
Quiet civilian	313
First among equals	315
Training	318
“Smooth as glass”	322
“Tumbling end-over-end”	327
Pacific return	330
Rocket armchairs and fireproof pants	335
The substitute	337
Third time lucky	339
The angry alligator	342
Hellish spacewalk	346
“Nothing special”	352
Success at last	355
‘Animal’	364
‘M equals 1’	366
High ride	370
Conquest of the ‘high ground’	378
Dr. Rendezvous	382
The end	385
6. Disaster, Recovery, Triumph	393
“Fire”	393
Moonship	404
Witch hunt	414
Outer Space Treaty	418

x **Contents**

Fall from heaven	419
Slow recovery	430
My Lai	438
‘The Wally, Walt and Donn show’	439
Walt and ‘whatshisname’	450
“101 per cent successful”	451
Soyuz resurgent	453
“Not a priority”	458
Moonward bound	463
Outsider	466
C-prime	467
Saved	479
Bibliography	484
Index	489

Illustrations

Chapter 1

Yuri Gagarin bids farewell to Sergei Korolev	5
The Vostok spacecraft during construction	9
Vostok 1 lifts off	19
A Vostok sharik after touchdown	26
Sergei Korolev and the 1960 cosmonauts	44

Chapter 2

The Mercury Seven with a Mercury capsule in the background	60
The MASTIF trainer	66
The Mercury spacecraft	74
The Redstone carries its first human passenger into space	79
Ham, the chimpanzee occupant of MR-2	81
Al Shepard prepares to clamber aboard Freedom 7	86
An exhausted Shepard is welcomed aboard the Lake Champlain	94
Gus Grissom inspects his spacecraft's periscope	98
The unsuccessful attempt to hoist Liberty Bell 7 from the ocean	106
The crumpled MA-1 spacecraft after its ill-fated Atlas launch	111
John Glenn and Cece Bibby proudly display the Friendship 7 logo	118
"Godspeed, John Glenn!" The Atlas takes flight with a man aboard	121
John Glenn at work during his five-hour mission	123
Glenn experiences his first taste of public adoration	130
Scott Carpenter prepares for his flight	137
Aurora 7, atop its Atlas, is readied for launch	141
Wally Schirra (left) and Wernher von Braun	152
Gordo Cooper trains for the last Mercury mission	166
Cooper's Atlas 130D booster is prepared for launch	171
A Mercury capsule after splashdown	176

Chapter 3

Voskhod 2 is readied for launch	182
The crew of sardines: Feoktistov, Komarov and Yegorov	190

xii Illustrations

Belyayev and Leonov, both in EVA suits, prepare for their mission	195
Alexei Leonov during humanity's historic first spacewalk	200

Chapter 4

The Mercury Seven and the 'New Nine'	213
Members of the Fourteen undergo desert survival training	217
A Gemini-Titan launch	223
A model of the Gemini paraglider under test.	228
Grissom (in water) and Young undergo water survival training exercises.	238
A Gemini spacecraft is prepared for launch.	241
The Mission Operations Control Room in Houston	250
Interior view from Gemini IV, showing McDivitt and White.	252
Zip-gun in hand, Ed White tumbles through space during his EVA.	259
White (left) and McDivitt speak to President Johnson after the flight	262
A tired and bearded Conrad (left) and Cooper after the flight.	270
Jim Lovell (seated left) and Frank Borman study plans.	278
Tom Stafford (standing) and Wally Schirra suit up	281
Frank Borman performs a visual acuity test during Gemini VII	286
Spectacular view of the Andes from Gemini VII	291
Gemini VII in space, as seen by Schirra and Stafford	299

Chapter 5

The original Gemini IX crew, Elliot See (left) and Charlie Bassett.	307
The space suit and equipment to be used by Dave Scott on Gemini VIII	319
Artist's concept of Dave Scott during his EVA	321
Launch of an Atlas-Agena target vehicle.	324
Gemini VIII during rendezvous activities with the Agena	328
Scott and Armstrong, surrounded by swimmers, after splashdown	332
Armstrong (left) and Scott on the deck of the recovery ship Mason	334
Stafford and Cernan's first close-up glimpse of The Blob	345
Two of the few photographs acquired during Gene Cernan's EVA	348/9
An exhausted Cernan puts on a brave face for Tom Stafford's camera	354
The crew of Gemini X: gregarious Collins (left) and reserved Young.	357
Gemini X performs the first Agena firing	360
Dick Gordon (left) and Pete Conrad demonstrate the tether experiment	367
Dick Gordon shortly before opening the hatch to discard unneeded gear	374
Jim Lovell (left) and Buzz Aldrin at breakfast on launch morning.	387
Aldrin during one of his three periods of EVA	390

Chapter 6

The first Apollo crew: Gus Grissom, Ed White and Roger Chaffee	395
The Apollo 1 command and service module during testing	398
The burnt-out remains of Apollo 1	403
Seated before the Senate, NASA managers are verbally grilled	415
Cosmonauts training for the Soyuz 1/2 joint mission.	420

Spectacular panoramic view of the Cape Kennedy landscape.	432
AS-501, the first flight of the Saturn V, is prepared in the VAB	434
The legless Apollo 5 lunar module is readied for flight	435
John Young enters the command module simulator during a test	440
The Saturn 1B carries its first crew into orbit	443
Apollo 7's S-IVB third stage during station-keeping operations.	445
An N-1 rocket on the launch pad at Tyuratam in 1972	459
The Zond 5 descent module after splashdown in the Indian Ocean	462
The Saturn V begins its maiden mission	470
The S-IVB recedes into the blackness as Apollo 8 heads for the Moon	472
The lunar farside, never before seen directly by human eyes	475
One of the 20th century's most iconic images: Earthrise from Apollo 8.	477
Apollo 8's fiery return to Earth on 27 December 1968.	478
The Apollo 8 crew arrive aboard the recovery ship Yorktown.	480

Author's preface

Overshadowed by the dark events of Vietnam, civil rights, the Kennedy and King murders, the Bay of Pigs and a close shave with nuclear holocaust, the Sixties will hopefully also be remembered by history as the decade in which humanity first ventured into the heavens. Men and a woman left Earth's atmosphere, spacewalked hundreds of kilometres above their home planet, rendezvoused and docked their ships together and travelled to the Moon for the first time. These triumphs, however, were tempered by tragedy: three astronauts asphyxiated in a launch pad fire, then a cosmonaut killed during his ill-fated descent to Earth. Still, by the end of the decade, both the United States and the Soviet Union had firmly established their presence in space. The excitement and euphoria which these years inspired were felt not just in America and Russia, but throughout the world. By the time Frank Borman, Jim Lovell and Bill Anders circled the Moon on Christmas Eve 1968, it is said that no fewer than a billion people back home were watching or listening.

This book explores the history of humanity's early exploration of space, beginning with the pioneering flight by Yuri Gagarin and ending with Apollo 8's circumnavigation of the Moon. It will, I hope, form the basis of a series to commemorate the first half-century of human exploration in space. By the time of that momentous anniversary in 2011, perhaps, the ongoing drive towards private spaceflight and 'space tourism' will begin to make human journeys into the heavens so commonplace that it will be impossible to catalogue them all! It is my most fervent wish that a further volume – covering the decade from 2011 – will be impossible to write, because men and women will be in space so often and human spaceflight will have changed from the realm of the few and the privileged to the realm of the many.

My intention in writing this volume was to convey some of my own enthusiasm for what was one of the most remarkable decades in human history. Born in 1976, sadly, I missed it all, and still await the chance to see my first manned lunar landing. Still, I have attempted to introduce the reader to some of the problems faced in the early days: from the basic questions of whether men could breathe, eat and avoid going mad in space, to more complex issues of the kinds of fuels and atmospheres to be used in rockets and spacecraft and the techniques needed to accomplish orbital rendezvous, docking and reaching the Moon. Many of the techniques pioneered by the trailblazing heroes of the Sixties continue to be used today by Shuttle and

International Space Station crews and close parallels can be drawn between Apollo lunar mission design and plans for the United States' proposed return to the Moon in 2020. However, in my mind, at least, the real achievement of that handful of early astronauts and cosmonauts is that they drew our attention away from petty problems on Earth and refocused it once more on the excitement of exploration, the thrill of discovery and the conquest of new frontiers. That legacy, that passion for adventure and that yearning to stretch our horizons, will surely drive the next generation of space explorers and inspire our next 50 years in space.

Ben Evans

Atherstone, February 2009

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1

From the East

CONTRASTS

The Sixties were a decade of contrasts. Their three thousand, six hundred and fifty-three days were marked by some of the most tumultuous, violent and devastating, yet far-reaching, inspiring and influential events in human history. They saw enormous political, social and cultural change and have been seen as a nostalgic era of peace and liberalism, overshadowed by a dark cloud of hatred, oppression and wanton excess. They began, ominously, under the longest shadow of the Cold War. Only days after the first man rocketed into space, a newly-elected United States president and a feisty Soviet premier locked horns over the fortunes of a young Cuban revolutionary, bringing the possibility of nuclear war onto an international stage.

As the decade wore on, that very same president was publicly cut down by an assassin's bullet – as, indeed, was his younger brother a few years later – and the Soviet leader was toppled from office in 1964, hours after bragging to the world of his nation's latest space triumph. Elsewhere, decades of servile colonialism drew to an end as a handful of African countries finally achieved independence from European mastery; some evolving into stable democracies fit for the modern world, others degenerating into corrupt and despotic dictatorships. Younger generations, inspired by the unequal conservative norms of the time, as well as an increasingly unpopular war brewing in Vietnam, cultivated a social revolution which swept across much of the western world.

Simmering discontent in America's black community boiled over with the 1968 murder of Martin Luther King in Memphis and, a year later, with the point-blank assassination of Black Panther Party co-founder Fred Hampton in Chicago. Meanwhile, Vietnam consumed ever-increasing numbers of lives on both sides – including, at My Lai, the infamous massacre of hundreds of unarmed civilians – and enforced conscription led to massive opposition, culminating in the 500,000-strong Moratorium protests in late 1969. Voting rights were questioned: why, asked American youth, should they die for their country if they were barred from casting at

2 From the East

the ballot box? Remarkably, amid all this chaos and carnage, men visited the Moon and, as one observer told Apollo 8 astronaut Frank Borman, saved what was otherwise the darkest point of the decade.

On the fringes of Europe, equally divisive measures were being undertaken to forcibly separate eastern communists from the democratic west. Beginning in August 1961, less than a week after the Soviets launched their second cosmonaut, East German troops sealed borders and set about building a physical barrier between the eastern and western halves of Berlin. An initial barbed-wire fence was, by 1965, replaced by one of the most hated icons of the communist regime: the 157 km Berlin Wall. In spite of its clear violation of the Potsdam Agreement (which granted Britain, France and the United States a say over Berlin's post-war future) little effort was made to challenge the wall by force. Even President John Kennedy's administration acquiesced that its existence was "a fact of international life". Closed by chain fences, walls, minefields and manned by sharpshooters, the despised barrier would divide families, friends and communities for almost three decades.

As Soviets and Americans spacewalked outside their Earth-circling ships and raced to put a man on the Moon, efforts to promote democracy in eastern communist states, including Poland and Yugoslavia, but notably Czechoslovakia, came to nothing. The optimistic Prague reforms of Alexander Dubček in the spring of 1968 raised such alarm that 250,000 Warsaw Pact troops and thousands of Soviet tanks rumbled into the country to stifle any attempt to create a new nation of pluralism, tolerance and improved human rights. The invasion provoked widespread opposition both within Czechoslovakia – visibly expressed through the self-immolation of student Jan Palach in Wenceslas Square in January 1969 – and from beyond, even from within the Soviet Union itself. Three hundred thousand emigrations from Czechoslovakia to the west represented an exodus so high in number that it has not been seen since. Dubček himself was forced from office to ensure that, in future, his country would subordinate its interests to those of the Eastern Bloc.

Similar opposition and destruction, not merely of people and places, but of an entire way of life, commenced in 1966, as the abject failure of Chairman Mao's Five-Year Plan to bring lasting economic prosperity to China culminated in the rampages of the Red Guards and the abolition of the so-called 'Four Olds', believed to stand in the way of socialist progress. Over the next few years, old customs, old cultures, old habits and old ideas were systematically eradicated, as the old world was smashed in favour of the new. It should have granted the Chinese people their most extensive period of free speech yet seen; in reality, it was a 'freedom' severely impaired by Maoist ideology, military brutality and the biggest single attempt by a nation to eliminate its own identity ever seen in the modern age.

A revolution of a somewhat different kind came one night in February 1964, with the triumphant arrival in New York of four mop-topped Liverpudlians called the 'Beatles'; their appearance on the Ed Sullivan Show transformed them overnight into one of the few British acts at the time to achieve enormous success in the United States. The so-called 'British Invasion' was followed by an infusion of new musical talent from across the Atlantic: the Kinks, the Yardbirds, the Moody Blues, the

Rolling Stones and the Who. Yet, although the late John Peel once remarked that his distinctive Merseyside accent alone enabled him to break into American radio, the invasion was by no means restricted to music. British movies, characters and television series, from James Bond to Mary Poppins and 'A Hard Day's Night' to 'The Avengers', were met with great enthusiasm Stateside.

The British Invasion, though, formed only part of a wider 'counter-culture', which ran like a broad vein through the mid to late Sixties, encompassing demands for improved rights and freedoms for women, homosexuals and racial minorities. Rampant use of psychedelic drugs seemed to journey hand-in-hand with, and influence, the music, artwork, movies and attitudes of the time. Only months after three American astronauts died in a launch pad fire and a Soviet cosmonaut plunged to his death when his parachute failed, one of the defining moments of this counter-culture came with San Francisco's 1967 Summer of Love and the associated rise of the hippie movement. Two years later came Woodstock, although the infamous Tate-LaBianca killings of August 1969 provoked growing mistrust of the counter-culture and its lax morals. Indeed, the excesses of the period prompted Jefferson Airplane co-founder Paul Kanter to quip: "If you can remember anything about the Sixties, you weren't really there!"

It is fortunate, therefore, that another of the decade's most persistent themes will remain forever entrenched in human memory. After countless millennia spent staring up at the heavens and wondering what lay beyond the thin veil of our atmosphere, men – and, in 1963, a woman – finally broke free of their home planet. Some would spend many days circling Earth, others would open hatches and venture outside in pressurised space suits to work, still more would dock their spacecraft together and a few hardy souls would visit the Moon. By the end of the first decade of humanity's adventure in space, men would have left their footprints in lunar dust.

We would be naïve and foolish to suppose that Russia and America – communist and capitalist rivals – undertook these escapades for purely scientific and peaceful purposes, although undoubtedly both of these reasons played a part. The development of rockets capable of hurling humans into space emerged from a long-nurtured desire on both sides to send weapons across thousands of kilometres and drop them onto each other's cities. In fact, at an August 1961 press conference in Moscow to announce the flight of the second cosmonaut, Gherman Titov, a New York Tribune journalist was not interested in the scientific accomplishments of the mission, but rather in its military implications. Was Titov's Vostok 2 spacecraft, the journalist asked, capable of delivering bombs to pre-selected spots on Earth? The cosmonaut, with a hint of embarrassment, replied that it was not, but the question certainly demonstrated the reality that space was the new 'high ground' and would be exploited by both superpowers for their own ends.

VEIL OF SECRECY

On a bleak, featureless expanse of steppe, some 200 km east of the Aral Sea, lies a tiny junction on the Moscow-to-Tashkent railway, known as Tyuratam. In the local

4 From the East

Kazakh tongue, its name is roughly translatable 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, the place began as an ancient cattle-rearing settlement on the north bank of the Syr Darya River, although at least one Soviet-era journalist expressed preference for giving it a more modern origin, hinting at its foundation as recently as 1901 as an outpost to refill steam engines passing between Orenburg and Tashkent.

Its significance 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 this place that Gary Powers, following the line of railway tracks in his U-2 reconnaissance aircraft, tried to find when he was shot down in May 1960. It was 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 a young man, clad in a bloated, pumpkin-orange suit and glistening white helmet, sat atop a converted ballistic missile, defied all the odds and took humanity's first voyage beyond the cradle of Earth.

One morning in April 1961, as five months of bitter snow and fierce, hurricane-strength blizzards yielded to the first murmurings of spring on the steppe, his kind achieved what had previously existed only in dreams. He rose from Earth, as Socrates once said, right to the top of the atmosphere and beyond and obtained a glimpse of the world from which he came. Contrary to some long-held expectations, the vista that Yuri Alexeyevich Gagarin beheld from 175–300 km high was not flat, nor could he discern any atlas-like lines dividing the countries, nor still, it is said, did he perceive any physical notion of God. Instead, he saw a beautiful, fragile oasis; a world iridescent with life and colour, encircled by what he described as “a very distinct and pretty blue halo” of an atmosphere, which almost merged into the blackness of space beyond. Flying at 28,000 km/h, in his journey of just 108 minutes, he somehow managed to plant fleeting images into his brain of rivers, islands, continents, forests and mountains. Never before had they been seen from so high by human eyes.

It is hardly surprising that the site from which he left Earth – known today simply as ‘Gagarin's Start’ and still used to blast humans into space – was kept under wraps by the Soviet government. Indeed, in the early Seventies, when American astronaut Tom Stafford asked to visit the site in readiness for the joint Apollo-Soyuz mission, he met stubborn resistance. The Soviets' desire to mislead and confuse prying westerners about this ultra-secret place was pursued to such an extent that even its name remained imprecise. Today, it is still variously known as Tyuratam, after the tiny railhead, or, more often, as Baikonur, which covers a wider and different geographical area. In fact, the town of Baikonur is more than 200 km from the launch base. For this reason, at a 1975 press conference, ABC News anchorman Jules Bergman expressed displeasure at the Baikonur name, pointing out that, despite its diminutive size, Tyuratam is actually closer.



Clad in space suit and helmet, the first man in space, Yuri Alexeyevich Gagarin, bids farewell to the genius who made his flight possible, Sergei Pavlovich Korolev.

Whatever one's preference, in February 1955 the site was chosen for a research and testing facility for the R-7 intercontinental ballistic missile; a missile developed by Sergei Korolev, the famed 'chief designer' of early Soviet spacecraft and rockets, originally to deliver huge warheads across distances of several thousand kilometres and, later, to send the first men into orbit. Assembly of the R-7 base – consisting of airports, rocket hangars, control blockhouses and the first of several colossal launch pads – was completed in a little over two years and, on 4 October 1957, one of these behemoths carried the world's first artificial satellite, Sputnik 1, aloft. Within a month, a living creature, the dog Laika, was boosted into space aboard Sputnik 2. However, not all missions were successful: two of Korolev's Mars-bound probes exploded shortly after liftoff and in October 1960 an R-16 missile misfired on the pad, destroying the launch complex in a conflagration which claimed the lives of almost 130 technicians, military officers, engineers and Marshal Mitrofan Nedelin. An American reconnaissance satellite, which overflew the site a day later, saw only a blackened smudge across the barren steppe. The awful truth of exactly what happened would not reach western ears for decades.

Ironically, only days before the R-16 disaster, Premier Nikita Khrushchev had boasted to the United Nations that Russia was producing intercontinental ballistic missiles "like sausages from a machine". On the fateful night of 23 October, just half

6 From the East

an hour before its scheduled liftoff, the R-16 exploded, destroying the launch pad and breaking in half. Everyone in the vicinity of the inferno was either incinerated in the 3,000°C temperatures or succumbed to the missile's toxic propellants. Marshal Nedelin's remains were recognisable only from a Gold Star pinned to his uniform, whilst another man was identified from the height of his burned corpse. Although the R-16 was not directly connected to the R-7, which would be used for piloted missions, its loss caused an inevitable delay to the first manned space launch. In fact, many design organisations were involved with both the R-16 and R-7 and Nedelin himself chaired the State Commission for the man-in-space effort.

Consequently, in spite of its relative youth, the place already had historic and tragic attributes by the time Nikolai Kamanin, head of the newly-established cosmonaut team, arrived there in the spring of 1961 to oversee final preparations to send a man into space. The middle-aged Kamanin was one of the Soviet Air Force's most distinguished generals, having led air brigades and divisions during the Second World War. In 1934 he had received the coveted Hero of the Soviet Union accolade for his role in the daring rescue of the icebound steamship Chelyuskin on the frozen Chukchi Sea. Throughout the Sixties, as the cosmonauts' commander, Kamanin frequently disagreed with Korolev over differing policies, attitudes and requirements for the spacecraft and rockets, the men who would ride them and the often whimsical desires of the Soviet leadership. His memoirs are preserved in a series of quite remarkable diary entries, first published in 1995, which reveal a tough, bitter man who would blame his country's loss of the Moon race on Soviet engineers' unwillingness to give cosmonauts active control of their spacecraft.

Kamanin's diaries paint a portrait of a man who fought fiercely for 'his' cosmonauts and show the close relationship between them during their time together on the isolated Kazakh steppe. However, he has also 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". Others, including cosmonaut Alexei Leonov, have proven more complimentary, seeing him as "very approachable" with a keen love of sports, especially tennis. Still, his brand of leadership, in most cases, successfully prepared the first generation of space explorers for their ventures into the heavens.

By the beginning of April 1961, wrote Kamanin, a number of obstacles remained to be overcome before a man could be launched. The basic design of his spacecraft had already been established and tested under the smokescreen name of 'Korabl-Sputnik' ('Spaceship-Satellite') which, between May 1960 and March 1961, had ferried dogs, rats, mice, flies, plant seeds, fungi and even a full-sized human mannequin famously nicknamed 'Ivan Ivanovich' into orbit. These missions evaluated everything from the spacecraft's habitability to the performance of its ejection seat. Some proved to be dismal failures: the retrorockets of one mission fired in the wrong direction, sending the capsule into a higher orbit, while a July 1960 attempt exploded seconds after liftoff, killing its two canine passengers, Chaika and Lisichka. Others, notably the flight of the dogs Belka and Strelka, were hugely successful.

The latter were launched at 11:44 am on 19 August, accompanied by mice, insects,

plants, fungi, cultures, seeds of corn, wheat, peas, onions, microbes, strips of human skin and other specimens. Two internal cameras provided televised views of them throughout the day-long mission. At first, the images showed the dogs to be deathly still – Belka, in particular, squirmed uncomfortably and vomited during the fourth orbit – prompting medical chief Vladimir Yazdovsky to gloomily recommend no more than one circuit for the first manned flight. The dogs' return to Earth, however, was perfect and the capsule landed just 10 km from its intended spot in the Orsk region of the southern Urals. Belka and Strelka earned their places in history as the first living creatures recovered safely from orbit.

Upon examination, both were found to be in excellent condition, with no fundamental changes to their health. This data, together with the exemplary performance of the capsule's systems, provided encouragement that a Soviet man could be launched before the year's end. In fact, documentation from the Council of Chief Designers to the Central Committee of the Communist Party, produced around this time and finally declassified in 1991, revealed the formal timetable for sending a human pilot aloft. It recommended one or two more test flights in October and November 1960, before attempting a manned shot in December. Signed by ministerial heads, rather than the standard deputy ministers, the document clearly reflected how important the man-in-space effort was to the Soviet leadership.

Known as 'Vostok' ('East' or 'Upward Rising'), the machine that Yuri Gagarin, Gherman Titov and others would fly comprised a spherical cabin to house the cosmonaut and a double-cone-shaped instrument section. However, unlike the United States' man-in-space effort, the true form of Vostok remained hidden from the world and would not be revealed in its entirety until a full-scale model appeared at the Moscow Economic Exhibition in April 1965. Until then, the Soviet Union's propaganda apparatus continued to misinform western observers as to precisely what kind of spacecraft had placed the first man into orbit. Careful to maintain the ambiguity, Gagarin himself waxed lyrical, cryptically describing it as "more beautiful than a locomotive, a steamer, a plane, a palace and a bridge; more beautiful than all of these creations put together". His praise, though understandable, was not especially helpful. In the four years before Vostok was finally unveiled, the world could rely only on brief clips from Soviet documentaries and scenes from the Moscow Parades, which variously showed a contraption with an attached rocket stage, payload shroud and even, in the case of Vostok 2, a pair of short, stubby wings.

Today, at the Tsiolkovsky Museum in Kaluga, just south-west of Moscow, Vostok is presented for what it was: a 4,730 kg monster of a spacecraft, some 4.4 m in length and 2.4 m wide. Its capsule – nicknamed 'the ball' or 'sharik' ('little sphere') by the cosmonauts – comprised a little over half of its total weight, rendering it so heavy that not only a hefty parachute, but also an impact-cushioning rocket, would be needed to bring a man safely to the ground. Since this additional weight would have pushed it above the R-7's payload capacity, Soviet designers incorporated an escape system to stabilise Vostok's own descent by parachute, then allowing the cosmonaut to eject at a relatively low altitude of 7 km and land under his own canopy. During his descent, he would separate from his seat and touch down at

8 From the East

about 5 m/sec. The Vostok, on the other hand, would impact roughly twice as fast, easily sufficient to injure the cosmonaut had he remained inside.

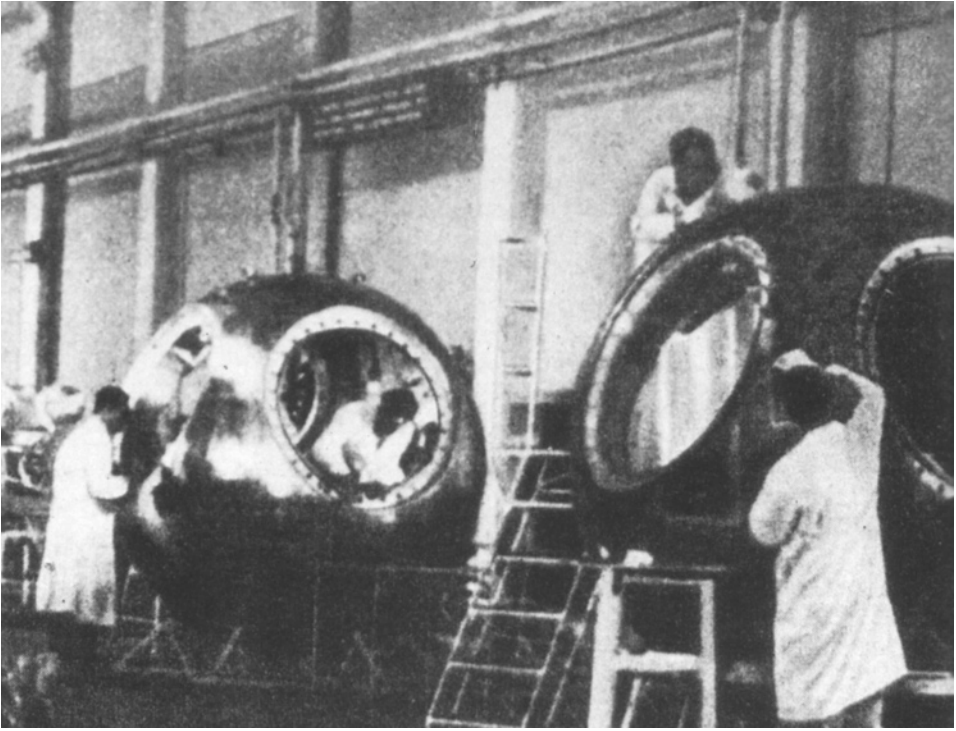
Questions of whether or not cosmonauts remained aboard their capsules throughout descent and landing were by no means insignificant. In order for such flights to be officially recognised for their achievements – specifically by taking the World Aviation Altitude Record – the Fédération Aéronautique Internationale (FAI) required pilots to remain inside their machines from launch until landing. This would sidestep any accusation that they had been obliged to abandon their ships due to problems and ensure that their missions would be considered a successful ‘first’. The reality that none of Vostok’s fliers accompanied their capsules to the ground, but still made successful flights, was kept carefully hidden by the Soviets for many years.

In June 1960, Korolev took Gagarin, Titov and 18 other cosmonauts to his OKB-1 design bureau in Kaliningrad, north-east of Moscow, to see the first Vostoks in production. Their silvery spheres contained no aerodynamics, control surfaces or propulsion systems and, with their double-coned instrument sections, could only stand upright with the aid of metal frames. All of the cosmonauts were fighter pilots who could barely comprehend what they were seeing. All were enthusiastic to someday guide these machines through space, but none could understand how, without wings, they were supposed to do it.

Within the capsule, they found a tan-coloured rubber cladding, covering a myriad of wiring and piping, with little obvious instrumentation, save for a single panel containing switches, status indicators, a chronometer and a small globe representing Earth. Other systems would provide Vostok’s fliers with temperature, pressure, carbon dioxide, oxygen and radiation readings, as well as ticking off each circuit of their home planet. The bulky ejection seat occupied much of the cabin. At its foot was the ‘Vzor’ (‘Eyesight’) periscope to indicate that the spacecraft was correctly oriented for atmospheric re-entry. It consisted of a central view, encircled by eight ports; when Vostok was perfectly centred with respect to the horizon, all eight would be lit up. Within reach of the cosmonaut was a small food locker, providing up to ten days’ worth of supplies, and herein lay one of the problems that, in April 1961, stood in the way of future flights.

Attached to the base of the capsule was the double-coned instrument section, some 2.25 m long and 2.4 m wide and weighing 2,270 kg. Spread around the ‘waist’ between the two sections was a set of 16 spherical oxygen and nitrogen tanks for Vostok’s life-support system. At the bottom was the TDU-1 retrorocket, which employed a self-igniting mixture of nitrous oxide and an amine-based fuel. Capable of delivering a total thrust of 1,614 kg with a specific impulse of 266 seconds, the device would operate for 45 seconds with a 275 kg propellant load, slowing Vostok by around 155 m/sec to permit atmospheric entry at the end of a mission.

As long as the retrorocket operated without incident, the best opportunities for bringing the capsule back to Earth, and back to Soviet territory, were after one orbital pass – as was planned for Gagarin’s flight – or a full day later, somewhere in the midst of the 17th revolution. Admittedly, it could be fired at any other time, if necessary, but at the risk of bringing Vostok down within foreign borders or possibly



The Vostok spacecraft during construction in the assembly shop.

into the sea. However, in the worst-case scenario that the retrorocket should fail to fire at all, the cosmonaut may have had to remain in orbit for up to ten days until his spacecraft naturally decayed from orbit. Although food and water were made available for such a long flight, the capsule's lithium hydroxide canisters, meant to scrub exhaled carbon dioxide from the cabin, proved insufficient and in ground tests were expended within four days. Since Gagarin's mission would last only a couple of hours, Kamanin felt that this would not preclude the ability to launch him in April 1961, but believed a new approach would be needed for longer flights.

Other obstacles had arisen during the Korabl-Sputnik missions, among them the 800 kg ejection seat. Although the ejection of a dog named Chernushka from the Korabl-Sputnik 4 spacecraft on 9 March 1961 and that of another dog, Zvezdochka, together with the life-sized mannequin Ivan Ivanovich, from Korabl-Sputnik 5 two weeks later, were successful, sea-based trials proved harder to quantify. Despite these misgivings, after three successful tests on the ground and from an Il-28 aircraft, coupled with the Korabl-Sputnik results, the seat was declared ready.

Months earlier, in September 1960, Korolev had submitted his proposal for a human flight to the Central Committee of the Communist Party and received approval. His original plan was to stage the mission before the end of that year, but the failure of Korabl-Sputnik 3 on 1 December – in which the dogs Pchelka and Mushka were incinerated, said the Soviets, when their capsule re-entered the

atmosphere at too steep an angle – cast doubt on this schedule. (In reality, Korabl-Sputnik 3 had suffered a failure of its TDU-1 retrorocket and was remotely destroyed lest it land in foreign territory.) Another attempt just three weeks later uncovered a rare anomaly with the R-7 booster itself, whose third stage ran out of thrust halfway to space, although both of its canine passengers were ejected safely ... landing thousands of kilometres off-course in a remote and inhospitable area of Siberia. Earlier in the year, another R-7 had exploded seconds after liftoff, ironically with many of the cosmonauts on hand to watch. “We saw how it could fly,” Gherman Titov said darkly. “More important, we saw how it blows up.”

By 7 April 1961, the final decision to go ahead with the mission was made and events moved rapidly. The Soviets were keenly aware that the United States’ first attempt to put a man into space was imminent, perhaps as soon as 28 April, although Kamanin firmly believed that Vostok would beat them. By this time, Gagarin and Titov had been selected as the prime and backup candidates for the flight. Their last few days were spent undergoing refresher classes on spacecraft and rocket systems, including the troublesome ejection seats. At one meeting, Kamanin reminded them of the option to fire the seat manually in the event of an emergency. Titov expressed total confidence in the seat and felt that worrying about it was a waste of time. Gagarin, on the other hand, offered a more considered response, perhaps so as not to embarrass Titov or the seat’s engineers, by pointing out that although his confidence was high, the manual option increased his chance of survival. He certainly knew how to play the game of cosmonaut politics.

It is difficult, though, to determine if one single event allowed the decision of Gagarin over Titov to be made. In their 1998 biography of Gagarin, Jamie Doran and Piers Bizony stressed that Kamanin himself had a hard time deciding between the two men. Only days before the mission, he noted in his diary that Titov completed his training more accurately than Gagarin, but that Titov’s “stronger character” put him in a better position to fly Vostok 2, which was planned to spend a full day in space. Others have hinted that Korolev simply liked Gagarin from their first meeting, that his calmness under duress and even his respectful removal of his boots before entering a Vostok capsule in the OKB-1 workshop may have played a part. Of equal, perhaps overriding, significance from the Soviet government’s point of view was the political need to favour a humble farmboy (Gagarin) over Titov, a more bourgeois teacher’s son. Even the simplicity of character between Gagarin and Soviet premier Nikita Khrushchev, both of whom came from peasant roots, has been cited, together with Titov’s perceived lack of charm, reserved personality and ‘strangeness’ when spouting from memory reams of poetry or quotes from tsarist literature.

Certainly, an early evaluation of Gagarin’s personality, conducted in August 1960 by Soviet Air Force physicians and psychologists, was highly favourable of his ‘other’ talents. It read: “Modest: embarrasses when his humour gets a little too racy: high degree of intellectual development evident in Yuri; fantastic memory; distinguishes himself from his colleagues by his sharp and far-ranging sense of attention to his surroundings: a well-developed imagination: quick reactions: persevering, prepares himself painstakingly for his activities and training exercises,

handles celestial mechanics and mathematical formulae with ease as well as excels in higher mathematics: does not feel constrained when he has to defend his point of view if he considers himself right: appears that he understands life better than a lot of his friends ...” He seemed the perfect choice.

On 9 April, that choice was publicly made and filmed in colour by the official cameraman, Vladimir Suvorov. In reality, the decision had been made in secret the previous day, after which Kamanin had told both cosmonauts the outcome. Titov, he wrote, was visibly disappointed to have lost the flight, but both men mimed their way through ‘spontaneous’, though pre-rehearsed, speeches. Ironically, Suvorov’s camera ran out of film halfway through the acceptance speech, forcing Gagarin to repeat everything, word for word.

At 5:00 am Moscow Time on 11 April, the enormous R-7 booster, carrying the Vostok 1 spacecraft – simply labelled ‘Vostok’, so as to give no hint to the world that it might be the first in a series of missions – left the main assembly building in a horizontal position atop a railcar. Korolev, who knew it intimately as his ‘Semyorka’ (‘Little Seven’), accompanied it to the launch pad. Fuelled by liquid oxygen and kerosene, it consisted of a two-stage core, measuring 34 m long and 3 m in diameter and weighed 280,000 kg. Strapped around the core were four tapering boosters. Upon arrival at the pad, it was raised to a vertical position, ready for the arrival of its human passenger early the next morning. Liftoff was set for 9:07 am on 12 April, with plans calling for the jettison of the strap-on boosters two minutes into the flight, followed by insertion into low-Earth orbit at 9:18 am. Half an hour later, Vostok would orient itself in preparation for an automatic retrofire at 10:25 am, parachute deployment from the capsule at 10:43 am, ejection of Gagarin at 10:44 am and touchdown of both shortly thereafter. The entire flight would be shorter than one of today’s Hollywood blockbusters.

That night, the prime and backup cosmonauts stayed in a cottage close to the pad, their every toss and turn monitored by strain gauges fitted to their mattresses to allow physicians to determine whether they experienced restful sleep. The results indicated that they did, but Gagarin would later admit to Korolev that he hardly rested at all and spent much of his time trying to remain perfectly still in bed, so that he would be declared well prepared to fly the following morning. Months later, he would joke with Kamanin that the only reason Titov did not ride Vostok 1 was because he had rolled over in his sleep. Korolev also slept very little. His major concern was that the R-7’s third stage might fail during the ascent, perhaps dropping the spacecraft into the ocean near Cape Horn, an area notorious for its violent storms. Shortly before the launch, he demanded that a telemetry antenna be set up at Tyuratam to confirm the satisfactory operation of the third stage; if it worked as planned, the telemetry data would print out a string of ‘fives’ on tape, but if not, there would be a string of ‘twos’.

At 5:30 am on what is now universally known as ‘Cosmonautics Day’, 12 April 1961, Korolev and his head of medical preparations, Vladimir Yazdovsky, woke Gagarin and Titov from their slumbers. After washing, shaving and a breakfast of meat puree and toast with blackcurrant jam, physicians glued sensor pads onto their torsos and sent them to the spacecraft assembly building to don their pumpkin-

12 From the East

orange suits. These had been designed by Gai Severin, the Soviet Union's most accomplished manufacturer of attire and ejection seats for MiG fighter pilots. Severin utilised several key elements of earlier suit designs – including a tight fit around the legs to prevent blood from pooling into the lower torso and starving the supply to the brain – to protect Gagarin from the rapid acceleration of the R-7. The main layers of the suit, designed and built in only nine months, consisted of a blue-tinted rubber material, overlaid by the high-visibility orange coverall.

On launch morning, Titov donned his suit first in order to reduce Gagarin's time spent overheating inside his own uncomfortable garment. As he continued his own suiting-up, Gagarin realised for the first time that he was – or soon would be – the most famous man on Earth. In his heavily-censored account of the mission, 'The Road to the Stars', published later in 1961, he recalled technicians offering him slips of paper and work passes on which to scrawl his signature. Titov beheld this and wished Gagarin luck, although he was disappointed and, even as he rode the bus to the launch pad, considered his role that day as hopeless. "He was commanding the flight and I was his backup," Titov said later, "but we both knew, 'just in case' wasn't going to happen. What could happen at this late stage? Was he going to catch the flu between the bus and the launch gantry? Break his leg? It was all nonsense! We shouldn't have gone out to the launch pad together. Only one of us should have gone." Vladimir Yazdovsky, who was also aboard the bus and gave him the order to remove his suit as soon as Gagarin was strapped inside Vostok, recalled Titov's tension. Admittedly, Titov would fly Vostok 2 in a few months' time, but history would not recall the Second Cosmonaut with the same clarity as the First.

Much tradition surrounds Gagarin's trip to the pad, including, famously, his need to relieve himself through his suit's urine tube against the tyres of the bus. Unable to share the going-away custom of kissing three times on alternate cheeks, he and Titov merely clanked their helmets together in a sign of solidarity. Korolev gave Gagarin a tiny pentagon of metal – a duplicate of a plaque flown on the Luna 1 probe two years before – and wryly suggested that, someday, perhaps the First Cosmonaut could pick up the original from the Moon's dusty surface.

After reaching the top of the gantry, Gagarin manoeuvred himself into his ejection seat. Senior engineer Oleg Ivanovsky and chief test pilot Mark Gallai tightened his harnesses and plugged his suit hoses into Vostok's oxygen supply. After giving him a good-luck tap on his helmet, Ivanovsky motioned for Gagarin to lift his faceplate to inform him of three significant numbers.

Since the beginning of their adventure in space, the Soviets had operated their machines through on-board systems controlled exclusively from the ground and, for a time, considered that manned missions should be undertaken in the same way. What would happen, wondered the medical experts, if a cosmonaut went mad in orbit, overcome by a profound sense of separation from his home planet, or even attempted to defect to the west, deliberately bringing his capsule down onto foreign soil? Guidance, it was decided, must be automatic.

However, if the cosmonaut's sanity and devotion to the Motherland could be demonstrated, and if he needed to assume command, a six-digit keypad was provided to unlock Vostok's navigation system, disengage it from the automatic controls and

allow him to fly the ship. The three-digit combination for the keypad would be radioed to Gagarin if ground staff considered him sane enough to take over. Yet the logic was questionable: what would happen if Vostok lost attitude control or its radio went dead and communications were impossible? Instead, a face-saving measure was adopted, whereby the three-digit code would be kept in a sealed envelope aboard the spacecraft, ready for the cosmonaut to open if needed. Gagarin's ability to open the envelope, type in the numbers and activate the keypad would supposedly 'prove' that he had not lost his mind and was fully aware of his actions.

"It was a dangerous comedy," Ivanovsky recalled later, "part of the silly secrecy we had in those days." The envelope, though, had to be placed somewhere within easy reach, should he need to get to it in an emergency and a mentally unstable Gagarin could easily have opened it if he really wanted to do so. Mark Gallai, whose role included supervising the training of the Vostok cosmonauts, agreed, pointing out that all were qualified military pilots with experience of flying high-altitude, nighttime missions. The chance of them going mad was considerably less likely than suffering a radio failure. Consequently, betraying an official state secret and theoretically putting himself at risk of a lengthy prison spell, Ivanovsky told Gagarin the three digits: 1-2-5. To his surprise, the cosmonaut smiled and replied that Kamanin had already given him the combination!

Assisted by Tyuratam's chief of rocket troops, Vladimir Shapovalov, and two launch pad staff members, the next task for Ivanovsky and Gallai was to seal Gagarin inside his capsule for liftoff. At this point, a problem reared its head. A series of electrical contacts encircling Vostok's hatch should have registered a signal – known as 'KP-3' – to Korolev and his control team in the nearby blockhouse, informing them that it was secure. Furthermore, the signal was supposed to confirm that explosive charges around the hatch could jettison it at a millisecond's notice in the event of an emergency and enable Gagarin to eject. On the gantry, the contacts seemed fine and the enormous hatch – which "weighed about a hundred kilos and was a metre wide," according to Ivanovsky – was manhandled into place and the laborious process of screwing its 30 bolts began. No sooner had they finished, the launch pad's telephone rang. No KP-3 signal had been received, barked Korolev, and he demanded that they unscrew, remove, then reseal the hatch. After more fiddling, it was done. This time, thankfully, the KP-3 signal came back clearly.

It was now less than 40 minutes away from the projected 9:07 am launch. Ivanovsky, Gallai and the remaining personnel left the pad for the nearest control bunker. Vladimir Suvorov, determined to seize the most important photo opportunity of his career, stayed out in the open and would record some of the 20th century's most remarkable imagery as the first man headed into space. Elsewhere, Gherman Titov was midway through stripping off his own space suit and his neckpiece was halfway over his head when the attending technicians disappeared to watch the launch. Meanwhile, alone in his tiny capsule, the young Soviet Air Force senior lieutenant, who had celebrated his 27th birthday and the birth of his second daughter a few weeks earlier, could scarcely have believed that his humble, peasant-stock roots in the small Russian village of Klushino could possibly have brought him this far.

'STAR SAILORS'

A little more than a year earlier, Gagarin had been just one of hundreds of Soviet military pilots who received unusual instructions to undergo classified briefings and physical and psychological tests as part of an entirely new, and mysterious, aviation project. The search for the world's first spacefarers began 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 under the supervision of Vice-President Mstislav Keldysh to discuss methods of selecting the most suitable candidates for Earth-orbital missions. Aviators, rocketeers and even car racers were considered in the early days, but, at length, bowing to Soviet Air Force pressure, Keldysh agreed to narrow the selection criteria to qualified pilots from this branch of the military.

Despite its obvious vested interest in wanting to have 'its' fliers taking the first manned spacecraft beyond the atmosphere, the logic was inescapable: Soviet Air Force 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 admissible if they could meet the height and weight requirements of the Vostok spacecraft: they needed to be no taller than 1.75 m and weigh no more than 72 kg. Moreover, anticipating that they would be embarking on lengthy careers as 'cosmonauts' (the word literally means 'star sailor'), the age limit was set between 25–30 years old.

Throughout 1959, groups of physicians were sent to a number of air bases in the western Soviet Union and by August the selection teams had the records of more than 3,000 pilots ready for inspection. Most of these were eliminated at a fairly early stage, on the basis of not meeting the height, weight, age or medical criteria; some, indeed, were dropped for bronchitis, angina, gastritis and colitis, renal and hepatic colic and pathological cardiac shifts. The remainder were then systematically interviewed from early September, still unaware of exactly what the so-called 'special flights' project entailed. Three thousand soon became a little over two hundred, who were despatched in groups of about 20 for further tests at the Central Scientific Research Aviation Hospital in Moscow. In addition to more interviews, the candidates were spun in stationary seats to assess their vestibular apparatus, placed in low-pressure barometric chambers and wrung through a centrifuge to evaluate their performance under high-gravity loads. Original plans, it seemed, called for seven or eight pilots, but Sergei Korolev insisted on tripling this number, for no other reason than because he wanted a larger team than the United States' seven-strong Mercury group.

In January 1960, Konstantin Vershinin, commander-in-chief of the Soviet Air Force, formally signed plans to establish a centre for cosmonaut training in Moscow. Although it was under the control of physicians, the Air Force General Staff eventually assumed command of cosmonaut affairs, under Nikolai Kamanin. It was Kamanin who formally approved a final shortlist of 20 Air Force cosmonaut candidates in late February: Ivan Anikeev, Pavel Belyayev, Valentin Bondarenko, Valeri Bykovsky, Valentin Filatyev, Yuri Gagarin, Viktor Gorbato, Anatoli

Kartashov, Yevgeni Khrunov, Vladimir Komarov, Alexei Leonov, Grigori Nelyubov, Andrian Nikolayev, Pavel Popovich, Mars Rafikov, Georgi Shonin, Gherman Titov, Valentin Varlamov, Boris Volynov and Dmitri Zaikin. Their ages ran from just 23 in Bondarenko's case to as old as 34 in that of Belyayev; this criteria was waived in a couple of instances out of respect for their exemplary performance during testing. Some of them would become the most famous names in spaceflight history, whilst others would disappear into anonymity ... and, in a few cases, disgrace.

On 7 March, the 20 cosmonauts were given their welcoming speech by Vershinin at the Central Scientific Research Aviation Hospital. A week later, after settling their affairs at their respective air bases, they began training with Vladimir Yazdovsky's first class in aerospace medicine. The following four months were consumed by a mixture of in-depth lectures and an intense physical fitness regime, the latter of which included two hours daily of intensive calisthenics at the Central Army Stadium in Moscow. Parachute training was also conducted in the Saratov region, near Engels, using a converted An-2 aircraft and within six weeks each of the candidates had made between 40–50 jumps over water and land, from high and low altitudes and during daytime and nighttime.

It was partway through this training regime that the Air Force began exploring a number of more suitable sites for the cosmonauts to continue their preparations. Two possible places were identified: one in Balashikha and the other close to the Tsiolkovsky Railway Station in Shelkovo. The latter was eventually chosen in recognition of its isolated location, large area and proximity to Korolev's OKB-1 design bureau, the Academy of Sciences and the Monino airfield. The new cosmonauts and their training staff relocated to the new site at the end of June 1960 and the suburb itself, near Shchyolkovo, some 30 km north-east of Moscow, came to be known as Zelenyy ('Green'). Nowadays, it has become world-famous as 'Zvezdny Gorodok' (variously 'Star City' or 'Starry Township').

With the appearance of the new cosmonaut town came the development of the first spacecraft simulators in which they could work. Known as 'TDK-1' and built by the M.M. Gromov Flight Research Institute, it received its first trainees – Gagarin, Kartashov, Nikolayev, Popovich, Titov and Varlamov, nicknamed 'The Vanguard Six' – in the summer of 1960. The make-up of this group changed almost immediately, however, when a reddening was discovered on Kartashov's spine, diagnosed as haemorrhages and he was dropped from the Six. He was eventually dismissed from the cosmonaut team in April 1962. Shortly after Kartashov's removal, Varlamov was involved in a swimming accident in which he displaced a cervical vertebra and disqualified himself from consideration. Their places were taken by Bykovsky and Nelyubov. The 'new' Six formed a cadre who would vie for the chance to become the Soviet Union's first man in space. Indeed, with the exception of Nelyubov, they would fly five of the six Vostok missions. First among them, of course, was Yuri Gagarin, whom many cosmonauts felt had been a strong contender right from the first time he met Korolev. His journey to the stars had begun, rather strangely, as a child saboteur.

FARMBOY

After checking his safety, the boy crept over to a pile of Panzer batteries and began dropping fistfuls of soil into their accumulator caps. On other occasions, he might deliberately muddle up their chemicals, pouring them into the wrong compartments, so that SS commanders would return furiously to Klushino at nightfall to complain about their tanks' dead batteries. Sometimes, he would even shove potatoes deep inside the exhaust pipes of German military cars. It was the autumn of 1942. The Nazi invasion had begun a year before, but, after scoring several major successes, they had now been drawn so deep into Soviet territory that the harsh Russian winter prompted a lengthy retreat. The Smolensk district, some 160 km west of Moscow and containing Klushino, lay directly in the path of the Nazi fallback. It was here that the young boy, Yuri Alexeyevich Gagarin, born on 9 March 1934, saw war for the first time. Yet although his childlike attempts at sabotage certainly helped his village's struggle against the German occupiers, he didn't do it for patriotism. He did it to avenge himself on the Devil.

'The Devil' was a red-haired Bavarian known only as Albert, whose job included collecting flat batteries from German vehicles and replenishing them with acid and purified water. The Klushino children had already used broken glass to burst their tyres and, one day, in retaliation, Albert tried to murder Gagarin's younger brother, six-year-old Boris, by stringing him from an apple tree with a woollen scarf. The attempt failed, but Albert still managed to evict the entire family from their home. Later, the two elder Gagarin children were abducted and taken to Poland, their father was beaten and their mother slashed with a scythe. It was just the start of what Gagarin's fellow cosmonaut Alexei Leonov would later describe as "a very dark period for our country".

Following the expulsion of the Germans from Klushino in March 1944, the family eventually moved to nearby Gzhatsk, building a new home, and as Gagarin entered his teens he and Boris learned to read from Russian military manuals. However, it was witnessing a wartime dogfight between two Soviet Yak fighters and a pair of German Messerschmitts that kindled Gagarin's interest in aviation, garnered a fascination with mathematics and physics and led to model aircraft clubs and maddening demands for his father to build him miniature gliders. By 1950, he had applied – but was not accepted – to study at the College of Physical Culture in Leningrad, hoping to become a gymnast or sportsman. Instead, he took his second option as an apprentice foundryman at the Lyubertsy Steel Plant in Moscow. His work record led directly to training at the newly-built technical school in Saratov on the Volga River and, while there, he saw a notice for an aeroclub, which he promptly joined.

After graduating from Saratov in 1955, and by now with considerable flying experience in an antiquated Yak-18 trainer through the aeroclub, Gagarin was recommended by his instructor for the pilots' school in Orenburg. This required him to sign up as a Soviet Air Force cadet, which neither of his parents found particularly appealing, and one of his Orenburg instructors, Yadkar Akbulatov, considered him by no means a piloting prodigy and felt that Gagarin may have failed the school