SLAVA GEROVITCH

VOICES OF THE SOVIET SPACE PROGRAM

Cosmonauts, Soldiers, and Engineers Who Took the USSR into Space

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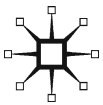

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To the memory of the polar explorer and space history enthusiast Valery Spitkovsky

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Acknowledgments

Interviews in this collection have been accumulated over several consecutive oral history projects. The first interviews were obtained during my trip to Russia in 2002 under the History of Recent Science and Technology (HRST) project, funded by the Sloan Foundation and the Dibner Institute for the History of Science and Technology. I am thankful to David Mindell, who led a historical study of the Apollo Guidance Computer under the HRST project and involved me in interviewing American space veterans, and then encouraged me to expand the study into the history of the Soviet space program. Two more trips to Russia in 2004 and 2006 were made under the projects, "Trusting the Machine: On-board Computing, Automation, and Human Control in the Soviet Space Program" (2003–2005) and "Designing a Cosmonaut: The Technopolitics of Automation in the Soviet Human Space Program" (2006–2007), funded by the National Science Foundation. Finally, in the years 2008–2010, additional interviews were collected, annotated, and prepared for publication under the project, "Oral History of the Soviet Space Program," supported by the NASA History Program.

I wish to thank William P. Barry, Steven J. Dick, and Stephen Garber at the NASA History Program, who provided both funds and patience that allowed me to complete this project, as it grew and changed shape over time. Roger Launius's outstanding scholarship and personal encouragement made the field of space history attractive to me. Cathleen Lewis kindly shared her deep knowledge of the Soviet space program; she also provided, along with an anonymous NASA reviewer, immensely helpful detailed comments on the first draft of this collection. In the preparation of this volume, scholarly exchanges with Igor Afanasyev, Jeffrey Hoffman, Andrew Jenks, Bettyann Kevles, Dmitry Payson, Eduard Proydakov, and John Tylko were extremely stimulating. My friend and colleague Asif Siddiqi traveled with me to Star City and participated in our joint interview with Vladimir Shatalov. This project greatly benefited from Asif's encouragement and generous sharing of his vast expertise.

I am very grateful to Mike Aperauch, Chris Chappell, and Kristin Purdy at Palgrave Macmillan, series editors Roger Launius and James Fleming, and the anonymous reviewers for their helpful suggestions and an audacious decision to include a volume of oral interviews in a series of history monographs.

This collection would not have appeared without the indefatigable efforts of the polar explorer and space history enthusiast Valery Spitkovsky. In the years 1961–1964, he worked at the Institute of Terrestrial Magnetism, Ionosphere and Radio Waves Propagation near Moscow and participated in several Arctic and Antarctic expeditions. In particular, he summered at Mirny Station in 1962 and wintered-over at Vostok Station in 1964.[1] In the years 1964–1973, he worked as a radio astronomer and telescope designer at Pulkovo Observatory near Leningrad (now St. Petersburg), serving one of the leading designers of the world's largest stand-alone radio telescope, the RATAN-600. In 1973 he joined the Moscow Scientific-Research Institute for Automatic Equipment (MNIIPA), where he designed mission control room equipment and trained personnel for the Soviet Strategic Missiles Forces and the space program. In 1977 Spitkovsky was offered a high-ranking position in a new missile defense program. By then, however, his political views had radically changed. He refused to work for the Soviet military and applied for an exit visa to emigrate. He was denied visa and remained a *refusenik* (a person denied permission to emigrate) under the tight control of the KGB for 12 years. Eventually, in 1989, after Mikhail Gorbachev's rise to power and several appeals from the Royal Society and a number of British political figures, Spitkovsky was allowed to leave the Soviet Union.[2] He came to the United States in 1990 and became an enthusiastic promoter of contacts between American and Soviet polar explorers and space veterans. In 2005 he organized the Pioneers of Space panel discussion at the Boston Museum of Science. In 2009 he initiated a public panel discussion on the prospects of establishing an Antarctic facility to serve as a training base for astronauts.[3] The astronaut Jeffrey Hoffman introduced me to Spitkovsky in May 2008, and I was immediately caught up in the whirl of his enthusiasm. On Valery's initiative, I undertook an oral history project to interview veterans whom Valery personally introduced to me, including Daron, Kolomiytsev, Krayzman, Meschansky, Ordyanskaya, and Safro. Valery tirelessly worked for the project, helping arrange interviews and collect historical documents and photographs. He urged me to interview space veterans while they were still alive and could tell their stories. Unfortunately he himself did not live to hold a printed copy of this book. He passed away on March 2, 2011. It is to his dear memory and to his ardent passion for space history that I dedicate this book.

Introduction

Multiple Perspectives on Soviet Space History

Instead of attempting to construct a single, "true" narrative of events that occurred in the Soviet space program, this book aspires to show the different perspectives of Soviet military officers, space engineers, and members of the cosmonaut corps. The interviews in this book contain a wealth of factual detail, but the focus is on the subjectivity of the experiences of Soviet space program participants. Secrecy restrictions limited their knowledge, institutional allegiances shaped their perspectives, and professional cultures formed their distinct collective identities. This book aims to capture this diversity of viewpoints; it stresses the multiplicity of perceptions of the same event by different participants. Together, these perspectives constitute a challenge to the idea of a master narrative of space history that privileges a limited set of "triumphs" and "tragedies" over the vast realm of the daily experience of space program participants.

The episode mentioned here from the history of the Soviet human space program illustrates a clash of memories, shaped by participants' distinct perspectives. On August 26, 1974, the Soviet spacecraft *Soyuz 15* was approaching the military orbital station *Almaz*, publicly disguised as a civilian station *Salyut 3*. The approach and docking were to be performed in the automatic mode, and the two-man crew, Commander Gennadiy Sarafanov and Flight Engineer Lev Demin, was busy monitoring the work of onboard systems. Suddenly, at a distance of 350 m from the station, the *Igla* rendezvous system on the *Soyuz* malfunctioned. It judged the distance of the spacecraft to be 20 km, and instead of slowing the *Soyuz* down, it issued a command to start acceleration. The *Soyuz* charged toward the station at 45 mph and missed it by barely 40 m. Two more attempts at automatic approach resulted in dangerous flybys. Due to the low level of remaining propellant, the crew had to return to Earth without completing the mission. Two of the three planned expeditions

to *Salyut 3* had to be canceled; without boosting from the *Soyuz* engines the station's orbit decayed, and soon it was lost.[1]

After the flight, a heated internal debate erupted over the responsibility for the failed mission. Engineers argued that the cosmonauts should have recognized the malfunction immediately and resorted to manual control. Officials responsible for cosmonaut training retorted that this type of emergency had not been anticipated and that the cosmonauts had not been trained for it. The investigation was further complicated by the fact that this failure occurred just a year before the scheduled docking of *Soyuz* with *Apollo*.[2] The American side, worried about the reliability of the Soviet rendezvous system, requested an explanation of the *Soyuz 15* incident. To gloss over the failure of the automatic rendezvous system, the Soviets preferred to put the blame on the cosmonauts—for not shutting down the malfunctioning system after the first failure. Both cosmonauts were officially reprimanded and never flew in space again.[3]

The mission was publicly declared a success, and detailed information about its failure was disclosed only 25 years later by Boris Chertok, the head of the control systems division of Energiya, the company that built the *Soyuz*. Between 1994 and 1999 he published four volumes of memoirs, filled with new revelations and presenting a sweeping and riveting account of the Soviet space program from its origins in the postwar years to the end of the Cold War. Well informed and engagingly told, these memoirs, however, were written entirely from the perspective of spacecraft designers from Energiya. Chertok alleged that the crew "didn't realize what was happening" and in the postflight report proposed "increasing the reliability of the human factor."[4]

In the absence of crucial archival sources, Chertok's memoirs, towering over other reminiscences in sheer size, richness of detail, and vividness of description, quickly became a major source for historical scholarship.[5] In today's Russia, reverence for patriarchal figures such as Chertok translates into unquestionable trust in their personal accounts. The entry on the *Soyuz 15* mission in the fundamental, 750-page-long Russian *Encyclopedia of Human Spaceflight*, for example, consists almost entirely of an extended quote from Chertok's memoirs. By letting an engineer tell his story unopposed, encyclopedia editors in effect presented a very partial view of that controversy, placing the blame on the crew.[6]

After the collapse of the Soviet Union, many cosmonauts began to speak publicly about previously hushed-up details of their missions, and an alternative version of the story of the *Soyuz 15* flight emerged. From the cosmonauts' perspective, "they evaluated the situation far more accurately than those who were on the ground," but did not receive the permission to switch to manual control. In their view, "the crew had nothing to reproach itself for." According to the cosmonauts, "a risk could be taken and they were ready to take the risk . . . But the ground decided

otherwise." The materials of the investigation commission remain inaccessible even to the *Soyuz 15* crew, leaving to the reader the task of reconciling two contradictory accounts.[7]

The recent publication of Chertok's memoirs in English, sponsored by NASA History Office, has made this very important source available to a much larger audience.[8] Asif Siddiqi, the editor of the English edition, has provided a very helpful introduction and commentary, placing Chertok's narrative in a wider context.[9] In the absence of other voices from the Soviet space program, however, Chertok's perspective may come to occupy a privileged position. This book attempts to address this issue by going beyond the circle of Energiya engineers and presenting diverse perspectives from a wide array of Soviet space program participants—engineers from rival design bureaus, military officers, flown cosmonauts and cosmonaut trainees, information technology specialists, and a physician.

On the subject of the *Soyuz 15* controversy, in particular, this book includes a testimony of the cosmonaut Vladimir Shatalov, who at that time served as assistant chief of the Air Force for preparation and support of space flights. Shatalov was at the Mission Control Center during the mission and took an active part in the discussions of the flight situation both at the State Commission and with the flight control group. His emotional recall of the story, of how he "almost teared up" at one moment, challenges Chertok's account in several important aspects. An interview with the cosmonaut candidate and space historian Valentina Ponomareva also included in this collection places the *Soyuz 15* mission in the larger context of discussions regarding automation and human control in the Soviet space program. Although the final settlement of the controversy may have to await the opening of archival sources, these two new perspectives complement Chertok's account and add rich detail and complexity to the story of the *Soyuz 15* mission. This story, a fascinating tale of a space crew caught between malfunctioning technology and risk-averse ground control, reveals much about the role of power relations in shaping the operations of complex human-machine systems.

The Soviet master narrative reduced space history to a set of clichés: flawless cosmonauts, inspired by Communist ideals, flew perfect missions, supported by unfailing technology, proving the superiority of Soviet science and engineering and, by implication, of the Soviet way of life.[10] All contingencies, failures, and alternative paths were thoroughly purged from Soviet history books. Entire programs, such as the human lunar program, were passed over in silence. While Soviet propaganda cultivated an idealized image of the space program for ideological purposes, the leaders of the space program had their own reasons for deemphasizing failures and contingencies before decision makers in the high echelons of Soviet power.[11] Deals were made behind the scenes to

exclude damaging evidence from reports submitted to the top. For example, the criticism concerning serious flaws in spacecraft design, which had endangered the *Voskhod 2* mission, was dropped from the mission report in exchange for removing criticism about the crew, who had violated prescribed procedures.[12]

Individual memories that could not fit into the master narrative did not disappear. Beneath the glossy surface of official history, a myriad of private stories circulated informally, and they shaped an oral tradition totally different from written accounts. Historians have traditionally associated such "counter memories in the very shadow of the official history" with groups that are "excluded or overlooked."[13] In the Soviet space program, by contrast, the groups that secretly cultivated such "counter memories" were at the front and center in official history: the space engineers and the cosmonauts. They were privy to information carefully concealed from the average Soviet citizen, and they preserved and passed on their memories as part of professional folklore. Telling and listening to the "true stories" of events hashed up or distorted in official accounts became an essential part of their group culture, a part of being a space engineer or a cosmonaut. Countermemory defined their private identity as much as the master narrative shaped their public persona.[14]

The tensions that brewed under the lid of the master narrative over decades eventually came to surface as the policy of glasnost (openness) during Gorbachev's perestroika gave voice to the suppressed countermemories. "The single narrative of Soviet space history," Siddiqi writes, "fractured into multiple and parallel narratives full of doubt (for the claimed successes of the program), drama (for the episodes we never knew about) and debate (over contesting narratives of history)."[15] Veteran engineers, cosmonauts, and politicians began to tell stories of multiple failures during Soviet space missions, fatal errors and true heroism, favoritism in project funding, and hidden pressures to launch by a politically motivated date.

The collapse of the Soviet Union, as the Russian state largely withdrew both its economic support for the space industry and its ideological oversight over historical discourse, became a truly traumatic event for the historical memory of the Space Age. This trauma resulted in a systematic transformation of the memory of all previous Soviet space history. The memory of the Space Age became atomized and decentralized, or, in Siddiqi's expression, "privatized" along with Russian industry itself. Trying to attract Western investors and clients, Russian space companies began advertising their history, challenging the claims of rival Russian companies, and placing their own accomplishments in the best possible light.[16] Even though these accounts purported to articulate "countermemory"—an alternative to the official story line—they

in fact showed a craving for a Soviet-style single master narrative that would elevate a particular chief designer—be it Sergey Korolev, Valentin Glushko, or Vladimir Chelomey—above others. "Countermemory" ended up reproducing the same stereotypes of the master narrative, for it still served a propaganda purpose—if not for the central government, then for a particular group within the space industry.[17]

The recent nostalgic turn to Soviet-era symbols of national greatness and pride has raised the Soviet space program to a new pedestal, making it the cornerstone of a new, nationalist master narrative. Gagarin's pioneering flight—the pinnacle of the Soviet space program—often stands as an emblem of the historical heritage that the Russians could really be proud of, despite the trauma of losing the superpower status. Both Russian government officials and critics of the government reach out to space history in support of their claims. Some critics, dismayed by the spirit of ruthless capitalism, long for Soviet-era values, epitomized by the space program. Government officials, on the other hand, are eager to draw political legitimacy by portraying themselves as heirs to Soviet space glory.[18]

The memoirs of space program participants—from the Soviet era to the perestroika to the post-Soviet period—reflect an adaptation of individual memory to a specific historical context.[19] An oft-cited memoir by the space engineer Oleg Ivanovskiy went through multiple editions from 1970 to 2005.[20] Ivanovskiy worked under Chief Designer Sergey Korolev, oversaw the production, testing, and preparation of Gagarin's spacecraft, and was later promoted to become the head of the space industry department of the Military-Industrial Commission, the top government body overseeing the space program. The early editions of his memoirs were published under the pseudonym Ivanov; he created a hagiographic image of Korolev and wrote about other leading space engineers, but could not reveal their true names. In the 1980s, he added their real names but did not change the Korolev-centered perspective. In none of the editions, even in the post-Soviet period, did he reveal any detail about his work at the Military-Industrial Commission, the epicenter of internal debates over space policy and mission planning. In the latest edition, Ivanovskiy still did not venture to criticize some of the Soviet government leaders overseeing the space program. Instead, he quoted from the published diary of the Air Force official Nikolay Kamanin, who was blunt in his (private) criticism. "Although he did not write about me, I must quote his thoughts," commented Ivanovskiy.[21] The three-page section on this period of his life is filled entirely with quotations from other people's memoirs and diaries. Conditioned by secrecy restrictions, habitual silence about controversial matters, and conscious self-censorship, the world of personal memory becomes self-referential. Ivanovskiy did openly what others do implicitly or even unconsciously—he presented other people's

memories as his own. The "contamination" of private memories by state-sponsored narratives and other cultural forces has been thoroughly examined by the discipline of memory studies.[22]

This book draws on the tradition of oral history, which is quite distinct from memory studies. While historians working within the framework of memory studies focus on social and cultural factors, they often leave out the question of the relationship between the individual and the group in practices of remembrance. Memory scholarship tends to focus on major transformative events in national history, while oral history is often concerned with individual life stories. Using Jan Assmann's terms, one might say that historians of memory have largely been interested in *cultural memory* (socially sanctioned remembrance, mediated by texts, symbols, and performances) than in *communicative memory* ("living, embodied," autobiographical memory).[23] Memory studies often overlook "much of the more reflective work done by oral historians about the dynamic nature of remembering, gaps or silences in the transmission of memory, the collapsing of past and present in individual recall, and people's sense of 'living in time' or historical consciousness."[24] Oral historians, on the other hand, tend to impose a narrative structure on an individual's life experiences at the expense of analysis of social and cultural forces that shaped the narrator's subjectivity. They often "privilege the individual narrator and focus necessarily on his/her agency in the world, an approach that too often fetishizes the interview process and fails to understand the interview as but one form of memory-making."[25]

Lacking access to still largely classified archival sources, space historians tend to focus on oral history as a source of factual knowledge, especially about those events in space history where no documentary evidence is available. From this perspective, inaccuracies, slips, and omissions in oral recollections are often regarded as inevitable "noise" in the transmission of useful signal. Yet the mechanism of memory is not random. As Alessandro Portelli has suggested in an oft-quoted phrase, "errors, inventions, and myths lead us through and beyond facts to their meanings."[26] Space history myths should not be seen merely as distorted memories. It is precisely these "distortions," embellished and perpetuated in the folklore of rocket engineers, cosmonauts, and other space professionals, that give these groups their unique character and distinct perspective. One's personal memories often reveal more about one's professional identity than about one's past. By shifting the focus from debunking myths to examining their origins, we can understand memory as a dynamic cultural force, not a static snapshot of the past.[27]

The view of oral history as a window into the collective identity of Soviet space program participants defined the organization and structure of this volume. It includes perspectives from a wide variety of

sources from all walks of Soviet space life: military officers, construction engineers, designers from different companies with distinct engineering cultures, specialists on human-machine systems, famous cosmonauts, virtually unknown cosmonaut trainees who never got a chance to fly in space, and psychiatrists dealing with cosmonauts' complex emotional states. This book includes interviews obtained by Slava Gerovitch in Russia and in the United States in 2002–2010.

The interviews are arranged in several groups by profession: the military, the space engineers, and the cosmonauts. The first group includes interviews with military officers who served in the Soviet rocket-space complex. Indeed, this complex was a unified entity, as the Soviet space enterprise emerged as an offshoot of the intercontinental ballistic missiles program. The same design bureaus that designed missiles modified them as space launchers, and the early spacecraft for human flights were designed in conjunction with the development of spy satellites. Soviet space boosters and spacecraft were produced in the same factories that made missiles and equipment for them; space testing and launch facilities were serviced by the Soviet Missile Forces and used for test-launching missiles. Space engineers were always surrounded by military personnel: by detachments servicing the launch facility, by military specialists testing rocket and spacecraft equipment, and by military's top brass supervising launches. The professional culture of space engineers became permeated with the spirit and values of the military.[28] Most cosmonauts were on active military duty. It is important therefore to glimpse into the world of the Soviet military, with its distinct cultural norms.

The two military interviewees are Colonel Engineer Abram Krayzman and First Lieutenant Sergey Safro. Krayzman was chief of the Technical Division and deputy chief of staff for technical intelligence at the Special Purpose Brigade of the Reserve of the Supreme Commander-in-Chief in the Soviet occupation force in Germany in the wake of World War II. He worked closely with the future chief designer Sergey Korolev and other leading rocketry specialists who participated in the top-secret Soviet mission to acquire German rocketry hardware and know-how. Krayzman commanded the train that took rocketry hardware from Germany to the Soviet Union, and in the interview he provides rare details about the composition of that train, as well as personal recollections about Korolev.[29]

Safro worked at the Tyuratam (Baykonur) launch site as a military construction officer in the early 1960s. In his interview, he talks about the grueling conditions in which military construction units had to live and work. Working in a desolate place drove some to drink and infidelity, while others read books voraciously and began questioning the ideological tenets of the Soviet regime. Safro's story illustrates a social mechanism of turning loyal Soviet citizens into dissenters. Partly out

of boredom, partly due to a lack of other means to channel his complaints, he began pushing the boundaries of permissible political action and gradually came to direct confrontation with the authorities.[30]

The second group of interviews offers perspectives of space engineers who worked at various Soviet design bureaus. The heads of these bureaus—the chief designers Sergey Korolev, Valentin Glushko, Vladimir Chelomey, Nikolay Pilyugin, and Mikhail Ryazanskiy—were responsible for various aspects of rocket and spacecraft design, from rocket engines to control systems to overall integration. All major Soviet space programs involved some form of collaboration and, occasionally, competition among these bureaus. Each chief designer was a powerful intellect and a skillful administrator, and each instilled a particular engineering culture at his bureau. The culture of Korolev's Special Design Bureau No. 1 (OKB-1) has been discussed extensively in memoirs by Chertok and many other engineers from Korolev's firm.[31] This collection focuses on other major space design bureaus. Each interviewee provides a glimpse of the specific engineering practices at their institutions.[32]

Anatoliy Daron was the lead designer of the rocket engines for the R-7/*Sputnik/Vostok/Soyuz* rocket, for the R-9 ICBM, and for the UR-700 lunar rocket. For 50 years, he worked as the lead designer and head of the design department at the Experimental Design Bureau No. 456 (OKB-456) led by Chief Designer Glushko. He regularly participated in top-level meetings of the Council of Chief Designers. Daron also served on the committee that developed regulations for cosmonaut selection and training and on numerous technical panels and accident-investigation committees. He sheds light on many "blank spots" in Soviet space history, for example, on the question of German know-how and the originality of Soviet designs of liquid propellant engines, on the notorious dispute between Chief Designers Korolev and Glushko, on the failings of the design and testing of the N1 lunar rocket, and on the cancellation of the UR-700 project. Daron offers a shrewd analysis of the reasons for the overall failure of the Soviet manned lunar program.[33]

Sergei Khrushchev worked on guidance systems for ballistic and cruise missiles, military and research spacecraft, moon vehicles, and the Proton booster rocket at the Joint Design Bureau No. 52 (OKB-52), led by General Designer Chelomey. Sergei Khrushchev, the son of the Soviet leader Nikita Khrushchev, offers a unique perspective, combining both an awareness of some high-level government discussions and a first-hand knowledge of the organizational and decision-making mechanisms at Chelomey's bureau. Complementing his account in published memoirs, Khrushchev reveals a complex web of relationships within Chelomey's design bureau, discusses the shifting priorities of OKB-52, and comments on Korolev's and Chelomey's personalities and management styles.[34]

Georgiy Priss worked on rocket guidance systems since 1948, first at the Scientific-Research Institute No. 885 (NII-885), led by Chief Designer Ryazanskiy, and later at the Scientific-Research Institute of Automatics and Instrument Building (NII AP), headed by Chief Designer Nikolay Pilyugin. Priss worked on gyroscopic equipment for the first Soviet rockets, served as the principal integration engineer designing control systems for the R-5 and the R-7 rockets, and was the principal developer of control systems for the N1 lunar rocket and the Buran projects. Reflecting on the engineering culture of Pilyugin's institute, Priss stresses the originality of Soviet design solutions and the constraints imposed by economic and institutional factors.[35]

Felix Meschansky worked as a radio communications specialist at various research institutions, including Ryazanskiy's NII-885. Meschansky became the founder of a new field of applied geodesy for radio communications and played an active part in the development of deep space communication antennas for the Soviet Deep Space Tracking Network. He explains several incidents of communication failure during space missions and brings out the contrast in the personalities of Chief Designers Korolev and Ryazanskiy.[36]

This group also includes interviews with information technology specialists. The design of control systems, both automatic and manual, was not merely a technical issue. It involved debates about the role of automatics on board, the division of function between manual and automatic control systems, and more broadly human-machine issues in spaceflight. These debates played an important role in shaping the direction of the Soviet space program and reflected serious tensions between different professional groups. The development of onboard computers, in particular, gave control systems engineers greater flexibility in deciding whether to automate control functions or to provide cosmonauts with a wider range of manual control options. Though they seemed purely technical, such decisions had profound implications for the role of cosmonauts in space missions and ultimately for the balance of power between the engineers and the cosmonauts within the Soviet space program. The development of information processing and display systems was therefore fraught with larger issues of responsibility, authority, and power.[37] The interviews with information technology specialists in this collection address both technical and social issues related to the development of control systems on Soviet rockets and spacecraft.

Yuriy Tyapchenko led the design, testing, and support of onboard information display systems (IDS) for Soviet piloted spacecraft at the Specialized Experimental Design Bureau led by Chief Designer Sergey Darevskiy. Tyapchenko participated in or supervised the development of IDS for *Vostok 2, Voskhod, Voskhod 3KV-6, Soyuz 7K/T/TM*, *Almaz*, *Salyut*, *Buran*, *Mir* space station, the International Space Station, and

the modernized piloted spacecraft *Soyuz TMA*. He also led the work on simulators for the *Soyuz 7K*, *Zond*, and N1-L3 programs. He speaks about the development of IDS, an essential part of the manual control system, in the context of relations among three groups—the IDS specialists, the systems engineers, and the cosmonauts.[38]

Without the use of onboard computers, the implementation of the human lunar program would have been impossible. Lagging behind the United States in electronics, the Soviet Union faced a serious technological challenge to develop small, reliable, low-weight computers for missiles, space boosters, and spacecraft. Viktor Przhiyalkovskiy was the chief designer of the Argon series of onboard computers at the Scientific Research Center for Electronic Computer Technology in Moscow. Argon computers were widely used on Soviet spacecraft and space stations. Przhiyalkovskiy discusses original Soviet hardware solutions, the relations between computer designers and space systems integrators, and the gap between military and civilian computing in the Soviet Union. Contrary to the common Western view of Soviet onboard computers as unreliable, he asserts the high reliability of Argon computers.[39]

The last group includes interviews with flown cosmonauts and cosmonaut trainees. The ratio of flown to unflown cosmonauts steadily decreased over time. Out of the first, Gagarin's cosmonaut group of 20, more than a half, 12 cosmonauts, flew in space. In the second selection of 1963, 8 out of 16 cosmonauts flew. In the third selection (1965), 7 out of 22 flew; in the fourth (1967), only 3 out of 12. The women's group had the worst ratio: out of 5 women selected in 1962, only 1 flew in space. The interviews included in this collection cover a wide range of issues, from the details of specific missions to the vicissitudes of crew selection to the fate of the cosmonaut trainees who never had a chance to realize their dream. The diverse professional backgrounds of the interviewees—a pilot, a military engineer, a scientist, and an aviation engineer—demonstrate what the Soviet cosmonaut corps might have looked like if the crew selection process was organized differently. As it happened, only one of the interviewees, a pilot, actually flew in space, which is reflective of a general trend in Soviet cosmonautics.

Vladimir Shatalov commanded the *Soyuz 4* mission and successfully performed the first manual docking of two piloted spacecraft in 1969. The same year he commanded the joint *Soyuz 6–7–8* mission, during which *Soyuz 7* and *Soyuz 8* spacecraft failed to approach due to a malfunction of the rendezvous control system. In 1971 he commanded the *Soyuz 10* mission to the *Salyut* space station, but failed to dock with the station due to a malfunction of the docking mechanism. In this interview, Shatalov discusses details of cosmonaut selection and training and provides his analysis of the causes of failures of his last two missions. In the period between 1971 and 1986, Shatalov served

as assistant chief of the Air Force for preparation and support of space flights. He supervised the selection and training of Soviet cosmonauts and the operations of the Cosmonaut Training Center. In this position Shatalov, in his own words, was "caught between a rock and a hard place," adroitly maneuvering among Party officials, chief designers, and his military superiors.[40]

Mikhail Burdayev trained under the *Soyuz VI* program, the *Almaz* program, and the *Salyut* program for flights on *Soyuz 7K-S* and *Soyuz 7K-T*. He also participated in flight control operations and served as a shift leader of the mission control group at the Cosmonaut Training Center. He never flew in space and embarked instead on a science career. Burdayev became a leading specialist on the mechanics of spaceflight. His interview sheds light on the relations between different groups of cosmonaut trainees, the conflicting interests involved in crew selection, and the cultural and ethical norms of the cosmonaut corps.[41]

Ordinard Kolomiytsev, a scientist at the Institute of Earth Magnetism, Ionosphere, and Radio Wave Propagation (IZMIRAN) of the Academy of Sciences, participated in several Antarctic research expeditions and trained for spaceflight as part of the Academy of Sciences cosmonaut group. As none of the Soviet scientist cosmonauts was allowed to fly in space, the research outcome of the Soviet space enterprise was adversely affected. While rejecting a purely political explanation, Kolomiytsev acknowledges the lack of support from the Academy of Sciences leading to the disbandment of his cosmonaut group and the decline of the research component of the space program. Soon after the interview was transcribed and its text sent to the interviewee for approval, Kolomiytsev expanded this text into a short book of memoirs, which has just come out in Russia.[42] He gratefully acknowledged that the interview stimulated him to work on his memoirs.[43]

Valentina Ponomareva trained for the *Vostok 6* mission and served as Valentina Tereshkova's second backup. Ponomareva later trained to be the commander of a planned all-women, 10–20-day *Voskhod* mission with a space walk, but the mission was cancelled, and Ponomareva never flew in space. She became a space historian, and in her interview she reflects on the vicissitudes and fate of her group of female cosmonauts and offers an analysis of what she views as excessive automation and the lack of trust by the engineers in the capabilities of the cosmonauts.[44]

The last interview is with Ada Ordyanskaya, who worked at the Scientific-Research Institute of Psychiatry of the Russian Federation Ministry of Health in Moscow. It provides a rare glimpse into the Soviet practices of dealing with stressful situations during space missions. As a leading specialist in schizophrenia psychotherapy, stressful state relief, and suicide prevention, she was consulted by researchers from the Institute of Biomedical Problems, the Soviet center for space

medicine, on several occasions. She gives some details about such cases, involving anxiety attacks and tense interpersonal relations among space crews. The fact that a cosmonaut's wife was permitted to participate in a communication session with him only as a therapeutic measure on a doctor's advice speaks volumes about the routine Soviet practices of mission control.[45]

Several themes surface time and again in the interviews: institutional rivalries, the clash of engineering cultures of aviation and rocketry, the tensions between the space industry and the cosmonaut corps, the debates over the division of function between human and machine, secrecy restrictions, and the competition with the United States. The organizational structure of the Soviet space industry, based on personal patronage more than on any explicit institutional subordination, facilitated fierce institutional rivalries—in particular, those involving the design bureaus led by the chief designers Korolev, Chelomey, and Yangel. Personal conflicts among leading figures, such as Korolev and Glushko, or Ustinov and Chelomey, further complicated the Byzantine world of Soviet rocket and space industry. Interviews in this collection shed light on these rivalries and conflicts from various perspectives, giving voice to different sides. For example, contrasting assessments of Chelomey and Korolev vividly represent the tension between the two camps, highlighting not only differences in personalities of the two chief designers, but also their different approaches to design, rooted in the distinct engineering cultures of aviation and rocketry.

According to the interviews with cosmonauts in this collection, the balance of power in the Soviet space program between the space industry and the cosmonaut corps was clearly tilted in favor of the industry. The top decision-making body for spaceflight—the Military-Industrial Commission—the occasional government commissions for specific flights, and the flight control groups were dominated by engineers and the military brass, leaving the members of the cosmonaut corps almost voiceless in policy discussions. Vladimir Shatalov's interview, recounting several instances of conflict between the engineers and the cosmonauts, gives a rare insight into the inner tensions that shaped Soviet space policy overall as well as decision making during specific missions.

The debates over the division of function between human and machine, the role of the cosmonauts in controlling spacecraft, and the impact of onboard computing on enabling or limiting crew's options are at the center of several interviews with control and information system designers and cosmonauts. While Georgiy Priss, expressing the engineers' typical view, argues that the machine thinks and executes commands faster that the cosmonaut, the interviews with cosmonauts uniformly stress the advantages provided by human expertise and ability to evaluate and act in extraordinary situations.

Restrictions on the circulation of information heavily shaped the secretive nature of the Soviet space program. Several interviewees mention that they did not know about Gagarin's impending launch, even though they worked for the space industry. Secrecy not only cut off the space program from Soviet society, masking real tensions with glossy covers; it also imposed rigid patterns on communication between the crew and the ground and on discussions among the engineers. As Valentina Ponomareva explains, a special coded language was invented for cosmonauts, who had to report a "thunderstorm" in case of ill health and to describe onboard malfunctions in the terminology of botany. The engineers, in turn, never uttered the words *rocket* or *spacecraft* even in internal discussions, replacing them with the neutral terms *izdeliye* (product) or *obyekt* (object). This habit became so ingrained that several contributors to this collection continued using these terms in their interviews, many years after they had left the space program. Secrecy shaped their professional jargon and became an integral part of their engineering culture. In this collection, Vladimir Shatalov describes how pervasive secrecy inhibited international collaboration, contrasting Soviet and American regulations in this area.

The competition with the United States was on the mind of both the engineers and the cosmonauts, not to mention the Soviet military. Several institutions were involved in systematic collection of information from open US sources and its distribution in the Soviet space industry. According to Sergei Khrushchev, space engineers also received intelligence information, though he denies its value. Other engineers suggest that copying American technology was neither feasible nor desirable—both because of different industry standards and because this would have stifled further development. Many interviewees, however, cite instances when specific policy decisions were made or specific missions were scheduled based on information about American plans.

The interviews in this collection often touch upon topics going beyond the immediate professional concerns of the interviewees—their family lives, cultural trends, and political developments. Recurring topics are ethnicity, gender, generational differences, the negotiation of the boundary between the public and the private, and the complex interplay of the socialist ideals and cynical practices of the Soviet regime. The interviews provide vivid accounts of everyday life in the Soviet space program—its hardships and joys, political and social pressures, and coping strategies.

Several interviewees tell stories of tacit anti-Semitic policies. One was fired during a state-sponsored purge of Jewish intelligentsia in the early 1950s; another faced discrimination at university admission and graduation in the late 1950s. The interviews indicate that such widespread but unspoken policies were sometimes circumvented—either by a skillful use

of political rhetoric or when qualified candidates were urgently needed—and dubious spots in their records were ignored.[46]

Despite the official Soviet declaration of gender equality, the Soviet space program was heavily male dominated. Interviews in this collection highlight the tension underlying attitudes toward gender. Women's flights were promoted by some leaders of the space program and opposed by others, reflecting a tension between catering to propaganda needs and upholding a traditional patriarchal system of values. While women were given an opportunity to train for space flight, they felt pressure to "be like everybody else" and to join the military, like their male colleagues. At remote rocket and space installations, run by the military, women had very limited professional opportunities.[47]

Interviewees also draw attention to the generational differences among the space engineers and within the cosmonaut corps. They often contrast two cohorts of engineers—the powerful personalities of Stalin-era general designers and the more pragmatic and flexible technical specialists of the Khrushchev and Brezhnev periods. Interviewees also describe tensions between different groups of cosmonauts—the first group of celebrated pioneers of space and the subsequent generations of more technically and scientifically educated cosmonauts, whose opportunities for flights, however, were often curtailed by their influential predecessors. Such generational tensions might be traced to a larger shift in Soviet society, connected to the rise of the Soviet "Baby Boomers."[48]

Interviews shed light on the complex interplay of private and public worlds in the lives of space program participants. The rocket and space engineers, the elite of the Soviet engineering corps, provided critical military and propaganda support for the Soviet regime while living in complete secrecy and obscurity. The cosmonauts painfully divided their identity between the public limelight of propaganda trips and the closed world of military service and cosmonaut training. Their personal lives were never completely private, often subjected to monitoring and regulation as their political loyalty and moral impeccability were as important for flight selection as professional skills.[49]

Both cosmonauts and engineers defy the simplistic labels of "believers" or "non-believers" in Soviet ideology. Their declaration of lofty goals was often paradoxically combined with adroit maneuvering and skillful manipulation of the economies of favor and prestige.[50] Like many other Soviet citizens, they shared abstract socialist values while acknowledging the corruption of the regime at the local level and took a cynical attitude toward official rhetoric.[51]

The mosaic of these interviews, coming from different professional groups in the Soviet space program, both adds factual detail to our knowledge of Soviet space history and illustrates the diversity of opinion

among program participants. The interviews discuss specific engineering challenges in the development of major rocket engines and onboard systems, and they also present a rare behind-the-scenes account of several failed missions and postflight investigations. More importantly, however, they present the human face of the Soviet space program—not the glossy smile of well-groomed cosmonaut heroes, but the deep wrinkles on the sunburned faces of the military, the gray hair of engineers burdened with anxiety over a failed launch, and the tired, but hopeful smile of a cosmonaut trainee after another day of exhausting tests, waiting patiently for a mission assignment that may or may not happen.