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Reconsidering Sputnik

Forty Years Since the Soviet Satellite

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CHAPTER 2

Korolev, Sputnik, and the International Geophysical Year

Asif A. Siddiqi

From the perspective of historical inquiry, the institutional and political machinations behind the genesis of Sputnik have remained a largely ignored area of scholarship. Embellished by speculation and fueled by Soviet secrecy, the story behind Sputnik has assumed the form of a parable, cobbled together from rumors and mythology, and colored by an eagerness to fill in the blanks of what we did not know. Thus, while the post-mortem effects of Sputnik have been the subject of much scholarly debate, the origins and motivations that led to the launch of the first artificial satellite have remained, to a large degree, in the realm of conjecture. In recent years, with the dissolution of the Soviet state in 1991, mythology came into confrontation with reality. Declassified primary documents have provided a rich resource and incentive to look back again at an event which had such a profound impact on the course of events in the latter part of the twentieth century.

MYTHS

In ... *The Heavens and the Earth*, a seminal contribution to the understanding of the political history of the space era, author Walter A. McDougall creates a masterful tapestry of the political dynamics between the two superpowers both before and after the launch of Sputnik. But the event itself is consigned to a three-page account constructed from Western sources which themselves were based on hearsay and speculation.[1] Thus, even the mythology of Sputnik was at best a skeleton of a story. We knew when it was launched, what it looked like, and possibly who built it, but not much else. Thus, almost by default, in the historiography of space exploration, the Soviet space

program, and indeed the so-called "space race," was said to have begun on October 4, 1957. One of the most entrenched paradigms of this history was that Sputnik was a political tool to demonstrate Soviet superiority in a new domain. James E. Oberg, one of the more ubiquitous followers of the former Soviet space program, wrote in his landmark 1981 book *Red Star In Orbit*:

> In the light of ... domestic and international problems [the] proposal for a Soviet artificial satellite ... suddenly became much more attractive to Khrushchev. First, it would signal to dissident political forces within the Soviet Union that Khrushchev was really leading the country to a glorious future; second, it would overawe the traditionalist "artillery generals" in the Red Army and allow a reorganization of the armed forces, including a reduction in obsolete ground forces ...; last, it would demonstrate in an unequivocal manner the existence of the long-range missile system, which was intended to discourage potential attack from the United States. Under these circumstances, what had first appeared to be a pointless diversion of technical resources suddenly became—as far as Khrushchev personally was concerned—a powerful idea ... "in the summer of 1957, the Central Committee ... finally endorsed the project." It should be noted that neither science nor world opinion seems to have entered into consideration.[2]

With the collapse of the Soviet Union and the opening of the archives, there has been an undue eagerness to engage in revisionism, especially vis-á-vis the view from the Soviet side. But in looking at the genesis of Sputnik, the "old" paradigms require a second look. Was Khrushchev personally involved in seeing the project through completion? If so, what were his motives? Did the International Geophysical Year play a role in the launch of Sputnik? On a larger level, did the space race really begin on October 4, 1957? Why did the Soviets launch Sputnik when they did? In looking at Sputnik's birth, was mythology the same as history?

CONCEPTION

In the pantheon of Soviet space historiography, one man's name stands out in both Western and Soviet scholarship, that of Sergey Pavlovich Korolev. Often called the founder of the Soviet space program, his contributions to the emergence of the Soviet Union as a space-faring nation have been amply chronicled in recent years, culminating in an 800-page *magnum opus* published in Russia in 1994.[3] Korolev had

become absorbed in dreams of space exploration during his short tenure as a member and eventual leader of an amateur Soviet rocketry group in the early 1930s.[4] Lesser well-known is the name of Mikhail Klavdiyevich Tikhonravov, another former glider pilot who worked with Korolev in the 1930s building the first Soviet liquid-propellant rockets. Their paths diverged during World War II and in its aftermath they were working in different institutions, both contributing to the new long-range ballistic missile effort. Korolev had the auspicious title of "Chief Designer," by dint of his official role as head of the Department No. 3 of the Specialized Design Bureau at the Scientific Research Institute No. 88 ("NII-88" in its Russian abbreviation).[5] Stalin had established the NII-88 (pronounced *nee-88*) in 1946 to serve as the leading engineering organization in Soviet industry to develop long-range missiles.

During the following decade, Korolev's department, which eventually became an independent organization, the Experimental Design Bureau No. 1 (OKB-1), focused efforts on developing a series of ballistic missiles for the Soviet armed forces. Since the primary thematic thrust of Korolev's group was military missiles, there was negligible work on projects which had purely scientific utility. Dedicated wholly to the grand ideals of space exploration, Korolev did make a few spurious efforts to interest the leadership in artificial satellites in the late 1940s, but none of these ever proved to have any results until he combined his lobbying with Tikhonravov's independent work at the NII-4 ("nee-4"), an unrelated military institution dedicated to research on applications of ballistic missiles. After authoring several important R&D reports on the possibility of space launch vehicles and artificial satellites in the late 1940s and early 1950s, Tikhonravov emerged in 1954 with a detailed technical exposition entitled "Report on an Artificial Satellite of the Earth."[6]

It was at the same time, on May 20, 1954, that the Soviet government formally tasked Korolev's Design Bureau to develop the first Soviet intercontinental ballistic missile (ICBM), the R-7. Korolev did not waste time. Just seven days later, he sent Tikhonravov's satellite report to the Soviet government with an attached cover letter stating:

> I draw your attention to the memorandum of Comrade M. K. Tikhonravov, "Report on an Artificial Satellite of the Earth," and also to the forwarded materials from the U.S.A. on work being carried out in this field. The current

development of a new product [the R-7 ICBM] makes it possible for us to speak of the possibility of developing in the near future an artificial satellite ... It seems to me that in the present time there is the opportunity ... for carrying out the initial exploratory work on a satellite and more detailed work on complex problems involved with this goal. We await your decision.[7]

If Korolev's goal was to elicit a formal decree for his proposal, his appeal was not very successful. However, his request appears to have been passed on through various levels of the government and reached the office of missile and nuclear industry chief Vyecheslav A. Malyshev, officially the Minister of Medium Machine Building. Prompted by Korolev's persuasive arguments, Malyshev, along with three other top defense industry officials, submitted a proposal to Soviet leader Georgiy M. Malenkov asking permission to carry out "work on the scientific-theoretical questions associated with space flight."[8] No doubt interested in the military applications of Tikhonravov's satellite, Malenkov approved the idea. Armed with a modicum of support, Korolev commenced a modest research project at his Design Bureau coordinated with Tikhonravov's own work at the NII-4. Incredibly, as this research was ongoing, the satellite issue remained divorced from further governmental involvement, as Korolev was diverted to more important matters relating to work on military missiles such as the R-7 ICBM. It was, however, the very first intervention by the Soviet government on an issue related to space exploration.

Korolev's satellite work may have continued at a leisurely pace through the mid-1950s with lukewarm governmental support were it not for some surprising and well-publicized events outside of the USSR. In the spring of 1950, a group of American scientists led by James van Allen met in Silver Spring, Maryland, to discuss the possibility of an international scientific program to study the upper atmosphere and outer space via sounding rockets, balloons, and ground observations. Strong support from Western European scientists allowed the idea to expand into a worldwide program timed to coincide with a period of intense solar activity, July 1, 1957 to December 31, 1958. The participants named this period the International Geophysical Year (IGY) and created the *Comité speciale de l'année géophysique internationale* (the "Special

Committee for the International Geophysical Year" or "CSAGI") to establish an agenda for the program. Soviet representatives, including Academy of Sciences Vice-President Academician Ivan P. Bardin, served on the Committee, but do not appear to have had any significant contribution to its proceedings. In fact, the May 1954 deadline for submissions for participation in the IGY passed without any word from Soviet authorities. At a subsequent meeting in Rome on October 4, 1954, Soviet scientists silently witnessed the approval of a historic U.S.-sponsored plan to orbit artificial satellites during the IGY.[9] The satellite proposal clearly surprised the Soviet delegation, and perhaps had repercussions within the USSR Academy of Sciences. In the fall of 1954, the Academy established the Interdepartmental Commission for the Coordination and Control of Work in the Field of Organization and Accomplishment of Interplanetary Communications, a typically longwinded title which obscured its primary role, a forum for Soviet scientists to discuss space exploration in abstract terms, both in secret and in public.[10]

The existence of the Commission was announced on April 16, 1955, in an article in a Moscow evening newspaper; Academician Leonid I. Sedov, a relatively well-known gas dynamics expert was listed as the Chairman of the Commission.[11] Unlike the title of the body, the primary duty of the Commission was stated with unusual explicitness: "One of the immediate tasks of the Commission is to organize work concerning building an automatic laboratory for scientific research in space."[12] In hindsight, it is clear that the Commission, a part of the Astronomy Council in the Academy, had very little input or influence over *de facto* decision-making in the Soviet space program, although one of its functions was to collect proposals from various scientists on possible scientific experiments which could be mounted on future satellites. Sedov himself played a major role as Chairman by appearing at numerous international conferences talking in very general terms on the future of space exploration. None of its members had any direct connection or contact with the missile and space program, although they were clearly aware of the broad nature of Korolev's work. The latter appears to have had little to do with the formation or work of the Commission. He evidently attended one meeting in 1954 to inquire about the group's work.[13]

While this Commission had little real authority, its Chairman Sedov may have played a crucial role in connecting Korolev's satellite efforts with the International Geophysical Year. The chain of events was set off on July 29, 1955, by U.S. President Dwight D. Eisenhower's Press Secretary James C. Hagerty who announced at the White House that the United States would launch "small Earth-circling satellites" as part of its participation in the IGY.[14] It was at this same time that the International Astronautical Federation was holding its Sixth International Astronautical Congress at Copenhagen, Denmark. Heading the Soviet delegation was Sedov and Kirill F. Ogorodnikov, the editor of a respected astronomy journal in the USSR. The two were called into action by an announcement on August 2 by Fred C. Durant III, the President of the Congress, who reported the Eisenhower administration's intentions of launching a satellite during the IGY. Not to be outdone, Sedov convened a press conference the same day at the Soviet embassy in Copenhagen for about 50 journalists during which he announced that "In my opinion, it will be possible to launch an artificial Earth satellite within the next two years." He added that "The realization of the Soviet project can be expected in the near future."[15]

It is quite unlikely that Sedov was speaking on his own authority and possibly had taken cues from highly-placed Party officials who were aware of the government's approval in August 1954 of exploratory research on space issues. Perhaps a Party or Academy of Sciences official back in Moscow had decreed that Durant's statement warranted a response from Sedov. Certainly, there had been much discussion on the possibility of Soviet satellites by that time, although no single project had received approval. What is known is that the two pronouncements, one by the Eisenhower administration, and the one by Sedov, were the subject of relatively intense scrutiny by the press all over the world. This response appears to have been critical for Korolev.

By coincidence, it was on July 16, 1955, that Tikhonravov, along with OKB-1 engineer Ilya V. Lavrov as coauthor, finished his latest study on artificial satellites.[16] Based on work originating from the May 1954 document, the two suggested a reduced mass of 1,000–1,400 kilograms for an automated satellite. They also proposed the formation of a group of 70–80 people to carry out the

task of designing and building the satellite and to work on future piloted spacecraft. (Korolev wrote in the margins: "Too many, 30–35 people.") The Chief Designer, more attuned to the political reality of such a project, also added that "the creation of [a satellite] would have enormous political significance as evidence of the high development level of our country's technology."[17] In a move symptomatic of Korolev's relentless perseverance of the space issue since the early 1950s, Korolev also had one of his sector chiefs at the OKB-1 prepare a technical report on the possibility of sending a probe to the Moon using modified versions of the R-7 ICBM.

The activity on the space front reached its zenith on August 30, 1955 when Korolev attended two different meetings, one with the defense community and one with the scientific community, to discuss the new satellite report. The former was at the offices of the powerful Military-Industrial Commission, the coordinating mechanism for management of the entire Soviet defense industry. Presiding over the meeting was the Commission's new Chairman Vasiliy M. Ryabikov. Also in attendance were Academician Mstislav V. Keldysh, a noted scientist involved in research and development on several high profile military programs, and Col.-Engineer Aleksandr G. Mrykin, a senior artillery officer responsible for overseeing the procurement of new ballistic missiles for the Soviet armed forces.[18] At the meeting Korolev spoke of both his satellites and lunar probes. Notorious for his legendary short temper and larger-than-life personality, Mrykin was not receptive to Korolev's old arguments of the possibly great political importance of a Soviet satellite. The artillery officer told Korolev in no uncertain terms that only when the R-7 had completed its flight testing would they consider a satellite. Fortunately for Korolev, he had Keldysh's support, and that may have tipped the scales. While details of the deliberations remain extremely sketchy, it appears that Ryabikov approved the use of an R-7 ICBM for a modest satellite program. Lunar probes were not considered. There were probably two factors working in Korolev's favor: the possible use of a satellite for military purposes; and the demonstration of Soviet science and technology during the IGY.

Armed with Ryabikov's approval, Korolev attended a second secret meeting the same day at the offices of the "chief scholarly secretary" of the Academy of Sciences Gennadiy V. Topchiyev. Many

other scientists and designers including Keldysh, Tikhonravov, and rocket engine specialist Valentin P. Glushko were present. Korolev reported to the distinguished assemblage that the Council of Chief Designers at a recent meeting had conducted a detailed examination on modifying the original R-7 into a vehicle capable of launching a satellite into orbit. No doubt, he also spoke of the government's interest on the matter. At the end of his speech he formally proposed to build and launch a series of satellites into space, including one with animals, and for the Academy to establish a formal commission to carry out this goal. The Chief Designer had a specific timetable in mind. He told his audience, "As for the booster rocket, we hope to begin the first launches in April-July 1957...before the start of the International Geophysical Year."[19] If earlier, Korolev's satellite plans had been timed for the indefinite future, the Eisenhower administration's announcement in July 1955 completely changed the direction of Korolev's attack. Not only did it imbue Korolev's satellite proposal with a new sense of urgency, but it also gave him a specific timetable to aim for. If the United States was planning to launch during the IGY, then the Soviets would launch one a few months *before* the beginning of the International Geophysical Year, guaranteeing a first place finish. The attending scientists at the meeting accepted the new proposal, and at Korolev's recommendation Keldysh was designated the Chairman of the commission. Korolev and Tikhonravov would serve as his deputies.

The following day, on August 31, a smaller group, including Korolev, Tikhonravov, and Keldysh met to discuss some of the proposals for satellite instruments which many scientists had submitted to Sedov's Commission in the past year. A few days later Tikhonravov and Keldysh convened with some prominent Soviet scientific scholars to explain details of the satellite design and how their instruments were being considered. Korolev himself approved a preliminary scientific program in September 1955, a program which included the study of the ionosphere, cosmic rays, the Earth's magnetic fields, luminescence in the upper atmosphere, the Sun, and its influence on the Earth, and other natural phenomena. The detailed development of a scientific program was left in the hands of the two existing commissions of the Academy headed by Anatoliy A. Blagonravov and Leonid I. Sedov.[20]

The approval by the Academy to conduct a purely scientific research program accelerated matters considerably. In the ensuing months, several important meetings were held, both by Keldysh's commission and by the Council of Chief Designers, which elaborated the details of the project. Between December 1955 and March 1956, Keldysh consulted a huge number of distinguished scholars to refine the scientific experiments package. They included numerous famous Soviet scientists, many of whose names were public knowledge unlike those who were actually developing the spacecraft.[21] It was a large-scale operation with a single coordinating mechanism which, because of its "civilian" nature, had little precedent. Korolev himself was very conscious of the fact that an official decree on the project had yet to be issued, which meant that a rocket was still not officially available for the project. The magnitude of the immediate tasks, however, obscured that important issue for the time being. There were continuous problems with the program, especially since many who were cooperating did not share Korolev's enthusiasm for the project.

It took about four months for Ryabikov's spoken approval in August 1955 to translate into a formal decree of the Soviet government. As a purely scientific project managed by the Academy of Sciences, it was not considered a top priority. In fact, the Soviet government probably viewed the satellite project in much the same manner as they viewed the continuing series of scientific rocket flights into the upper atmosphere which also used military missiles for "civilian" purposes. They were relatively inexpensive, unobtrusive, and ignored by the political leadership. The evidence suggests that First Secretary Nikita S. Khrushchev was not even consulted on the matter.

The satellite project became a reality on January 30, 1956, when the USSR Council of Ministers issued decree number 149–88ss. The document approved the launch in 1957 of an unoriented artificial satellite, designated the "Object D," in time for the International Geophysical Year. As per Tikhonravov's previous computations, the mass of the satellite was limited to 1,000 to 1,400 kilograms of which 200 to 300 kilograms would be scientific instruments. Apart from the Academy of Sciences, five industrial ministries would be involved in the project. The responsibility for preparing a Draft Plan

for the Object D fell on the shoulders of Sergey S. Kryukov, at the time a Department Chief at the OKB-1. Tikhonravov served as the "chief scientific consultant."[22]

The decree in support of the Object D was not enough for Korolev, who did not want to consign his dreams of space exploration to a single decree, one among possibly hundreds signed by the Council of Ministers the same month. He wanted a direct verbal promise from the Soviet leadership on the satellite project, in particular from Khrushchev himself. His chance came in February 1956, during a high level state visit to the OKB-1. Khrushchev, escorted by the top Presidium members Aleksey I. Adzhubey, Nikolay A. Bulganin, Vyecheslav M. Molotov, and Mikhail G. Pervukhin, as well as Korolev's boss Minister of Defense Industries Dmitriy F. Ustinov, were on hand to congratulate the OKB-1 on their recent success with a new missile and also to review the progress on the R-7 ICBM project.[23]

The visit was important for Khrushchev since it was his first direct exposure to the top-secret ballistic missile program, an effort which had essentially been run by a number of industrial bureaucrats since Stalin's death out of view from Party leaders like Khrushchev.[24] During the visit, the delegation were shown around the premises of the institute by Korolev on a tour which culminated with a presentation of a full-scale non-functional model of the R-7 intercontinental ballistic missile. The guests were apparently stunned into silence by the size of the vehicle. Like a good performer, Korolev waited a few seconds for the sight to sink in, before giving a brief presentation on the vehicle. Glushko then began an elaborate presentation, much different from Korolev's, filled with extraneous technical details "like he was talking to first course students at the neighboring forestry institute ... rather than the higher leadership."[25] Recognizing the pointlessness of a technical treatise, Korolev cut Glushko short, before summarizing with a succinct conclusion. After a short discussion on the R-7's capabilities, Korolev innocuously added that: "Nikita Sergeyevich [Khrushchev], we want to introduce you to an application of our rockets for research into the higher layers of the atmosphere, and for experiments outside the atmosphere."[26] The Soviet leader expressed polite interest, although it was clear by this time that most of the guests were becoming tired and bored with the proceedings. Undeterred, Korolev first showed them

huge photographs of suborbital missiles that were used for biological and geophysical investigations. Detecting that his guests were in a hurry to leave, the Chief Designer quickly moved ahead and pointed everyone's attention to a display in a corner of the room of a model of the Object D satellite. Invoking the name of a legendary Soviet scientist, Korolev hurriedly explained that it would now be possible to realize the dreams of Tsiolkovskiy with the use of the R-7 missile. Perceiving that the audience was not much impressed by the speech, Korolev pointed out that the United States had stepped up their satellite program, but that compared to the "skinny" U.S. launch vehicle, the Soviet R-7 could significantly outdo that project in terms of the mass of the satellite. In closing, he added that the costs for such a project would be meager, since the basic expense for the launcher was already allocated for in the R-7 booster. Khrushchev began to exhibit some interest and asked Korolev if such a plan might not harm the R-7 weapons research program given that was the primary focus of work at Korolev's Design Bureau. Clearly oversimplifying the difficulties involved, Korolev shot back that unlike the United States, which was spending millions of dollars to develop a special rocket to launch a satellite, all the Soviets would have to do would be to replace the warhead with a satellite on the R-7. Khrushchev hesitated for a second, perhaps suspicious of Korolev's intentions, but answered back: "If the main task doesn't suffer, do it."[27]

After over two years of explicit lobbying the artificial satellite project was a reality. And it owed its approval more than anyone to Korolev. Tikhonravov had provided the technical expertise, Keldysh had helped with his political clout, but it was finally Korolev's repeated requests, letters, meetings, reports, and entreaties which finally forced the decision. Korolev also had a climate conducive to his needs. His standing among the military and industrial community had evolved over the years from maverick engineer to genius manager. His successes with a series of ballistic missiles pleased both the military and the industry. And it could not hurt that both of these sectors, by 1956, were populated by individuals who were sympathetic to the Chief Designers unquenchable thirst for space exploration. Clearly, Korolev alone could not have done it. Events outside his control, such as the Eisenhower administration's announcement, Sedov's press conference, the fall of the Beriya group

in the nuclear weapons industry, and Khrushchev's rise to power were pivotal events in the road to approval. But hindsight suggests that the Soviet space program was born on January 30, 1956, and without Korolev it would never have been conceived.

LABOR

The Object D (or D-1) was so named since it would be the fifth type of payload to be carried on an R-7, Objects A, B, V, and G being designations for different nuclear warhead containers.[28] The satellite was a complex scientific laboratory, far more sophisticated than any other IGY proposal from the period. While Kryukov's engineers depended a great deal on Tikhonravov's early work on satellites, much of the actual design was a journey into uncharted territory for the OKB-1. There was little precedent for creating pressurized containers and instrumentation for work in Earth orbit, while long-range communications systems had to be designed without the benefit of prior experience. The engineers were aware of the trajectory tracking and support capabilities for the R-7 missile, and this provided a context for determining the levels of contact with the vehicle. The fact that the object would be out of contact with the ground for long periods of time (unlike sounding rockets) meant that new self-switching automated systems would have to be used. The selection of metals to construct the satellite also presented problems to the engineers, since the effects of continuous exposure to the space environment was still in the realm of conjecture. The experiments and experience from sounding rocket tests provided a database for the final selection.

Technical work on the vehicle officially began on February 25, 1956, with contracts handed out on March 5. Tikhonravov's group at the NII-4 and Korolev's Design Bureau at the NII-88 were the two most active participants in this process, but numerous other organizations provided various elements of the complete satellite. By June 14, Korolev finalized the necessary changes to the basic version of the R-7 ICBM in order to use it for a satellite launch. The new booster would incorporate a number of major changes including the use of uprated main engines, deletion of the central radio package on the booster, and a new payload fairing replacing the old one used for a nuclear warhead.[29] A month later, on July 24, 1956, Korolev formally approved the initial

Draft Plan for the Object D. The document was co-signed by his senior associates Tikhonravov, Konstantin D. Bushuyev, Sergey O. Okhapkin, and Leonid A. Voskresenskiy.[30]

By mid-1956 the Object D project was beginning to fall significantly behind schedule. Some subcontractors were particularly lackadaisical in their assignments, and parts were often delivered which did not fit the original specifications. On September 14, Keldysh made a personal plea at a meeting of the Academy of Sciences Presidium for speeding up work, invoking a threat all would understand: "We all want our satellite to fly earlier than the Americans."[31] Events in the satellite program took an abrupt turn in the waning months of 1956. Actual test models of the Object D, expected to be ready by October, remained unfinished. By the end of November, Korolev began to suffer from great anxiety, no doubt compounded by his extraordinarily busy plans, traveling from Kaliningrad to Kapustin Yar to Tyura-Tam to Molotovsk and back several times to oversee various projects.[32] Part of this anxiety was due to serious concerns that his project would be suddenly preempted with a satellite launch from the United States. He had been informed of a September 1956 launch of a missile from Patrick Air Force Base at Cape Canaveral, Florida, which, according to his erroneous information, was a failed attempt to launch a satellite into orbit.[33] A second concern were the results of static testing of the R-7 engines on the ground. Instead of the projected specific impulse of 309–310 seconds, the R-7 engines would not produce more than 304 seconds, too low for the heavy Object D satellite. He realized that perhaps he was making this effort too complicated. Why not attempt to launch something simpler on the first orbital attempt instead of a sophisticated one-and-a-half-ton scientific observatory?

At the end of November Tikhonravov was perceptive enough to detect Korolev's anxiety and verbalized it: "What if we make the satellite a little lighter? Thirty kilograms or so, or even lighter?"[34] Keldysh was at first opposed to the idea, but eventually ceded to the strong-willed Korolev. This time Korolev would not depend on dozens of other subcontractors; he made sure that the smaller satellite would be designed and manufactured completely in his own Design Bureau with the help of only two outside organizations: the Scientific-Research Institute of Current Sources under Nikolay S. Lidorenko for the design of the onboard batteries and the NII-885 under Chief Designer Mikhail

S. Ryazanskiy for the radio-transmitters. On January 5, 1957, Korolev sent off a letter to the government which described his revised plan. He asked that permission be given to launch two small satellites, each with a mass of 40–50 kilograms, in the period April-June 1957 immediately *prior* to the beginning of the IGY. This plan would be contingent upon the timetable for the R-7 program which Korolev admitted was behind schedule; the first launch of the missile was set for March 1957 at the earliest. Each satellite would orbit the Earth at altitudes of 225 X 500 kilometers and contain a simple shortwave transmitter with a power source sufficient for 10 days operation. Korolev did not obscure the reasons for the abrupt change in plans:

> ... the United States is conducting very intensive plans for launching an artificial Earth satellite. The most well-known project under the name "Vanguard" uses a three-stage missile ... the satellite proposed is a spherical container of 50 centimeters diameter and a mass of approximately 10 kilograms. In September 1956, the U.S.A. attempted to launch a three-stage missile with a satellite from Patrick Base [sic] in the state of Florida which was kept secret. The Americans failed to launch the satellite ... and the payload flew about 3,000 miles o\r approximately 4,800 kilometers. This flight was then publicized in the press as a national record. They emphasized that U.S. rockets can fly higher and farther than all the rockets in the world, including Soviet rockets. From separate printed reports, it is known that the U.S.A. is preparing in the nearest months a new attempt to launch an artificial Earth satellite and is willing to pay any price to achieve this priority.[35]

While Korolev's information on U.S. plans may have been in error, his instincts were not that far off. The United States could have launched a satellite by early 1957, but various institutional and political obstacles precluded such an attempt.

By January 25, 1957, the Chief Designer approved the initial design details of the satellite, now officially designated Simple Satellite No. 1 (PS-1).[36] Although there was some token resistance to Korolev's revised plan, primarily from Keldysh, his letter appeared to have adequately invoked the specter of U.S. eminence in the field of military technology. On February 15, the USSR Council of Ministers formally issued a new decree (no. 171–83ss) entitled "On Measures to Carry Out in the International Geophysical Year," approving the

new proposal.[37] The two new satellites, PS-1 and PS-2, weighing approximately 100 kilograms each, would be launched in April–May 1957 after one or two fully successful R-7 launches. Eisenhower's plan to launch an American satellite during IGY was the deciding factor on a launch date. The Object D launch, meanwhile was pushed back to April 1958. Focused on a more modest objective, Korolev wasted little time. He quickly sent out technical specifications for the initial satellite PS-1 to the two subcontractors. By this time there was an impressive sight at the Tyura-Tam launch base in Soviet Central Asia: the first flight article of the magnificent R-7 was on the launch pad.

The first three launches of the R-7 ICBM in May-July 1957 were all failures, completely disrupting Korolev's schedule to launch a satellite before the beginning of the IGY. The days following the last failure were the lowest point for Korolev and his associates. Suddenly everything they had labored for over three years had been put into doubt. There was severe criticism from higher officials and even talk of curtailing the entire program. For Korolev, the headaches were compounded by the cumulative delays of his Simple Satellite project. It was now a month *into* the IGY and the R-7 itself had not flown a successful mission. His dreams, his position, his status were all in jeopardy, and this began to affect his temperament. In mid-June he had written to his wife from the launch site, "Things are not going very well again," adding with a note of optimism, "... right here and now, we must strive for the solution we need!" By July things began to deteriorate. On the 8th he wrote "We are working very hard," but after the second launch failure, he wrote on the 23rd "Things are very, very bad."[38] Korolev's biographer wrote in 1987, "In all the postwar years, no days were more painful, difficult, or tense for Sergey Pavlovich Korolev than those of that hot summer of 1957."[39]

Apart from competition from the United States, Korolev had to unexpectedly deal with a different kind of threat at the time, one from within the USSR in the person of Chief Designer Mikhail K. Yangel of the Experimental Design Bureau No. 586 (OKB-586). In the first quarter of 1957, Yangel's Design Bureau at Dnepropetrovsk in Ukraine, on orders from ministerial boss Dmitriy F. Ustinov, had begun to explore the possibility of modifying their R-12 intermediate range ballistic missile into a satellite launch vehicle.[40] The missile

itself, fueled by storable hypergolic propellants unlike the R-7, was the subject of a five year long development program, at first under Korolev's tutelage, but later transferred to Dnepropetrovsk. Prodded by the unending delays in the R-7 program, Yangel evaluated "the possibility of the *immediate* launch of a similar satellite [as Korolev's] using the simplest of booster rockets based on the strategic R-12 missile."[41] Although analysis proved that a hastily modified two-stage R-12 could be used for this goal, it did not seem likely that a first launch could be carried out prior to either the R-7 or the Americans. To Korolev's relief, the plan was shelved.

Back at the launch range of Tyura-Tam, the fourth R-7 launch on August 21, 1957 was successful. The missile and its payload flew 6,500 kilometers, the warhead finally entering the atmosphere over the target point at Kamchatka. Korolev was so subsumed by euphoria that he stayed awake until three in the morning speaking to his deputies and aides about the great possibilities that had opened up, the future, and mostly about his artificial satellite.[42] It was extremely unusual for the Soviets to publicize successes in any military field, so it was all the more odd when six days after the R-7 launch, the official news agency TASS released a brief communiqué:

> A few days ago a super-long-range, intercontinental multistage ballistic missile was launched. The tests of the missile were successful; they fully confirmed the correctness of the calculations and the selected design. The flight of the missile took place at a very great, hitherto unattained, altitude. Covering an enormous distance in a short time, the missile hit the assigned region. The results obtained show that there is the possibility of launching missiles into any region of the terrestrial globe. The solution of the problem of creating intercontinental ballistic missiles will make it possible to reach remote regions without resorting to strategic aviation, which at the present time is vulnerable to modern means of antiaircraft defense.[43]

Clearly it did not have the intended effect on the U.S. public or media, since for the most part, little attention was given it. Those that did pay lip service to the announcement spoke only to dismiss the claim, a stance justified partly by the black hole of information on Soviet ballistic missiles. It would take 38 more days before the entire world would take notice that a new age had arrived, heralded by that same intercontinental ballistic missile.

BIRTH

Work on the "simple satellite" PS-1 had continued at an uneven pace since development of the object began in January 1957. Between March and August, engineers carried out computations to select and refine the trajectory of the launch vehicle and the satellite during launch. These enormously complicated computations for the R-7 program were initially done by hand using electrical arithrometers and six-digit trigonometric tables. When more complex calculations were required, engineers at the OKB-1 were offered the use of a "real" computer recently installed at the premises of the Academy of Sciences at Keldysh's request. The gigantic machine filled up a huge room at the department and may have been the fastest computer in the USSR in the late 1950s: it could perform ten thousand operations per second, a high-end capability for Soviet computing machines of the time.[44]

There were many debates on the shape of the first satellite, with most senior OKB-1 designers preferring a conical form since it fit well with the nose cone of the rocket. At a meeting early in the year, Korolev had a change of heart and suggested a metal sphere at least one meter in diameter.[45] There were six major guidelines followed in the construction of PS-1:

- the satellite would have to be of maximum simplicity and reliability while keeping in mind that methods used for the spacecraft would be used in future projects;
- the body of the satellite was to be spherical in order to determine atmospheric density in its path;
- the satellite was to be equipped with radio equipment working on at least two wavelengths of sufficient power to be tracked by amateurs and to obtain data on the propagation of radio waves through the atmosphere;
- the antennae were to be designed so as to not affect the intensity of the radio signals due to spinning;
- the power sources were to be onboard batteries ensuring work for two to three weeks; and
- the attachment of the satellite to the core stage would be such that there would be no failure to separate.

The five primary scientific objectives of the mission were:

— to test the method of placing an artificial satellite into Earth orbit;
— to provide information on the density of the atmosphere by calculating its lifetime in orbit;
— to test radio and optical methods of orbital tracking;
— to determine the effects of radio wave propagation through the atmosphere; and
— to check principles of pressurization used on the satellite.[46]

The satellite as it eventually emerged was a pressurized sphere, 58 centimeters in diameter made of an aluminum alloy. The sphere was constructed by combining two hemispherical casings together. The pressurized internal volume of the sphere was filled with nitrogen at 1.3 atmospheres which maintained an electro-chemical source of power (three silver-zinc batteries), two radio-transmitters, a thermo-regulation system, a ventilation system, a communications system, temperature and pressure transmitters, and associated wiring. The two radio transmitters operated at frequencies of 20.005 and 40.002 megacycles at wavelengths of 1.5 and 7.5 meters. The signals on both the frequencies were spurts lasting 0.2 to 0.6 seconds, providing the famous "beep-beep" sound to the transmissions. The antennae system comprised four rods, two with a length of 2.4 meters each and the remaining two with a length of 2.9 meters each. Tests of this radio system were completed as early as May 5, 1957, using a helicopter and a ground station.[47] The total mass of the satellite was 83.6 kilograms of which 51.0 kilograms was simply the power source. The lead designer for PS-1 was Mikhail S. Khomyakov. Oleg G. Ivanovskiy was his deputy.[48]

Korolev, of course, kept close tabs on the development of PS-1 and continuously saw to it that the spherical satellite was kept spotlessly clean and shiny not only for its reflective qualities, but perhaps also for its overall aesthetic beauty. On one occasion he flew into a rage at a junior assembly shop worker for doing a poor job on the outer surface of a *mockup* of the satellite. "This ball will be exhibited in museums!" he shouted.[49] An aide from Moscow telephoned Korolev at Tyura-Tam on June 24 to inform him that he had just signed the

document specifying the final configuration of the satellite. The launch vehicle earmarked for the satellite was a slightly uprated version of the basic R-7 ICBM variant. The modifications included the omission of a 300 kilogram radio-package from the top of the core booster, the changing of burn times of the main engines; the removal of a vibration measurement system, the use of a special nozzle system to separate the booster from the satellite installed at the top of the core stage, and the installation of a completely new payload shroud and container replacing the warhead configuration.[50] The length of the booster with the new shroud was 29.167 meters, almost four meters shorter than the ICBM version.

The Council of Ministers had formally approved the simple satellite program in February 1957. With one R-7 success under his belt, Korolev now needed final permission from the State Commission to proceed with a satellite launch. It was supposed to be merely a formality, since the Soviet government had already approved the satellite attempt, but the process appears to have been fraught with difficulty, suggesting that even at this late stage, there were individuals on the Commission who were not interested in a satellite. At a Commission meeting in late August, Korolev formally asked for permission to launch a satellite if a second R-7 ICBM successfully flew in early September. Convincing the Commission proved to be much harder than expected and the meeting ended in fierce arguments and recriminations. Not easily turned away, Korolev tried again at a second session soon after, this time using a political ploy: "I propose let us put the question of national priority in launching the world's first artificial Earth satellite to the Presidium of the Central Committee of the Communist Party. Let them settle it."[51] It worked. None of the members wanted to take the blame for a potential miscalculation, and Korolev got what he wanted. A final document for launch, "The Program for Carrying Out a Test Launch of a Simple Unoriented ISZ (the Object PS) Using the Product 8K71PS," was later signed by:

— Vasiliy F. Ryabikov (Military-Industrial Commission);
— Mitrofan I. Nedelin (Ministry of Defense);
— Dmitriy F. Ustinov (Ministry of Defense Industries);

— Valeriy D. Kalmykov (Ministry of Radio-Technical Industry); and
— Aleksandr N. Nesmeyanov (Academy of Sciences).[52]

The subsequent launch of the R-7 on September 7 was as successful as the one in August, and the R-7 ICBM flew across the Soviet Union before depositing its dummy warhead over the Kamchatka peninsula.[53] In the summer, Korolev and the other Chief Designers began to informally target the satellite launch for the one hundredth anniversary of spaceflight visionary Tsiolkovskiy's birth on September 17, but achieving this date proved increasingly unrealistic. Instead of being at Tyura-Tam for a space launch on that day, Korolev and R-7 rocket engine designer Glushko were both in attendance at the Pillard Hall of the Palace of Unions in Moscow for a special celebration of the great visionary's birthday. In a long speech to the distinguished audience, Korolev, whose real job was not revealed, prophesized that, "in the nearest future the first test launches of artificial satellites of the Earth with scientific goals will take place in the USSR and the USA."[54] The audience had little idea of the accuracy of the prediction.

On September 20 Korolev was at Moscow for a meeting of the State Commission for the PS-1 launch.[55] Chairman Ryabikov, Korolev, Keldysh, and Marshall Nedelin were the principal participants and established October 6 as the target date of the launch based on the pace of preparations. At the same meeting, the Commission decided to publicly announce the launch of PS-1 only after completion of the first orbit. A communiqué to this effect was written up by Ryabikov himself on September 23.[56] The frequencies for tracking by amateurs had already been announced earlier in the year in the issues of the journal *Radio* although details of the program had obviously been omitted. Korolev himself flew into Tyura-Tam on September 29 staying in a small house close to the primary activity area near site two.

The preparations for launching were for the most part uneventful save for the last minute replacement of one of the batteries on the flight version of PS-1. Still apprehensive over a last minute U.S. launch, Korolev abruptly proposed to the State Commission that the launch be brought forward two days. His concerns were apparently

prompted by plans for a conference in Washington, D.C. in early October as part of IGY proceedings. On the 6th, the day of PS-1's scheduled launch, a paper entitled "Satellite Over the Planet" was to be presented by the American delegation. He believed that the presentation was to be timed to coincide with a hitherto unannounced launch of a U.S. satellite.[57] KGB representatives assured Korolev that this was not so, but Korolev was convinced that a launch of Army Jupiter C might be attempted. In the end, the schedule for PS-1's launch was moved forward two days to the 4th; Korolev signed the final order for launch at four in the afternoon on the 2nd and sent it to Moscow for approval.[58]

The R-7 was transported and installed on the launch pad in the early morning of October 3 escorted on foot by Korolev, Ryabikov, and other members of the State Commission. Fueling began early the following morning at 5:45 a.m. local time.[59] Korolev, under a great amount of pressure, remained cautious throughout the proceedings. He told his engineers, "Nobody will hurry us. If you have even the tiniest doubt, we will stop the testing and make the corrections on the satellite. There is still time ... ."[60] Most of the engineers, understandably enough, did not have time to ponder over the historical value or importance of the upcoming event. PS-1's deputy designer Ivanovskiy recalled "... Nobody back then was thinking about the magnitude of what was going on: everyone did his own job, living through its disappointments and joys."[61]

On the night of the 4th, huge flood lights illuminated the launch-pad as the engineers in their blockhouse checked off all the systems. In the command bunker accompanying Korolev were some of the senior members of the State Commission. All launch operations were handled by two men, a civilian and a military officer. Representing the civilians was Korolev's deputy Leonid A. Voskresenskiy, one of the most colorful characters in the history of the Soviet space program. A daredevil motorcyclist with a legendary penchant for taking risks, he had been with the program since the early days in 1945 when the Soviets had scoured Germany for the remains of the A-4 missile. Lt.-Col. Aleksandr I. Nosov represented the military. Both men were 44 years old at the time. The actual command for launch was entrusted to the hands of Boris S. Chekunov, a young artillery forces lieutenant. He later recalled the final moments as the

clock ticked past midnight local time: "When only a few minutes remained until lift-off, Korolev nodded to his deputy Voskresenskiy. The operators froze, awaiting the final order. Nosov, the chief of the launch control team, stood at the periscope. He could see the whole pad. 'One minute to go!' he called."[62] Another senior engineer in the bunker recalled:

> With the exception of the operators, everybody was standing. Only N. A. Pilyugin and S. P. Korolev were allowed to sit down. The launch director [Nosov] began issuing commands. I kept an eye on S. P. Korolev. He seemed nervous although he tried to conceal it. He was carefully examining the readings of the various instruments without missing any nuance of our body language and tone of voice. If anybody raised their voice or showed signs of nervousness, Korolev was instantly on the alert to see what was going on.[63]

The seconds counted down to zero and Nosov shouted the command for lift-off. Chekunov immediately pressed the lift-off button. At exactly 2228 hours 34 seconds Moscow Time on October 4, the engines ignited and the 272,830 kilogram booster lifted off the pad in a blaze of light and smoke. The five engines of the R-7 generated about 398 tons of thrust at launch. Although the rocket lifted off gracefully, there were problems. Delays in the firing of several engines almost resulted in a launch abort. Additionally, at T+16 seconds, the System for the Synchronous Emptying of the Tanks (SOBIS) failed, which resulted in higher than normal kerosene consumption. A turbine failure due to this resulted in main engine cut-off one second prior to the planned moment.[64] Separation from the core stage, however, occurred successfully at T+324.5 seconds, and the 83.6 kilogram PS-1 successfully flew into a free-fall elliptical trajectory. The first human-made object entered orbit around the Earth inaugurating a new era in exploration.

With most State Commission members still in the bunker, engineers at Tyura-Tam awaited confirmation of orbit insertion from the satellite in a van set up about 800 meters from the launch pad. As a huge crowd waited outside the van, radio operator Vyecheslav I. Lappo from the NII-885, who had personally designed the onboard transmitters, sat expectantly for the first signal. The Kamchatka station picked up signals from the satellite and there was cheering

but Korolev cut everybody off: "Hold off on the celebrations. The station people could be mistaken. Let's judge the signals for ourselves when the satellite comes back after its first orbit around the Earth."[65] Eventually the distinct "beep-beep-beep" of the craft came in clearly over the radio waves and the crowd began to celebrate. Chief Designer Ryazanskiy who was at the van immediately telephoned Korolev in the bunker. The ballistics experts at the Coordination-Computation Center in Moscow had determined that the satellite was in an orbit with a perigee of 228 kilometers and an apogee of 947 kilometers, the latter about 80 kilometers lower than planned due to the early engine cut-off. Inclination of the orbit to the Earth's equator was 65.6 degrees while orbital period was 96.17 minutes.[66] Experts at the Moscow Center also ascertained that the satellite was slowly losing altitude, but State Commission Chairman Ryabikov waited until the second orbit was over prior to telephoning Soviet leader Nikita S. Khrushchev.

According to conventional wisdom, Khrushchev's reaction to the launch was unusually subdued for an event of such magnitude, indicating that he, like many others, did not immediately grasp the true propaganda effect of such a historic moment. He told the press later that:

> When the satellite was launched, they phoned me that the rocket had taken the right course and that the satellite was already revolving around the earth. I congratulated the entire group of engineers and technicians on this outstanding achievement and calmly went to bed.[67]

Khrushchev's son, however, recalls his father's reaction was a little more enthused. The older Khrushchev at the time was on visit to Kiev to discuss economic issues with the Ukrainian Party leadership. Around 11 p.m., these negotiations were interrupted by a telephone call. Khrushchev quietly took the call, then returned back to his discussions, without saying anything. Eventually, as his son recalled, the news was too difficult to keep under wraps:

> He finally couldn't resist saying [to the Ukrainian officials]: "I can tell you some very pleasant and important news. Korolev just called (at this point he acquired a secretive look). He's one of our missile designers.

> Remember not to mention his name—it's classified. So, Korolev has just reported that today, a little while ago, an artificial satellite of the earth was launched."[68]

The Soviet leader was evidently animated the rest of the evening, speaking in glowing terms about the new era of missiles which could "demonstrate the advantages of socialism in actual practice" to the Americans.

The official Soviet news agency TASS released the communiqué Ryabikov had authored on the morning of October 5. Published in the morning edition of *Pravda*, it was exceptionally low-key and was not the headline of the day:

> For several years scientific research and experimental design work have been conducted in the Soviet Union on the creation of artificial satellites. As has already been reported in the press, the first launching of the satellites in the USSR were planned for realization in accordance with the scientific research program of the International Geophysical Year. As a result of very intensive work by scientific research institutes and design bureaus the first artificial satellite in the world has been created. On October 4, 1957, this first satellite was successfully launched in the USSR. According to preliminary data, the carrier rocket has imparted to the satellite the required orbital velocity of about 8,000 meters per second. At the present time the satellite is describing elliptical trajectories around the Earth, and its flight can be observed in the rays of the rising and setting Sun with the aid of very simple optical instruments (binoculars, telescopes, etc.).[69]

The Soviet media did not ascribe a specific name for the satellite, generally referring to it as "Sputnik," the Russian word for "satellite," often also loosely translated as "fellow traveler."

As the media tumult over Sputnik began to mount in the West, the Soviet leadership began to capitalize on the utter pandemonium pervading the discourse on the satellite in the United States. On October 9, *Pravda* published a long report anonymously authored by Korolev and other designers detailing the construction and design of the satellite.[70] The parties responsible for this great deed were, of course, not named. Having been involved in the defense industry, the real job titles of the members of the Council of Chief Designers had always remained secret, although Tikhonravov and others had freely

published under their own names through the 1950s on topics of general interest. This suddenly changed as their names disappeared from official histories. Beginning with the launch of Sputnik, of the four major contributors to its success, Korolev, Glushko, and Keldysh were referred in the open press as the Chief Designer of Rocket-Space Systems, the Chief Designer of Rocket Engines, and the Chief Theoretician of Cosmonautics respectively. The fourth, Tikhonravov, did not even have a pseudonym for himself.

The titles not only hid their identities, but also added an element of attraction and enigma to the men behind the world's first space program. New editions of histories of Soviet rocketry published prior to 1957 ceased to carry Korolev's name, and Soviet encyclopedias now merely listed him as heading a laboratory in an unspecified "machine building" institute in the USSR. Glushko meanwhile was now said to be laboratory chief at the Moscow Institute of Mineral Fuels.[71] Korolev, certainly in recognition of the key role he played, was allowed to write in no less an important newspaper as *Pravda*, but under the pseudonym "Professor K. Sergeyev." His first article titled "Research into Cosmic Space" was published on December 12, 1957. Khrushchev claimed at the time that as the years went by "the photographs and names of these illustrious people will be made public," but that for the moment "in order to ensure the country's security and the lives of these scientists, engineers, technicians, and other specialists, we cannot yet make known their names or publish their photographs."[72]

CONCLUSION

Khrushchev was clearly cognizant of the satellite project, but he seems to have been remarkably uninterested in it. Certainly, he used Sputnik to advance his political agenda *post-facto*, but the launch itself was never intended as anything more than a response to Korolev's formidable powers of persuasion. As such, the timing of the Sputnik launch was motivated by a single reasoning: Korolev's drive to preempt a U.S. satellite launch attempt during the International Geophysical Year. At first, it was a competition with Vanguard. Spurred by the July 1955 announcement of U.S. satellite plans for the IGY, Korolev, joined by Tikhonravov and Keldysh, convinced both the government and the Academy of Sciences within

a month to proffer support for a complex Soviet satellite project timed for launch before the IGY. A second jolt came as a result of miscommunication about a U.S. Army missile launch in September 1956. Putting the heavy scientific satellite on the backburner, Korolev's engineers put together a much simpler satellite to beat any American attempt. Once again, they timed it for launch before the start of the IGY. This 84 kilogram ball, although delayed several months, lifted off into orbit on October 4, 1957, and opened a new era.

The political and cultural shock bequeathed by Sputnik set events in motion that eventually gave rise to Apollo, perhaps the central artifact of the so-called "space race" of the Cold War. Conventional wisdom suggests that the race began on October 4, 1957, and ended on July 20, 1969, with the Moon landing. But as we begin to dig deeper into the origins of the space race, it is clear that the race began not with the launch of Sputnik, but in fact with the Eisenhower administration's announcement in July 1955, more than two years before Sputnik. And perhaps fortunately for the Soviet Union, it was a race in which one of the participants, the United States, did not even know it was running until it was too late.

1. Walter McDougall, ... *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, Inc., 1985), pp. 60–62.
2. James E. Oberg, *Red Star in Orbit* (New York: Random House, 1981), pp. 29–30.
3. See Yaroslav Golovanov, Korolev: *fakty i mify* (Moscow, Ruussia: Nauka Press, 1994).
4. For a detailed look at Korolev's scientific activities in the 1930s see G. S. Vetrov, *S. P. Korolev i kosmonavtika: pervye shagi* (Moscow, Russia: Nauka Press, 1994).
5. Yu. P. Semenov, ed., *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva* (Korolev, Russia: RKK Energiya named after S. P. Korolev, 1996), p. 22.
6. For a detailed english language summary of the details of Tikhonravov's research during the 1940s and early 1950s as well as the famous 1954 report itself, see Asif A. Siddiqi, "Before Sputnik: Early Satellite Studies in the Soviet Union, 1947–1957," *Spaceflight* (October 1997): 334–337; Asif A. Siddiqi, "Before Sputnik: Early Satellite Studies in the Soviet Union, 1947–1957—Part 2," *Spaceflight* (November 1997): 389–392. Tikhonravov's document has been reproduced as M. Tikhonravov, "Report on an Artificial Satellite of the Earth" (in Russian) in B. V. Raushenbakh, ed., *Materialy po istorii kosmicheskogo korabl "vostok"* (Moscow, USSR: Nauka Press, 1991), pp. 5–15.
7. The text of this letter in a censored version has been published as S. P. Korolev, "On the Possibility of Work on an Artificial Satellite of the Earth" (in Russian), M. V. Keldysh, ed., *Tvorcheskoye naslediye Akademika Sergeya Pavlovicha Koroleva: izbrannyye trudy i dokumenty* (Moscow, USSR: Nauka Press, 1980), p. 343.
8. Semenov, *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva*, p. 86. The coauthors of the proposal were: B. L. Vannikov (First Deputy Minister of Medium Machine Building), M. V. Khrunichev (First Deputy Minister of Medium Machine Building), and K. N. Rudnev (Deputy Minister of Defense Industries). Of interest is the fact that Malyshev, Vannikov, and Khrunichev were all high officials in the *nuclear* weapons industry. Rudnev was the only one from the missile industry.
9. Edward Clinton Ezell and Linda Neumann Ezell, *The Partnership: A History of the Apollo-Soyuz Test Project* (Washington, D.C.: NASA SP-4209, 1978), p. 16; Nicholas Daniloff, *The Kremlin and the Cosmos* (New York: Alfred A. Knopf, 1972), p. 54.
10. A. Yu. Ishlinskiy, ed., *Akademik S. P. Korolev: ucheniy, inzhener, chelovek* (Moscow USSR: Nauka Press, 1986), p. 453; Boris Konovalov, "The Genealogy of Sputnik" (in Russian), in V. Shcherbakov, ed., *Zagadki zvezdnykh ostrovov* (Moscow, USSR: Molodaya gvardiya, 1989), p. 115.
11. "Commission on Interplanetary Communications" (in Russian), *Vechernaya moskva*, April 16, 1955, p. 1. An English translation of the announcement is included in F. J. Krieger, *Behind The Sputniks: A Survey of Soviet Space Science* (Washington, D.C.: Public Affairs Press, 1958), pp. 328–30. The names of only four other members were announced at the time: V. A. Ambartsumyan, P. L. Kapitsa, B. V. Kukarin, and P. P. Parenago. A larger 27 member list was submitted to the International Astronautical Federation in October 1957.
12. "Commission on Interplanetary Communications," 1955.
13. Of the 27 Commission members listed in 1957, only two individuals, A. A. Blagonravov and D. Ye. Okhotsimskiy, were directly involved in the ballistic missile and space programs. The former headed the Commission for Upper Atmosphere Research of the Academy of Sciences which oversaw all scientific suborbital launches, while the latter was one of the leading mathematicians at the Department of Applied Mathematics of the V. A. Steklov Mathematics Institute of the Academy of Sciences (OPM MIAN) who was involved in the early design of the R-7 ICBM. See also Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 453.
14. Ezell and Ezell, *The Partnership*, p. 18.
15. Robert W. Buchheim and the Staff of the Rand Corporation, *Space Handbook: Astronautics and its Applications* (New York: Random House, 1959), p. 277; "We'll Launch 1st Moon, and Bigger, Says Russ," *Los Angeles Examiner*, August 3, 1955; John Hillary, "Soviets Planning Early Satellite," *The New York Times*, August 3, 1955.
16. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 445; Yaroslav Golovanov, "The Beginning of the Space Era" (in Russian), *Pravda*, October 4, 1987, p. 3. Note that in Semenov, *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva*, p. 86, it is stated that the report was authored only by Lavrov and it was completed on June 16, 1955, not July 16, 1955. Tikhonravov himself has, however, claimed they *both* authored the report.
17. Semenov, *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva*, p. 87.
18. *Ibid.* Keldysh's official posts were: Director of the NII-1 and Chief of the OPM MIAN. Mrykin's official post was First Deputy Commander of the Directorate of the Chief of Reactive Armaments (UNRV). The UNRV was subordinate to the Chief Artillery Directorate (GAU) of the General Staff of the Ministry of Defense.
19. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 455; Golovanov, *Korolev: fakty i mify*, pp. 523–24; Golovanov, "The Beginning of the Space Era." Others present at this meeting were M. A. Lavrentiyev and G. A. Skuridin.
20. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, pp. 455–56; Christian Lardier, *L'Astronautique Soviétique* (Paris: Armand Colin, 1992), p. 107; Golovanov, "The Beginning of the Space Era." Blagonravov's commission was at the time directing the scientific investigations on board suborbital rockets, while Sedov's commission had recently been established as a public forum for Soviet scientists to discuss space exploration.

21. These included: atmospheric specialists V. I. Krasovskiy, L. V. Kurnosovaya, and S. N. Vernov; the young mathematicians from the OPM MIAN T. M. Eneyev, M. L. Lidov, D. Ye. Okhotsimskiy, and V. A. Yegorov; solar battery expert N. S. Lidorenko; and the more famous Academicians L. A. Artsimovich, V. L. Ginsburg, A. F. Ioffe, P. L. Kapitsa, B. P. Konstantinov, and V. A. Kotelnikov. See Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 456; Golovanov, "The Beginning of the Space Era."
22. Keldysh, *Tvorcheskoye naslediye Akademika Sergeya Pavlovicha Koroleva*, p. 362; Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 445; Konovalov, "The Genealogy of Sputnik," pp. 116–117; Golovanov, *Korolev: fakty i mify*, p. 529; Semenov, *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva*, p. 87. B. Konovalov, "Dash to the Stars" (in Russian), *Izvestiya*, October 1, 1987, p. 3. The five industrial ministries were: the Ministry of Defense Industries, the Ministry of Radiotechnical Industry, the Ministry of Ship Building Industry, the Ministry of Machine Building, and the Ministry of Defense.
23. Sergey Khrushchev, *Nikita Khrushchev: krizisy i rakety: vzglyad iznutri: tom 1* (Moscow, Russia: Novosti, 1994), p. 97.
24. William P. Barry, *The Missile Design Bureaux and Soviet Piloted Space Policy, 1953–1974*, Draft of University of Oxford D.Phil., Dissertation, 1995.
25. Khrushchev, *Nikita Khrushchev: krizisy i rakety: vzglyad iznutri: tom 1*, p. 106.
26. Khrushchev, *Nikita Khrushchev: krizisy i rakety: vzglyad iznutri: tom 1*, p. 109.
27. Khrushchev, *Nikita Khrushchev: krizisy i rakety: vzglyad iznutri: tom 1*, pp. 110–11.
28. Raushenbakh, *Materialy po istorii kosmicheskogo korabl "vostok"*, p. 209. A, B, V, G, and D are the first five letters of the Russian cyrillic alphabet.
29. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 446; Golovanov, *Korolev: fakty i mify*, p. 530; Timothy Varfolomeyev, "Soviet Rocketry that Conquered Space: Part 1: From First ICBM to Sputnik Launcher," *Spaceflight* (August 1995): 260–63.
30. Golovanov, *Korolev: fakty i mify*, p. 530; Lardier, *L'Astronautique Soviétique*, p. 107. Tikhonravov was officially an employee of the NII-4 but was temporarily working as the Chief Consultant to the NII-88 OKB-1.
31. An edited version of Keldysh's speech has been published as M. V. Keldysh, "On Artificial Satellites of the Earth" (in Russian), V. S. Avduyevskiy and T. M. Eneyev, eds. *M. V. Keldysh: izbrannyye trudy: raketnaya tekhnika i kosmonavtika* (Moscow, USSR: Nauka Press, 1988), 235–240; See also Golovanov, *Korolev: fakty i mify*, p. 530.
32. Kaliningrad was the location of the OKB-1, while sea trials of the R-11FM were carried out near Molotovsk. Kapustin Yar and Tyura-Tam were the two missile launch ranges.
33. This was a Jupiter C missile (no. RTV-1) which flew a distance of 5,300 kilometers on September 20, 1956, during a re-entry test. A live third stage could have put a small payload into orbit, but this was not the intended goal.
34. Golovanov, "The Beginning of the Space Era"; Golovanov, *Korolev: fakty i mify*, p. 532.
35. The complete text of Korolev's letter is reproduced as S. P. Korolev, "Proposal on the First Launch of an Artificial Satellite of the Earth Before the Start of the International Geophysical Year" (in Russian) in Keldysh, *Tvorcheskoye naslediye Akademika Sergeya Pavlovicha Koroleva*, pp. 369–70.
36. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 447.
37. Semenov, *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva*, pp. 88, 632.
38. Golovanov, "The Beginning of the Space Era."
39. *Ibid.*
40. V. Pappo-Korystin, V. Platonov, and V. Pashchenko, *Dneprovskiy raketno-kosmicheskiy tsentr* (Dnepropetrovsk, Ukraine: PO YuMZ/KBYu, 1994), p. 60; S. N. Konyukhov and V. A. Pashchenko, "History of Space Launch Vehicles Development," presented at the 46th International Astronautical Congress, October 2–6, 1995, Oslo, Norway, IAA-95-IAA 2.2.09. The range of the missile was about 2,000 kilometers.

41. Yu. Biryukov, "From the History of Space Science: The Price of Decision—First Place (The First Satellites)" (in Russian), *Aviatsiya i kosmonavtika* (October 1991): 37–39. Author's emphasis.
42. Golovanov, "The Beginning of the Space Era"; Golovanov, *Korolev: fakty i mify*, p. 514; Council of Veterans of the Baykonur Cosmodrome, *Proryv v kosmos: ocherki ob ispitatelyakh spetsialistakh i stroitelyakh kosmodroma Baykonur* (Moscow, Russia: TOO Veles, 1994), pp. 25, 174.
43. "Report on Intercontinental Ballistic Missile" (in Russian), *Pravda*, August 27, 1957. A complete English translation of the press release is included in Krieger, *Behind The Sputniks*, pp. 233–34.
44. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 447; V. Lysenko, ed., *Three Paces Beyond the Horizon* (Moscow, USSR: Mir Publishers, 1989), p. 58.
45. I. Minyuk and G. Vetrov, "Fantasy and Reality" (in Russian), *Aviatsiya i kosmonavtika* (September 1987): 46–47.
46. M. K. Tikhonravov, "The Creation of the First Artificial Earth Satellite: Some Historical Details," *Journal of the British Interplanetary Society* 47 (May 1994): 191–194.
47. Ibid.; G. A. Kustova, *Ot pervogo Sputnika do "Energii"—"Burana" i "Mir"* (Kaliningrad, Russia: RKK Energiya, 1994), p. 37; Jacques Villain, ed., *Baikonour: la porte des étoiles* (Paris: Armand Colin, 1994), p. 26; Golovanov, *Korolev: fakty i mify*, p. 537.
48. O. G. Ivanovskiy, *Naperekor zemnomy prityazhenyu* (Moscow, USSR: Politicheskoy literatury, 1988), pp. 167–169.
49. Mikhail Florianskiy, "October 4—For the First Time in the World," *Moscow News Supplement* (1987), no. 40.
50. Varfolomeyev, "Soviet Rocketry that Conquered Space"; Keldysh, *Tvorcheskoye naslediye Akademika Sergeya Pavlovicha Koroleva*, p. 365; Yu. A. Mozzhorin et al., eds., *Nachalo kosmicheskoy ery: vospominaniya veteranov raketno-kosmicheskoy tekhniki i kosmonavtiki: vypusk vtoroy* (Moscow, Russia: RNITsKD, 1994), pp. 60–61.
51. Council of Veterans of the Baykonur Cosmodrome, *Proryv v kosmos*, pp. 29–30.
52. Semenov, *Raketno-Kosmicheskaya Korporatsiya "Energiya" imeni S. P. Koroleva*, p. 90. "ISZ" is the Russian abbreviation for Artificial Satellite of the Earth. The 8K71PS was the industrial designation for the modified version of the R-7 used for the satellite launch.
53. Yu. V. Biryukov, "Materials from the Biographical Chronicles of Sergey Pavlovich Korolev" (in Russian), in B. V. Raushenbakh, ed., *Iz istorii Sovetskoy kosmonavtiki* (Moscow, USSR: Nauka Press, 1983), p. 238; Lardier, *L'Astronautique Soviétique*, p. 93; Golovanov, *Korolev: fakty i mify*, p. 517. According to some Western sources, Soviet leader Khrushchev is said to have been present at this launch, but this is unconfirmed by Soviet or Russian sources.
54. S. P. Korolev, "On the Practical Significance of K. E. Tsiolkovskiy's Proposals in the Field of Rocket Technology" (in Russian), in B. V. Raushenbakh, ed., *Issledovaniya po istorii i teorii razvitiya aviatsionnoy i raketno-kosmicheskoy nauki i tekhniki* (Moscow, Russia: Nauka Press, 1981), p. 40. This is a complete version of his speech. An abridged English translation has been reproduced in Institute of the History of Natural Sciences and Technology, *History of the USSR: New Research. 5: Yuri Gagarin: To Mark the 25th Anniversary of the First Manned Space Flight* (Moscow, Russia: Social Sciences Today, 1986), pp. 48–63. Note that the latter does not include the above quote.
55. The State Commission for the Launch of the Object PS-1 comprised the following members: Chairman V. M. Ryabikov (Chairman of the VPK); V. P. Barmin (Chief Designer of GKSB SpetsMash); I. T. Bulychev (Deputy Chief of Military Communications of the Ministry of Defense General Staff); V. P. Glushko (Chief Designer of OKB-456); S. P. Korolev (Chief Designer of OKB-1); V. I. Kuznetsov (Chief Designer of NII-944); A. A. Maksimov (from the UNRV); A. G. Mrykin (First Deputy Chief of the UNRV); M. I. Nedelin (Deputy Minister of Defense for Reactive Armaments); A. I. Nesterenko (Commander of the

NIIP-5); G. N. Pashkov (Deputy Chairman of the VPK); N. A. Pilyugin (Chief Designer of NII-885); M. S. Ryazanskiy (Chief Designer and Director of NII-885); S. P. Shishkin (Chief Designer at KB-11). Others involved were: A. F. Bogolomov (Chief Designer of the OKB-MEI); M. V. Keldysh (Director of NII-1 and Chief of the OPM MIAN); I. T. Peresypkin (Minister of Communications); K. N. Rudnev (Deputy Minister of Defense Industries); G. R. Udarov (Deputy Chairman of the State Committee for Defense Technology); and S. M. Vladimirskiy (Deputy Chairman of the State Committee for Radio Electronics). See Yu. A. Skopinskiy, "State Acceptance of the Space Program: Thirty Years of Work" (in Russian), *Zemlya i vselennaya* (September–October 1988): 73–79; Lardier, *L'Astronautique Soviétique*, p. 285.

56. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 447; Lardier, *L'Astronautique Soviétique*, pp. 108–9; Konovalov, "The Genealogy of Sputnik," pp. 122–123.
57. Golovanov, *Korolev: fakty i mify*, p. 537–38.
58. This document was not actually signed until the morning of the launch. See Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 448.
59. Mozzhorin, *Nachalo kosmicheskoy ery*, p. 63.
60. Golovanov, "The Beginning of the Space Era."
61. *Ibid.*
62. Ivan Borisenko and Alexander Romanov, *Where All Roads Lead to Space Begin* (Moscow, USSR: Progress Publishers, 1982), p. 66.
63. Mozzhorin, *Nachalo kosmicheskoy ery*, p. 63. The author of this quote was (at the time) OKB-1 engineer Ye. V. Shabarov.
64. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 448, 464; B. Ye. Chertok, *Rakety i lyudi: Fili Podlipki Tyuratam* (Moscow, Russia: Mashinostroyeniye, 1996), p. 197.
65. Mozzhorin, *Nachalo kosmicheskoy ery*, p. 64.
66. Ishlinskiy, *Akademik S. P. Korolev: ucheniy, inzhener, chelovek*, p. 464.
67. Daniloff, *The Kremlin and the Cosmos*, pp. 65–66.
68. Khrushchev, *Nikita Khrushchev: krizisy i rakety: vzglyad iznutri: tom 1*, pp. 337–38.
69. "Announcement of the First Satellite" (in Russian), *Pravda*, October 5, 1957. A complete English translation of this announcement is included in Krieger, *Behind The Sputniks*, pp. 311–12.
70. "Report on the First Satellite" (in Russian), *Pravda*, October 9, 1957. A complete English translation of this article in included in Krieger, *Behind The Sputniks*, pp. 313–25.
71. *Soviet Space Programs, 1962–65; Goals and Purposes, Achievements, Plans, and International Implications*, Prepared for the Committee on Aeronautical and Space Sciences, U.S. Senate, 89th Cong., 2nd Sess. (Washington, D.C.: U.S. Government Printing Office, December 1966), pp. 149–50.
72. *Soviet Space Programs, 1962–65*, pp. 71–72.

CHAPTER 3

Korolev's Triple Play: *Sputniks 1, 2 and 3*

James J. Harford

Soviet politics, planning, and technology spanning the period 1946–1958 made possible the launching of an artificial satellite to the surprise of the West. The strategy used by Sergey Pavlovich Korolev, with the support of Mstislav Keldysh, in bringing the satellite from conceptualization by Mikhail Tikhonravov to actuality was nothing short of inspiring. In this essay I will explore the early work on *Sputnik 3*, which was planned to be *Sputnik 1*; the hurried development of *Sputnik 1* when *Sputnik 3* was not ready; the even more hurried development of *Sputnik 2* (the Layka carrier) at Premier Nikita Khrushchev's behest; the actual launches and the casual reaction, at first, by Kremlin officialdom to *Sputnik 1*'s success; and then the quick switch to braggadocio when the world impact was realized.[1]

INITIAL SOVIET REACTION TO THE *SPUTNIK 1* LAUNCH

While it jolted the rest of the world, the successful launch of *Sputnik 1* on October 4, 1957, received casual treatment, at first, in Moscow. Korolev's former colleague, Academician Boris Raushenbakh, told me, some 35 years later, "Look up the pages of *Pravda* for the first day after the launch. It got only a few paragraphs. Then look at the next day's issue, when the Kremlin realized what the world impact was."[2]

The article in the October 5 *Pravda* was, indeed, tersely phrased. Positioned modestly in a right hand column part way down on the first page, it did not even mention the satellite in its head. Titled routinely, "TASS Report," it gave the facts of the launch clinically.