"New Soviet Man" Inside Machine:
Human Engineering, Spacecraft Design, and the Construction of Communism

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ABSTRACT

Soviet propaganda often used the Soviet space program as a symbol of a much larger and more ambitious political/engineering project—the construction of communism. Both projects involved the construction of a new self, and the cosmonaut was often regarded as a model for the "new Soviet man." The Soviet cosmonauts publicly represented a communist ideal, an active human agency of sociopolitical and economic change. At the same time, space engineers and psychologists viewed human operators as integral parts of a complex technological system and assigned the cosmonauts a very limited role in spacecraft control. This article examines how the cosmonaut self became the subject of "human engineering," explores the tension between the public image of the cosmonauts and their professional identity, and draws parallels between the iconic roles of the cosmonaut and the astronaut in the cold war context.

INTRODUCTION

On April 12, 1961, Yurii Gagarin's historic spaceflight shook the world, sending enthusiastic crowds of Soviet citizens onto the streets to celebrate. Just a few months later, the Twenty-Second Congress adopted a new Communist Party program, which set the goal of building the foundations of communism in the Soviet Union by 1980. This all-out drive toward communism had two crucial components: the construction of a material and technical basis of communism, and the development of the "new Soviet man"—"a harmonic combination of rich spirituality, moral purity, and physical perfection."[1] Who better than Gagarin to embody this new ideological construct? The

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[1] *Materialy XXII s'ezda KPSS* (Moscow, 1962), 411.

Soviet media machine quickly generated a propaganda cliché: "the Soviet cosmonaut is not merely a victor of outer space, not merely a hero of science and technology, but first and foremost he is a real, living, flesh-and-blood *new man,* who demonstrates in action all the invaluable qualities of the Soviet character, which Lenin's Party has been cultivating for decades."[2]

In the first half of the 1960s, the Soviet space program boasted one success after another—the first man's flight, the first group flight, the first woman's flight, the first multicrew mission, and the first space walk.[3] Ordinary people became genuinely fascinated with the Soviet triumphs in space. "Gagarin's achievement was our greatest pride," recalled one member of the "Sputnik generation."[4] According to the 1963 poll of the readers of a popular youth-oriented Soviet newspaper, Gagarin's flight was by far the greatest human achievement of the century, and Sputnik the greatest technological feat.[5]

Soviet propaganda vividly portrayed cosmonaut heroes bravely flying their spacecraft into the unknown, but the cosmonauts, in fact, were assigned a very limited role on board a spacecraft. Soviet spaceships were fully automated. Although systems of manual control were installed, their functions and use were severely limited. Gagarin's *Vostok* had only two manual control functions: attitude correction and firing the retrorocket for reentry—and those could be used only in case of emergency.[6] The designer of *Vostok*'s manual control system jokingly summed up Gagarin's instructions in four words: "Do not touch anything!" The Soviet engineers' vision of a manned flight was that of a cosmonaut flying *on board* a spacecraft, rather than flying a spacecraft.[7]

On later models of spacecraft, the cosmonauts gradually gained more control functions, but they still served mostly as backup for failed automatics; the standard mode of control remained automatic. Soviet cosmonauts were "designed" as part of a larger technological system; their height and weight were strictly regulated, and their actions were thoroughly programmed. Soviet space politics, one might say, was inscribed on the cosmonauts' bodies and minds, as they had to fit, both physically and mentally, into their spaceships.

The cosmonauts strongly opposed this trend, which they labeled "the domination of automata."[8] With their professional background as pilots, they felt that greater human control of spacecraft would increase the reliability and effectiveness of space missions. Some cosmonauts regarded the domination of automata in the Soviet space program as the manifestation of a general ideological attitude toward the individual

[2] Evgenii Riabchikov, "Volia k pobede," *Aviatsiia i kosmonavtika,* no. 4 (1962): 10–19, on 19 (emphasis added).

[3] The most comprehensive history of the Soviet space program is Asif A. Siddiqi's thoroughly researched *Challenge to Apollo: The Soviet Union and the Space Race, 1945–1974* (Washington, D.C., 2000), which includes an excellent bibliographic essay.

[4] Donald J. Raleigh, trans. and ed., *Russia's Sputnik Generation: Soviet Baby Boomers Talk about Their Lives* (Bloomington, Ind., 2006), 133.

[5] Boris A. Grushin, *Chetyre zhizni Rossii v zerkale oprosov obshchestvennogo mneniia,* vol. 1, *Zhizn' 1-ia: Epokha Khrushcheva* (Moscow, 2001), 403.

[6] Valentina Ponomareva, "Osobennosti razvitiia pilotiruemoi kosmonavtiki na nachal'nom etape," in *Iz istorii raketno-kosmicheskoi nauki i tekhniki,* no. 3, ed. V.S. Avduevskii et al. (Moscow, 1999), 132–67.

[7] Boris E. Chertok, *Fili—Podlipki—Tiuratam,* vol. 2 of *Rakety i liudi,* 3rd ed. (Moscow, 2002), 428.

[8] Georgii Beregovoi, as quoted in Valentina Ponomareva, "Nachalo vtorogo etapa razvitiia pilotiruemoi kosmonavtiki (1965–1970 gg.)," in *Issledovaniia po istorii i teorii razvitiia aviatsionnoi i raketno-kosmicheskoi tekhniki,* nos. 8–10, ed. Boris Raushenbakh (Moscow, 2001), 150–74, on 166.

as an insignificant cog in the wheel.[9] They viewed the strict regulation of their activities as part of a general pattern of social control in the Soviet state.[10] In my view, exploring this tension between the cosmonauts' public identity as icons of communism and their conflicted professional identity may throw light on some fundamental contradictions in the Soviet discourse on the communist self in the Khrushchev era.

Soviet historians have long focused their attention on the attempts to reform the human self, and they bring up the new Soviet man as being essential to the Soviet project. The "totalitarian model" of Soviet society traditionally considered "the cog in a wheel" as a central metaphor for the new Soviet man.[11] This metaphor embodied the notion of the passive individual subsumed under the collective and implied the machinelike operation of the party and state apparatus controlling social life.

Recently, scholars began to question the passive nature of the "totalitarian self" and to explore the historical evolution of the Soviet notions of the self. Vladimir Papernyi has suggested that two opposing cultural patterns coexisted in Soviet society, dominating in different periods: the first, which privileged the mechanism and collectivism, dominated in the 1920s; the second, which focused on the human and individualism, prevailed in the 1930s–1950s.[12] Igal Halfin and Jochen Hellbeck have argued that the Stalinist subject was not merely a passive recipient of official ideology. In their views, young Soviet people internalized communist values and made active attempts to reform themselves, striving for the alluring ideal of the new Soviet man.[13] Sheila Fitzpatrick has found more mundane reasons for individuals' attempts to construct new identities for themselves. The Soviet state, she argues, discriminated on the basis of class, and resourceful individuals often resorted to self-fashioning, impersonation, and outright imposture to claim their "proletarian" origins and revolutionary identity.[14]

The transition from the Stalin era to Khrushchev's political "thaw" led to a marked shift in the prevailing conception of the self. Historians differ, however, on the exact direction of that shift. Elena Zubkova has described the Stalin era as an age of collectivism, followed by the "turn to the individual" in the Khrushchev years.[15] Oleg Kharkhordin, by contrast, has suggested a historical trajectory from the collectivism of the 1920s to the individualism of the 1930s–1950s to the new collectivism of the 1960s. He provocatively argues that there was more room for individual freedom under Stalin than under Khrushchev. Whereas Stalinist terror was punitive and haphazard, Khrushchev's policies were aimed at a pervasive rational system of preventive mutual surveillance.[16]

[9] Valentina Ponomareva, *Zhenskoe litso kosmosa* (Moscow, 2002), 207.

[10] Ponomareva, "Nachalo vtorogo etapa" (cit. n. 8), 170.

[11] Mikhail Heller, *Cogs in the Soviet Wheel: The Formation of Soviet Man,* trans. David Floyd (London, 1988).

[12] Vladimir Papernyi, *Architecture in the Age of Stalin: Culture Two,* trans. John Hill and Roann Barris (New York, 2002).

[13] See Igal Halfin, *From Darkness to Light: Class, Consciousness, and Salvation in Revolutionary Russia* (Pittsburgh, 2000); Halfin, *Terror in My Soul: Communist Autobiographies on Trial* (Cambridge, Mass., 2003); and Jochen Hellbeck, *Revolution on My Mind: Writing a Diary under Stalin* (Cambridge, Mass., 2006).

[14] Sheila Fitzpatrick, *Tear off the Masks! Identity and Imposture in Twentieth-Century Russia* (Princeton, N.J., 2005).

[15] Elena Zubkova, "Turning to the Individual: The Paths from Above and from Below," in *Russia after the War: Hopes, Illusions, and Disappointments, 1945–1957,* trans. Hugh Ragsdale (Armonk, N.Y., 1998).

[16] Oleg Kharkhordin, *The Collective and the Individual in Russia: A Study of Practices* (Berkeley, Calif., 1999); see, especially, 299–300.

If the Soviet policy on the new Soviet man is still baffling historians, it must have looked even more confusing to contemporaries. It is precisely the ambiguity of the new Soviet man as an ideological construct that will be addressed in this paper. Instead of viewing this ambiguity as a result of policy inconsistencies, I will interpret it as a product of fundamental ideological tensions in the Soviet discourse on the self.

Soviet propaganda often used large technological projects, such as the space program, as symbols of the construction of socialism and communism. I will examine the notion of the new Soviet man through its iconic representations—from the heroic aviator in the Stalin period to the cosmonaut in the Khrushchev era. In these cases, the self was viewed as an active agency and, at the same time, defined as part of a technological system. The first quality implied autonomy; the second, discipline and subordination. I will argue that this tension gave rise to the paradox of "disciplined initiative," which plagued both the cosmonaut self and the new Soviet man.

Based on recently declassified archival documents related to the Soviet space program, private papers of leading space engineers and officials, and interviews with spacecraft designers and cosmonauts, I will examine the application of principles of "human engineering" to the training of Soviet cosmonauts, the formation of their professional identity, and the clash between their professional and public identities. In conclusion, I will draw parallels between the iconic roles of the cosmonaut and the astronaut in the cold war context.

"A FLAMING MOTOR FOR A HEART": NEW SOVIET MAN IN THE SKY

In his pioneering study of Soviet technology under Lenin and Stalin, the historian Kendall Bailes noted that in the 1930s, famous Soviet aviators became "prime exhibits of the 'new Soviet men' whom the authorities wished to create."[17] In April 1934, Mikhail Vodop'ianov and Nikolai Kamanin and five other pilots, all of whom had distinguished themselves during the Arctic rescue of the crew of the stranded icebreaker *Cheliuskin,* became the first Soviet citizens to be awarded the newly established title of Hero of the Soviet Union. As the historian Jay Bergman aptly put it, air heroes became "ideological prototypes, precursors of the people who would inhabit the future, from whose achievements . . . the Soviet people could develop a sense of what living under communism would be like."[18]

In November 1933, Stalin put forward a new slogan, calling on Soviet aviators to fly farther, faster, and higher than anyone else, and the Soviet Union jumped into the international race for air records. By 1938, the Soviets claimed to have achieved sixty-two world records, including, as requested by Stalin, the longest, fastest, and highest flights.[19] Aviation became one of the most spectacular "display technologies," showing off the Soviet technological prowess and implying the ideological superiority of the Soviet regime.[20]

As Bailes keenly observed, the regime skillfully exploited the public enthusiasm

[17] Kendall Bailes, *Technology and Society under Lenin and Stalin: Origins of the Soviet Technical Intelligentsia, 1917–1941* (Princeton, N.J., 1978), 391.

[18] Jay Bergman, "Valerii Chkalov: Soviet Pilot as New Soviet Man," *Journal of Contemporary History* 33 (1998): 135–52, on 139.

[19] Bailes, *Technology and Society under Lenin and Stalin* (cit. n. 17), 386.

[20] Paul R. Josephson, "'Projects of the Century' in Soviet History: Large-Scale Technologies from Lenin to Gorbachev," *Technology and Culture* 36 (July 1995): 519–59.

for aviation to counterbalance the sobering effect of the Great Purges of 1936–1938.[21] As hundreds of thousands perished in prisons and labor camps, Stalin used the celebratory occasions of record flights to stress his personal concern for human life. "Your lives are dearer than any machine," he frequently told aviators, urging them not to take unjustified risks.[22] Yet that was precisely what the aviators had to do in order to set records, so valuable on the propaganda front. In January 1934, the crew of the *Osoaviakhim* stratosphere balloon, dedicating their feat to the Seventeenth Party Congress, set a new world record in height. In doing so, however, they pushed the balloon beyond its technological limits and died in the ensuing crash. During the funeral, Stalin personally carried the ashes through Red Square.[23]

The political project of creating the public image of the aviator as a new Soviet man took precedence over the practical demands for the development of modern military aircraft. Concerned largely with the propaganda aspect of aviation as a "display technology," Soviet leaders neglected much-needed technological reforms in the aviation industry. Instead of designing swift, maneuverable aircraft with sophisticated electronic equipment, the Soviets produced heavy, slow, long-distance models, which were good for setting world records but useless in bombing or air combat.[24]

Stalin's famous toast to "the 'little cogs' of a grand state mechanism" at a June 1945 reception celebrating victory in the Second World War encapsulated a popular cultural image of the individual under Stalin's rule: a necessary but ultimately subservient and replaceable part.[25] The more loudly Stalin proclaimed that human life was "dearer than any machine," the more plainly his actual policies forced individuals to obey the relentless rhythm of the state machine.

The popular culture of the 1930s was filled with man-machine metaphors that reinforced the regime's ideological message. For instance, in the 1930s, in the well-known 1920s song "Aviation March," the word "reason" in "Reason gave us steel wings for arms, and a flaming motor for a heart" was replaced with "Stalin." Visual imagery in public spaces reinforced the metaphorical merger of humans and airplanes as well. For example, the ceiling of the Mayakovskaya subway station, completed in 1938, was decorated with mosaics depicting athletic men and women soaring in the sky like airplanes, "as if these people themselves were a technical achievement of the new Soviet epoch."[26] Along with aviation, the spectacular Moscow subway system itself became, in the words of a contemporary, "a majestic school in the formation of the new man."[27]

The widely propagated image of the new Soviet man was filled with inner tensions and ambiguities. The new man was both a distinct individual and a "little cog"; he strove for personal achievement and wanted to be a good member of the collective; he

[21] Bailes, *Technology and Society under Lenin and Stalin* (cit. n. 17), 381.
[22] Ibid., 387.
[23] Iaroslav Golovanov, *Korolev: Fakty i mify* (Moscow, 1994), 198.
[24] Bailes, *Technology and Society under Lenin and Stalin* (cit. n. 17), 390; Bergman, "Valerii Chkalov" (cit. n. 18), 151.
[25] Iosif Stalin, "Vystuplenie na prieme v Kremle v chest' uchastnikov Parada Pobedy" (1945), in *Sochineniia* 15 (Moscow, 1997): 232.
[26] Michael O'Mahony, "Zapiski iz podzemki: moskovskoe metro i fizkul'tura v 30-e gody XX veka," *Neprikosnovennyi zapas (NZ)* 23 (2002); http://www.nz-online.ru/index.phtml/index.phtml?aid=25011375 (accessed 1 June 2005).
[27] Quoted in Andrew Jenks, "A Metro on the Mount: The Underground as a Church of Soviet Civilization," *Technol. Cult.* 41 (Oct. 2000): 697–724, on 697.

was to be a master of technology, yet he merged with technology as its intrinsic part. Stalin publicly encouraged air heroes to choose their own courses of action during flights, ignoring, if necessary, advice from the ground, and at the same time he instructed them not to take any risks. Paradoxically, "while individual initiative, even disobedience, were qualities that Stalin considered admirable and highly desirable in the new Soviet man, they were also things that, in Stalin's view, would be strictly limited in the communist society he envisioned," a society that would be "rigidly hierarchical" and "informed by an ethos of deference and obedience."[28] The ideological constructs of the new Soviet man and of the bright communist future did not quite match up. This did not particularly upset professional ideologues, however: those constructs were to be believed, rather than rationally examined.

The contradictory nature of Stalin's new man stemmed from the fundamental ambiguity of Stalinist official discourse.[29] Soviet ideology constantly oscillated between belief in the power of technology and trust in active human agency. Stalin's 1931 slogan, "in the reconstruction period, technology decides everything,"[30] was replaced in 1935 by its exact opposite, "cadres decide everything."[31] Despite the clear signal from the top marking a significant ideological shift, the public discourse had inertia of its own, and the two slogans—"technology decides everything" and "cadres decide everything"—coexisted in popular writings and speeches for quite a while, creating much confusion about the correct party priorities with respect to people and machines. Whereas the old slogan presented technology as a measure of progress, the new one placed an equally high value on human skill and personal sacrifice.

In the 1960s the cosmonaut quickly supplanted the aviator as a top model for the Soviet self. The role of the new Soviet man in a complex technological system, however, remained ambiguous: Will he become the master of technology or its servant?

FROM STALIN'S "FALCONS" TO KOROLEV'S "LITTLE EAGLES"

In the 1930s, the Soviet media habitually referred to the aviation heroes as "Stalin's falcons," implying their "extra-human, and even superhuman, characteristics and abilities."[32] Sergei Korolev, the chief designer of Soviet spacecraft, echoed this cultural image, calling the first cosmonauts "my little eagles." He expected the cosmonauts to be ready for self-sacrifice, just like the famous aviators of the 1930s. At a meeting of the Military Industrial Commission two weeks before Gagarin's flight, Korolev admitted the considerable risks of the mission but cited the courage of the *Osoaviakhim* stratosphere balloon crew: "They died but held a record for the Soviet Union for 22 years."[33]

Which personal qualities were required of the Soviet cosmonaut became a matter of serious debate. In January 1959, top scientists, physicians, and spacecraft design-

[28] Bergman, "Valerii Chkalov" (cit. n. 18), 143, 149.

[29] Slava Gerovitch, *From Newspeak to Cyberspeak: A History of Soviet Cybernetics* (Cambridge, Mass., 2002), chap. 1, "The Cold War in Code Words: The Newspeak of Soviet Science."

[30] Iosif Stalin, "O zadachakh khoziaistvennikov" (1931), in *Sochineniia* 13 (Moscow, 1951): 29–42, on 41.

[31] Iosif Stalin, "Rech' v Kremlevskom dvortse na vypuske akademikov Krasnoi armii" (1935), in *Sochineniia* 14 (Moscow, 1997): 58–63, on 61.

[32] Bergman, "Valerii Chkalov" (cit. n. 18), 138.

[33] Boris Chertok, 29 March 1961, notebook no. 41, Chertok Papers, National Air and Space Museum, Smithsonian Institution, Washington, D.C.

ers gathered at the Soviet Academy of Sciences to discuss the criteria for cosmonaut selection. The physical requirements were clear: because of the small size of the *Vostok* spacecraft, the candidates had to be no taller than 1.75 meters (5'7") and no heavier than 72 kilograms (158 pounds). Opinions divided over the question of future candidates' professional background. Some participants thought submarine sailors, missile forces officers, and even race car drivers should be considered. Korolev argued, however, that fighter jet pilots were best prepared for space missions: "A fighter pilot has the universal skills that we need. He flies in the stratosphere on a one-seat airplane. He is a pilot, a navigator, and a radio operator in one. It is also important that he is a regular military man and therefore possesses such necessary qualities for a future cosmonaut as assiduousness, self-discipline, and unwavering determination to reach the set goal."[34]

Selection was made from among fighter pilots age twenty-five to thirty in perfect health; no requirements were set for their piloting skills. As a result, most of the twenty selected candidates had relatively little flying experience—230 hours in Gagarin's case; the Mercury astronauts, by contrast, had to have a minimum of 1,500 hours. Nineteen out of the twenty cosmonauts were fighter pilots with no training in engineering; the Mercury seven were skilled test pilots with strong engineering backgrounds. Soviet spacecraft designers believed that the high degree of automation of spacecraft control allowed them to run the entire mission in the automatic or semiautomatic mode, thus making high piloting and engineering skills unnecessary. Korolev explained: "As has been repeatedly demonstrated in our automated flights and those with animals on board, our technology is such that we do not require, as the American Mercury project does, that our early cosmonauts be skilled engineers."[35]

The task of cosmonaut training was assigned to the air force, which in 1960 established the Cosmonaut Training Center in an isolated area eighteen miles northeast of Moscow, now widely known as Star City. Lieutenant General Nikolai Kamanin was appointed the deputy chief of the air force's General Staff in charge of cosmonaut selection and training. It was the same Kamanin who received the highest Soviet honor, Hero of the Soviet Union, for his role in the 1934 *Cheliuskin* rescue mission. One of the most famous aviators of the 1930s, a public icon of Stalin's regime, Kamanin had strong convictions and a commanding personality. He did not hesitate to confront an equally authoritative Korolev and the powerful leadership of the air force and the Ministry of Defense whenever they did not go along with his uncompromising views on space policy.

Kamanin's vision of the role of the cosmonauts in the space program forcefully clashed with Korolev's position. While Korolev extolled the virtues of automation and proudly asserted that on his spacecraft even "rabbits could fly,"[36] Kamanin insisted that the cosmonauts be assigned a greater role in spacecraft control.

In preparation for Gagarin's historic launch, Korolev suggested that Gagarin should limit his actions during the flight to visual inspection of onboard equipment and should not touch any controls. Korolev's cautious approach may have been prompted by the responsibility placed on him by the political authorities. At a meeting of the

[34] Iaroslav Golovanov, *Nash Gagarin* (Moscow, 1978), 50–1.
[35] Quoted in Siddiqi, *Challenge to Apollo* (cit. n. 3), 244.
[36] Nikolai Kamanin, *Skrytyi kosmos,* vol. 3, *1967–1968* (Moscow, 1999), 335 (diary entry of 12 Dec. 1968).

Presidium of the Party Central Committee on April 3, 1961, just a few days before Gagarin's launch, Nikita Khrushchev himself raised a question about the cosmonaut's working capacity and psychological stability in orbit. Korolev had to give his personal assurances to the Soviet premier.[37] Not relying entirely on the disciplining force of the cosmonaut's written instructions, spacecraft designers took some technological measures to prevent any accidental damage by the cosmonaut should he lose his psychological stability. They blocked the manual orientation system for reentry with a digital lock. There was some debate about whether to give the combination to the cosmonaut or to transmit it over the radio in case of emergency. Eventually, they decided to put the combination in a sealed envelope and to place it on board so the cosmonaut could open it in an emergency.[38]

Supported by flight physicians, Kamanin proposed giving Gagarin a broader set of functions, such as checking equipment before launch, writing down his observations and instrument readings in the onboard journal, and reporting those over the radio.[39] As doctors explained, keeping the cosmonaut busy would help deflect his attention from possible negative emotions during g-loads and weightlessness.[40] Kamanin prevailed, and Gagarin performed his monitoring functions very well, while the flight itself was conducted in the automatic mode.

Kamanin carefully supervised the official reports written by the cosmonauts after their flights. Based on his suggestions, the cosmonauts Andrian Nikolaev and Pavel Popovich, who tested the possibility of carrying out various military tasks during their *Vostok 3* and *Vostok 4* flights, reported that the human was "capable of performing in space all the military tasks analogous to aviation tasks (reconnaissance, intercept, strike)." Kamanin then used their reports to substantiate his view that "man can maintain good working capacity in a prolonged spaceflight. The 'central character' in space is man, not an automaton."[41]

Kamanin envisioned the cosmonaut as a quintessential pilot of a space vehicle, in full control of his craft and of his mission. Korolev, by contrast, viewed the cosmonaut as part of a complex technological system—a part that had to obey the logic of system operations as faithfully as any other part. Despite their conflicting visions of the overall cosmonaut role, the two men often agreed on cosmonaut training, though they emphasized different aspects. Korolev stressed the cosmonaut's ability to fit into the machine, to carry out precisely programmed actions.[42] Kamanin, for his part, demanded strict military discipline and political loyalty. While spacecraft designers standardized cosmonauts' bodies, Air Force officials regularized their thoughts. Together Korolev and Kamanin attempted to engineer the Soviet cosmonaut, a living embodiment of the new Soviet man. They were aided in this project by specialists in human engineering.

[37] Nikolai Kamanin, *Skrytyi kosmos,* vol. 1, *1960–1963* (Moscow, 1995), 23 (diary entry of 2 March 1961), 43 (diary entry of 4 April 1961).

[38] As it turned out, two people independently told Yurii Gagarin the combination before the launch so that he would not waste time in a real emergency. See Chertok, *Fili—Podlipki—Tiuratam* (cit. n. 7), 428–9.

[39] Siddiqi, *Challenge to Apollo* (cit. n. 3), 264.

[40] Kamanin, *Skrytyi kosmos* (cit. n. 37), 1:23 (diary entry of 2 March 1961).

[41] Ibid., 174 (diary entry of 13 Sept. 1962), 149 (diary entry of 16 Aug. 1962).

[42] Siddiqi, *Challenge to Apollo* (cit. n. 3), 244.

HUMAN ENGINEERING AND THE DESIGN OF A COSMONAUT

Human engineering emerged in the Soviet Union in the early 1960s under the name engineering psychology. This field developed under the wide umbrella of cybernetics and also became known as cybernetic psychology.[43] The Council on Cybernetics of the Soviet Academy of Sciences set up a psychology section, which included a committee on human engineering that coordinated nationwide research in this field. Soviet specialists in engineering psychology defined their discipline as a "study of humans as part of a control system" and included in their area of interest such fields as applied psychology, experimental psychology, biomechanics, psychoacoustics, ergonomics, operations research, and the study of human-machine systems.[44] Adopting the cybernetic conceptual framework, they viewed both humans and machines as cybernetic systems governed by the same feedback mechanism. Blurring the boundary between human and machine, cybernetics legitimized the idea of designing, or human engineering, the self.

The Council on Cybernetics coordinated research on human perception, information processing, and the impact of emotional states on control functions at several universities and research institutes, including the Air Force Institute of Aviation and Space Medicine. The institute set up a department of spacecraft simulators, which was responsible for the adaptation of onboard equipment to cosmonauts' psychological and physiological characteristics and for the development of specifications for ground simulators.[45] By early 1967, the institute had conducted several hundred flight experiments and more than 1,000 tests on simulators to find an optimal division of function between human and machine.[46] Moscow University and Leningrad University also conducted a number of studies focused on the human operator on board a spacecraft. They examined various statistical characteristics, work efficiency, interaction among human operators, and selection and special training of personnel for working with various types of control systems.[47]

As "cybernetic psychologists," Soviet specialists in human engineering conceptualized the spacecraft control system as a "cybernetic 'human-machine' system."[48] They defined the cosmonaut as a "living link"[49] in this system, and analyzed this living link in cybernetic terms, borrowed from control theory and information theory—the same terms as applied to the other links in this system. They discussed how efficiently a human operator could perform the functions of a logical switchboard, an

[43] On Soviet cybernetics, see Gerovitch, *From Newspeak to Cyberspeak* (cit. n. 29).

[44] E. I Boiko et al., "Kibernetika i problemy psikhologii," in *Kibernetiku—na sluzhbu kommunizmu,* ed. A. I. Berg (Moscow, 1967), 5:314–50, on 316.

[45] V. I. Iazdovskii, *Na tropakh Vselennoi* (Moscow, 1996), chap. 1.

[46] Georgii T. Beregovoi et al., *Eksperimental'no-psikhologicheskie issledovaniia v aviatsii i kosmonavtike* (Moscow, 1978), 64–7.

[47] Records of the Psychology Section of the Council on Cybernetics, 1962, f. 1807, op. 1, d. 24, ll. 27–9, Archive of the Russian Academy of Sciences, Moscow.

[48] Viktor G. Denisov, "Nekotorye aspekty problemy sochetaniia cheloveka i mashiny v slozhnykh sistemakh upravleniia," in *Problemy kosmicheskoi biologii,* ed. N. M. Sisakian and V. I. Iazdovskii, vol. 2 (Moscow, 1962), 54–67, on 54.

[49] V. G. Denisov, A. P. Kuz'minov, and V. I. Iazdovskii, "Osnovnye problemy inzhenernoi psikhologii kosmicheskogo poleta," in *Problemy kosmicheskoi biologii,* ed. N. M. Sisakian and V. I. Iazdovskii, vol. 3 (Moscow, 1964), 66–79, on 77.

amplifier, an integrator, a differentiator, and a computer.[50] They described the "static and dynamic characteristics" of a human operator in terms of delay time, perception speed, reaction speed, bandwidth, and so on.[51] The "human channel capacity," for example, was estimated at 0.8 bit per second. Based on this estimate, human engineering specialists concluded that, if forced to make a decision within ten seconds, a human could take into account no more than two or three factors.[52]

The cybernetic framework effectively set a standard for evaluating human performance in machine terms. Based on quantitative evaluations, human engineering specialists argued that the human was better than the machine in intelligence, reasoning, and overall flexibility (receiving and processing diverse types of information, learning, and performing diverse tasks). The machine, however, was vastly superior in receiving and processing large amounts of information, performing precise operations, multitasking, work capacity, computation, and discarding unnecessary information.[53] Purely human qualities were seen as a mixed blessing: "The machine does not feel boredom, irritation, hesitation in decision making, apathy, fear, or lack of self-confidence. Neither does the machine possess élan, responsibility, the ability to take risks, or imagination."[54]

The psychologists concluded that the human could be either the strongest or the weakest link in the system, depending on how the functions were divided between human and machine.[55] They formulated the principle of an "active operator" and developed basic guidelines for the joint human/machine, or semiautomatic, control. Researchers recommended, for example, trusting rendezvous and repair operations to the cosmonaut and routine equipment operation to the machine.[56] If these considerations were taken into account, they argued, a human operator could increase the reliability, and in some cases reduce the weight and bulk, of onboard equipment.[57]

Although these conclusions seemed to support a greater role for the cosmonaut on board, the cybernetic framework underlying this approach fundamentally assigned the human operator a secondary role. Ultimately, the function of the human operator was to enhance the operations of machines, not the other way around.

OPERATOR TRAINING: TOWARD A PERFECT AUTOMATON

The spacecraft designers tended to be more skeptical about the human abilities in space than were the psychologists. Most engineers viewed the cosmonaut on board as a weak link, a source of potential errors. For example, Konstantin Feoktistov, the lead-

[50] P. K. Isakov, V. A. Popov, and M. M. Sil'vestrov, "Problemy nadezhnosti cheloveka v sistemakh upravleniia kosmicheskim korablem," in *Problemy kosmicheskoi biologii,* ed. N. M. Sisakian, vol. 7 (Moscow, 1967), 5–11, on 6.

[51] Denisov, "Nekotorye aspekty" (cit. n. 48), 55.

[52] Aleksandr I. Men'shov, *Kosmicheskaia ergonomika* (Leningrad, 1971), 14.

[53] V. N. Kubasov, V. A. Taran, and S. N. Maksimov, *Professional'naia podgotovka kosmonavtov* (Moscow, 1985), 6; Men'shov, *Kosmicheskaia ergonomika* (cit. n. 52), 11.

[54] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 6.

[55] Men'shov, *Kosmicheskaia ergonomika* (cit. n. 52), 10.

[56] Denisov, Kuz'minov, and Iazdovskii, "Osnovnye problemy" (cit. n. 49), 67; Men'shov, *Kosmicheskaia ergonomika* (cit. n. 52), 220.

[57] Denisov, Kuz'minov, and Iazdovskii, "Osnovnye problemy" (cit. n. 49), 66–7; Isakov, Popov, and Sil'vestrov, "Problemy nadezhnosti cheloveka" (cit. n. 50), 5; Men'shov, *Kosmicheskaia ergonomika* (cit. n. 52), 237.

ing integration designer of the *Vostok* spacecraft, openly told the cosmonauts that "in principle, all work will be done by automatic systems in order to avoid any accidental human errors."[58] He put forward the principle that "every operation that can be automated on board a spaceship should be automated."[59]

The perception of human operators as unreliable was not entirely due to slow human reaction or limited memory capacity. Engineers discovered that quantitative characteristics of human activity in flight often differed from the characteristics measured during ground-training sessions. Thus the main problem was not that the human was not capable; the main problem was that the human was not fully predictable. Engineers therefore recommended that the manual control regime be used only in emergencies.[60] As one candidate cosmonaut put it, "They trusted hardware and did not trust the human being."[61]

Cosmonaut training was geared toward reducing this fundamental human unpredictability and turning the cosmonaut into a perfect machine. Korolev's Experimental Design Bureau No. 1 set up a special department to design cosmonaut activity so that it conformed to the logic of onboard automatics. Spacecraft designers viewed cosmonaut activity as auxiliary to the spacecraft's automatic control system, and therefore avoided the word "pilot" and preferred the term "spacecraft guidance operator."[62]

Spacecraft designers took to heart advice given by Igor' Poletaev, a leading Soviet cybernetics expert. He argued that the way to avoid human error was to train the human to operate like a machine: "The less his various human abilities are displayed, the more his work resembles the work of an automaton, the less [the human operator] debates and digresses, the better he carries out his task."[63] Yurii Gagarin recalled how the cosmonauts were "getting used to every button and every tumbler switch, learning all the movements necessary during the flight, making them automatic."[64] The *Vostok 5* pilot, Valerii Bykovskii, was praised in his official evaluation for "the high stability of automation of skill."[65] A cosmonaut training manual explicitly stated that "the main method of training is repetition."[66] The cosmonaut Vladimir Shatalov had to perform 800 dockings on a ground simulator before he was allowed to carry out the first manual docking of *Soyuz 4* and *Soyuz 5* in January 1969.[67] Later on, the requirement for crews training for rendezvous missions was reduced to 150 simulated dockings.[68]

The planning of cosmonaut activity in orbit was detailed and thorough. The timing and length of every action was predetermined on the ground. The control system engineer and cosmonaut Aleksei Eliseev designed a step-by-step procedure (a *cyclogram*) for a transfer from one spacecraft to another by spacewalk, which he himself carried out during the *Soyuz 4/Soyuz 5* mission. Eliseev specified all the actions and

[58] Vladimir Komarov, 1961, workbook no. 39, Gagarin Memorial Museum Archive, Gagarin, Smolensk, Russia (hereafter cited as GMMA); http://web.mit.edu/slava/space/documents.htm (accessed 28 Aug. 2006).
[59] Viktor D. Pekelis, *Cybernetic Medley,* trans. Oleg Sapunov (Moscow, 1986), 287.
[60] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 190.
[61] Ponomareva, *Zhenskoe litso kosmosa* (cit. n. 9), 207.
[62] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 278.
[63] Igor' A. Poletaev, *Signal: O nekotorykh poniatiiakh kibernetiki* (Moscow, 1958), 281.
[64] Yurii Gagarin, *Doroga v kosmos* (Moscow, 1961), 137.
[65] Quoted in A. N. Babiichuk, *Chelovek, nebo, kosmos* (Moscow, 1979), 209.
[66] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 138.
[67] Vladimir A. Shatalov, *Trudnye dorogi kosmosa,* 2nd ed. (Moscow, 1981), 129.
[68] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 138.

code words for every crew member. The procedure was recorded on a four-meter-long scroll of paper.[69]

For every deviation from the established procedure during the flight, cosmonauts received a citation. An error could be as small as flipping the wrong switch, even if it did not affect the operation of any systems. On average, two-person crews accumulated fifty to sixty citations during a several-month mission. This amounted to only one or two transgressions per person per week.[70] The cosmonauts truly achieved automaticity in their actions.

The cosmonauts occasionally complained about the "excessive algorithmization" of their activities, which, they claimed, turned them into automatons and stripped them of the possibility of planning their own actions.[71] If a cosmonaut finished a certain task before the specified time, he or she was not allowed to start the next task earlier than was specified in the cyclogram. This often led to idling, loss of valuable observation time, and waste of limited resources. During their seven-month-long stay on the Salyut-7 station in 1982, the cosmonauts Anatolii Berezovoi and Valentin Lebedev often chose to perform the most interesting experiments on their days off because on those days they could work at their own pace, without waiting for instructions from the ground.[72]

PSYCHOLOGICAL TRAINING: TOWARD TOTAL SELF-CONTROL

The psychologists who participated in cosmonaut training came largely from the field of aviation psychology, and they conceptualized cosmonaut activity in essentially the same terms as piloting. They stressed that the activities of the cosmonaut and the pilot had the following characteristics in common: (1) "continuity of work"—constant participation in controlling the most critical phases of flight, even if an autopilot is available; (2) "a mandatory or compulsory order of operations"—no change in the order of operations is allowed; the prescribed length of every operation must be followed; (3) "time deficit"—limits on flight operations, reception and processing of information from the ground and from onboard equipment; and (4) "mediated sensory inputs"—hearing is mediated by the radio, vision by optical equipment, and so on.[73]

Space psychologists had limited influence within the space program, and their advice was taken very selectively. Spacecraft designers embraced the idea of "a mandatory or compulsory order of operations," for it fitted well with their insistence on the automaticity of operations. They were skeptical, however, about the proposed parallels between piloting and cosmonaut work. The leading control system designer Boris Chertok wrote: "We, engineers who designed the control system, believed that controlling a spacecraft is much easier that controlling an aircraft. All processes are extended in time; there is always time to think things over. The craft will not suddenly break into a downward spin; . . . the laws of celestial mechanics will not let the spacecraft leave its orbit."[74] Spacecraft designers not only denied the significance of the

[69] Aleksei Eliseev, *Zhizn'—kaplia v more* (Moscow, 1998), 91.
[70] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 235.
[71] Beregovoi et al., *Eksperimental'no-psikhologicheskie issledovaniia* (cit. n. 46), 31.
[72] Valentin V. Lebedev, *Moe izmerenie* (Moscow, 1994), 246–7 (diary entry of 3 Sept. 1982).
[73] F. D. Gorbov and F. P. Kosmolinskii, "Ot psikhologii aviatsionnoi do psikhologii kosmicheskoi," *Voprosy psikhologii,* no. 6 (1967): 46–58, on 49.
[74] Boris E. Chertok, *Goriachie dni kholodnoi voiny,* vol. 3 of *Rakety i liudi* (cit. n. 7), 237.

time deficit factor but also neglected the principle of continuity of work. They preferred to keep the crew in "cold reserve," passively monitoring the operations of an automatic control system. Only if the automatic system failed was the crew expected to resort to manual control. The cosmonauts complained that being in cold reserve effectively kept them out of the control loop. Without regular participation in control operations, the crew would find it exceedingly difficult to switch from passive observation to active control in case of emergency.[75]

Space psychologists described the model cosmonaut as "a human being with great self-discipline, with a high degree of self-control, capable of thinking clearly and acting decisively in uncertain situations."[76] To prepare them psychologically for the dangers of spaceflight, the trainees were flown on high-performance airplanes and helicopters, performed parachute jumping, and escaped from a submarine through the torpedo compartment. Such life-threatening exercises were meant to re-create the level of emotional tension characteristic of spaceflight.[77] After 1963, parachute jumping was no longer a requisite skill for the cosmonauts, yet, despite occasional traumas, such as broken legs, it was retained in the training program as a means of "shaping the psychological structure of the cosmonaut as practitioner in a dangerous profession."[78] Cosmonaut training was based on the principle "the safety of spaceflight through the dangers of training."[79]

Particular attention in cosmonaut training was given to psychological stability in the presence of various disturbing factors. The model cosmonaut, space psychologists argued, "must be able to pick out relevant signals, even in the presence of interfering speech."[80] Cosmonauts were trained to control spacecraft motion and monitor eight onboard systems at the same time while being distracted by constant questioning about control panel readings.[81] Gagarin was selected for the first piloted mission based on his mastery of such skills. According to his official evaluation, he "showed high precision in performing various experimental psychological tasks, high resistance to interference from sudden and strong irritants," and "the ability to control himself in various unexpected situations."[82]

Cosmonauts not only had to perform their tasks flawlessly but also, just as important, retain perfect composure under stress. During simulated docking tests, the examiners closely watched the trainees' faces. As one cosmonaut recalled, "It was imperative not merely to carry out the procedure, but to do it calmly, confidently, without visible strain."[83]

[75] Ponomareva, "Nachalo vtorogo etapa" (cit. n. 8), 170. For specific examples of how the Soviet approach to automation of control affected the course of various space missions, see Slava Gerovitch, "Human-Machine Issues in the Soviet Space Program," in *Critical Issues in the History of Spaceflight,* ed. Steven J. Dick and Roger D. Launius (Washington, D.C., 2006), 107–40.

[76] Gorbov and Kosmolinskii, "Ot psikhologii aviatsionnoi do psikhologii kosmicheskoi" (cit. n. 73), 50.

[77] Georgii T. Beregovoi et al., "Ob otsenke effektivnosti raboty cheloveka v usloviiakh kosmicheskogo poleta," *Voprosy psikhologii,* no. 4 (1974): 3–9, on 7.

[78] V. A. Dovzhenko et al., "Spetsial'naia parashiutnaia podgotovka kosmonavtov," in *Materialy XXXVII chtenii K. E. Tsiolkovskogo* (Kaluga, 2002); http://www.museum.ru/gmik/readings.htm (accessed 30 June 2005).

[79] R. B. Bogdashevskii et al., "Psikhologicheskaia podgotovka i bezopasnost' kosmicheskogo poleta," in *Materialy XXXVII chtenii K. E. Tsiolkovskogo* (Kaluga, 2003); http://www.museum.ru/gmik/readings.htm (accessed 30 June 2005).

[80] Gorbov and Kosmolinskii, "Ot psikhologii aviatsionnoi do psikhologii kosmicheskoi" (cit. n. 73), 50.

[81] Isakov, Popov, and Sil'vestrov, "Problemy nadezhnosti cheloveka" (cit. n. 50), 10.

[82] Golovanov, *Nash Gagarin* (cit. n. 34), 137.

[83] V. N. Kubasov, *Prikosnovenie kosmosa* (Moscow, 1984), 125.

The trainers tried to boost the cosmonauts' "self-control and self-regulation of action in extreme circumstances" by requiring a continuous verbal report in the course of a complex parachute jump.[84] The cosmonauts were asked to report their every action, velocity, distance to their partners, and so on.[85] By comparing the acoustic characteristics of the reportage with regular speech patterns recorded on the ground, psychologists made conclusions about the degree of stress and self-control exhibited by the trainee. To avoid being disqualified for lack of self-control, the cosmonaut candidates had to manage their vocabularies and intonations very carefully, trying to minimize the emotional element in their speech—all while performing a difficult parachute jump.

Speech control proved a very useful skill in actual spaceflight. During prolonged flights, psychologists thoroughly analyzed communication sessions to determine the degree of psychological stability of the crew and their ability to continue the flight. As Valentin Lebedev, who spent more than seven months on board the Salyut-7 station, confessed, "One must keep himself in check all the time; one must control every word."[86] He likened the need to control speech to "prolonged abstinence from intercourse: it is painful, but it has to be endured."[87]

To train cosmonauts to deal with the emotional tension of a life-threatening situation, space psychologists not only placed cosmonaut candidates in dangerous conditions but also used hypnotic experiments. Under hypnosis, experimental subjects were given the instruction, "Your life will depend on how you perform your job. Any error may lead to a catastrophe." The psychologists were hoping that this instruction would hold power even after the subject was awakened from the hypnotic state and instill greater care in the subject's subsequent actions.[88]

Space psychologists suggested that the cosmonaut must be able to endure the feeling of disconnection from the Earth, solitude, limited sensory input, and noise-ridden communications.[89] To prepare for such eventualities, the cosmonauts were confined individually to a "silence chamber" for ten to fifteen days. During the entire period, the experimental subject remained alone, isolated from any outside light, sound, or other sensory input, and limited to four one-way communication sessions a day, during which the subject sent reports but received no reply. The subject's physiological parameters were constantly monitored. The high degree of "emotional stability" displayed by Gagarin during his silence chamber test may have contributed to his selection as the first cosmonaut.[90]

Space psychologists further insisted that the cosmonaut must feel equally comfortable in an unlimited ("empty") space and in a narrowly confined space. The candidate cosmonauts were subjected to short-term zero gravity during parabolic trajectory flights on a specially equipped airplane; psychologists also successfully experimented with suggesting a state of weightlessness under hypnosis. Studies of forced limitation on body movements were also conducted by restraining subjects' limbs with multiple

[84] Dovzhenko et al., "Spetsial'naia parashiutnaia podgotovka" (cit. n. 78).
[85] Irina Solov'eva, interview with author, 9 June 2004, Zvezdnyi Gorodok (Star City).
[86] Lebedev, *Moe izmerenie* (cit. n. 72), 281 (diary entry of 19 Sept. 1982).
[87] Ibid., 272 (diary entry of 15 Sept. 1982).
[88] Georgii T. Beregovoi and Andrei I. Iakovlev, *Modelirovanie system poluavtomaticheskogo upravleniia kosmicheskikh korablei* (Moscow, 1986), 59.
[89] Gorbov and Kosmolinskii, "Ot psikhologii aviatsionnoi do psikhologii kosmicheskoi" (cit. n. 73), 49.
[90] I. B. Ushakov, V. S. Bednenko, and E. V. Lapaeva, eds., *Istoriia otechestvennoi kosmicheskoi meditsiny* (Voronezh, Russia, 2001), chap. 16.

belts or plaster casts. In contrast to the ecstatic feelings expressed during weightlessness sessions, movement restriction tests led to a "severe psychological condition."[91] Yet one of the most spectacular Soviet space feats—the 1964 launch of a three-man crew on board the *Voskhod* spacecraft—was achieved by exploiting the cosmonauts' ability to operate in a narrow space. Instead of designing a larger spacecraft, Korolev's engineers fitted three cosmonaut seats side by side in the space previously occupied by only one cosmonaut on *Vostok*. As a result, the three cosmonauts had five times less space and air per capita than had the *Vostok* cosmonauts.[92]

In a certain way, the extraordinary trials that the cosmonauts went through during their training and actual flights presented in a concentrated form some familiar experiences of Soviet citizens. As social life in the Soviet Union was highly regulated, the cosmonauts' activity was also subjected to "a mandatory or compulsory order of operations." As Soviet citizens scrambled to find grains of information in the propaganda-filled official discourse, the cosmonauts trained to "pick out relevant signals" in the presence of noise. As Soviet citizens were virtually isolated from the outside world, the cosmonauts endured isolation tests in a silence chamber. As the secret police and an army of informers constantly watched ordinary citizens, ready to persecute them for any sign of political disloyalty, physicians constantly monitored the cosmonauts' physiological and psychological parameters, ready to disqualify anyone who showed a deviation from the norm. Most important, as Soviet citizens had to constantly watch themselves not to allow any slip, the cosmonauts had to exercise ultimate self-control, carefully choosing every action and every word. Like ordinary Soviet citizens, the cosmonauts had to follow the rules. As one candidate cosmonaut has observed, "The social behavior of the Soviet man is strictly regulated; similarly, for the cosmonauts instructions and guidelines of various sorts play a very significant role."[93]

A model cosmonaut was truly an exemplary Soviet citizen. Yet the cosmonauts' resentment toward the excessive algorithmization of their activity and their efforts to preserve their professional identities as pilots made them less than perfect candidates for the public embodiment of the new Soviet man. To turn the cosmonauts into walking emblems of the communist self, their political overseers had to reshape their public personas, just as the engineers and the psychologists had remodeled the cosmonauts' bodies and minds.

SHAPING THE COSMONAUTS' PUBLIC IDENTITY

If before the flight the cosmonauts' training was largely technical, their activity after the flight was to a large extent political. For many months after completing their space missions, Gagarin, Gherman Titov, and the other first cosmonauts toured the world, serving as "agitators for communism." Their visits had a particular political importance in the third world, where their public appearances were carefully planned to support pro-Soviet politicians. During a trip with his wife to India, Gagarin privately complained to Kamanin that their schedule was overloaded: "Too much politics, and nothing for ourselves; we did not even see any elephants."[94] In the course of one day of his visit to Ceylon, for example, Gagarin traveled more than 300 miles, visited nine

[91] Gorbov and Kosmolinskii, "Ot psikhologii aviatsionnoi do psikhologii kosmicheskoi" (cit. n. 73), 51.
[92] Siddiqi, *Challenge to Apollo* (cit. n. 3), 416.
[93] Ponomareva, "Nachalo vtorogo etapa" (cit. n. 8), 170.
[94] Kamanin, *Skrytyi kosmos* (cit. n. 37), 1:76 (diary entry of 7 Dec. 1961).

towns, and gave more than fifteen speeches. During his numerous foreign trips, he endured a total of nearly 150 days of such political marathons. No wonder he considered worldwide fame his heaviest burden.[95] During 1961–1970, the cosmonauts made 200 trips abroad.[96] The first woman in space, Valentina Tereshkova, alone made 42 foreign trips; she was able to escape the political speech circuit only when she was several months into her pregnancy.[97]

Groomed by the Soviet political leadership to serve as ideological icons of communism, cosmonauts had to appear personally at all major public forums inside the country. Kamanin, who oversaw the cosmonauts' schedules, received dozens of requests daily. In 1961–1970, the cosmonauts attended more than 6,000 public events in the Soviet Union.[98] Kamanin carefully scripted their public appearances, rehearsed their speeches, and corrected their "mistakes." He took upon himself not only the formal supervision of the cosmonauts' selection and training but also their moral bearing. Kamanin did not spare any effort to make the cosmonauts conform to their public images as exemplary Soviet citizens, scolding them for marital troubles and withholding their promotions in rank for drunken driving incidents. His own role as a famous aviator and a public icon in the 1930s served as a model for his efforts to shape the cosmonaut self.

Under Kamanin's supervision, the Cosmonaut Training Center introduced a program of enculturation to broaden the fighter pilots' intellectual horizons. The cosmonauts went on group trips to museums, art galleries, and historic sights, visited the Bolshoi and other theaters, and attended concerts by performers from Czechoslovakia, Cuba, and the United States. They listened to lectures about ancient Greece and Rome, the Renaissance men, Peter the Great, and famous Russian painters and opera singers.[99] Political education was made part of the formal curriculum. The first group of six candidate cosmonauts, including Gagarin, received forty-six hours of instruction in Marxism-Leninism, 8 percent of their total training time.[100] Any overt sign of political dissent was quickly suppressed. After one trainee refused to give a ritual speech at a party meeting and told a senior party official, "I will not speak to a Party of swindlers and sycophants!" he was immediately expelled from the cosmonaut corps.[101]

The attempts to make the cosmonauts into exemplary communists proceeded with difficulty. Cosmonauts privately exchanged political jokes, such as the double entendre slogan "Officers of the Missile Forces, Our Target Is Communism!" Even some of their supervisors laughed at ideological clichés. One cosmonaut recalled that the deputy director of the center in charge of political education "understood everything, believed that the cosmonauts would not give him away, and did not make pretenses with us. . . . When asked 'How are things?' he invariably replied, 'Our country is on the rise.' If we mockingly asked 'And how is the Party?' he replied with an equal measure of irony, 'The Party teaches us that heated gases expand.'"[102]

In 1961, Gagarin and Titov were elected deputies of the Twenty-Second Congress

[95] Golovanov, *Nash Gagarin* (cit. n. 34), 207, 211, and 183.
[96] Nikolai Kamanin, *Skrytyi kosmos,* vol. 4, *1969–1978* (Moscow, 2001), 252 (diary entry of 23 Jan. 1971).
[97] Kamanin, *Skrytyi kosmos* (cit. n. 37), 1:399 (diary entry of 21 Dec. 1963).
[98] Kamanin, *Skrytyi kosmos* (cit. n. 96), 4:252 (diary entry of 23 Jan. 1971).
[99] Golovanov, *Nash Gagarin* (cit. n. 34), 56.
[100] "Akt o rezul'tatakh ekzamenov," 18 Jan. 1961, GMMA.
[101] Siddiqi, *Challenge to Apollo* (cit. n. 3), 817.
[102] Eliseev, *Zhizn'—kaplia v more* (cit. n. 69), 120, 93.

of the Communist Party. The congress would adopt a new party program, which set a triple goal of creating a material and technical basis of communism, forming the new communist social relations, and bringing up the new Soviet man. The "Moral Code of the Builder of Communism," to be approved by the congress, included the ethical imperatives of honesty, sincerity, moral purity, modesty, and conscientious work. Gagarin and Titov were supposed to sit in the presidium of the congress and to showcase the tangible achievements of the regime both in high technology and in the upbringing of the new man. The plans went awry, however, when a few days before the congress, Gagarin broke a facial bone jumping out of the window following a womanizing incident. Gagarin missed the opening of the congress, and he and Titov were dropped from the presidium list. Khrushchev was furious when he learned about the behavior of Gagarin, next to whom he had stood on top of Lenin's mausoleum during the May Day celebrations just a few months before.[103] Gagarin's transgressions were soon forgiven, however, and he was sent on a propaganda mission abroad, escorted by his wife and by Kamanin.

As the popularity of the cosmonauts grew, it became more and more difficult for Kamanin to control their behavior. They were well known around the world as the public face of the space program. Because of the shroud of secrecy that surrounded Soviet rocketry, the leading designers of spacecraft, such as Sergei Korolev, remained anonymous, and the public tended to view human space flights as the cosmonauts' personal achievements. Not all the cosmonauts could carry the burden of celebrity with honor. Kamanin bitterly complained in his private diary that "the cosmonauts overestimate the significance of their personal accomplishments and take at face value everything that is written, said, and shown about every human spaceflight in the media."[104]

Both foreign and domestic audiences viewed the cosmonauts as an emblem of the Soviet regime. For many people around the world, these young, enthusiastic, and technically proficient people were a living embodiment of the Soviet communist dream. "For all of us, Yurii [Gagarin] personified the whole generation of Soviet people, whose childhood was singed by the war," recalled one cosmonaut.[105] In the 1960s, more than thirty feature movies were made and hundreds of books and newspaper articles written about the cosmonauts, all extolling their glorious achievements.

More controversial representations of human space exploration were discouraged.[106] No information about equipment failures or crew mistakes during space missions was publicly released. As a result, Kamanin admitted, "people get the impression of 'extraordinary ease' and almost complete safety of prolonged space flights. In fact, such flights are very difficult and dangerous for the cosmonauts, not only physically but also psychologically."[107]

The cosmonauts found it difficult to reconcile their professional selves with the ideal public images assigned to them. The role of a public hero whose feats supposedly did not involve any danger was uncomfortable for the cosmonauts originally trained as fighter pilots. Most of them preferred training for new space flights to public

[103] Kamanin, *Skrytyi kosmos* (cit. n. 37), 1:59–60 (diary entries of 4–17 Oct. 1961).
[104] Kamanin, *Skrytyi kosmos* (cit. n. 96), 4:116–7 (diary entry of 11 Jan. 1970).
[105] Golovanov, *Nash Gagarin* (cit. n. 34), 281.
[106] Kamanin refused to serve as consultant for Andrei Tarkovsky's movie *Solaris* because, as he explained, such fiction "belittles human dignity and denigrates the prospects of civilization." Kamanin, *Skrytyi kosmos* (cit. n. 96), 4:152 (diary entry of 18 April 1970).
[107] Ibid., 4:182 (diary entry of 6 June 1970).

appearances. Valentina Tereshkova long resisted Kamanin's attempts to turn her into a professional politician and even entered the Air Force Engineering Academy, hoping to retain her qualifications for another spaceflight. Kamanin was convinced, however, that "Tereshkova as the head of a Soviet women's organization and of international women's organizations would do for our country and for our Party a thousand times more than she can do in space."[108] Eventually he prevailed, and Tereshkova left the cosmonaut corps and served as the head of the Soviet Women's Committee for more than twenty years.

The Soviet propaganda portrayal of heroism without risk was not the only inner contradiction that plagued the cosmonaut self. The organization of spacecraft control had profound implications for the cosmonauts' professional identities. Both the cosmonauts and the flight controllers struggled with the question of how to find a proper balance between personal courage, ingenuity, and creativity and the need to follow a strict sequence of flight operations.

PARADOX OF DISCIPLINED INITIATIVE

Korolev's design bureau was responsible not only for the design and construction but also for the operation of piloted spacecraft during the flight. Spacecraft designers therefore tended to view the cosmonauts as their subordinates. One of Korolev's leading engineers, who later headed the bureau, explained that the managers expected the cosmonauts "to carry out their prescribed tasks just like other employed specialists."[109]

From the very beginning, Soviet spacecraft designers adopted the principle that they have followed to this day: all critical systems have three independent control channels: automatic, remote (from the ground), and manual.[110] Control during the three main stages of the flight—reaching the orbit, orbital flight, and reentry—is automatic; instructions to switch programs between the stages are given either from the ground or manually by the cosmonaut. The cosmonaut, however, has to obtain permission from the ground for any critical action. The norms of cosmonaut activity therefore include not only a technical protocol of interaction with onboard equipment but also a social protocol of subordination to their superiors on the ground. A cosmonaut training manual clearly stipulates that "all the most important decisions are made by Mission Control."[111]

Spacecraft designers believed that comprehensive automation and the strict following of instructions by the crew would best guarantee flight safety, but the cosmonauts pointed out that it was often necessary to break the rules in an emergency. Although the engineers tended to regard any departure from the standard procedure as a human error, it was precisely this ability to deviate from the standard path that made human presence on board so valuable in an emergency situation.

During a space mission, cosmonauts often found themselves in situations unforeseen by mission planners on the ground, situations to which the original instructions did not apply. The crew then faced a dilemma: to follow the rules and fail the mission, or to take risks and break the rules. Such an emergency occurred, for example, during

[108] Kamanin, *Skrytyi kosmos* (cit. n. 37), 1:332 (diary entry of 1 Aug. 1963).
[109] Iu. P. Semenov, "Slovo monopolistu," *Aviatsiia i kosmonavtika,* no. 6 (1991): 40-41, on 41.
[110] Vladimir S. Syromiatnikov, *100 rasskazov o stykovke i o drugikh prikliucheniiakh v kosmose i na Zemle,* vol. 1, *20 let nazad* (Moscow, 2003), 145.
[111] Kubasov, Taran, and Maksimov, *Professional'naia podgotovka kosmonavtov* (cit. n. 53), 190.

the *Voskhod 2* flight in March 1965. After completing his historic space walk, the cosmonaut Alexei Leonov realized that his spacesuit had ballooned (his arms and legs were not even touching the inside of the suit), making it impossible for him to reenter the airlock. He was supposed to report all emergencies to the ground and wait for instructions. He later recalled: "At first I thought of reporting what I planned to do to Mission Control, but I decided against it. I did not want to create nervousness on the ground. And anyway, I was the only one who could bring the situation under control."[112] He may have calculated that various bureaucratic procedures and possible reluctance of some managers to take responsibility could critically delay vital decisions, and it would be unwise for him to spend his limited oxygen supply waiting for them. Leonov turned a switch on his spacesuit, drastically reducing the internal air pressure, which allowed him to regain control of his movements. Yet he was still unable to enter the airlock feet first, which was required in order to squeeze into the landing module. Once Leonov had broken one rule, he decided that he could not make the situation worse by breaking another, so he climbed into the airlock head first, in violation of established procedure. He then performed an incredible acrobatic feat by turning around inside a narrow airlock.

The *Voskhod 2* crew—Leonov and Pavel Beliaev, both military pilots—had been trained to follow the rules and to obey orders from the ground. After more than 150 training sessions on a space walk simulator, Leonov was said to have brought his skills "to the point of automatic performance."[113] Yet in a real emergency, Leonov had to perform actions for which he was not trained, to violate explicit rules concerning entry into the airlock, and to make decisions without consulting Mission Control. He thus ensured the success of his mission by *not* acting like a perfect machine.

Control system designers realized that there was a tension between centralized control and the need to maintain what they called "relative autonomy of subsystems and even individual elements,"[114] one such element being the cosmonaut. One of the walls in Korolev's design bureau was adorned with a 1910 memo of the prerevolutionary Russian Navy Engineering Committee: "No manual can enumerate all the responsibilities of an official, account for all individual cases, and provide full instructions ahead of time. For this reason, gentlemen engineers must show initiative and, guided by their specialized knowledge and consideration for the common good, must apply every effort to justify their vocation."[115] "This recommendation," Korolev's deputy Boris Chertok argued in 1972, "holds true today both for the engineers who control space systems and for the cosmonauts who control spacecraft."[116]

While encouraging initiative, mission planners also made it very difficult for space crews to deviate from their instructions. During their mission on the Salyut-7 station in 1982, the cosmonauts Anatolii Berezovoi and Valentin Lebedev showed remarkable ingenuity in fixing malfunctioning equipment and conducting scientific experiments

[112] David R. Scott and Alexei A. Leonov, *Two Sides of the Moon: Our Story of the Cold War Space Race* (London, 2004), 109.

[113] N. N. Gurovskii et al., "Trenazhery dlia podgotovki kosmonavtov k professional'noi deiatel'nosti po upravleniiu korablem i ego sistemami," in *Problemy kosmicheskoi biologii,* ed. N. M. Sisakian, vol. 4 (Moscow, 1965), 3–9, on 6; Siddiqi, *Challenge to Apollo* (cit. n. 3), 451.

[114] B. Evseev [Boris Chertok], "Chelovek ili avtomat?" in *Shagi k zvezdam,* ed. M. Vasil'ev [Vasilii Mishin] (Moscow, 1972), 281–7, on 286.

[115] Ibid., 284–5; Kubasov, *Prikosnovenie kosmosa* (cit. n. 83), 123; Lebedev, *Moe izmerenie* (cit. n. 72), 258 (diary entry of 8 Sept. 1982).

[116] Evseev [Chertok], "Chelovek ili avtomat?" (cit. n. 114), 284–6.

that would have otherwise been canceled. Yet they received advice from the ground "to do less improvisation": their performance was evaluated not by the amount of research successfully done on board, but by the number of minor errors, which they occasionally made by trying their innovations. "Here is a paradox," wrote Lebedev in his diary. "If we had not improvised . . . and just followed orders and instructions, the end result would have been worse, but we would not have had any citations."[117] The engineer cosmonaut Valerii Kubasov made up a list of ten "cosmonaut's commandments," two of which perfectly illustrated the ambivalence of mission planners about cosmonauts' initiative: "always try to consult with Mission Control, but also take your own initiative"; "initiative is good, but always try to stick to the rules, otherwise you will be considered undisciplined, and your grades will be lowered."[118]

The cosmonaut self thus fractures into two barely compatible parts: an active, autonomous agent and a disciplined subordinate. Valentina Ponomareva, a member of the first women's cosmonaut group, has captured this contradiction in her vision of the model cosmonaut:

> The requirements [for being a cosmonaut] are very strict. They include readiness to take risks, the sense of highest responsibility, the ability to carry out complex tasks in harsh conditions, high dependability of the operator's work, advanced intellectual abilities, and physical fortitude. . . . In addition, the cosmonaut must possess such qualities as curiosity and the ability to break rules. . . . Regulations work well only when everything goes as planned. . . . The ability to act in extraordinary situations is a special quality. In order to do that, one has to have inner freedom . . . the ability to make nontrivial decisions and to take nonstandard actions. In an extreme situation, the very life of the cosmonaut depends on these qualities.[119]

Despite her high qualifications as an engineer and a pilot and her excellent test marks, Ponomareva was not selected for the first woman's flight, and she never got a chance to fly. In his private diary, Kamanin admitted that two female candidates, Ponomareva and Irina Solov'eva, were better prepared for the mission than Tereshkova. Yet they "would never be able to compete with her in the skill of influencing the crowd, in the ability to attract warm sympathies of people, or in the readiness to speak well before any audience. These qualities of Tereshkova determined her selection as the first female cosmonaut."[120] The first female cosmonaut's public persona proved more important than her professional skills.

The need for the cosmonaut to be both obedient and creative, to follow the rules and to break them, one might call a paradox of "disciplined initiative." The historian Sonja Schmid, in her study of Soviet nuclear power station operators, observed a similar contradiction in the way the operators were viewed by nuclear reactor designers: both as a "weak link" and a "reliable cog in the wheel."[121] Both spacecraft designers and nuclear engineers viewed the human operator as part of the technology, which must always function according to the rules, yet at the same time they expected the operators to show human qualities such as initiative and inventiveness.

[117] Lebedev, *Moe izmerenie* (cit. n. 72), 258 (diary entry of 8 Sept. 1982).
[118] Kubasov, *Prikosnovenie kosmosa* (cit. n. 83), 123.
[119] Ponomareva, *Zhenskoe litso kosmosa* (cit. n. 9), 285.
[120] Kamanin, *Skrytyi kosmos* (cit. n. 37), 1:391 (diary entry of 28 Nov. 1963).
[121] Sonja Schmid, "Reliable Cogs in the Nuclear Wheel: Assigning Risk, Expertise and Responsibility to Nuclear Power Plant Operators in the Soviet Union" (paper presented at The Forty-Fifth Meeting of the Society for the History of Technology, Amsterdam, the Netherlands, 7–10 Oct. 2004).

The leaders of the Soviet space program constantly vacillated between belief in the power of technology and trust in human skill and creativity. Echoing the duality of Stalin's old slogans, Dmitrii Ustinov, the secretary of the Party Central Committee in charge of the military-industrial complex, told top space managers in February 1971: "One should not jump to the extremes—either the human decides everything or the machine does. . . . The human must not enter into competition with the machine in pressing keys on a keyboard but must engage in research, in discovery, where his creative faculties and brain abilities are needed most." He acknowledged that it was difficult to take advantage of human creativity on fully automated spaceships: "We have not been using these [creative] capabilities in space."[122]

One could suggest that this paradox reflected a fundamental contradiction in the Soviet approach to the role of the human in large technological systems and perhaps more broadly to social control and government. According to the "Moral Code of the Builder of Communism," a model Soviet citizen was expected to be an active member of society and to take "an uncompromising attitude" toward any injustice or insincerity. At the same time, an exemplary citizen was supposed to have "a strong sense of social duty."[123] As the historian Polly Jones has noted, two opposite trends paradoxically combined in the Khrushchev era: the new emphasis on individual identity, personal well-being, and private freedoms was held in check by the policy of mass mobilization to participate in public events and collective action.[124] Although Stalinism was followed by a political thaw, the Soviet ideological discourse preserved its signature trait—fundamental ambivalence. The new man had to be both an active agent of change and a disciplined member of the collective, dutifully fulfilling orders.

CONCLUSION: NEW SOVIET MAN MEETS AMERICAN HERO

The communist ideal of the 1960s was imagined as a "harmonic merger" of a technological utopia, the construction of a material and technical basis of communism, and a humanist utopia, the creation of the spiritually fulfilled new Soviet man. The tension between the two parts of this project—technological and human—can be traced throughout Soviet history. Early Bolshevik ideas of the "machinization of man" paradoxically combined traditional images of machinery as an exploitative force and futurist visions of a creative merger of workers and machines.[125] A similar field of ideological tension was maintained in the 1930s by Stalin's dual slogans, "In the reconstruction period, technology decides everything!" and "Cadres decide everything!" The aviator hero, who personified Stalin's new Soviet man, also had a split self: both a distinct individual and a little cog, a master of technology and a part of the machine.

In the space age, the old tensions resurfaced in the debates over automation of spacecraft control. The division of function between human and machine on board determined the cosmonauts' degree of autonomy in the control of their missions and, more broadly, both reflected and shaped the role of the cosmonaut corps within the

[122] Boris E. Chertok, *Lunnaia gonka,* vol. 4 of *Rakety i liudi* (cit. n. 7), 249.
[123] *Materialy XXII s'ezda* (cit. n. 1), 411.
[124] Polly Jones, introduction to *The Dilemmas of De-Stalinization: Negotiating Cultural and Social Change in the Khrushchev Era,* ed. Polly Jones (London, 2006), 1–18, on 9.
[125] See Richard Stites, *Revolutionary Dreams: Utopian Vision and Experimental Life in the Russian Revolution* (New York, 1989), chap. 7, "Man the Machine."

space program. The cosmonaut identity itself was constructed as part of spacecraft control system design.

The attempts to appropriate the cosmonaut as an exemplar of the new Soviet man revealed that the chosen model was far from perfect. The cosmonauts resisted their transformation into propaganda icons, just as they resisted their full integration into a technological system. Perhaps they appealed to ordinary Soviet people precisely because they were not perfect embodiments of ideology but living beings with their own thoughts and doubts.

While the Soviets designed the cosmonaut as a prototype for the new Soviet man, the Americans turned their astronauts into public icons as well. As the historian Roger Launius observed, "Both NASA officials and the astronauts themselves carefully molded and controlled their public images every bit as successfully as those of movie idols or rock music stars." Combining youth, vigor, playfulness, and virile masculinity, the astronaut image represented the American ideal, the quintessential American hero. The astronauts served as "surrogates for the society that they represented."[126]

Soviet space engineers and cosmonauts often regarded the U.S. space program as the paragon of a human-centered approach to spacecraft design. One of Korolev's deputies, for example, remarked: "Americans rely on the human being, while we are installing heavy trunks of triple-redundancy automatics."[127] Yet the Soviet perception of the American emphasis on manual control was to a large extent based on a myth. In fact, the astronauts did not manually fly their spacecraft to the Moon and back. As the historian David Mindell has shown, a tight coupling of the crew and the onboard computer was required for effective control of Apollo operations. The astronaut served as "a systems manager, coordinating a variety of controls as much as directly controlling himself." Working in close contact with flight controllers on the ground, the astronauts carried out such crucial operations as spacecraft docking and lunar landing via the computer. Dealing with a computer alarm in the final moments of the *Apollo 11* lunar landing, Neil Armstrong performed the landing manually, and NASA "narrated the landing as the victory of a skilled human operator over fallible automation—a result that highlighted the heroic goals of the program."[128] In fact, as MIT engineers later pointed out, the crew had failed to turn off a switch, which led to computer overload and produced an alarm signal.

Just like the cosmonauts, the astronauts were working within a complex technological system, and their actions were strictly regulated and controlled from the ground. Both American and Soviet engineers chose to rely on automation, even though the means of automation in the American case (the computer) proved more complex and versatile. The cybernetic vision of human-machine merger gave rise to the notion of "cyborg," first formulated by U.S. space psychologists and also contemplated by Soviet physicians.[129] Although they did not resort to cyborglike modifi-

[126] Roger D. Launius, "Heroes in a Vacuum: The Apollo Astronaut as a Cultural Icon," AIAA Paper 2005-702 (paper presented at the Forty-Third Aerospace Sciences Meeting and Exhibit of the American Institute of Aeronautics and Astronautics, Reno, Nevada, 10–13 Jan. 2005); http://klabs.org/history/roger/launius_2005.pdf (accessed 30 June 2005), 1, 10.

[127] Sergei Okhapkin, as quoted in Chertok, *Goriachie dni kholodnoi voiny* (cit. n. 74), 257.

[128] David Mindell, "Human and Machine in the History of Spaceflight," in Dick and Launius, *Critical Issues in the History of Spaceflight* (cit. n. 75), 141–62, on 153 and 158.

[129] See Manfred E. Clynes and Nathan S. Kline, "Cyborgs and Space" (1960), in *The Cyborg Handbook,* ed. Chris Hables Gray (New York, 1995), 29–33; N. Sisakian, "Biologiia i osvoenie kosmosa," *Aviatsiia i kosmonavtika,* no. 2 (1962): 24–30.

cations of the human body, both American and Soviet specialists in "human engineering" took an active part in reshaping the space explorer's self. Firm discipline and the ability to function as part of control machinery were equally important for the cosmonauts and the astronauts. In different political contexts, however, the same professional qualities were reinterpreted to build two opposite ideological constructs—the American "right stuff" and the new Soviet man.

Ideological declarations of the cold war rivals differed, but the figures they chose to represent those declarations proved remarkably similar. Both sides viewed the space race as a proxy for the cold war, and both sides chose to personify the technological competition with a human space explorer. "From a larger perspective, our designers are probably right in their intention to create fully automated piloted spaceships," grudgingly admitted Kamanin in his private diary. "Perhaps in the future, when communism triumphs over the entire planet, people will fly into space on such ships. But in our time, one must not forget about the severe struggle between two opposing ideologies."[130] In the U.S. and in the Soviet Union, the main reasons for building piloted ships were political, rather than technological or scientific. Instead of showcasing the difference of ideologies, the appropriation of the cosmonauts and astronauts as public icons illustrated the similar dependence of the two superpowers on the cold war mindset.

[130] Kamanin, *Skrytyi kosmos* (cit. n. 36), 3:348 (diary entry of 28 Dec. 1968).