INTO THE STARS:

A LOOK INTO THE SOVIET SPACE PROGRAM

Brett Potomac

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The Cold War is a defining conflict of the twentieth century. Waged by the two most powerful nations on Earth, it was a battle of ideologies fought and won largely through symbolic victories. Among the conflicts fought, the Space Race is one of the most influential. While American infrastructure emerged largely untouched after World War II, the conditions in the Soviet Union could not have been more starkly contrasting. With the Soviet Union largely in ruins and the United States at the height of its industrial capability, it is surprising that the Soviets were able to match, and even surpass, American efforts in the Space Race. In this essay, I will examine how it was possible for the Soviet Union to triumph over the United States in several key aspects of the Space Race and analyze the differing attitudes towards space exploration itself within the Soviet Union.

The Soviet Union was established in 1922 on the ruins of the Russian Empire. As a direct result of the catastrophic losses sustained during World War I and the Russian Revolution, the Soviet Union began as technologically and industrially behind their Western counterparts. This was clear to Stalin, who came to power in the late 1920's, as he immediately ordered "a 111% increase in coal production, 200% increase in iron production and 335% increase in electric power."[1] This process, though criticized as being extremely brutal and inhumane at times, caused the Soviet Union to industrialize at an unprecedented rate. The spirit of Stalin can be interpreted from a speech he gave to industrial workers in 1931: "To slacken the tempo would mean falling behind. And those who fall behind get beaten. But we do not want to be beaten. No, we refuse to be beaten!"[2]

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[1] John Simkin, *Stalin's Five-Year Plans*, (Spartacus Educational, 1997).
[2] Joseph Stalin, *Problems of Leninism*, (Foreign Languages Publishing House, Moscow, 1953), 455.

In addition to industrializing during this period, the Soviet rocketry program also underwent great improvements. Konstantin Tsiolkovsky, a Soviet pioneer of space exploration, is credited with a wide variety of breakthroughs in this field earning the title of the "Father of Rocketry."[3] Throughout his life, Tsiolkovsky established mathematical relationships between rockets, propellants, object mass, and fuel consumption which are the basis for equations still used today. His work ultimately culminated in the publication of a theory on multistage rockets using liquid propellants.[4] Without Tsiolkovsky, it is likely the Soviet Union, despite its rapid industrialization, would not have been competitive with other powerhouses of the time such as Germany and the United States.

Tsiolkovsky is also one of the first notable figures in the Soviet Union to be motivated by the idea of space exploration itself. He began his prolific engineering career by writing science fiction novels about space, and in his work *Necessity of a Cosmic Mindset*, he philosophizes that "every reasonable being must enter into the spirit of history of the Universe. Such a supreme worldview is essential."[5] This highlights the notion that, contrary to what will be covered later in this essay, the Soviet attitude towards space was not unanimously focused on national defense. Unfortunately, Tsiolkovsky died in 1935 and never saw his dreams of space exploration actualized.[6]

Among Tsiolkovsky in early Soviet rocketry programs was Friedrich Zander and Sergei Korolev. Zander was a German born scientist with a lifelong passion for space. After finishing college in 1914, he moved to Moscow where his love for space led him to develop new rocket

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[3] Brian Dunbar, *Konstantin E. Tsiolkovsky*, (NASA, 2010).
[4] Ibid.
[5] Konstantin Tsiolkovsky, *Necessity of a Cosmic Mindset*, (1934).
[6] Dunbar, *Tsiolkovsky*.

designs, more efficient fuels, and various propulsion theories for the Soviet Union. He later became head of the Group for the Study of Reactive Motion, abbreviated as GIRD in Russian.[7]

It was at this time in 1931 that a young Sergei Korolev approached Zander with designs of a rocket using liquid propellant- a relatively new development for the time. For the next few months, Zander, Korolev, and their team of engineers at GIRD developed liquid propelled rockets such as the RP-1 and the OR-2. These rockets were extremely advanced in the early1930s, and they kept the Soviet Union at the forefront of rocket technology. Tragically, Zander died in 1933 leaving Korolev to continue as the head of GIRD.[8]

Around this time, the Soviet government merged GIRD with their competitor organization Gas Dynamics Laboratory. While infighting occasionally hindered progress, this amalgamation brought together two of the most brilliant Soviet rocket scientists of the time: Sergei Korolev and propulsion engineer Valentin Glushko. Together in the newly established RN II Rocket Scientific Research Institution, the Soviet rocketry program in the mid-1930s exceeded that of even the United States. This success was ephemeral, however, as Stalin's Great Purges would impact the RN II before the turn of the decade.[9]

Between 1936 and 1938, Stalin began targeting longstanding Soviet officials in what came to be known as the Great Purge. In this campaign, Stalin targeted, imprisoned, and often executed anyone he perceived as a threat to his rule. This often extended to non-governmental organizations, and the RN II was no exception. In 1938, Korolev, Glushko, and other RN II leaders were arrested and sent to a prison in the Soviet secret police headquarters. Some RN II

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[7] Anna Kizilova, *Friedrich Zander*, (Russia-InfoCentre, 2004).
[8] Ibid.
[9] Michael van Pelt, *Rocketing into the Future: The History and Technology of Rocket Planes*, (New York, Springer, 2012), 120-122.

leaders were executed, but Korolev and Glushko survived as convicts for nearly ten years before being released.[10]

As a direct result of these purges, many Soviet rocketry projects "came to an abrupt end in 1937 when Stalin's Great Purges reached its zenith."[11] Though some weapons were still successfully developed for World War II such as the Katyusha multiple rocket launcher, the Soviet rocketry program largely stagnated until the end of the War. This was not evident until the Soviets started capturing German research facilities with rockets in various stages of production. Soviet engineers who analyzed these rockets were astounded at the technological advancement of the Germans. Georgi Tyulin, a Soviet officer involved with later Vostok missions, is quoted saying:

> In Germany we realized that if there were no arrests [during the Great Purges], we would have reached a very high technical level as early as the late thirties. As a result of repressions in the army and the scientific community, the development of our rocketry had stopped at powder rockets, and only when our leaders learned about the "V" rockets, Stalin took an interest in rocketry.[12]

A notable takeaway from Tyulin is that the Soviet rocketry program was reinvigorated primarily because Stalin realized the huge military potential such advanced rockets had.

Immediately when the War ended, the Soviets, not unlike their European counterparts, began to take advantage of German technology: "All of the major allied powers began quickly to investigate and exploit the advances in German military technology. Even before the conclusive end of hostilities, the major rocketry centers of Peenemunde and Nordhausen had become prime

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[10] Francis French and Colin Burgess, *Into That Silent Sea: Trailblazers of the Space Era, 1961-1965*, (Nebraska, University of Nebraska Press, 2009), 109-111.
[11] Asif Siddiqi, *Challenge to Apollo: The Soviet Union and the Space Race, 1945-1974*, (Washington DC, NASA History Division, 2000), 10-13.
[12] Mariya Pastukhova, *Brighter Than Any Legend*, (Ogonek, 1987), 18-23.

targets for intelligence services."[13] Peenemunde and Nordhausen were key German research facilities during the war, and both were hastily abandoned at the onset of the Soviet advance. The discoveries at these facilities patently benefited Soviet technology as "within three years of the end of the war, the Soviets had managed to establish a level of capability at least equivalent to wartime German accomplishments."[14]

However, the Soviets were not alone in their ambitions to seize and replicate German missiles. This was also a priority for the United States, and unfortunately for the Soviets, the United States encountered German facilities such as Peenemunde prior to Soviet arrival. This gave the United States a competitive advantage over the Soviets as they were able to obtain the most sophisticated equipment before the Soviets could intervene. The United States was disadvantaged, however, by its extreme geographical distance from Europe. Resultingly, "a major portion of what could not be taken back in the given time was simply destroyed."[15]

Equipment was not the only resource extracted from the abandoned German research facilities. Shortly after the war in an operation deemed Operation Paperclip, "the U.S. Office of Strategic Services brought Dr. Wernher von Braun and over 1,500 German scientists and engineers to the U.S."[16] Distinguished from other German scientists, Dr. Wernher von Braun spearheaded the German V2 rocket program, and, upon realizing that Nazi Germany was destined to lose the war, surrendered to the Americans rather than wait to be captured by the Soviet Union.[17] Operation Paperclip, combined with the equipment taken from Peenemunde and

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[13] Siddiqi, *Challenge to Apollo*, 24.
[14] Ibid., 69.
[15] Ibid., 23-25.
[16] *Operation Paperclip*, (National Archives and Records Administration).
[17] Jennifer Harbaugh, *Biography of Wernher Von Braun*, (NASA, 2016).

Nordhausen, resulted in the United States emerging from World War II with a decisive advantage in missile technology compared to the Soviet Union.

Unsurprisingly, Stalin was infuriated by this. Stalin is reported saying "This is absolutely intolerable. We defeated the Nazi armies, we occupied Berlin and Peenemunde, but the Americans got the rocket engineers. What could be more revolting and more inexcusable?"[18] This is an early indication of the fiercely competitive relationship that developed between the two superpowers in the ensuing years.

Though the actions of the United States infuriated Soviet leaders, the necessary haste of the Americans resulted in failure to destroy the facilities in their entirety. In Nordhausen, Soviet forces discovered several A-4 missiles in various stages of production as well as German scientists unable or unwilling to flee before Soviet arrival. The scientists who remained reported that the Nordhausen manufacturing facility was remarkably still in working condition.[19]

In the following years, Soviet engineers studied, replicated, and improved these newly obtained German rockets. Sergei Korolev, who was released from prison in 1945, successfully adjusted back into his role as a lead engineer. Under the leadership of Korolev, in only a few years "the Soviets had almost completely left behind the German antecedents of their missile program and moved into the realm of intercontinental ballistic missile (ICBM) development, effectively laying the foundation for the birth of the Soviet space program."[20]

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[18] Walter McDougall, *...the Heavens and the Earth: A Political History of the Space Age*, (New York, Basic Books, 1985), 44.
[19] Siddiqi, *Challenge to Apollo*, 27-28.
[20] Ibid., 69.

Before 1950, the newly founded NII-88 Central Research Institute of Machine Building successfully tested two medium range missiles capable of carrying explosive payloads. The R-1 missile was simply a Soviet replica of the German A-4, also known as the V-2, used in World War II. The R-2 featured an increase in range and offered better protection for vital components of the rocket. Though there was debate within the NI-88 research institute between Korolev and head German scientists, the NI-88 made steady progress improving rocket capabilities.[21]

After the R-1 and R-2 missiles, there were competing designs over the next rocket to be funded for production. Among these were the R-3, a rocket with a revolutionary concept for its time. While the R-1 and R-2 rockets were only capable of reaching up to 280 kilometers and 600 kilometers respectively, the R-3 would have been able to reach targets up to 3,000 kilometers away. With both Japan and England in range of the R-3, it would have been the first strategic rocket for the Soviet Union.[22]

Despite these ambitious guarantees, the R-3 never received funding. This is due to the competition of the R-3, such as the G-4 design by Valentin Glushko, and the approval needed from the Scientific-Technical Soviet board before continuing. During the board's meeting, both the R-3 and G-4 designs were pitched, and both were met with criticism. Ultimately, neither the R-3 nor the G-4 were approved for production.[23]

Though denied approval, these missile designs did not go to waste: "While the R-3 had never left drawing board, the project had long-lasting effect on Soviet rocketry. It challenged Russian designers with a new level of technical complexity and prepared unprecedented

[21] Zak Anatoly, *Rockets: R-2 Family*, (Russian Space Web, 2016).
[22] Zak Anatoly, *Rockets: R-3 Family*, (Russian Space Web, 2016).
[23] Mark Wade, *R-3*, (Astronautix, 1997).

expansion of the Soviet rocket industry, which was soon used in its full capacity to develop the first ICBM."[24] Subsequent designs included the nuclear capable R-5 IRBM, or Intermediate-Range Ballistic Missile, and the R-11 submarine-launched ballistic missile. The groundwork of the R-3 also provided the basis for the extremely reliable R-7 Semyorka.[25]

Unlike other rockets, the R-7 is noteworthy for its reliability and deviation from German design. Among various improvements, the R-7 used Vernier thrusters, or a quad-booster design in which each booster contains its own fuel reserve, and added a new radio system which synchronized fuel consumption of the boosters. These technological advancements revolutionized how rockets were constructed, as versions of the R-7 were modified to serve wildly different purposes. One version of the R-7 became the first true intercontinental ballistic missile for the Soviet Union, and another version was tasked with transporting the first lifeforms into space.[26]

Yet, even with the technology to explore space, Soviet leaders such as Stalin and later Khrushchev were uninterested in the prospect of space travel. Rather, both leaders were concerned strictly about the military applications of rockets. This was made obvious to Korolev in a meeting with Stalin, when Korolev had "intended to speak to Stalin about a 'space rocket' capable of traveling the upper reaches of the atmosphere, eventually with humans on board. At the last minute, he omitted his notes on the subject, perhaps for fear that Stalin would see no interest in it."[27]

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[24] Anatoly, *R-3 Family*.
[25] Wade, *R-3.*
[26] Boris Chertok, *Rockets and People - Volume III: Hot Days of the Cold War*, (NASA History Division, Washington DC, 2009), 22-26.
[27] Siddiqi, *Challenge to Apollo*, 87.

This did not fully deter Korolev from his dream of space travel, however. As early as 1948, "he began to informally consider ways of lifting human passengers into space using available technology. Inspired by U.S. programs using A-4 and Aerobee missiles for launching animals into space, Korolev mentioned his plans for human spaceflight to famous aviation designer Andrey N. Tupolev during a conversation in late 1948."[28] Following this conversation, Korolev and his team selected nine dogs to form the core pool of passengers.[29]

Amazingly, in 1951, the state commission approved of a launch carrying two of the nine dogs selected. The results of this experiment were revolutionary, as no other nation on Earth had achieved an equal feat at the time:

> Following Blagonravov's formal approval, the rocket finally lifted off in a roar amid the dust of Kapustin Yar, carrying its two canine passengers. During their flight, the animals reached a velocity of 4,200 kilometers per hour and an altitude of 101 kilometers, and they experienced four minutes of weightlessness. Approximately 188 seconds following launch… the parachute successfully deployed… At the landing site, the cabin hatch was hurriedly unscrewed, and both dogs were found barking and wagging their tails… The dogs were the first living organisms successfully recovered after a flight into space, coming two months before the United States achieved a similar feat.[30]

With this, the Soviets became the first nation in the world to successfully recover any lifeform deliberately put into space. Remarkably, the rocket used in this ordeal was a modified version of the original R-1; a rocket which by 1951 was already becoming incredibly outdated.

Shortly after this successful recovery, Stalin abruptly passed away. Nikita Khrushchev, though not the obvious successor to Stalin, soon became the new Soviet premier. In a meeting between Korolev and Khrushchev, Khrushchev recalls seeing excitement and passion emanating from the engineer: "We had absolute confidence in Comrade Korolev. We believed him when he

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[28] Ibid., 92.
[29] Evgeny Riabchikov, *Russians in Space*, (London, Weidenfeld & Nicholson, 1972), 141.
[30] Siddiqi, *Challenge to Apollo*, 95.

told us that his rocket would not fly, but that it would travel 7,000 kilometers. When he expounded or defended ideas, you could see passion burning in his eyes, and his reports were always models of clarity."[31] This foreshadowed the close relationship Khrushchev had with Soviet engineers, signifying a substantial shift from the era of Stalin.

Even with the close relationship Khrushchev had with Soviet engineers, the Soviet Union retained a militaristic-centered mindset until the United States stated their ambitions towards space. When the Eisenhower administration announced that the United States' planned to launch a satellite into Earth's orbit during the International Geophysical Year in 1958, Soviet attention suddenly shifted towards the achieving the same feat. A special committee was formed in 1955 to discuss the possibility of satellites and even lunar probes. The concept of lunar probes was too far-fetched to receive support this early, but Committee Chairman Vasili Ryabikov gave Korolev conditional approval to begin construction of a satellite once the R-7 finished testing.[32]

While Ryabikovs' approval was not yet equivalent to a government sanctioned approval, it gave Korolev and his team a newfound sense of urgency. In addition to this, the Eisenhower administration's announcement gave him a deadline to work towards. With this in mind, Korolev began work immediately despite the Soviet government taking four months to officially approve the project.[33]

Even when official authorization was given, the Soviet government was profoundly indifferent towards space exploration:

> It was not considered a top priority. In fact, Soviet government officials probably viewed the satellite project in much the same manner as they viewed the continuing series

[31] Nikita Khrushchev, *Khrushchev Recalls*, (Penguin, Harmondsworth, 1977), 45-46.
[32] Siddiqi, *Challenge to Apollo*., 146-147.
[33] Ibid., 147-148.

> of scientific rocket flights into the upper atmosphere- an effort that also used military missiles for civilian purposes. Such flights were relatively inexpensive, unobtrusive, and ignored by the political leadership.[34]

Nonetheless, armed with official approval from the Soviet government, Korolev went to work on what became the first artificial object ever put into Earth's orbit.

The rocket, Sputnik I, was based off the R-7 Semyorka. Equipped with four protruding radio antennas, Sputnik I launched successfully and orbited the world for about three weeks. Consequently, panic spread throughout the Western world in what became known as the Sputnik Crisis, and Soviet propogandists used the successful launch to promote the success of Communism.[35]

Upon hearing Sputnik I's resounding success, Khrushchev was "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."[36] Even critics of the Soviet Union, such as a rocket engineer who fled the Soviet Union after World War II named Grigori Tokaty, admitted that "politically and ideologically, I am not an admirer of the Soviet Government. I have always disagreed also with many of its practical acts. But this does not prevent me from having a high opinion of the Soviet Government where rocket technology is concerned."[37]

Due to the monumental success of Sputnik I, the Soviet government ordered another voyage. In only one month, Sputnik II was built and ready to be launched. Sputnik II, also based

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[34] Ibid., 147-149.
[35] Steven Garber, *Sputnik*, (NASA, 2007).
[36] Siddiqi, *Challenge to Apollo*, 168.
[37] Grigori Tokaty, *Soviet Rocket Technology*, (Technology and Culture, 1963), 526.

on the R-7 design, received worldwide recognition for carrying the first dog into orbit. Though the dog did not survive, the emblematic success was not ignored by Soviet propogandists.[38]

With these successes astounding the world, a now-veteran chief engineer Sergei Korolev led the Soviet Union in the construction of the Vostok series of rockets. The Vostok rockets continued Soviet dominance early in the Space Race, as Vostok I famously carried a human, Yuri Gagarin, into orbit for the first time in history. The Soviet Union only lost momentum when Korolev died in 1966 from a botched routine operation.[39] Though tragic, Korolev did not pass away without helping cement the Soviet Union in history.

The history of the Soviet rocketry program is one of impossible odds followed by resounding successes. Beginning the twentieth century with an infrastructure in shambles, pioneers such as Konstantin Tsiolkovsky and Friedrich Zander elevated the Soviet Union to the forefront of rocket technology in the early 1930s. However, this success was only momentary as Stalin's purges combined with the widespread destruction of World War II brought the Soviet Union back to a state of industrial ruin. In an almost cyclical fashion, the Soviet Union again rapidly industrialized, and a new generation of engineers with a passion for space exploration emerged. These engineers, such as Valentin Glushko and Sergei Korolev, helped the Soviet Union progress from replicating German missiles to constructing rockets capable of both intercontinental and extraterrestrial travel. From starting at an inherent industrial disadvantage to becoming the first nation ever to put a satellite, an animal, and a human into orbit, it was a combination of passion and persistence that allowed the Soviet Union to outdo the United States in several key aspects of the Space Race.

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[38] Garber, *Sputnik.*
[39] Brian Dunbar, *Sergei P. Korolev*, (NASA, 2014).

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