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Chapter 1

They Blazed the Trail for the Space Pioneers (On Some Little-Known Ukrainian Names in the History of Astronautics and Rocketry)*

Oleg Ventskovsky,† Iryna Vavilova,‡ and Yaroslav Yatskiv§

Abstract

Presented is a *tour d'horizon* of the lives and main space- and rocketry-related activities of four Ukrainian forerunners to the famous space pioneers. The talented inventor Olexander Zasyad'ko (1779–1837) created a new rocket system and elaborated a theory of rocket propulsion. Konstantin Konstantinov (1818–1871)—engineer, inventor, designer—is mentioned for the rocket fuel combustion formula he proposed in 1857, long before the famous Konstantin Tsiolkovsky formula surfaced. Mykola Kibal'chich (1853–1881), was among the first scientists who precisely elaborated and substantiated the idea of the rocket engine use for the flights. The real genius, Yuriy Kondratyuk, (Olexander Shargey, 1897–1942), who was well in advance of his time, had a very tragic fate. Being just 17 years old, he proposed a scheme (in later years called "the Kondratyuk's

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route") of spaceflight which was later, in the 1960s, used for both launching unmanned spacecraft, as well as for human flights to the Moon (by Americans). He elaborated original schemes of the launch vehicle control systems, stressed the importance of safety measures for astronauts, and invented a thermal protection system for the descending module. But most of his life, he was forced to live incognito, and died at the front during World War II.

Olexander Zasyad'ko (1779–1837)

It is a historical fact that in 1516, the Ukrainian Cossacks defeated the tartar horde near the Ukrainian city of Bilgorod using military rockets. But the secret of the formidable Cossack weapon was lost, it seemed, forever. Only 300 years later, the mystery was puzzled out by Olexander Zasyad'ko (Figure 1–1), the artillery officer, the war of 1812 hero, and one of the outstanding representatives of military technical thought of the first half of the 19th century, to whom belongs the acknowledgment of the creation of military rockets [1].

Figure 1–1: Olexander Zasyad'ko.

Olexander Zasyad'ko, descendent of the famous Zaporizhzhya Cossacks, was born in 1779 in the Poltava region of Ukraine. From childhood, he was obsessed by his father's dream—to unthread the Cossack mystery. In order to get the necessary knowledge and attain his aim, he studied at the artillery department of the cadet corps in Petersburg. But Olexander was only able to start using his knowledge 15 years later, since beginning in 1799, he was permanently at war.

He participated in almost all the Russian military campaigns: A. Suvorov's Italian march, and battles of the Danube army under the command of M. Kutuzov, the 1812–1815 war.

Zasyad'ko's bravery was famed in legends. The officer (he started as a lieutenant), was awarded a golden sword for courage, the title of colonel, and a number of war decorations. Throughout this period of his life, he continued to dream of the military rocket's creation. Still serving in the artillery, he commenced to design rockets only in 1815, when the 1812–1815 war came to its end. Using his own money, he equipped a laboratory where he did all the major work on building the rockets, as well as a projector for them.

He was a talented inventor. He not only created a new rocket system, and elaborated a theory of rocket propulsion, but also matured tactics of military use of the weapons invented by him. He designed launching systems which allowed the execution of a volley fire by six rockets simultaneously. He dreamt of rocket flights to the Moon, and even made the necessary calculations of the required gunpowder—which was, he understood, not the best fuel for this purpose.

These works were finished in 1817, and brought a wide recognition to the inventor. He got the title of major-general, and was appointed a superior of the Mikhailov artillery academy, which had just been created in Russia. At the same time, he was a chief of the Petersburg pyrotechnic laboratory, a supervisor of the Okhtyn powder plant and of the Petersburg arsenal. But he had a thorny route to success due to the necessity of overcoming the resistance of skeptics, enviers, and snobs. Among them were mainly highly placed bureaucrats behaving presumptuously vis-à-vis a talented representative of "Malorossia" (Ukraine's name in the tsarist Russia), who was proud of his Cossack origin.

The official testing of Zasyad'ko's rockets took place in the field marshal Barklay-de-Tolli's General Headquarters in Mohylyov. It appeared that the rockets were already developed up to the level which left no doubts that they would be very useful for the army, and were ready to be taken into service (Figure 1–2). The field marshal's opinion was very positive, and mass production of the new weapon was started. According to the official sources, from 1826 to 1850, there were nearly 50,000 rockets produced for different purposes, (incendiary, demolition, canister-shot).

In 1827 Zasyad'ko was appointed Chief of Staff of the Commanding General of the Russian artillery. This position gave him an opportunity to pay more attention to rocket building and military use. That same year, under his leadership, the first permanent rocket unit was formed in the Russian army (rocket squadron №1, later on—rocket battery №1). Zasyad'ko's military rockets were successfully used for the siege of the Turkish fortresses during the Russian–

Turkish war of 1828–1829. Zasyad'ko was personally in charge of all the siege artillery. When the war finished, he got the title of lieutenant-general, and retired from military service in 1834. Nevertheless, he continued his inventor's activity.

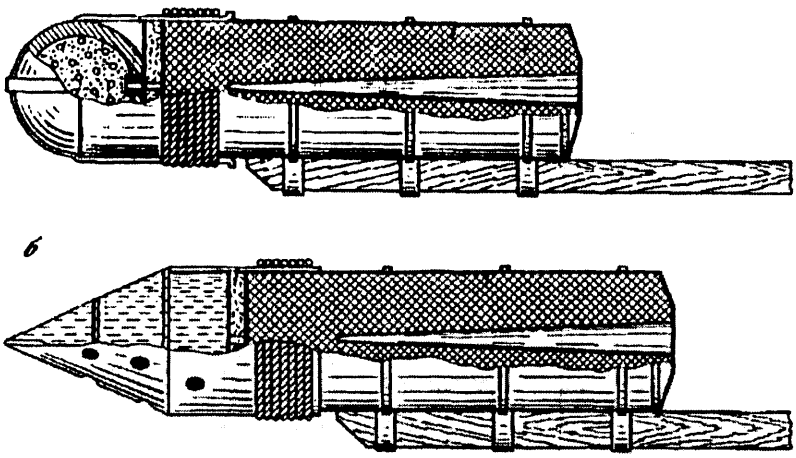

Figure 1–2: Zasyad'ko's rockets.

Olexander Zasyad'ko died in 1837 in Kharkiv (Ukraine), after a long illness. His pioneering inventions stimulated further development of rocket building, and afterwards played an important role in the creation of rockets.

Konstantin Konstantinov (1818–1871)

Among historians and researchers, there are discrepancies as to the date of birth and origin of Konstantin Konstantinov—the outstanding designer of military rockets, scientist, and lieutenant-general (Figure 1–3). The most probable version says that he was born in 1818 in Warsaw and was the second child in the illegitimate "marriage" of Grand Duke Konstantin (1773–1831), son of the Russian Emperor Pavel I, and French singer Clara-Anne de Lorence (1799–1857). Other biographies of Konstantinov point out that he was born in 1817 in Chernigov region. In 1820–1834, Duke Ivan Golitsyn (1783–1852) was in charge of Konstantin's education. In February 1834, Golitsyn sent his foster child to the Junker department of the Mikhailov artillery academy—one of the best educational establishments in Russia, created by Olexander Zasyad'ko [1].

Konstantinov studied well, and this was the reason for the rapid progress in his military career, after he graduated from the academy in 1836. In October 1840, he moved abroad for a long-term mission, during which he worked fruitfully on the creation of an electro-ballistic device for precise measurement of the artillery projectile's velocity, for which he is famous. He returned to Petersburg in June 1844, and in the autumn of the same year, he demonstrated his invention to a highly authoritative commission. Its conclusion was very favorable. As a result, Konstantinov was awarded an order and a large amount of money (2,000 rubles in silver). In June 1845, his testing of the electro-ballistic device was published, and this opened a new chapter in the history of national metrology.

Figure 1–3: Konstantin Konstantinov.

During the next several years, Konstantinov's research and engineering engagements were very versatile. He devoted a lot of time to ballistics problems. He designed a sight peephole for vertical firing, an optical distometer, and improved his own electro-ballistic device. The bar sight for the vertical and ricochet fire developed by Konstantinov successfully passed testing, and during 1849–1856 was in service as an authorized bar sight for siege artillery in the Russian Army. At the same time, he was a chief of the school where future specialists in the use of gunpowder, nitre, and sulphur studied. A series of fireworks, set off by him in 1847, were marked by a program and technical innovations never seen before.

Beginning in 1847, Konstantinov worked permanently on design and production of military rockets (Figure 1–4), as well as on the development of his famous rocket ballistic pendulum. This device became the main means for the scientific analysis of the rocket and its ballistic features, and he organized the pendulum's production for research purposes. Konstantinov was the first to introduce military rockets as a navy weapon, by designing special equipment which was widely used during the Crimean War. In 1855 he was honored with a state award for the reconstruction of the military plant producing the rockets, and the automation of the majority of rocket production processes and equipment, in particular of the hydraulic press. After the war, he received the rank of major-general. During 1856–1857 he finalized his fundamental works on the military rockets.

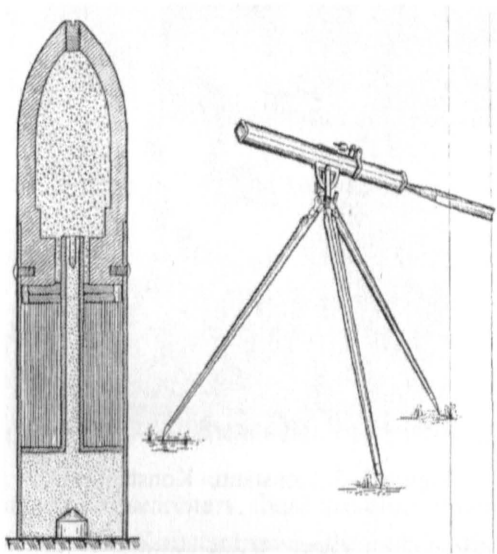

Figure 1–4: Konstantinov's rocket and launching machine, 1862 system.

In 1861 he moved to Mykolayiv (Ukraine), to select a place for future rocket plant construction, and from 1867 on, he lived in the city permanently and managed the rocket plant. Several important works written by Konstantinov were published during this period of time, such as "Military Rockets in Russia from the End of 1861 to 1863," "Use of Rotational Motion for the Rockets Guidance," "Artificial Production of Cold," and others. Some of his works were written and published in French, for example, "Hausse de l'artillerie de campagne russe" (St. Petersburg, 1856), "Lectures sur les fusees de guerre" (Paris, 1861). He died in Mykolayiv in 1971 due to serious illness.

As an engineer, inventor, and designer, Konstantinov is to be remembered for his encyclopedism, breadth of outlook, and diversity of interests. His engineering creativity was based on the application of scientific foundations to the solving of technical problems. He proposed the rocket fuel combustion formula in 1857, long before the famous Tsiolkovsky formula surfaced. He also designed rockets that were the best for his time—in terms of their form and military characteristics (for example, the range capability of his 4-inch rocket was 4.2 km, while the same parameter of his predecessors' rockets was only a little bit more than 1 km), as well as unrivalled devices, such as the ballistic pendulum, rocket automatic measurement and production systems, and some others.

Mykola Kibal'chich (1853–1881)

This man, who was among the first to propose the idea of the use of a rocket engine for flights, was born in 1853 in Chernihiv region (Ukraine) into the family of a parish priest. Mykola Kibal'chich (Figure 1–5) got a spiritual education (he finished the seminary on his father's insistence), and also graduated from a secondary school in 1871. He demonstrated excellent abilities in mathematics and languages, and was honored with a silver medal.

Figure 1–5: Mykola Kibal'chich.

In 1871–1873, he studied at the St. Petersburg Institute of Transportation Engineers. Without having finished, in 1873, Kibal'chich joined the Medico-Surgical Academy in the same city. At the time, this establishment was a big center of the student movement. Here Kibal'chich learned about, and got interested in, the Narodniks (populist) ideology. In 1875, the Tsarist police arrested Kibal'chich for possession of banned literature, and he remained in prison until 1878.

After his release, he was not allowed to continue his study at the Academy. Kibal'chich joined Narodnaya Volya, a radical revolutionary movement. Within the organization, Kibal'chich worked as "chief technician," specializing in explosives, which were used for terrorist actions. Simultaneously, he studied the possibilities of the use of gunpowder for the flying vehicles.

On 1 March 1881, some of the grenades produced by Kibal'chich were used in the assassination of Tsar Alexander II. In the wake of the attack, Kibal'chich was arrested on 17 March 1881 and sentenced to death, together with other conspirators. During his 17-day incarceration in the Petrapavloskaya fortress, while awaiting execution, Kibal'chich sketched a masterpiece, and described an original manned flight vehicle propelled by a solid-fuel engine (Figure 1–6). In the work, he provided the proof for the selection of the rocket propellant, and the energy source of the spacecraft; proposed the idea of restricted-burning gunpowder for the jet-propulsion engine; as well as the necessity to provide a programmed regime of the gunpowder burning; and developed the propellant flow device and regulator.

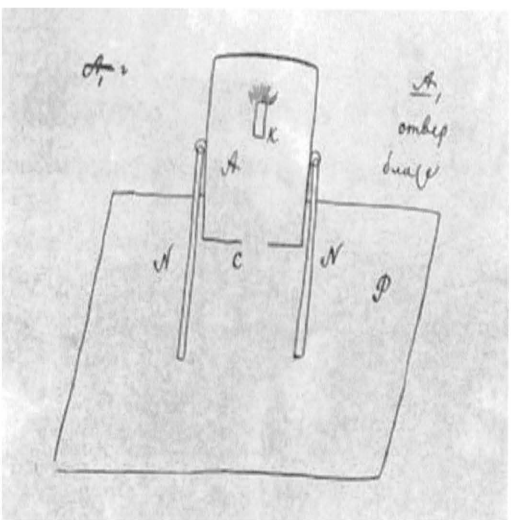

Figure 1–6: Sketch made by Kibal'chich in his condemned cell.

Analyzing the problem of flight stability, Kibal'chich considered two approaches: stabilization due to the corresponding mass distribution, and by means of wing-guiding fins. He mentioned that changing the rocket's axis direction would alter the vehicle's flight path. Kibal'chich also devoted attention to the issue of deboost during spacecraft descent. He summarized the problem by suggesting that in general, flight success depends on the proper choice of proportions among the payload mass, the burner envelope, and the size of the engine's combustion chamber [2].

In his notes, he explained: "I am writing this project in prison, a few days before my death. I believe in the practicability of my idea and this faith supports me in my desperate plight" [3]. It should be noted that on behalf of the Tsar, his lawyer proposed to Kibal'chich that the Tsar might change his capital punishment for life imprisonment, if Kibal'chich would continue his research on military rocket design for the Tsarist regime. But Kibal'chich turned down this proposal.

Three days before his execution, Kibal'chich sent an official request to the Ministry of Internal Affairs asking, not for a pardon, but for passing over his project to the specialists for evaluation. However, his paper was placed into the archives, and only in 1918 was Professor Rynin's favorable opinion of his work published in the *Byloye* magazine.

Kibal'chich was hanged on 3 April 1881, along with other conspirators of the 1 March 1881 assassination.

Konstantin Tsiolkovsky highly esteemed Kibal'chich's scientific achievement, and placed him the first among his, (Tsiolkovsky's), predecessors. There is evidence that Sergey Korolev became familiar with rocket technology from Kibal'chich's project.

Yuriy Kondratyuk (Olexander Shargey) (1897–1942)

Future genius of humankind, Olexander Shargey, (Figure 1–7) was born in Poltava (Ukraine) on 21 June 1897 into the family of Hnat Shargey, a student at Kiev University, and his wife, Lyudmyla. Both of his parents were well-educated people, and gave a lot to their child. But they both passed away very early in his life: his mother died in 1903, and the father years later. Thus from 1910, Olexander lived in the care of his grandmother, Kateryna, in Poltava.

From his gymnasium, or high school, years, the boy started to dream of interplanetary journeys, in order to learn more about the universe. Of great assistance were his "amazing abilities in mathematics and other exact sciences," as one of his teachers wrote. Many years later, Olexander Shargey wrote to Tsiolk-

ovsky: "I have worked on the problem of inter-planetary communications from the age of 16; since then, I have understood that there is the possibility of a flight from Earth. The task of achieving this became my life's purpose." Being just 17 years old, he proposed a scheme (in after years called "the Kondratyuk's route" or "the Kondratyuk's loop") of spaceflight which was later, in the 1960s, used for both launching unmanned spacecraft, as well as for manned flights to the Moon (by Americans) [1].

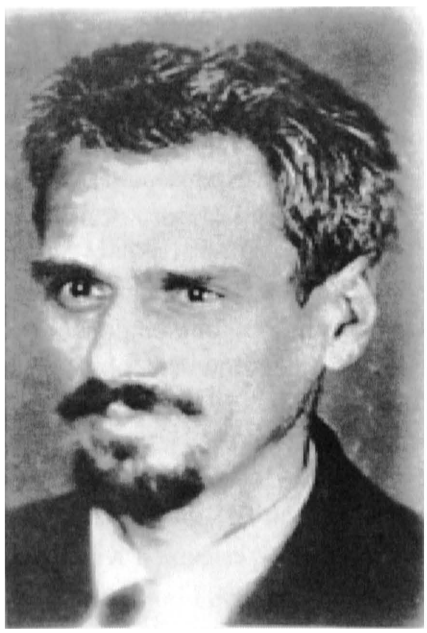

Figure 1–7: Yuriy Kondratyuk (Olexander Shargey).

His life was very difficult. In 1916 Shargey entered the Mechanical Department of the Petrograd Polytechnic Institute. But World War I was going on, and he was mobilized into the Army and sent to the front. Before this happened, he managed to finish his work, in which he substantiated the possibility of surmounting gravity, by use of a rocket with jet engine. He designed the rocket, and studied trajectories of flights from Earth to the Moon and other planets of the solar system.

Shargey finished his first scientific work on 25 March 1917, and in autumn 1919, the second work was written with the original title: "To Those Who Will Read in Order to Build." In the latter, he described the project of the space journeys of which he dreamed. The work contained a number of scientific foresights of the space era, but unfortunately it was only revealed in 1964. The same fate

could have been waiting for another of Shargey's outstanding works—"Conquest of Interplanetary Space" (Figure 1–8). Despite the fact that in the foreword, the well-known scientist V. P. Vetchinkin expressed a high opinion of Shargey's work, it was not published for reasons which are unclear. Shargey published the 72-page work at his own expense in 1929, in 2,000 copies.

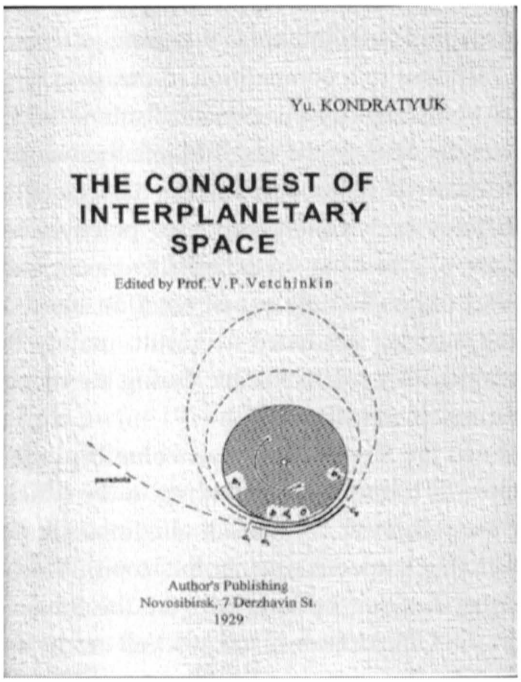

Figure 1–8: The title page of Kondratyuk's famous work.

It was the tragic events of the Civil War that forced Olexander Shargey to change his name. During 1919–1921 he was twice drafted into the White Army in order to fight the Bolsheviks, and it was too dangerous to keep his real name, since the Bolsheviks would not tolerate the facts of his biography. His mother-in-law managed to obtain false identification papers for him, in the name of Yuri Kondratyuk (born in Lutsk in 1900 and died of tuberculosis on 1 March 1921). Shargey resisted changing his identity for a long time, but in the end he admitted it was the only way to save his life, as well as the lives of his sister and mother-in-law. He also accepted the advice to move from his native Ukraine, again for security reasons, and he settled in the Siberian city Novosibirsk.

It was there, in Novosibirsk, that his most famous work, "Conquest of Interplanetary Space," was written (1929). But his engineering genius was also ap-

plied to more earthly, local problems. Kondratyuk designed a huge grain elevator, nicknamed "Mastodon," that was built under his guidance in 1930, without a single nail, since metal was in such short supply in Siberia. But the lack of nails in the structure was used by his ill-wishers as evidence that he had planned the structure to collapse. Convicted of anti-Soviet activity, Kondratyuk was sentenced to three years in prison [4]. Only the personal intervention of Sergo Ordzhonikidze, then Minister for Heavy Industry, saved Kondratyuk from imprisonment. The reason for Ordzhonikidze's patronage is explained by the fact that Kondratyuk, in response to a competition to design a large wind power generator for the Crimea sponsored by the minister, submitted (in cooperation with two colleagues) a proposal, that, in the end, became the winning one.

Life with a "borrowed" name permanently depressed Shargey. In 1933, a meeting between Korolev and Kondratyuk took place in Moscow. The future famous Chief Designer was looking for a bright engineer and theoretician to replace Friedrich Zander (who died the same year), in his rocket research group called GIRD. But the meeting produced no result, mainly because Kondratyuk was afraid that his real identity might surface during the security scrutiny preceding the acceptance of him as a staff member.

Kondratyuk joined the Soviet Army as a volunteer in the very beginning of World War II, in June 1941, and died, according to the official version, either at the end of 1941, or early in 1942. The exact circumstances of his death are not known, and there was much speculation on this topic. Since no body was ever recovered, there are theories that he escaped from the Soviet Union and eventually made his way to the United States, and worked on the space program there, under yet another identity. But there is no evidence to support these claims [4].

The scientific heritage of Olexander Shargey, his outstanding talent, and the genius of his forecasts, are really mesmerizing. Without knowing the works of Tsiolkovsky and Tsander—the founders of cosmonautics, he got results independently. His novel approach was in singling out the key problems and finding solutions for them. For example, he proposed the scheme of chamber and nozzle cooling by fuel components, as well as chessboard-wise placement of the injection holes of the propellant and oxidizer in the engine's chamber; he formulated the "proportional passive" principle, which is one of the essentials of modern weight analysis of the rocket; he proposed a multi-layer, armor-vacuum, thermal protection to secure the optimal temperature regime of the spacecraft.

He elaborated original schemes of the launch vehicle control systems, stressed the importance of safety measures for astronauts on the ascending and especially descending part of the trajectory, and invented simple and reliable seats for astronauts, as well as a thermal protection system for the descending

module and parachute landing. These ideas were implemented in the descent control systems of Soviet and American spacecraft.

Kondratyuk's great achievement in the methodology of cosmonautics is that he proposed: that for the purpose of space exploration, the artificial satellites of the Moon and other planets (and not ones of Earth), should be employed as intermediate bases. He stressed that in order to descend to the Moon or other space bodies, it is expedient to use a special descending module that will separate from such an intermediate base, and then come back to it. In fact, this strategy was used in the Apollo program.

Kondratyuk determined the formula of rocket flight in the field of Earth gravity. He proposed two probable flight trajectories: (1) the rocket flies away from Earth vertically; (2) the rocket is accelerated circle-wise. The detailed analysis of these two scenarios brought him to the conclusion that the most optimal approach is to use the so-called "escape trajectory"—the circle which develops into elongated ellipses with the foci in Earth's center and perigee at the same height.

Olexander Shargey was well in advance of his time, but the two world wars and realities of the awful 1930s in the Soviet Union did not allow him to implement many of his brilliant ideas.

The names of Olexander Zasyad'ko, Konstantin Konstantinov, Mykola Kibal'chich, and Yuriy Kondratyuk (Olexander Shargey) are well recognized in Ukraine, by the establishment of a dedicated museum in Poltava, Kyiv, Chernihiv regions, which publish books and produce films, as well as placing commemorative plaques in places where they lived and worked.

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