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Chapter 17

Sputnik Technology—40 Years Ago*

Vladimir Syromiatnikov† and Guy Pignolet‡

On the 4th of October 1957, Sputnik-1 came as a shock to the world, opening the space era for Mankind. The event occurred at a peak of the "Cold War" and the technical details were kept under heavy military secret. The event was of paramount importance—a turning point in the evolution of life on Planet Earth.

Sputnik Engineer Vladimir Syromiatnikov remembers the glorious years at OKB-1 under the leadership of General Designer Serguei Korolev and how the "Most Simple Satellite" came to open the now called "Space Era."

Forty years later, high school students from Russia and from France have undertaken cooperative efforts to give the world a reminder by building and launching a functional scale model of the original Sputnik.

A Shock to the World

On Friday, August 1, 1997, the Russian engineer Vladimir Syromiatnikov and the French writer Guy Pignolet were meeting in the beautiful French Pyrenees Mountains, riding a very scenic Yellow Train on the occasion of the 15th

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anniversary of the founding of the U3P solar sailing association. But they had also another anniversary in mind.

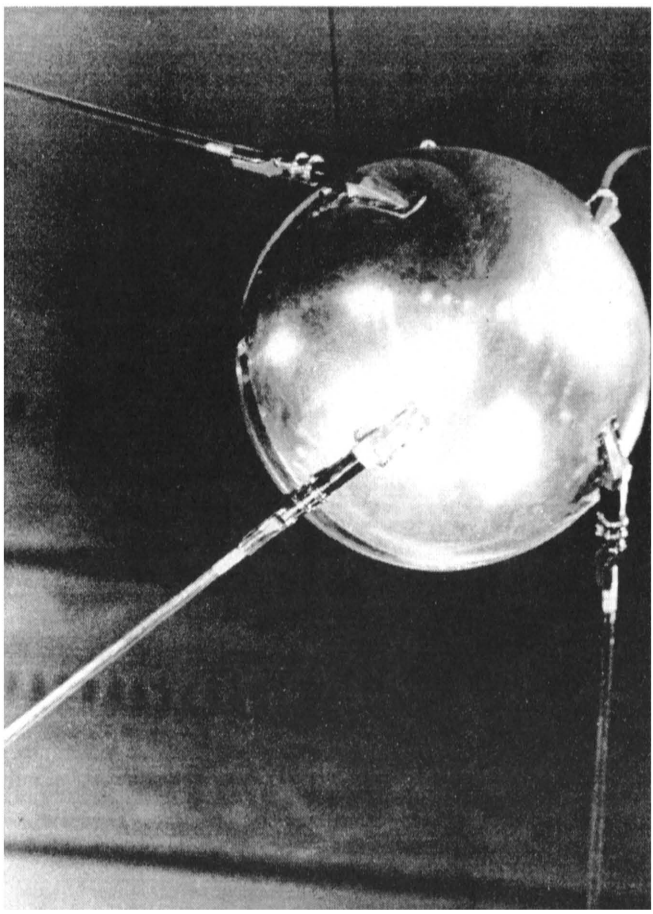
[Guy Pignolet] "I remember, I was in senior high school, and that morning, our Geography teacher came late to school: that never happened. After he let us students into the classroom, he began walking back and forth in front of his blackboard, in a state of excitement. He told us "he was late, because he could not refrain from listening to the news on the radio: the Soviets had launched an artificial satellite around the Earth, and one could hear the beep-beep it beamed while circling the planet." Our teacher told us "he had read before that it was possible, but never had really considered that it was possible." Now, the unbelievable reality was with us... This was the 4th October 1957.

One of the architects of this quantum step in the history of Mankind was Vladimir Serguei Syromiatnikov. Vladimir was born at the end of the thirties in Arkangelsk, in the North of Russia. Then his parents had come to live in the northern suburbs of Moscow, in a small town called "Padlibki." There were two large industry complexes in the city, heavily protected, where secret business was conducted. And while the young Vladimir was studying to become an engineer, he knew nothing of what was happening behind the tall concrete walls. When he received his degree, in 1956, one of Vladimir's neighbors who was working in the secret factory asked him whether he wanted to work there and introduced him to the man who was to become his boss for many years: General Designer Korolev. Vladimir Syromiatnikov was assigned the task of designing and building the heat control system for what was to be the simplest, but first, artificial satellite of the Earth: Sputnik 1.

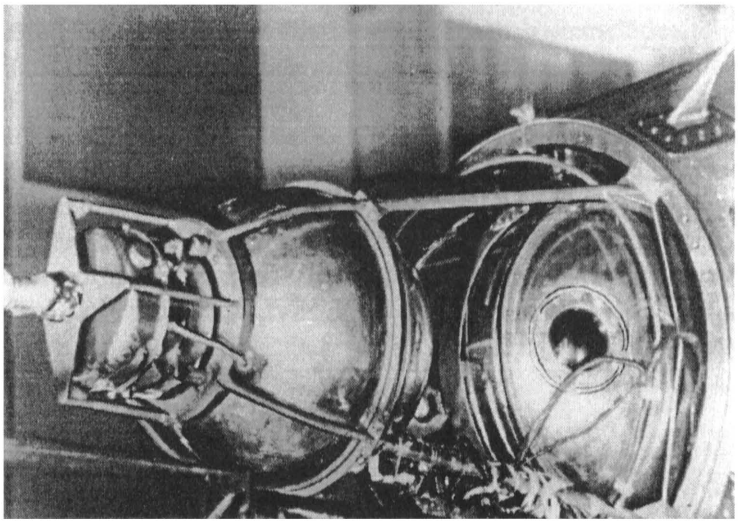
The "Artificial Luna"

[Vladimir Syromiatnikov] "I was lucky to be at the OKB-1, the First Construction Bureau, when I joined Korolev in April 1956. It was the time when the final development of a new two-stage missile, the future famous launch vehicle, was being developed. All the work had been done during 1956 and early 1957. At the same time, somewhere at the end of 1956, engineers began to talk about Sputnik, and also it was in August 1956 when another great milestone happened, because Korolev's OKB-I became independent. It was previously working among other OKB's in the framework of the Institute N°88, now TSNIMASH. In the late months of 1956, not only talks began, but also preliminary design work started, first for a bigger sputnik. Actually it was what became later Sputnik-3. It was a bigger one, with much more electric power, more system development, and much more safety built into it. It was more than one ton. But at the same time there were many rumors and much speculation that the Americans also were trying to develop and launch a satellite. It was not

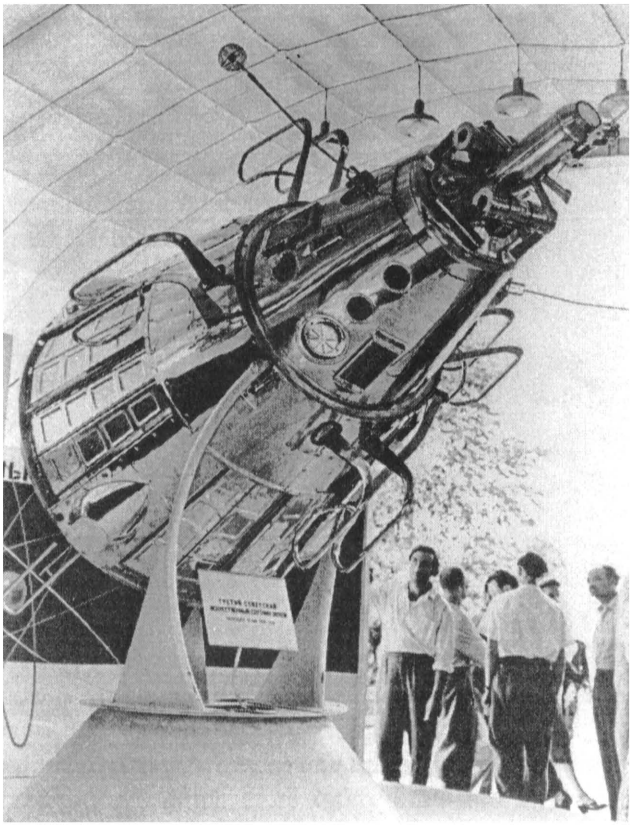
only speculation: there were many many publications abroad, so the Russians, and especially Korolev, were eager to build the first Earth satellite. It was announced that "the Simplest Sputnik," it was called "Prostischii Sputnik" in Russian, with the acronym "PS", would be designed. First, the general outline was carried out, and I think that the shape and mass and appearance were very good. You could judge this by the fact that nowadays, it remains of symbol of the space era that was started then. It was round, spherical, it was an artificial satellite like a small moon. It was called by many people the "artificial Luna." The antennas added some kind of streamline aspect, and when you look, you feel that it flies with high speed."



Sputnik 1, the world's first artificial satellite.



Sputnik 2, launched 3 November 1957.



Sputnik 3 nose cone, launched 15 May 1958.

The "Simplest Satellite"

[VS] "So it was outlined and eventually integrated with the launch vehicle, and then different departments of OKB-1, Korolev's design bureau started their work. And as usual it was a difficult arrangement. There were integration people, and there were specialist designers of all the systems. There was the electrical power supply, the thermal control system, and the radio system for transmitting signals. Like any reconnaissance object that is sent far away from its home base, it should send signals back to confirm that it flies, that it exists, that it carries out its task... Another system I could mention, also important, is the system of automatic control to switch on and off all the devices that it is necessary to activate or deactivate. Another system was a telemetry system that measured temperature, and pressure inside the spherical shell of the Sputnik. Also, there was some kind of attitude control system: actually it was not an active attitude control, but still, due to the shape, the mass distribution of the sputnik, with the antennas pointing at the Earth, we could consider it as the predecessor of the spacecraft attitude control systems. So, I took part in the development of the thermal control system. I personally designed the first space mechanism, the ventilator, an electromechanical device that flew in space in 1957, and initiated the family of many other electromechanical devices. Judging by this short story, you could realize that all systems that are now on board each artificial spacecraft were designed for the first sputnik. They were very simple. They were very light, not consuming much power, but still the predecessors of much more complex devices. So, when I deliver lectures on space technology, I start with descriptions of Sputnik-1. It is very good to start from the very beginning, for several reasons: first, it was the first! then, it is very easy to describe to the students; another good point is that from describing this simple system, you can proceed and explain further steps of development for more complicated spacecraft, more complex sub-systems."

A Very Secret Team

The people who knew about Sputnik did not speak, the people who spoke did not know...

[VS] "The enthusiastic team who was doing the real job was never allowed to get in contact with other scientists; especially foreign scientists, and to talk to them. It was said they delegated some scientists who were very far from the real development, and who actually did not even realize what was done. For example, after the launch, Leonid Sedov became known worldwide as the father of Sputnik, he was invited to many international meetings, and decorated with medals, and elected to Academies of Sciences in different countries, and he became the first Soviet fellow of the AIAA in the U.S.A. He should have said that

he had nothing to do with the real development of the Sputnik, but he never did... At an international space congress in Copenhagen, in 1955, he was told to tell eastern and western scientists about some plans about an artificial satellite without going into details. But actually he did not know any details himself... Even myself, I watched some integration in Kaliningrad, but I did not go to Baïkonur, I have not been to the launch site during that time. We expected the launch to take place, we knew it in advance, but not the exact hour..."

A Natural Design

Unlike most satellites which were developed in the West later, Sputnik, like many other Soviet spacecraft, was pressurized, with an internal atmosphere...

[VS] "It was a more natural way. It was a little more complex, but most of the components for the Sputnik were not designed for long stays in a vacuum. So, to make it reliable, to ensure the performance, it was better to place them in a more natural environment. Also it was easier to control the temperature. It had good and bad consequences. Good ones, because it was easier to design pressurized spacecraft to fly animals and human beings later. The bad part of that was that Russian electronic people actually never worked seriously to design avionics for performance in a vacuum..."

"There were no electronic tubes on Sputnik, it was all solid state, not integrated of course, but solid state with the already available transistors. At that time most of the transistors were still germanium. But I could not tell precisely, because the avionics were designed by sub-contractors, specialists of missile radio systems. They knew what they were doing, and they had been presented with the details of the mission."

"All the electrical equipment had been sub-contracted: motors, relays, switches, wires, thermal sensors, and so on... All the sub-contractors had been involved in rocketry during the previous years. They had designed, developed and built components for rocketry, and all the space technology was actually based on rocketry technology, and all the general philosophy of development and testing was based on the rocketry experience. So, we could say that all the space technology was "ground-based," but this was true also in America."

"A clever decision was made to use simple chemical zinc-silver batteries, not solar arrays, to support radio transmissions, internal measurements, the double control systems, and the ventilator. Two-thirds of the weight of Sputnik-1 was made-up of the 50 kg of batteries. The batteries were designed to power the Sputnik for 3 weeks, but actually they lasted some 4 weeks, a little bit longer. They were efficient and they worked perfectly, although the specific mass was rather low."

Testing for Space Conditions

Most of the testing was based on the practice of rocketry.

[VS] "First of all the design had to be strong enough, to accommodate all the loads during the launch or in space: pressure loading and a lot of vibration loading. The loads in the testing facilities were higher than the actual loads during the launch, with a kind of safety factor, to avoid any failure. Of course, all the functions were tested. I remember the test facility to check the separation device that separated the Sputnik from the launch vehicle. There was a special suspension, with cables, and it a was a pyro-device that was fired, and the separation took place, there was no interference, and even the antennas did not interfere with the structure of the launch vehicle. And of course, all the sub-systems underwent all kinds of tests: high temperature, low temperature, and vacuum, and they had to perform at low voltage, high voltage. They had to survive the failure of some components, and some redundancy was introduced, even in that simple sputnik design."

A New Challenge: Thermal Control

However, there was one thing rockets had never done: remain in space for an extended period of time, in weightlessness, and periodical change from full sunlight to deep shadow conditions.

[VS] "Space is a special environment. First of all, it is weightless, you should provide that all the equipment perform in weightless conditions. There is no natural motion of air. This is why the ventilator was introduced to move the air and cool the most power consuming devices such as transmitters, and the electric batteries themselves. Of course, speaking of thermal control, the outer skin of Sputnik was specially designed. I has special optical characteristics on the outer surface. Even in direct sunlight. it had to reject the sunlight while on the other hand not emitting too much heat. The optical coefficients had to be in a certain range to provide an average temperature both in the case of direct sunlight and when it was in the shade of the Earth. This was new technology, new calculations, never done before. The calculations were performed, and then the Sputnik was tested in a vacuum chamber that simulated the sunlight. There were measurements of temperature with different conditions. But this test equipment had already been developed for testing high altitude rockets."

Management, Korolev style

In 1996, Vladimir Syromiatnikov lectured at the ISU International Space University, on the management of early Russian space projects, starting with Sputnik-1.

[VS] "It was very efficient management, with one man of much power above the whole activity, and he managed for all the people. At that time, he had enough funds to fund everything. There were several managers of this kind at that time, very efficient, very professional, but Serguei Korolev was absolutely special. He was an ideologist, he was a designer, he was an organizer, he was a manager, he was a diplomat, he was a scientist. He established good business-like relations with all the levels of management of the Soviet Academy of Sciences, including the President himself and many other scientists. He established the management rules with the Communist Party, and with special leaders like Mitri Ustinov, who since the very beginning, 1945, was in charge of this kind of industry. Also he was a real leader among his own people, and he encouraged them to do the work in the best way possible. He established good relationships with all of them, and he appreciated when the job was done efficiently, with good quality. Because in space technology, quality goes first. He was also an actor: he could become angry on purpose, he could become kind, even sly on purpose, if he considered it was needed. He could become cruel sometimes, just for show. He was actually not really cruel to people, but people were a little bit afraid of that, that was his natural way of behavior. He was an absolutely outstanding man... outstanding!"

Epilogue

Forty years after Sputnik-1, high school students in Russia and in France have cooperated together and build a 1/3 functional scale replica of the original "PS-1/ Sputnik-1." The "PS-2/Sputnik 40 Years" satellite is to be the first international space project launched by hand from the space station MIR during an EVA by a Russian cosmonaut, and also the first scale model in space. Due to the technological progress, with high power batteries and integrated chip components for the radio transmitter, the 2.7 kg commemorative satellite is expected to beep beep for one month, like his ancestor. A new generation is ready to pick up the pioneering spirit of Sputnik-1, ready for new steps in the development of Mankind in Space and on the Earth.