A Look at Eastern Europe's Secret Space Programs

The history of the Eastern European space programs under the Soviet Union, long unknown, is yielding some new and sometimes surprising revelations. Marsha Freeman gives a conference report.

Since the 1930s, the space programs of the Soviet Union were closely guarded, combining both military and civilian technology and applications together under military control. In contrast, the United States created the civilian NASA space agency in 1958, and made all of its mistakes, and showed its accomplishments, in public.

Since the end of the Soviet Union a decade ago, archive material about the secretive space program has been made public, and over the past few years, new, and sometimes astonishing, revelations have come to light.

Since the opening of the Space Age, with the launch of Sputnik in 1957, the contributions of the nations of Eastern Europe in space were simply lumped together under the "Soviet space program," with no national distinctions. In fact, most of the leaders of the "Soviet" space program were actually born in Ukraine. Not only were these nameless nations given no credit for their contributions; there was an effort by the Soviet military to stop them, when they tried to engage in even modest national space technology and applications efforts.

This year's annual meeting of the International Astronautical Federation (IAF), held between Sept. 29-Oct. 3 in Bremen, Germany, provided an opportunity for researchers and participants in the space efforts in Romania and Slovenia to reveal their accomplishments. It also provided a forum for one of the few surviving pioneers of the Soviet space program to describe the importance of the German contributions to the Soviet effort, following the end of the Second World War.

Slovenian Rockets To Suppress Hail

The western part of Slovenia, a nation of 2 million people and formerly part of Yugoslavia, is a wine-growing region, with vineyards that are vulnerable to damage from hail. In the Summer, there are frequent thunderstorms, often accompanied by hail. In a paper presented at the IAF Congress by Aleksander Kerstein, co-authored with his colleagues from Slovenia, the history of the use of rockets for hail suppression was described, with something of a surprise ending.

In 1951, the program to use rockets to suppress hail from storms was introduced into western Slovenia. The rockets were French, and the payload was about 10 grams of a chemical reagent, which was dispersed throughout the clouds. The purpose was to seed the clouds with chemicals that become condensation nuclei, changing the mechanism for the formation of hail. As a result, the size of the ice crystals is reduced, and as they travel through the warmer layers in the atmosphere, they melt into rain drops. "The rockets were discharged vertically by [the] winegrowers themselves, on the basis of their own estimation of weather conditions, usually at the start of a hail storm," Kerstein et al. reported. The rockets reached a height of about 1,000 meters, but they were in use only for a few years.

At the end of the 1960s, hail-suppression rockets were again introduced in the former Yugoslavia, this time along with meteorological radar to identify clouds that contained hail. The rockets were built in the Kamnik gunpowder plant near Ljubljana. They carried 400 grams of silver iodine reagent, were made with filament-wound composite materials, and used solid fuel. Parenthetically, this is the same basic design used today for the solid rocket boosters attached to the Space Shuttle for launch!

The Kamnik 1 rockets could reach a height of up to 2,800 meters, following the order to fire from the radar center. During the 1970s, between 2,000 and 5,000 Kamnik 1 rockets were fired per year; but the results they achieved, in height and reliability, were unsatisfactory. Kamnik proposed a new rocket be designed and built, with an extended vertical range.

The new effort was started at the end of the 1970s at Kamnik, in cooperation with the Ljubljana Engineering Faculty and the amateur Astronautical and Rocket Society Celije (ARSC), which had formed a small working team for research and development of a small meteorological hail-suppression rocket. The second Slovenian hail-suppression rocket program was called RCHX-Storm, and in 1986, the Yugoslav Ministry of Agriculture signed a contract with the Slovenian Research and Development Institute Celije (RDIC) to finance the development of the Storm rocket. Aleksander Kerstein was the Project Manager.

The 'Storm'

When the program began, the team members realized they needed sophisticated research facilities, factories capable of producing high-quality complex products, skilled technical manpower, and adequate test facilities. Slovenia had developed all of these crucial elements. Kerstein points out that this was the only Slovene rocket project that had an exclusively non-military purpose.

There was pressure on the Storm group to create a system with significant advantages over what already existed, because the hydro-meteorological services in each Yugoslav republic had standardized its own vague requirements, regarding the reagents used in the rocket, the range of the rocket, and requirements for safe transport, storage, and handling. The goals set for the new Storm system included the potential for 7,000-10,000 launches per year, using mass production. The rocket was to also have high safety characteristics, eliminate the need for highly trained operating personnel, eliminate any special system for storing and handling, and be low in cost. A major innovation in the design was that it was built almost entirely of light-weight composite materials, mainly epoxy resin, and reinforced glass fibers.

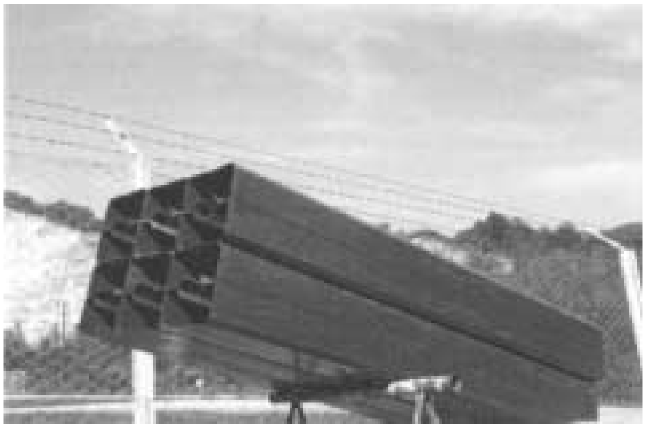
Most of the work carried out by the research and development team was in laboratory tests of new, hybrid propellant, and intensive static tests of the models of the motors. In less than a year, the motor had been developed to be able to be dynamically tested in flight.

The payload of the RCHX-Storm was 16 flares of silver iodide reagent each weighing 60 grams. They were arranged in a cluster, and emptied in approximately one second. The payload also included passive radar markers made out of aluminum, so for each rocket, it could be determined in which part of the cloud the flares were dispersed, and to control and measure the efficiency of the process of sowing artificial nuclei into the cloud.

The indigenously-developed Slovenia Kamnik-1 rocket was used to seed clouds and suppress the formation of hail during thunderstorms. The program, itself, was later suppressed by the Yugoslav military.

A new launch system was developed for Storm: a container that had six tubes, to launch six rockets at once. After launching, the containers were returned to the producer, and were used several times. After the rockets exhausted their reagent they would self-destruct. In the earlier programs, a high-strength explosive was used, but this caused considerable problems. For the RCHX-Storm, two systems to prevent the rockets from causing damage on the ground were developed and tested. These consisted of a self-destruct system which could use a standard and less violent explosive charge; and a parachute to break the rocket's fall to a velocity of less than 4 meters per second.

Test launches of the RCHX-Storm rockets started on May 12, 1987 and nearly 50 were conducted. A larger version of



The "Storm" hail suppression rockets were launched six at a time from containers that could be refurbished and reused.

the rocket was also developed, to be able to carry scientific instruments on sub-orbital ballistic trajectories, known as atmospheric sounding rockets. Then in 1988, the military authorities in Belgrade took an interest in the rocket project. Two visits were made by military representatives to the Institute, which then received an order to prepare a feasibility study and a program for further development. On Christmas Day, 1988, project representatives defended their study at the headquarters of the Yugoslav army in front of a special commission.

As Kerstein et al. report: "After sharp criticism and negative opinion, more than half [the] members concluded that [our] hybrid rocket motor wasn't promising, and important for suppressing hail. Therefore, they decided to end the RCHX project." Considering the extreme nature of what followed, it hardly seems possible that the military ended the program because they believed it would not work. If that were so, there would be no reason to remove every trace of it. The central Yugoslav government intervened in 1989 from Belgrade, and in April, the project was terminated. As requested, all of the documentation was given over to the authorities. All of the tools and rocket components were destroyed.

But Slovenia's space and rocket specialists are anxious to use their expertise for international space projects in the future.

Home of the Father of Space Flight

Romania will always have a special place in the history of astronautics, because it was the place where the father of space flight, the German-speaking Transylvanian Hermann Oberth, was born in 1894. At a History session of the International Astronautical Federal Congress in Bremen, Romania's first cosmonaut, Dumitru Prunariu, presented a personal and revealing picture of Oberth's scientific activity in Romania. The material was, in large part, new to many in the English-speaking audience, because Oberth is best known for the work he did in Germany in the late 1920s and 1930s, and the influence he had on the young space pioneers in Germany, including Wernher von Braun, since Oberth's books were published in German. One of Prunariu's co-authors on the paper was Dr. Hans Barth, who was a personal friend and biographer of Oberth.

They described in their paper how, while still in high school in Romania, Oberth designed his first rocket; in 1912, he had a design for a high-altitude liquid-fueled launcher. Five years later, Oberth completed the detailed design of a liquid-propelled rocket, using alcohol and liquid oxygen for propulsion, a gyroscope for stability, and regenerative cooling of the combustion chamber walls. The response Oberth received to his design from the scientific community was predictable—"You must have made an error in your calculations." Oberth was not too discouraged, and the good-natured people of the town of Sighisoara where he lived, gave him the nickname of Herr-Moon Oberth!

In 1918, Oberth traveled to Germany to continue his college education, and in 1923, published his rejected doctoral thesis as his first book, titled, *The Rocket to Interplanetary Space.* This work started a revolution in scientific thinking in Germany, which spilled over to the United States, and elsewhere. But with no job prospect in Germany, the author was already back in Romania, teaching in a girls' high school.

Hermann Oberth and his family moved to Medias, Romania in 1925, and be began teaching mathematics and physics at the Stephan Ludwig Roth Gymnasium—comparable to high school. He was also able to secure permission and facilities to carry out experiments at the air force school workshop. But he was not just tucked away alone in a laboratory, doing experiments. The authors report that the press in Romania circulated the professor's ideas, with his encouragement, which had an impact on the scientific community and on young people in his native land.

Oberth also carried out a series of public lectures in many cities in Romania, including Bucharest, the capital, and spoke on Romanian radio. In 1923, he held two conferences in Bucharest—one in Romanian and the other in German—hosted by the Polytechnic Society; the same year, the Romanian magazine *Nature* published an article written by Oberth on the possibility of space flight.

There is no question that the most dramatic impact of Oberth's ideas before World War II was in Germany, where he helped von Braun, and other young people and amateurs, carry out rocket experiments, and advised on the film *The Woman in the Moon,* which encouraged scores more young men to dedicate their lives to the challenge of space travel. But it was obvious from the affection with which cosmonaut Prunariu spoke of the old professor, that Oberth also had a palpable impact on young people in Romania. In 1984, at a

Hermann Oberth, the "Father of Space Flight," here on the 1929 movie set for Frau im Mond, *was the inspiration for young space enthusiasts in Germany, and also in his native Romania. (Inset) Romanian cosmonaut Dumitru Prunariu, seen here at the IAF Congress, on the right, next to Russian space agency head Yuri Koptev, reviewed Professor Oberth's impact on astronautics in Romania at the IAF Congress.*

celebration of Oberth's 90th birthday, Prunariu was very proud to be awarded the Hermann Oberth Gold Medal, bestowed by the Oberth-von Braun German Society of Astronautics.

Romanian Rocket Research After Oberth

Hermann Oberth was the last person to conduct rocket experiments in Romania until the early 1960s, as they were essentially forbidden there after World War II, even though the country had a well-developed aircraft industry. In 1962, a group of very young students, led by Radu Rugescu at the Polytechnic University in Bucharest, began a limited program in rocket propulsion research, which was neither funded nor encouraged by the government. At the IAF Congress, Dr. Rugescu described this unusual program, which was, unfortunately, stopped by the Romanian military in 1969, just as it attained success.

Dr. Rugescu said he wanted to "raise the Iron Curtain," to look back to 16 years after the end of World War II, when he and six friends designed and built a test stand for experiments, in what was called the MRE rocket engine program. Dr. Rugescu reported the young students were "secretly" encouraged by Oberth, who knew about their work. "This paper," he said, "is the first international presentation of the experimental research activity in rocket propulsion developed in Bucharest."

The goal of the program, carried out by the Association Dedicated to the Development of Astronautics, was to design and build a small, low-thrust rocket motor, and the accompanying test stand for static firing of the engine. The intention was to prove the feasibility of an engine, as a scale model for a motor ten times larger that could propel a sub-orbital sounding research rocket.

The developers did extensive testing of various types of rocket propellants, studied the efficiency of various combustion chamber designs, examined the performance of different materials, and all other aspects of rocket technology. The diminutive size of the engine developed and tested is indicated by the fact that its mass flow rate of propellant to the engine was 127 grams per second, or a little over four ounces.

The test stand was a sophisticated apparatus, consisting of the propellant feed system, and measuring instruments to collect technical data on the performance of the engine during a test. The MRE rocket engine was successfully tested for 20 seconds on April 9, 1969 at the main laboratory of the Polytechnic University in Bucharest. That was the engine's first, and only, test. The military ended the program.

Today, the MRE engine and test stand are used as a training installation for students and faculty at the University. Demonstrations are carried out in workshops for students of the Faculty of Aerospace Engineering.

This work can now, for the first time, begin to be appreciated, as the Iron Curtain has been lifted.

Did Germans Influence Soviet Rockets?

No space program in the Eastern European countries was more secretive, for more decades, than the Russian one. Much of what the West learned about what the Soviets were doing in space was disinformation released by government sources. Only the cosmonauts were paraded in public, with the most important technical thinkers, and chief designers, kept carefully out of sight. It was not until after he died in 1966, that the world even found out that it was Sergei Korolev who was the Soviet Union's Wernher von Braun.

It is fortunate that one of the early Soviet space pioneers, and a deputy to Korolev, was able to participate at the IAF Congress in Bremen. Due to the location of the meeting, the emphasis of two history sessions was German contributions to astronautics.

This subject has been one of great controversy for many years: The Germans stress that their early groundbreaking work in rocketry laid the basis for the world's two great space programs in the United States and Russia; the Russians defensively counter that the German contributions were minor in the accomplishments of the Soviet Union after the Second World War. Few are better able to discuss the German influence on the Soviet space program than Boris Chertok.

Chertok was born into a Jewish family in the Polish city of Lodz in 1912. In the 1930s, he found a job at Plant No. 22 outside Moscow, which today is the world-famous spacecraft design center, the M.V. Khrunichev State Space Scientific Production Center. In 1944, the Soviet military put together a secret group of technical specialists including Chertok, which they designated *Raketa*—the Russian word for missile. The team's mission was to investigate the remains of German A-4 rockets that had been found, to study their design. They were astonished to find how far ahead of Soviet specialists the Germans were in rocket technology.

In June 1945, thirty-three-year-old Chertok was among a group of Soviet engineers and Army officers who went to Peenemünde to make an assessment of the German rocket program. Chertok had actually arrived in Germany in April as part of a Russian Air Force inspection team, interested in German radar and precision instrument research. He went to the Mittelwerk production plant in Nordhausen in July, to investigate how the Germans had mass produced the A-4 rocket. The Soviet military decided to try to restart production of A-4s at the plant, and the Institute Rabe was established, with Chertok as co-leader, along with a German engineer.

Chertok was one of Korolev's most senior colleagues, and became Deputy Chief Designer at OKB-1, the design bureau headed by Korolev. Over the course of his career, he worked on the development of the Soyuz spacecraft, the Soviet manned lunar program, and later was one of the principal flight controllers for manned space missions.

In his presentation on Oct. 3 in Bremen, Chertok began by explaining that there were three basic new types of weapons developed during World War II—the atomic bomb, radar, and guided missiles. "Guided missiles were developed, and were operational arms, only in Germany," he stated.

Chertok revealed that on July 13, 1944, British Prime Minister Winston Churchill sent a personal and strictly confidential message to Marshal Joseph Stalin, reporting on German missile tests taking place at a facility in Debits, Poland. Chertok was one in a group of Soviet specialists deployed to study the equipment found in the Debits area, before it was handed over to the Allies. He reported that an engine was found in good condition, because it had hit the ground without exploding. But "its control system remained a mystery to us. We were amazed by the dimensions of the missile, and its engine's theoretical thrust of approximately 20 tons. The maximum thrust of the Russian liquid-propellant engines [at that time] was only up to 1,500 kilograms (3,300 pounds).

On March 10, Chertok reported, "the Second Belorussian Front marched into the Peenemünde area. A group of Soviet experts led by Gen. Andrey Sokolov was immediately detached there." As is well known, the Americans had gotten to Peenemünde first. "Our experts found neither valuable engineering documentation, nor rockets, engines, or equipment. All important munition, engineering documentation, and experts had been evacuated, initially to the Nordhausen area, and [then] further West, 15 days before the Soviet forces arrived."

While in Berlin in May 1945, Chertok reports that he "found and kept a confidential report, which had been developed by engineer Kurt Magnus [a gyroscope specialist who worked on the A-4], and approved by professor Schuler, famous in the engineering world. In October 2002, I handed over that already-declassified report to the honorary professor of Munich and Stuttgart University, Kurt Magnus, in connection with his 90th anniversary."

In the opinion of Soviet space pioneer Boris Chertok, (right), the early work of the German space rocket specialists laid the groundwork in the Soviet Union "for rapid development of nuclear-missile technology and cosmonautics for the next decades."

Upon arrival at the Mittelwerk production facility in Nordhausen in July 1945, Chertok says that using what they found from the plant, "assembling an entire missile was reasonable to attempt." In addition, an engine-firing test facility was found in Leetsten, as well as several dozen ready-to-fire units in railcars. "We could hardly overcome the temptation to take all our findings and send them to the Soviet Union as soon as possible," Chertok said; "however, after the situation had been evaluated and support from the local military authorities obtained, we made a decision—unusual for those times—incompatible with the directive from Moscow, and a risk to my career. We decided to establish the first Soviet-German Institute for Rocket Technology in the occupied territory of Germany." Chertok was the director of the Institute.

The German-Russian Team

About 150 Soviet engineers worked with the Germans, among them all of the future leaders of Soviet space science and industry. Detailed and comprehensive histories of the development of the rocket programs were written by the German engineers. In Berlin, an Institute was founded to study and restore German developments in tactical rockets and air defense missiles.

On May 13, 1946, impressed with the work done by the Soviet-German team, Stalin signed a decree setting up a committee to further infrastructure development in rocket science and industry. The top priority was to duplicate the German A-4, to be manufactured from domestic materials and engineering design. Refurbishing German laboratories and training Soviet engineers were the first tasks in this project, and, Chertok recalled, the work was considered to be so important, that the "recalling of specialists investigating the German technology, from Germany to the U.S.S.R., was prohibited."

In October 1946, the Soviet government decided to transfer the German rocket work to Russia, and about 20% of the German staff of Chertok's Nordhausen Institute were relocated, as were experts from the other joint Institutes. Key personnel from the German staff were assigned to the leading Soviet rocket development institutes, in "special" affiliate organizations.

In mid-1947, German specialists accompanied their Russian colleagues to the launch site in Kapustin Yar, to test the rockets that had been assembled in Germany. The German experts were key to fixing the problems that arose in these tests, and the result was, according to Chertok, that "the missiles then started to fly better than those from Peenemünde."

The Germans next began work on the design of a long-range rocket, to lead to an intercontinental ballistic missile. As is known, the design work of the Germans was not adopted as the next-step rocket effort by the Soviet government; Chertok offers two reasons why. The first, which was given out for public consumption, was that the A-4 technology still had to be mastered, produced, and had to be able to be launched "at least as well as the Germans." The second, and confidential reason at that time, was that Korolev had already initiated work on the R-2 missile, which had the same 600 kilometer range as the German design, and it was beyond the capacity of Soviet industry to produce two different, but comparable, missiles.

Development work continued, and recommendations from the German specialists were taken into account in the highly-secret Soviet missile program. He notes, for example: "Doctors Hoch and Magnus designed a summing gyroscope that found its way into the automatic pilots of anti-aircraft missiles. Under the guidance of Prof. Albring, a 6-component aerodynamic balance of unique design had been developed. Also, the first simulators had been developed for integrated development tests of control systems."

But as more tests were conducted, the Germans were not included. Finally, in 1950, a Soviet government resolution was enacted to return the German specialists to Germany, and the last train departed for East Germany in November 1953. The Soviet military had decided that they had no further need of the foreign engineers, whom they would not allow to work on their secret missile projects.

Boris Chertok's evaluation of the German contribution to the Soviet program puts an end to the academic debate about which engineers invented what technologies, and who should be given credit for what. He states: "Although German experts did not participate in [later] tests, it would be impossible to overestimate the historical role of the A-4 and R-1 [Russian copy of the A-4] missiles. An entirely new area of technology had been ushered in."

More important than specific missile designs, Chertok says, the long-lasting contribution from the German rocket program is that "large engineering systems, integrating many science disciplines and different technologies, had been created," based on the experience of the German space pioneers.

While the German input into the Soviet space program ended a half-decade before the launch of Sputnik, Chertok states, "Chief designers initially had started their joint activities in Germany, and became a solid team while developing the first rocket system, the R-1. In those years, the groundwork was laid in the Soviet Union for the rapid development of nuclear-missile technology, and cosmonautics, for the next decades."