COLD WAR SPACE SLEUTHS

The Untold Secrets of the Soviet Space Program

Dominic Phelan *Editor*

Springer

PRAXIS

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Foreword

By William P. Barry, NASA Chief Historian

It is a very rare field of study that has written its own autobiography, but that is exactly what you have in your hands with this book. As a professional pursuit, the study of the Soviet/Russian space programme in the West simply didn't exist until the people who contributed to this book, along with a few others, created it. It was not easy, but these pioneers developed the necessary techniques and persevered in the face of deliberate obfuscation on one side and disheartened ignorance on the other to pursue their passion for understanding the Soviet/Russian space programme.

Space history is, of course, a new field, but after some fifty years it is coming into its own. In the early years, fans, or those with a huge enthusiasm for the technology, wrote much of what passed for space history. Respectable historians rarely touched the subject (although some, like Walter McDougall in his 1985 work *The Heavens and the Earth*, did so to tremendous effect.) In the West, outside of a few government agencies (who kept what they knew close to their collective vests), serious analysts and historians appear to have been put off by the inability to make use of the traditional tools of research when trying to decipher the Soviet space programme. Historians and participants on the Soviet side faced their own set of challenges in telling the tale. Even long after space archives had been established, they proved inaccessible, especially to Westerners. Published material was carefully edited. Memoirs, other than the largely vacuous puff pieces put out in the name of the cosmonauts, were non-existent. Interviewing participants, whose identities were often state secrets, was impossible to arrange in a systematic manner. Little wonder that public work in this field of study was left to the creativity of amateur "space sleuths" until recent years.

Each of the sleuths who contributed to this book developed skills that allowed for remarkable insights with the limited data available. With his doggedly inquisitive mind, Jim Oberg set the early standard for close reading of the published sources. Others used a personal approach to cosmonauts to methodically gather nuggets of information that helped to assemble a fuller picture. Technical skills, like the ability to find and track spacecraft radio signals, were used by some of the sleuths. Others honed their Russian language skills and pored through so much material that they could find the inconsistencies and telling errors in the carefully managed stream of propaganda. To me, one of the most remarkable skill-development stories here is that of Phil Clark – a man who largely taught himself the math and computer skills needed to do sophisticated and stunningly accurate analyses of orbital mechanics. Whatever talent they brought to bear, each of these sleuths showed remarkable tenacity in pursuing a better understanding the Soviet/Russian space programme.

While the individual accomplishments in these stories are remarkable, what is most

striking is the degree to which an international community of interest grew out of these efforts. There was certainly a fair amount of competition among the sleuths, and a few old grudges are evident in these pages. However, long before the Internet-age made it easy, this group of enthusiasts from some seven different countries (and others beside them) discovered one another. Initially gravitating to the remarkable Geoffrey Perry and his Kettering Group, the Soviet space sleuths eventually found an institutional home of sorts in the British Interplanetary Society. In the pages of its *Spaceflight* magazine and at the annual Soviet Forum, the sleuths soon found that the sum of their efforts was much greater than the parts. How do you explain the creation of such a fertile cooperative effort among such disparate and admittedly competitive researchers? It was not merely a willingness to collaborate for the greater good, nor the outlet for their work provided by the society. To my mind a critical role was played by the selfless mentorship of early leaders like Geoff Perry and, later, Rex Hall. When I had the opportunity to indulge my passion for Soviet space sleuthing in the early 1990s, Nick Johnson introduced me to Rex. From the warm reception and encouragement that I received, you would have thought I was Rex's long lost brother. But, Rex and his ever-patient wife Lynn, seemed to treat everyone that way. Without the help of Rex, Phil Clark, and the rest of the Soviet space sleuths, I certainly would never have been able to make my small contribution to the literature. The value of selfless mentorship and commitment to a community of effort is a powerful lesson that you will find reinforced in the stories collected in this book.

One of the other delightful aspects of this book is that the stories complement one another, but still present a unique perspective. Like the apocryphal story of the blind men and the elephant, each of the contributors tells the story from their point of view. The result is that the enigma of Soviet/Russian space history is conveyed from a number of angles. Such variations add to the richness of our understanding of space history, and also to our understanding of the founders of the Western study of the Soviet/Russian space programme. Having known most of these authors for the last twenty years, I continually found myself surprised (and a bit embarrassed) to learn new details about them and their struggles to pursue their passion.

One theme repeated throughout these essays is the question of whether the age of "space sleuthing" is over. There is no doubt that the situation has changed radically since the collapse of the Soviet Union over twenty years ago. It is now possible for both Russians and those of us in other parts of the world to use some of the more traditional tools of historic research and analysis. While the (partial) openness of Russian archives, and the availability of participants and their papers, is largely a result of political change, our knowledge of the questions to ask and the ability to put the answers into perspective is largely a result of the efforts of the Soviet space sleuths. Those that contributed to this book, and the many that passed away before their stories could be told, created the field of Western Soviet/Russian space history. Yet, it is also clear that their work is not done. While the field may now be more mainstream, and allow for the use of more traditional analytic tools, it still poses a number of unique challenges. Creativity, tenacity and many of the tools developed by the early space sleuths will still be required when dealing with conflicting stories and limited access to issues that were highly classified state secrets. There is plenty of sleuthing left to do. Those of you just getting started, as well as many of us who have been around awhile, could do nothing better than to read this autobiography of the field. Happy hunting!

Editor's introduction

The idea for this book came to me only days after the death of Rex Hall – the legendary host of the British Interplanetary Society's annual 'Soviet Forum'. Over the years he had become the chief moderator for a tight-knit international network of amateur space historians called the 'space sleuths'. Although this group has lost five well-known researchers recently, to me his passing really did seem to symbolise the end of an era.

Within weeks I was in contact with many of his friends and colleagues in search of their 'war stories' about the golden era of space sleuthing – many of which I include in my chapter. For me this task was an honour, as my own fascination with their efforts dated back to October 1986 when, as a fourteen-year-old astronomy student, I first spotted the now iconic *National Geographic* with a saluting, spacewalking cosmonaut Leonid Kizim on the cover. Ironically, 1986 ought to have been memorable for a host of exciting space events, including the launch of a new Soviet space station, a flotilla of space probes to Halley's Comet and the launch of the Hubble Space Telescope, but instead it is now remembered as the year of the Challenger disaster. As a profoundly shocked West looked on, an invigorated USSR under the dynamic leadership of Mikhail Gorbachev seemed (finally) to be winning the 'Space Race' – an impression enhanced by the launch of their giant Energiya super booster in May 1987.

What really caught my eye about that launch was the fact that the above mentioned *National Geographic* article contained a detailed drawing of the top-secret booster six months before it was revealed to the world. Quickly rereading the article introduced me to now familiar names such as Geoffrey Perry, Rex Hall, James Oberg and Charles Vick. Luckily, my growing interest in their work was aided by the chance discovery of a complete set of the British Interplanetary Society's *Spaceflight* magazine from the 1970s in a second-hand bookshop in Dublin – allowing me to cherry-pick a decade's worth of the best articles from the 'golden era' of space sleuthing. In those days (before the Internet), it really did feel like you were an amateur spy if you tuned into Radio Moscow to catch the latest space news. My notebooks from that period also show my interest in how this news was reported in the West, as they mention various appearances by space sleuths in the media

0.1: *Cold War Space Sleuths'* editor Dominic Phelan.

explaining what it all meant. This interest would later influence my decision to study Journalism in college – something that I hope gives this book a slightly different angle on the usual story of Soviet spaceflight.

During 1988 the publication of three books on the subject – Phillip Clark's *Soviet Manned Space Programme*, James Oberg's *Uncovering Soviet Disasters*, and Brian Harvey's *Race into Space* – provided references to new books and articles for me to track down. The discovery that Brian Harvey also lived in Dublin and gave regular talks to the Irish Astronomical Society there now seems serendipitous. Thankfully he turned out not to be over-protective of his knowledge and became a mentor, encouraging me to attend the BIS' Soviet Forum in London. Although I didn't attend until 1993, it was still possible to meet legendary figures such as Rex Hall and Phil Clark in person, and whilst some of the sleuths' politics might have ranged from ideological 'Fellow Travellers' to 'Cold Warriors', most of them were simply in it to apply their detective skills to discovering the truth behind the public face of the Soviet space programme. You might ask yourself what makes me uniquely qualified to be the editor of this book, when I haven't revealed any previously unknown Soviet space secrets myself? Coming from a younger generation that missed most of the actual 'sleuthing' gives me, I believe, the slight detachment needed to judge their work objectively.

Although space sleuthing itself might now seem like 'history' too, working on *Cold War Space Sleuths* has given me renewed grounds for optimism that the craft is alive and well. Currently, the most promising future target is undoubtedly China. This rising superpower is not only using Soviet-style technology, but in many ways is also copying its media control techniques. Also, Russia might revert to its centuries-old tradition of attempting to hide embarrassing facts from foreigners when co-operation aboard the ISS comes to an end. Apart from these future possibilities, those lucky enough to be searching through the Russian archives tell me that there are plenty of undiscovered documents waiting to be found which could potentially rewrite our understanding of some aspects of spaceflight history.

The space sleuthing discussed in this volume might be the product of a certain age, but the skills they pioneered might come in useful again during the 21st Century!

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Dublin, Ireland

Acknowledgements

Naturally, it has been a pleasure working on this book because I never imagined that one day I would get the opportunity to ask many of my writing heroes to contribute a chapter to a book with my name on the cover. *Cold War Space Sleuths* is the type of book I've always wanted to read myself, and I'm just lucky that I got there first with the idea to ask the sleuths to put their stories on paper.

My sincere thanks then to: Asif, Bart, Bert, Brian, Christian, Claude, Dave, Jim, Phil and Sven for their enthusiastic responses when I told them about the proposal to produce this book.

The list of those who didn't contribute a chapter but whose input was just as valuable is as important, and I would also like to acknowledge the help of: NASA historian William Barry for the Foreword; Peter Smolders, Lynn Hall, Robert Christy, Leo Enright, Marcia Smith and Michael Cassutt for background information; Charles P. Vick for permission to use his famed Cold War-era rocket drawings; although the photographs used in each chapter are the copyright of the individual authors, I would also like to thank Martin Dawson, Alistair Scott, Gerald Borrowman, Charles Vick, Bert Vis and Ed Cameron for some additional hard-to-find images that were used; Ralph Gibson/RIA Novosti for the photograph on the front cover; Stephen Corbett and Ed Zigoy for providing vital *Spaceflight* and *JBIS* back issues; Colin Burgess (my own editor on *Footprints in the Dust*) for making me realise that anything is possible if you can assemble the right team; Mary Todd and Suszann Parry of the British Interplanetary Society for their tireless efforts to ensure the Soviet/Chinese Forum runs smoothly each year; former *Spaceflight* editor Clive Simpson for publishing some of my earlier articles; and Clive, Maury, Romy, Jim and David at Springer-Praxis for making the publication process run smoothly.

Finally and most importantly a big thank-you to all my family, especially my parents Beryl and Tony, my brother Damien and sister Lisa, for their continued support and interest in my writing. Enjoy the book!

1

Space sleuths and their 'scoops'

by Dominic Phelan

The USSR was famously described by Winston Churchill as "a riddle, wrapped in a mystery, inside an enigma" and nothing signified this more than the search for the truth behind its space programme during the Cold War. Although the Space Race was literally played out above our heads, it was often obscured by a figurative 'space curtain' that took much effort to see through. Although Western governments with the latest spy technology at their disposal often had a pretty good idea of the real story they tended to keep their findings to themselves. As a result, to find out what was really going on, amateurs often had to rely on their own skills at reading between the lines of official Soviet announcements.

BEHIND THE IRON CURTAIN

The first time Westerners noticed the Soviet's seriousness about spaceflight was a 1951 newspaper article by scientist Mikhail Tikhonravov [1]. Around that time the first Western speculation on Soviet rocket technology also emerged in the form of an influential paper presented to the American Rocket Society [2]. At the Californian 'think tank' RAND, analyst Firmin Krieger had started a detailed survey of Soviet newspaper articles seeking definitive proof of serious Kremlin interest in spaceflight [3], but it was Russian-born Colgate University academic Albert Parry who predicted that the first satellite would probably be launched close to September 1957 in order to mark the centenary of space theorist Konstantin Tsiolkovsky's birth [4].

The first English-language book devoted to the subject of Soviet space technology was published in 1961, but unfortunately Alfred Zaehringer's slim volume is now only notable as an example of how little Western writers had to work with in trying to paint a picture of what was going on behind the Iron Curtain in the early days of the Space Race [5].

The situation had somewhat improved by the time prolific American aerospace writer Martin Caidin penned *Red Star in Space* [6]. Although technical details were

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1.1: Soviet secrecy only provoked sceptics like author Lloyd Mallan.

still difficult to find, Caidin rightly acknowledged that the Americans had nobody but themselves to blame for ignoring Soviet intentions in space. At the other end of the spectrum was ultra-sceptical American journalist Lloyd Mallan, who firmly believed that the Soviets were lying about everything [7]. He didn't believe they had launched anyone into space!

'Space Sleuths' – early media creation

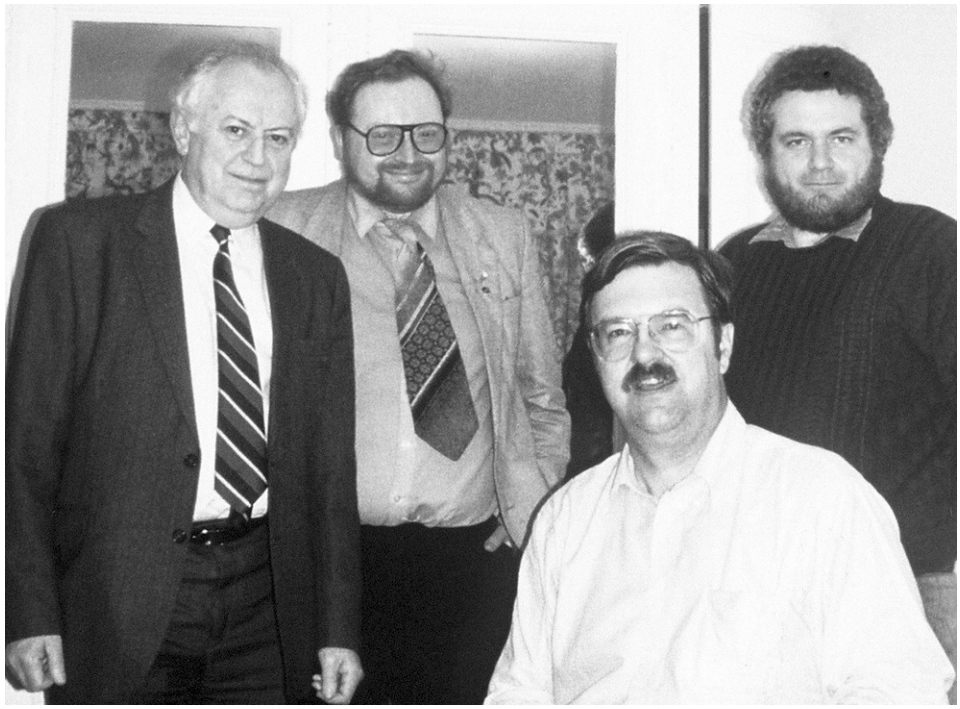
The first time the unofficial Soviet space watchers were termed "space sleuths" was in a 1963 *Popular Mechanics* article [8]. Although it noted that there were about a dozen part-time space analysts in the US, it focused on Donald J. Ritchie of the Bendix Corporation and his efforts to reconstruct the still-secret Vostok spacecraft and its launch vehicle.

Unfortunately these speculations were far from reality and his drawings included such imaginary features as a large tailfin with four rocket cylinders attached, a sealed internal cockpit for the pilot, and solid-propellant retrorockets. "I think people did their best to try to get what they could," believes space author Brian Harvey, whose own interest was sparked as an eight-year-old boy when he saw Vostok 2 fly over Ireland in August 1961. "At the Red Square parade there would be a helicopter flying past with a model of Vostok underneath it – with a big ringed tail. These models would appear in the Western press as what Vostok looked like, but the accompanying commentaries were generally responsible, as they would say that this is best that we knew. The people who did know what it looked like were the CIA but they weren't going to tell."

All these early non-covert speculations suffered from the fact that the only way to try and reconstruct the Soviet launch vehicle was to observe the left-over fuel tanks placed into orbit with the satellite. This mainly involved guessing its dimensions by the brightness as it streaked overhead. Thankfully, the third stage of the vehicle was already known because it was often exhibited in the West attached to models of the early Luna probes. These fragmented clues, combined with the long-held view that the Soviets were using upgraded German V2 rocket technology, gave the impression of a booster that was very different from the reality. It was only when the Soviets revealed the true shape of their workhorse R-7 rocket at the Paris Air Show in 1967 – after it was militarily obsolete – that the Western sleuths realised their mistake. They soon discovered that Russian approaches to technology often differed markedly from those imagined.

A Cold War bluff?

In Britain, television astronomer Patrick Moore and writer Kenneth Gatland were the first to make important contacts with Soviet scientists at various international conferences. Both men had connections to the famed British Interplanetary Society (BIS), with Moore editing its magazine *Spaceflight* before Gatland took over the job in 1959. The society's reputation for exposing Soviet space secrets was made in 1963 when Russian defector Grigory Tokaty-Tokaev used one of its lectures to reveal that



1.2: (L-R) Defector Leonid Vladimirov pictured with space sleuths Phil Clark, James Oberg and Rex Hall in 1988.

the previously unknown Sergei Korolev was an important figure. Britain at that time was an important link between the two space powers, with the giant Jodrell Bank radio-telescope just outside Manchester becoming the focus of some early scoops, mainly because the Soviets had the habit of informing its director, Bernard Lovell, whenever they launched a new lunar probe!

Although a few good books on Soviet spaceflight were available around the time of the tenth anniversary of the launch of Sputnik [9], the appearance of two 'insider accounts' packed with new information in the early 1970s caused a sensation. After his defection to Britain in 1966, Russian science journalist Leonid Vladimirov tried to publish a book revealing that the Soviets were behind in the Space Race but he soon found that publishers just didn't believe him and didn't want to risk printing a book that would be out-of-date if the Soviets won the Moon Race as then imagined. It was only after the triumph of Apollo 11 that he was finally able to find a market for his work, with *The Russian Space Bluff* appearing in 1971. Strangely, many respectable Western experts refused to take the book seriously [10].

To give it a balanced review, *Spaceflight* magazine's new editor Kenneth Gatland turned to Rolls Royce engineer Arthur 'Val' Cleaver but unfortunately he, too, was so taken with the long list of Soviet space spectaculars that he failed to see the truth in some of the defector's claims [11]. His scepticism motivated professional historian

Robert Conquest (a long-standing BIS Fellow) to write a letter in defence of the defector's view of the USSR [12].

A more significant book was *The Kremlin and the Cosmos* by American correspondent Nicholas Daniloff [13]. "Daniloff was a native Russian speaker and an accomplished journalist who did an extensive amount of research on the topic," notes space historian Asif Siddiqi. "Despite some missteps, about the Moon Race, for example, his book still stands up 40 years later as a remarkably good introduction to what was known about the Soviet space programme in the early 1970s."

Asif Siddiqi, a Bangladeshi-American now regarded as one of the pre-eminent historians of the subject, believes several distinct groups of space sleuths existed. "My feeling is that there have been three generations of researchers. The first from the 1950s and 1960s included Krieger, Sheldon, Perry, Shelton, Stine, Daniloff, and Zaehringer. The second from the 1970s and 1980s included Clark, Gibbons, Grahn, Hall, Hooper, Kidger, Lardier, Smolders, Covault, Johnson, Oberg, Vick, Wachtel, Woods, and Zaloga. The third from the 1990s included Haeseler, Harvey, Hendrickx, Przybilski, Shayler, Villain, Vis, Wotzlaw, Barry, Gorin, Harford, Newkirk, Pesavento, Podvig, Wade, and Zak."

These sleuths can also be classified into three distinct groups: those writing in the English language (a diverse group that included not only British and American but Irish, Scandinavian, Belgian and Dutch sleuths); continental Europeans writing exclusively in French and German; and a small band of native Russian historians whose research efforts would only start to emerge in the 1990s after the demise of the USSR. The three groups worked in isolation owing to language barriers – often resulting in them independently coming to the same conclusions.

THE KETTERING GROUP

In the early 1960s a whole division of amateur radio enthusiasts sprung up around the globe tuning into 'secret' Russian satellite transmissions. Ironically their interest was sparked by the early Soviet decision to choose radio frequencies for the Sputniks that could easily be picked up by amateurs as proof that they were successful. One of the first to master the techniques needed to track Soviet satellites was Kettering Grammar School teacher Geoffrey Perry. He originally started tracking Sputniks as a means of inspiring his science class, but soon became so adept at it that he often scooped the professionals at tipping off the press to the latest Soviet mission. A grateful media soon termed his team the "Kettering Group". Over the years, this informal group would grow to include well-known satellite trackers such as Robert Christy, Max White and Fritz Muse in England, Sven Grahn in Sweden, and Chris van den Berg of The Netherlands.

Listening to satellite signals

By the mid-1960s Perry had noticed that some satellites were being inserted into different orbits, and inferred that a new launch site was being used. By "walking

1.3: Geoffrey Perry tracked satellites from his classroom.

back'' their orbital tracks to a starting point on the map, he was able to discover its location near Archangel in northern Russia. Although the Plesetsk Cosmodrome was well-known to the CIA – the U2 flown by Gary Powers had been shot down trying to photograph it – Perry was the first in the West to tip-off the media about it when he mentioned it at a BIS lecture in November 1966 and wrote a follow-up letter to *Flight* magazine. Shortly thereafter, *Time* magazine reported his ''discovery'' [14].

Strangely, he wasn't the first to use this method to discover a launch site. Back in 1957 an astronomer at Tokyo Observatory had used the first two Sputnik flights to pinpoint their launch site in Soviet Central Asia – when many still thought they were being launched from inside Russia. Unfortunately his scoop wasn't noticed because he only published it in Japanese [15].

A friend in Washington DC

Someone who benefited greatly from the work of the Kettering Group was Dr Charles S. Sheldon II. His own fascination with spaceflight started when he met German rocket pioneer Wernher von Braun at White Sands, New Mexico, in the 1940s. By the 1960s Sheldon was chief of the Science Policy Research Division of the Congressional Research Service (CRS) and was tasked with preparing objective, non-partisan reports on the Soviet space programme for the US Congress.

These volumes – published from the 1960s to the 1980s under the general title *Soviet Space Programs* – were the most informative works on the subject in the

1.4: Charles Sheldon with young protégés James Oberg and Charles Vick in 1974.

English language during the Cold War. A major handicap for Sheldon was the fact that he could only use material already printed in the open literature, so he did his best to encourage amateur sleuths in their own researches [16].

"Sheldon had full security access, but could only use non-classified material for his congressional reports," remembers American sleuth James Oberg. "Without ever once transgressing his security boundaries, he encouraged our investigations and speculations in directions along which he knew in advance we'd find pay dirt. When he published our BIS papers in his own reports, we felt verified – and we had been."

Although Sheldon died in September 1981, his reports continued, thanks largely to the on-going detective work of the sleuths he had encouraged.

"The last two of the series, 1976-1980 and 1981-1987, were written after Charles died and I can state authoritatively that they could not have been completed without Geoff and the Kettering Group," notes Sheldon's former research assistant Marcia S. Smith.

REPORTER'S EYE FOR DETAIL

Over the years, The Netherlands has produced more than its fair share of good space sleuths. The first was Peter Smolders, a journalist fluent in Russian as a result of his training with Dutch Army Intelligence during his national service from 1961 to 1963.

1.5: Dutch journalist Peter Smolders, with back to camera, interviews cosmonaut boss General Kamanin in 1970.

With this skill, Smolders was able to tease facts from his hosts during dozens of trips to the Soviet Union researching space stories.

"As a Dutchman I was somewhere in between the US and Russia, both geographically and culturally," believes Smolders. "The fact that I was well received had, I think, to do with my objectivity – especially in the sixties and seventies when there was a lot of unpleasant propaganda and politics involved from both sides. During the Cold War I did not feel like a spy but more like a detective. The Dutch intelligence service wanted me to work for them. I refused but, at the same time, I felt lucky to live in a normal country where I was able to do that."

Soviet newsreels provide clues

Slowly 'secrets' began to slip through to the West because of the increasing number of official Soviet newsreels then being released. They often contained interesting clues for those willing to watch them frame-by-frame. Luckily for Smolders, his connections with the authorities gave him access to 35-mm Sovexportfilm newsreels. "I had a simple hand-operated device with film reels, and could check every individual frame. I looked at a scene where Soyuz cosmonauts were walking in the RKK Energiya museum (then still closed to the public) with the Voskhod 2 capsule in the background. And there, out of focus, on the wall I discovered a scheme of the Voskhod spacecraft – and that became the basis of my drawing in *Soviets in Space*."

His book was first published in The Netherlands in 1971, with the English translation appearing in 1973 [17]. The main revelation of his drawing was the location of an extra retrorocket on the top of the Voskhod capsule – itself merely a modified Vostok. During the IAF congress held in The Hague in 1974, Smolders was surprised when Alexei Leonov drew a sketch of Voskhod 2 with the extra retrorocket and called it "Eta Voskhod Smoldersa" [18]. "So he had seen the drawing that we did for the English-language book published in 1973. Up to that moment, Leonov had only made fantasy drawings of the spacecraft, as he was not allowed to show the real thing. Later of course he did his realistic oil paintings of his spacewalk."

Cosmonaut Musa Manarov would later tell Smolders that they had seen a copy of his book in the library of RKK Energiya, and were always amazed at the amount of information known in the West.

Proton rocket in the frame

The release of the Soviet movie *Steep Road to Space* (1972) about the triumph and tragedy of Salyut 1, provided Smolders with the first hint of the layout of the then secret Proton booster: "I analysed a film of the launch of the Proton carrying the first Salyut. I could see only the upper part of the rocket, but there was one frame (just one!) showing the tips of the boosters. Had I just looked at the films on the screen, I would never have discovered those details. It must have come as a surprise to the Russians!"

But even this first glimpse was deceptive, because what in reality was a novel arrangement of six cylindrical fuel tanks wrapped around a central core tank was wrongly interpreted.

Smolders' drawing of the booster (which was first published in a Dutch magazine when he was in Florida covering the Apollo 17 mission in December 1972) shows the booster as a giant version of the tapered Vostok rocket but with six strap-on boosters instead of four. A long-range view of the rocket also shown in *Steep Road to Space* confused matters further by appearing to show that the central 'core stage' wasn't firing at lift-off.

It took the skills of experienced nuclear industry draftsman Charles Patrick Vick to create a more accurate representation of the Proton. His 1973 drawing had cylindrical strap-on boosters, and this interpretation became the accepted configuration until the truth was revealed in 1984 [19]. At that time it was believed in the West that this rocket started out as a giant intercontinental ballistic missile (ICBM) developed by missile designer M. K. Yangel [20]. Westerners never guessed that what appeared to be strap-on boosters were really external fuel tanks surrounding a central core oxidiser tank; reminiscent of the design of NASA's first giant rocket, the Saturn I. The Proton (UR-500) had been conceived as a giant missile to carry a huge 30 megaton nuclear warhead and its novel arrangement of propellant tanks was dictated by the size limits imposed on what could be carried around the country on the Soviet railway network.