Soviet space—the first twenty years

Man's first historic venture into space took place 20 years ago this week. The USSR's Sputnik I has been followed by other firsts and some notable omissions. What is the background to the Soviet Union's unique space programme?

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Twenty years ago, on 4 October, 1957, the third and last stage of a powerful rocket projected a man-made satellite into an orbit round the Earth. At 0148 the following day as Sputnik I followed by the last stage of the rocket orbited over Moscow the Kremlin proclaimed the beginning of the Space Age. The scientists and engineers who made up the team of observers and the Sputnik's creators shed tears of joy, embraced and kissed each other, then started singing the Air Force anthem "We're born to make the tale a fact . . ." Such elation had not been known since the victory over Nazi Germany.

The Soviet Union's joy also had its roots in the scars of that war. At the end of the Second World War, it had suddenly found itself face-to-face with a new situation beyond the capacity of its still warm war machine. To their surprise and horror, the Kremlin leaders and strategists realised that the traditional infantry, tanks and even air force would be almost totally irrelevant in the event of a US-USSR war, which at the time seemed more than probable. While American ground forces in Europe (and their allies) could attempt a blitz against the USSR, no Soviet soldier, tank or bomber could possibly reach US territory even if they overran the whole of Europe. Washington had bombers on the fringes of the USSR—Moscow had neither air bases near the US nor long-range bombers. The US possessed the A-bomb and B-29—the USSR had neither. And a matter of special significance: by the end of the war the Soviets had not a single jet aircraft of any description, or a rocket even remotely resembling the German V-2.

Nothing short of a complete and urgent overhaul of the traditional concepts of war and peace would offer a way out. Moreover, the way itself could be constructed not by the politicians or generals, but exclusively by scientists and engineers. This explains the sudden change of emphasis in the Kremlin: at whatever cost or sacrifice, the decision was to push the scientists and technologists to the forefront. That was the beginning of the story of Sputnik I.

The New Scientist *celebrated the news of Sputnik 1 by looking ahead to the possibilities of Moon exploration. Sir Harold Spencer Jones, however, thought that generations would pass before man ever made a landing on the Moon, and that even if he did succeed in getting there, he would have precious little chance of getting back*

Notwithstanding such powerful support, the scientific-technological avenue of Soviet rocketry was destined to run up a Sisyphean hill. To begin with, the cream of German rocket designers—117 of them, with Wernher von Braun and projects, archives, research materials, valuable laboratory equipment, ready rocket engines, fresh V-2s, precision industrial machines and tools, and construction materials—landed in the US in Autumn 1945 and started work almost at once. On the other hand, the USSR captured only ruins, casual bits of projects, a few damaged and incomplete V-2s, and *not a single leading German rocket designer*.

There could, therefore, be no direct and quick gain of knowledge from existing (German) experience for the Soviet Union. In the circumstances, Soviet rocket scientists and engineers had no alternative but to make the best use of whatever German information and experience was available, and start from square one. The task was made more onerous by the damage inflicted on the USSR by the war. Conditions of work were so harsh that Western men would have rebelled; but Soviet rocket designers laboured on until in 1947 they succeeded in achieving the 1945 level of German rocket technology. This gave the USSR the opportunity to form its first rocket divisions and to master the techniques of launching V-2 type missiles.

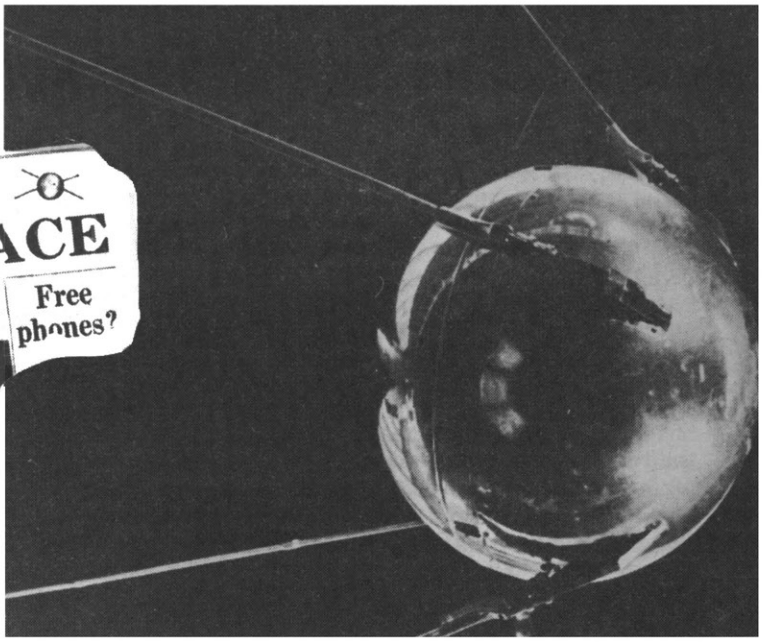
About a year later, in mid-1948, there emerged a new, entirely Soviet designed, meteorological rocket MR-1: it was 9·5 m tall, 0·52 m in diameter, 1020 kg of all-up weight, and carried 112 kg of payload to an altitude of about 100 km (an altitude which then represented outer space). Two years later, this was followed by another fully Soviet designed rocket, the GFR, whose two versions, B-2-B and B-5-B, represented a spectacular breakthrough towards Sputnik I and the later successes. The B-2-B was 20 m tall and 1·66 m in diameter; its instruments section weighed 1340 kg, while its space exploration package alone weighed 860 kg; with a total payload of 2200 kg, it was able to reach altitudes up to 112 km. The B-5-B was even more remarkable: 23 m tall and 1·66 m in diameter, it carried a payload of 1300 kg to altitudes up to 512 km!

With such rockets of its own design by the beginning of the 1950s, the USSR was already an advanced rocket power which already could, and did, afford to start re-arming its rocket divisions with medium-range tactical/strategic missiles superior to the V-2s. Simultaneously, it embarked on a systematic space exploration programme by launching dogs, other living beings and scientific packages (bringing them back on automatic parachutes). The specific objectives were to study the behaviour of animals in outer space, to establish the physical properties of the ionosphere and upper layers of the atmosphere, to photograph the Sun's corona, to evaluate the composition of cosmic rays, to develop methods and techniques of re-entry and automatic parachute descent—all important for further space projects.

By mid-1955, the Soviet Union was already in possession of an entirely new concept of multi-stage rocket design, and the chief designer, Sergei Korolyev (1906-1966), adopted the method of placing full-size systems and components in a full-size mock-up of the launch vehicle. In addition, a full-scale assembly drawing occupied the floor of a large

The News Chronicle *was one of the first British papers to break the dramatic news of the successful Earth satellite*
Right Sputnik 1

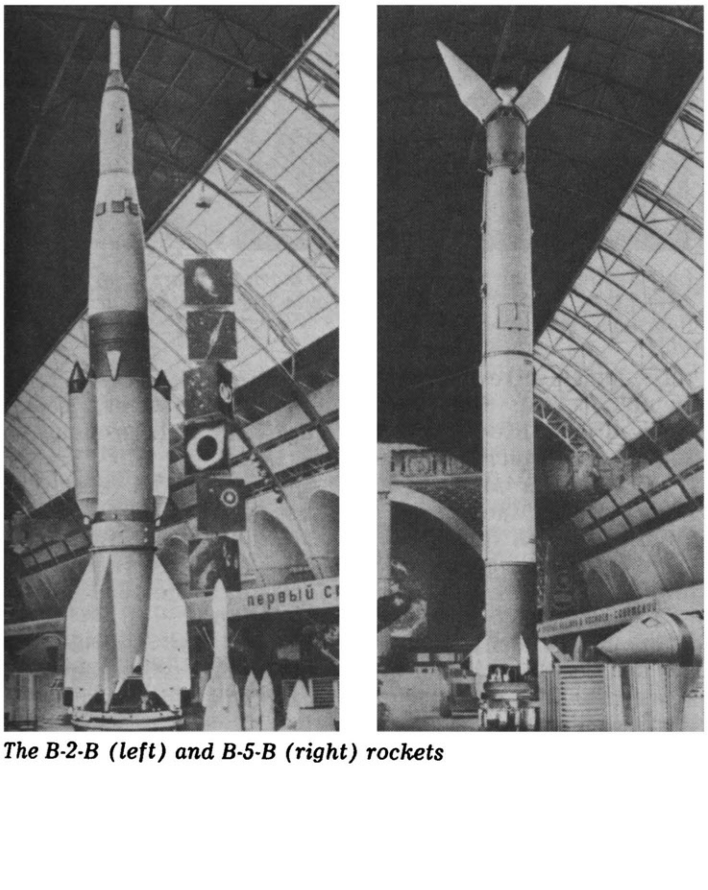

News Chronicle
Daily Dispatch
SATURDAY, OCTOBER 5, 1957
Soviet scientists launch first man-made moon
23-inch 'football' circles earth 560 miles up
RUSSIA WINS SPACE RACE
Poles battle in the streets
Wife starts Ryder Cup row
Free phones?
Round the world in 90 minutes



building — the designers could walk and work on it without the usual uncertainties of smaller scales and the associated brain strains.

This method not only accelerated the creation of the inter-continental ballistic missile (ICBM), but also sharply reduced the amount of theoretical and experimental research, removed many difficulties and simplified the complex tasks facing the industrial tool makers and those who worked on the development of the launching facilities. By the spring of 1957, the real ICBM stood almost ready, but a further three months were needed to fill it with electrical, electronic and other onboard equipment and for its transportation to and erection on the launch pad.

The creation of the launching facilities and associated services, ie of a Space Centre, represented an engineering-technological task far more massive and complex than the ICBM itself. But as soon as the design concept of the missile emerged, Soviet experts arrived at a wild desert spot in the western part of the Kazakh SSR, east of the Aral Sea, near the community of Tyura-Tam on the Syr-Darya river, and started working. That was 22 years ago, and today the spot is called Leninsk—the space town of the USSR with a population of about 55 000.


The B-2-B (left) and B-5-B (right) rockets

Some 20 miles from it stands the launch pad. A long desert belt running from Leninsk to the north-east through the Baikonur region constitutes the main rocket launching range. The area where it begins and which includes the actual launching facilities, is known as the Leninsk-Baikonur Space Centre (LBSC).

The LBSC includes a large number of space age buildings and special purpose structures, equipment and areas for assembling, preparing and launching rocket vehicles, measuring their flight trajectories, sending commands, receiving and processing telemetry information; a few kilometres of the rocket range belt, on which the burnt-out stages of launch vehicles fall back, also constitutes a part of the LBSC.

By August 1957 the LBSC dominated the Kazakh desert. On 26 August, the Soviet telegraph agency TASS announced that the USSR had carried out a series of nuclear and thermonuclear explosions; on 27 August came another announcement: that the USSR had created and successfully launched a multi-stage ICBM capable of carrying nuclear warheads to distances of "thousands of kilometres".

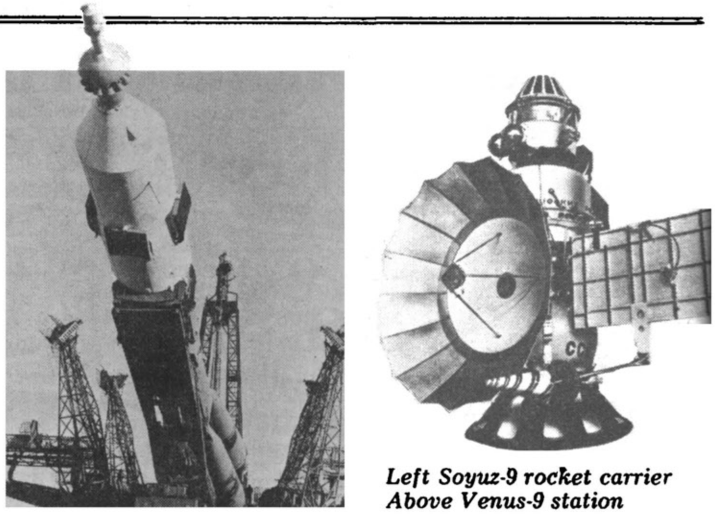
Ten years and six months earlier in the presence of his Politbureau members, Joseph Stalin had told me slowly, clearly and firmly that a certain global rocket bomber would be *"khoróshei smirítel'noi rubákhoi dlya shumlívogo lávochnika Garri Trumana"*—"a good straitjacket for the noisy little shopkeeper Harry Truman," then President of the United States. Now the "straitjacket" was there and, for better or worse, symbolised a profound revolution in the traditional concepts of peace and war. The East/West strategic ratio had been blown up and international relations ceased to be what they used to be. For, indeed, the potential implication of the Leninsk-Baikonur event could not be clearer: since the USSR had no other means of reaching its main foe (with the limited exception of the Navy), an American-Soviet war would inevitably be a nuclear-rocket war; and in such a war there would be no front, rear, civilians, military or neutrals.

But let us see what followed in the wake of the revolutionary event and how it did so. The idea of a man-made satellite around the Earth was put forward by Konstantin Tsiolkovsky a long time ago, and Soviet rocket designers had kept it in mind all the time. In 1947 the danger of a global rocket bomber becoming a satellite was talked about even at a Politbureau meeting. But the moment Korolyev consolidated his ICBM design concept, the Soviets started working on the actual theory and design of a satellite, and by the early autumn of 1957 it was in being. Sputnik I was an aluminium sphere of 0·58 m in diameter; its main components and their weights are listed in the table.

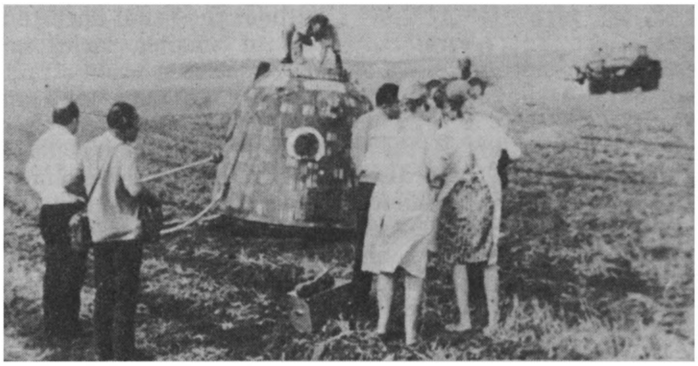
Sputnik I Main components and their weights

Upper hemisphere	5·8 kg	Diffuser	1·2 kg
Lower hemisphere	5·9 kg	Electric cables	0·7 kg
Screen between the hemispheres	1·6 kg	Valves, etc	0·4 kg
Other structural elements	0·6 kg	Fixing joints	0·8 kg
Energy sources	51·0 kg	Outside antennae	8·4 kg
Radio transmitters	3·5 kg	Assembly devices	2·9 kg
Remote switches	1·6 kg	**Total weight**	84·6 kg (184·6 lb)
Ventilator	0·2 kg		

This was the history-making "piece of metal", as an angry western VIP chose to call it, which on 4 October, 1957, hurtled into an orbit around the Earth. On the outside surface of the hermetically-sealed, nitrogen-filled Sputnik I, four antenna rods automatically extended the moment it became free. The two transmitters began their famous bleep-bleep, telling the world that the chains of the pull of gravity, Coulomb's friction and aerodynamic obstruction could be and had been broken.



Left Soyuz-9 rocket carrier
Above Venus-9 station



The soft landing of Soyuz-9 in June 1970

Photographs: Tass

Left Soviet stamps issued in 1976 to mark 15 years of manned spaceflight. Right The capsule of Luna-20 returns to Earth in February 1972

A long chain of developments

Two aspects of this great milestone deserve special attention. First, it was not a "one-off" event, but the beginning of a long chain of further developments of steadily increasing sophistication: Sputnik 2, Sputnik 3, a large family of Luna-s, lunar soil scoopers, Lunokhods, explorers of Venus and Mars, manned orbital stations. The second aspect: with the exception of the initial V-2s, all Soviet rockets and spaceships were genuinely Soviet in design and manufacture, launching and remote control. In this sense, *Pravda* of 13 April, 1961, was absolutely right in stating that: "The *first* person to penetrate outer space was a *Soviet* man on 12 April, 1961, the *Soviet* Union was the *first* to fire an intercontinental ballistic missile, the *Soviets* were the *first* to send a space probe to the Moon, the *Soviets* created the *first* artificial satellite of the Sun, *Soviet* orbital spaceships with living creatures on board carried out flight in space for the *first* time . . ."

Time and experience, the greatest levellers on Earth, soon revealed that in the field of strategic rocketry the US quickly caught up and bypassed the USSR; that Soviet spaceships Vostok, Voskhod and Soyuz simply could not compete with American Gemini and Apollo. Initial firsts sounded sweet, but it was the Apollo, not any of the three Soviet spaceships, which took 24 Americans to lunar orbit, including landing 12 of them on the Moon and bringing them back safely.

It would, however, be less than scholarly to conclude from here that Soviet space achievements have lost their significance, their scientific value. The truth is that Soviet and American philosophies of space exploration always differed quite noticeably. The technological lines chosen and consolidated by them are so different that simplified comparisons are not easy. With regard to Apollo/Saturn-type projects, for economic reasons as well as those described at the beginning of this article, the USSR was simply unable to dedicate to a single such project the $24 billion, over 20 000 industrial contractors and sub-contractors, 400 000 scientists and technologists as the US did.

Unquestionably, robots like Luna-16 and Lunokhod have paved the most rational way into the tomorrow of deep space exploration. There is no doubt at all that they will find extensive applications on the planets, sea and ocean beds, and Earth's deserts and polar regions.

Then there are, of course, the Salyut Orbital Stations, technological complexes circling the Earth at a given altitude, housing crew, research-exploration equipment, radio-radar-TV and other communications systems, energy sources, and life-support systems. They will probably be followed by much larger stations.

Salyut-1 was launched on 19 April, 1971, and there were four more in due course. The last of them, Salyut-5, was launched on 22 June, 1976, and is still orbiting unmanned. Combined with the Soyuz spaceship, the average Soviet orbital station weighs 25 tonnes (Salyut alone 18·9 tonnes) and has 100 cubic metres of interior space.

Salyut has already proved its worth, but unfortunately for the USSR it has not always been successful; the Soyuz spaceship, without which the orbital cannot be manned, has also given trouble.

Vostok, the first Soviet manned spaceship, which carried

Cosmonaut-1, was abandoned after only six missions. Voskhod, which replaced it in 1964, made only two flights, and during the erratic return of the last of these in March 1965 Pavel Belyaev and Aleksei Leonov were nearly killed.

All hopes were now in the new spaceship Soyuz. But during its very first mission, on 23 April, 1967, it killed probably the most experienced cosmonaut of the USSR at that time, Vladimir Komarov. From then on, Soyuz was subjected to most rigorous re-examination and modifications. In October 1968 its flights were resumed and it served the programme of manned space exploration very well indeed. But on 29 June, 1971, after a 23-day joint mission with Salyut-1 in orbit, it returned to Earth with its three cosmonauts dead; again, the flights of the spaceship were suspended, new re-examination and modifications followed. Up to February 1977, it served the programme again rather well, but almost never without a hitch; from February to the day of writing this article, there has not been a Soyuz mission, and Salyut-5 wastes away without anybody to operate the systems vital to keep it fully useful.

It is easy to imagine that, because of the already well established carrier-rocket, Soviet spaceship designers were not quite at liberty in choosing the basic scheme of the Soyuz and one feels sorry for this. A close theoretical and experimental study of the chosen three-module configuration leads one to a disturbing conclusion. However well designed and well manufactured it could not be, and perhaps it is not, the best configuration for a manned re-entry vehicle. Figuratively speaking, it seems to have been riding all the time near the edge of a vertical cliff, the width of the safety margin being no more than one centimetre. A vehicle, with rather complicated separations on re-entry into three modules, of which the middle one carries the returning cosmonauts, can hardly be what a manned vehicle should be. In turn this means that the cosmonauts deserve high praise for their skill in keeping Soyuz almost always a centimetre away from the cliff edge.

During the 20 years since Sputnik I, Soviet rocket designers had to endure their sad occasions as well as their well deserved glories. Many leading members of the Sputnik I generation are dead: Korolyov, the chief designer, Mikhael Yangel, his successor, Georgy Babakin, chief designer of the Lunokhod and other robots, Aleksei Isayev, chief designer of the rocket engines, and others. Dead also are the cosmonauts Yuri Gagarin, the first man in space, Pavel Belyaev, Vladimir Komarov, Georgy Dobrovolsky, Vladislav Volkov and Viktor Patsayev—the last four were victims of Soyuz re-entry.

There were also the technical difficulties described above, accidents in both military and non-military vehicles and setbacks not described anywhere, but known both at home and abroad.

It will be reasonable to assume that the USSR has been working on new projects for some time. I do not suggest for one moment that the present generation of Soviet rocket designers is less capable than the previous one. They may in fact have already reached the advent of a new breakthrough. It is probable that by the time this article appears, in connection with the anniversary of Sputnik I combined with the 60th anniversary of the October Revolution, the USSR will not only have resumed its space exploration programme but also announced the emergence of an improved, modified version of the Soyuz-Salyut combination. New developments of Lunokhod and Luna-16 type vehicles for exploration of the moon and the planets may also be described. Finally it would be out of character of the Soviet space effort for the past 20 years if it had not been working along lines similar to those of the US space shuttle project—a totally new concept in space technology. □

The Asian Invasion (I)

Far from being beleagured under the onslaught of cheap Asian imports, several American television manufacturers have taken a leaf out of the electronic calculator industry's book and begun to use technology to fight back. In fact, the trend towards the use of more and more integrated circuits in various consumer goods is reducing the advantage of South-East Asia's traditionally cheap labour assembly plants, and making it more profitable to manufacture close to home where transport costs are much lower. In the next article in this series, the author will look at how Japan, Taiwan, Korea and Hong Kong are reacting to this change, and then later examine the lessons for Europe

Technological cavalry to the rescue

Gene Gregory
is an industrial economist and specialist on Asian affairs

A question currently being asked by numerous US trade officials is whether their beleagured television manufacturers can regain their former prowess by a massive restructuring of the industry, following the example of their calculator makers during the first half of the 1970s. And, if so, what are the implications for the Asian electronics industry? These are the muted—and, yet, largely unmooted—questions that ultimately must be answered once the smokescreen of diplomatic double-talk clears from the battlefield in which the electronics industries of three continents are locked in mortal contest.

On the surface, the recent decision of the Customs Court of New York to overrule the US Treasury Department's refusal to impose countervailing duties on the Japanese television sets benefiting from consumption tax exemptions —and the almost simultaneous recommendation of the US International Trade Commission (ITC) that relief in the form of increased custom tariffs be given to an "injured" US television industry—have the appearance of nothing other than an ominous resurgence of protectionism sponsored by a new and powerful coalition of industry and labour, a union forged at the brink of alleged disaster during the "halcyon" days of the recent recession.

But the action brought by Zenith Radio Corporation in the New York Customs Court and the petition of the ITC by the consortium of 11 labour unions and five firms from the industry—the so-called Committee to Preserve American Color Television (COMPACT)—must be seen in the context of a much broader legal counter-offensive mounted against imports of television sets from Japan, Taiwan, Korea and Mexico.

In January 1976, GTE Sylvania Inc, also a member of COMPACT and a petitioner in the latest Escape Clause action, had already filed a complaint with the ITC, alleging