

## The Race to the Moon

From September to March 2016 the Science Museum in South Kensington, London, staged the Cosmonauts Exhibition. Many of the exhibits from the early days of the Russian space race have never been seen before in this country, engineering mock-ups and scale models of probes along with flight spares and equipment. The largest item on show was a full size engineering prototype of the Russian lunar landing craft above, which would have carried one cosmonaut down to the lunar surface. It was a lot smaller than the two man American Lunar Module which landed six times on the Moon. At the top right a model of Sputnik, showing the batteries and radio equipment. Below fitted into the nose cone of the third stage rocket and bottom the first living thing in space, the dog Laika in her capsule.

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# *The Race to the Moon*

*By Ivor Clarke*

***“Earth is the cradle of humanity, but one cannot live in a cradle forever.”  
Tsiolkovsky, 1911***

July 20<sup>th</sup> 1969 was the day that America won the Space Race to the Moon. What many don't realise is how close the Russians were to putting their man on the Moon first. Even as the Apollo 11 LM was descending to the surface Russia was still trying to get back a soil sample back first with a robotic Luna 15. It crashed into Mare Crisium later that day after Neal Armstrong and Buzz Aldrin had walked on the Moon.

Since Sputnik, on October 4<sup>th</sup> 1957 became the first satellite to orbit Earth, the Russians had been forging ahead with ever more extraordinary feats of rocket power lifting ever greater loads into near Earth orbit. Sputnik was a very simple device with only batteries and a radio transmitter fitted into its 23" shining silver ball with 4 long radio antennae. The whole device weighed 184 pounds, mostly the batteries. It had been hoped to send up a satellite with scientific measuring equipment to explore the space environment but it had proved difficult to fit into the space available and not exceed the weight limits. But still the shock to the world that the Russians could do such a thing was alarming to the west and especially the USA. Wernher von Braun the V2 rocket scientist who was developing the rockets for the US Army, was furious. During the 1950's his team had developed the Redstone and Jupiter series of rockets. He had the rockets to reach space and low Earth orbit but was stopped by the Pentagon from doing so.

## **The End of WW2**

Wernher Magnus Maximilian Freiherr von Braun was born on 23<sup>rd</sup> March 1912 in Prussia, Germany. His mother could trace her family history back to medieval European royalty. He developed a passion for astronomy from an early age. At the technical institute in Berlin 1930 he helped Willy Ley with developing liquid fuelled rockets. By 1939 he was Technical Director at the Army Rocket Centre at Peenemünde on the Baltic coast doing rocket research and development.

In spring 1945 von Braun and over 200 scientists, their wives and families had escaped the Nazis by getting out of Peenemünde, just before the Russian Army arrived. With a small detachment of soldiers and SS to guard them and with lots of material and drawings on the V2 rocket, they managed to get to a village in the Alpines. Von Braun was nursing an arm broken in a car crash weeks earlier. If it looked like they were going to fall into the Allies hands the SS and SD soldiers guarding them had been ordered to shoot them all. The Germany Army General Dornberger travelling with them, with a small detachment on troops, had a word with the SS Major over several excellent bottles of fine wine about what would happen to them if the Americans arrived to find all the civilians dead and the SS still there? The unhappy Major knew they would be shot on sight and agreed to "join" the army by burning all the SS uniforms and his men handing in their weapons to Dornberger and putting on army uniforms.

On May 2<sup>nd</sup> the American Seventh Army met up with the party and those that wanted to be eventually allowed to enter the USA. The US Army soon manage to get their hands on enough material and equipment to make 100 or so V2 rockets and tons of documents and research data before all of the research facilities were handed over to the Russians. All

this was shipped off to the USA to start the rocket program at White Sands, New Mexico. The Russians were not happy, "we've not got the right Germans" was the reaction of the Soviets to the technicians they captured. It was obvious that the major prize of the top German scientists had gone to the Americans along with most of the material to build V2's.

From this promising start it looked like America would develop space travel soon.

The Russians soon realised they had missed a lot the best scientists and help was given to any German technician who would help the Soviets develop rockets, but after a few years of picking the brains and ideas of the Germans it was the Russians who built the organisation and larger and more powerful missiles. One man who had been sent to a labour camp in Siberia on trumped-up charges in March 1938 was released to become the head of the Soviet Rocket program, Sergei Pavlovich Korolev. He was born on January 12<sup>th</sup> 1907 near Kiev. As a young boy he was fascinated by flight, built gliders and read about space travel. He joined the amateur rocket society in Moscow while an engineer at Moscow's Central Aerohydrodynamics Institute. Their greeting was "Onwards to Mars." They had been inspired by reading the work of Konstantin Tsiolkovsky, a village schoolteacher who's ideas came to be known as the father of Soviet space science. Tsiolkovsky understood Newton's laws of gravity and motion and was one of the first to use calculations to show how multi-stage rockets could reach out into space with each stage getting smaller and faster.

By 1935 Korolev was deputy director in the new Reactive Scientific Research Institute were his leadership skills focused on military missiles. Even being a deputy director was not safe from Stalin's purges and in 1938 Korolev was sent to a labour camp in eastern Siberia. Luckily for him in late November 1939 he was retried and some of the (false) charges against him reduced. So by 1940 he was in the Central Design Bureau 29 in Moscow where the food was better and he regained his health. Soon he was moved 400 miles away to work on rockets for a dive bomber. It was not until November 1944 he got permission to travel to Moscow to see his wife and daughter for the first time in 7 years!

It took many months to get all of the German scientists who wanted to go to the USA along with a few of the families and all the equipment they had. Problems with membership of the Nazi party and security were eventually dealt with and they moved into an army base called Fort Bliss, Texas. During 1946 they fired 25 V2's into the upper atmosphere, but it was not the development of new rockets which they had hoped for. While the Germans in the States wiled away the days, in Russia Korolev was given the job of making a better V2. He got hold of every thing he could that the Americans had left and started to build V2's from parts, they had enough for



*Surrounded by his rocket models, Dr. Wernher von Braun is pictured in his new office at NASA headquarters in 1970 and Sergei Korolev the unknown Soviet 'Chief Designer'.*

about 12. He even got to see one of the V2 launches the Allies did in Germany. He soon found many design faults which would improve the performance and range and set about designing a better rocket.

By 1946 in Germany a workforce of 7,000 was at work reproducing blueprints and documentation and building parts for rockets with the hope of increasing its range from 200 to 400 miles. On March 5<sup>th</sup> Winston Churchill made his "Iron Curtain" speech in America and an era of distrust between Russia and the west started. In October that year 7,000 German technicians and workers were moved to form a new Scientific Research Institute NII-88 a few miles north of Moscow. It was not a happy place with everything in short supply, including food, housing and heating in the -30°C winters.

In 1947 von Braun married his 18 year old cousin in Germany and more of the scientists families moved to America to join them at White Sands. But von Braun and fellow scientists had the problem of being in the Nazi Party and what they had known of the labour camps. At the main V2 complex at Mittelwerk sixty thousand prisoners had worked and twenty thousand had died. At the War Crimes Trial at Dachau von Braun and other rocket scientists did not appear but gave a full deposition stating he had been to the site a few times but never worked there. Most of the defendants were acquitted, with a few receiving prison sentences, but the shadow of the war never fully left them. In February 1948 they were all formerly cleared as not a security threat to the USA.

October 1947 saw the first firing of a Russian built V2, it was a success unlike the next V2 which nearly took out a nearby town. Korolev had permission to build his next project the R-1 while developing the R-2. This would be bigger than a V2 at 57 feet tall and fly twice the distance. The first launches of the R-1 were in September 1948 and didn't go well, but on October 10<sup>th</sup> one went 190 miles. Following firings proved that a fault in the guidance system was making all of them miss their target. In July 1949 Korolev and others met with Stalin and told him of his ideas for a R-3 rocket with 120 tons of thrust and with a range of 1,800 miles, able to hit England. Stalin was quite for while, digesting this information and Korolev went 'white as chalk' as he thought he had gone to far, but Stalin after pacing the room said "Let us ask Comrade Korolev to make the next rocket more precise. . . "

### The 1950's

Korolev had developed plans for a range of rockets, the R-3 and R-5. By October 1950 he had a R-2 travel 370 miles, further than any rocket the America's had. In just five years the Russians were ahead of the American efforts. Von Braun while working on the Redstone series of rockets wrote articles in Collier's magazine in 1952 called "Man Will Conquer Space Soon" in which he pointed out that a man-made island in space could have atomic weapons which could target any spot on earth. He described how a platform at 1075 miles high would complete an orbit in 2 hours at 15,000 mph and by 1977 could make the 239,000 mile journey to the Moon.

In March 1953 Stalin died of a stroke leaving a power vacuum at the heart of the Kremlin. Korolev was having problems

with his design for the R3 and even contemplated scrapping it and concentrating on a better design. The R3 was important to the military and scrapping it was not an option, but with the explosion of the first Soviet H Bomb a larger missile would be needed to carry the 5 ton warhead. A one ton payload was just about achievable, 3 tons and then 5 tons lay with new engines and new rocket designs. Korolev came up with a design known as the R-7. This would be a revolutionary design for a massive rocket with a central core which had four strap-on booster rockets mounted around it, the whole to have a total thrust of 390 tons, 9 times more powerful than any other rocket. Each engine would be multi-chambered with four combustion chambers producing a thrust of 75 tons.

In America it looked like all interest in space had dried up, with many of the German team leaving for jobs in industry, when von Braun had a phone call. 1957 would be the International Geophysical Year and was timed to coincide with the height of the 11 year sun spot cycle with research into the upper atmosphere and the Earth. President Eisenhower announced that America would put a satellite in orbit during the IGY. Von Braun said his Redstone rocket could carry a small satellite of a few pounds and Professor James Van Allen was to lead the scientific research for the satellite. Suddenly the military seemed interested in looking down onto the Earth from orbit. But a decision was made to let all three services bid for the work instead of all working together. In Huntsville many of the Germans applied for US citizenship as criticism that it would be a German rocket and not an American one mounted.

By 1955 von Braun was hosting a Disney TV show about space, showing four stage rockets getting into orbit and a 250 foot atomic powered wheel space station to an audience of 50 million! The Airforce wanted to launch a satellite with its Atlas intercontinental missile, the Navy with its unbuilt Vanguard, and the Army with the von Braun Redstone. A Committee formed of representatives of various upper echelons of power thought that the first US satellite should be built by Americans and not Germans. And the winner was the Navy with their Vanguard. Von Braun was told he had ". . .no authority to do any work on the satellite." As a consolation he was to design a larger rocket, the Jupiter with a range of 1,500 miles. He also worked on designing a nose cone to withstand the heat of re-entry.

During 1955 a new launch site was being built at Kazakhstan, well away from the west's radar stations. The

town of Baikonur was 220 miles away to confuse western intelligence. Vast new hangars 330 by 160 feet were built and 30 million cubic feet of soil removed to make the launch complex. The summer sun made work hard in temperatures of 50°C and in the winter it was as cold as -40°C. Korolev was reading all the articles written by von Braun and knew of his TV shows and got to know the man, but they would never meet and talk about the dreams they both had. Nikita Khrushchev was now in power and Korolev had a chance to show him round the design felicity were they had full size mock-ups of the R-7 and a satellite. The visitors were stunned by the size of the rocket but the thought of beating the Americans prompted them into giving him permission to build the R-7; as long as it did not impede the missile development.

The first Jupiter C launch in September '56 was a success reaching a height of 682 miles and travelling 3,335. *"If we had just one small rocket on top . . ."* pleaded von Braun. Again a refusal, even though the Navy's Vanguard was behind schedule. Korolev saw the news of the Jupiter flight and thought it had tried to launch a satellite. His R-7 was having problems with engine thrust, guidance and re-entry materials. Explosions were wrecking both the engines and test rigs. The satellite was causing problems too, it was too bulky and heavy for the rocket to orbit. Basic mistakes at Kazakhstan with some of the components and equipment sent Korolev into a rage at the *"sloppy workmanship"*. The working conditions at the site remained primitive with the dismal outlook, cold and tension of long hours of work.

### **The First Satellite: Sputnik**

Work also started on a new 150lbs, 23 inch satellite with just a radio transmitter which beeped, this would tell the world the Soviet had won the race. It had taken 3 years to bring the R-7 from drawing board to the test stand and on May 15<sup>th</sup> 1957 often working 15 hour days Korolev was ready for the first test flight. The R-7 was 108 feet tall after being raised into the upright position with the four strap-on boosters each 62 feet long. It lifted off and rose into the sky with a total thrust of nearly 400 tons, but after 2 minutes one of the boosters tore loose and the rocket crashed in flames. More failures followed, tempers flared, the summer heat was like an oven with the next launch due in July; it too failed with the rocket veering left then exploding like a firework. Gloom descended on everyone, the heat unending and more failures.

A launch date of 21<sup>st</sup> August was set, Korolev was now aware how complex his arraignment of engines was and how they must all work perfectly to achieve a flight. It was almost perfect landing near its target. 6 days later the TASS news agency reported the successful flight and von Braun tried again to get permission for his rocket, a Jupiter C to be made ready. His team even had all the parts necessary stored away in a shed at Cape Canaveral. The same month his team recovered a nose cone from a rocket after it had reached over 300 miles high.

Korolev wanted the first satellite to be a perfect silver ball, it weighed 184 lbs with 4 long aerials, no one knew if the radio would send signals through the ionosphere. The complex calculations for the orbit was made on one of the first Soviet computers at Moscow University, a speed of 18,000 mph was needed for the low Earth orbit. One of the technicians heard a radio report that the Americans were giving a talk *"Satellite over the Planet"* on October 6<sup>th</sup> at the National Academy of Sciences in Washington. Were they launching a satellite the day before? Korolev was frantic,

could they get a R-7 to the launch site before the 4<sup>th</sup>? Korolev was rushing around the site checking everything, *"It is better to check ten times than forget once!"*

On the 3<sup>rd</sup> October the giant R-7 was rolled out to the launch pad with Korolev walking ahead of it, and slowly raised upright for launch. A large crowd of VIP's had arrived from Moscow to watch this launch, the rocket and satellite had passed all the tests, Korolev made a small speech *"we will launch today at 22 hours 28 minutes."* The rocket rose on a column of fire and disappeared into the sky. Would it achieve orbit? No tracking stations were built then. Everyone who could then squeezed into a radio van to listen for the bleep bleep as it completed its first orbit of 142 by 590 mile journey into history. The relief and joy at the faint beeping sound getting louder as it passed overhead was a cause of wild celebration. Earth now had two moons, one called Sputnik.

### **The Race Begins**

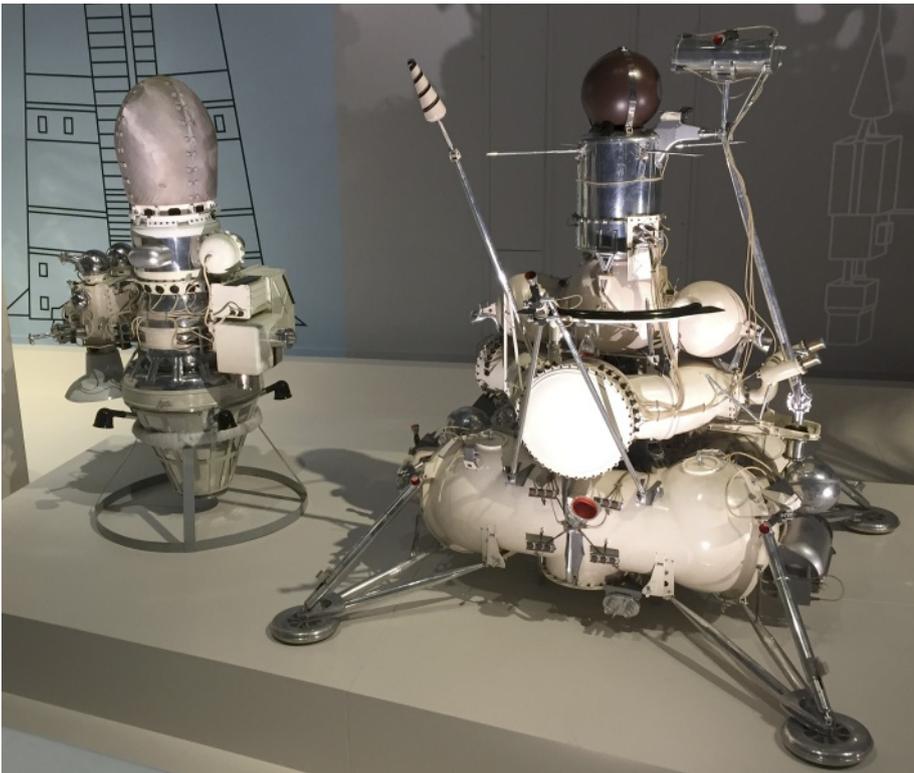
Von Braun was at a cocktail party when he heard the news that night and was furious that the Soviets had stolen a march on them. The western press had a field day with dire warnings of Russian supremacy over the USA. Khrushchev wanted to know if another landmark event could be timed for the 40th anniversary of the October Revolution on November 7<sup>th</sup>. With less than a month to go could Korolev build another bigger satellite and launch an animal into space and would it survive? They had several dogs in training for high altitude testing and one was readied. Called Laika she was a friendly dog and on November 3<sup>rd</sup> with her heart racing, was launched into space. For a few hours all looked fine and no abnormalities were detected but despite the cooling system installed in the capsule the heat rose until she died after 6 hours. For years after the Soviets claimed she had lived for 4 days. In the USA a blame game insured with von Braun getting the blame for the failure of their program and he and General John Medaris, Commander of the US Army Ballistic Missile Agency wrote letters of resignation.

The very next day brought a change of heart and an urgency to *"Get Satellite Up There"* Even though the Jupiter C was twice as powerful as the Navy Vanguard, the Vanguard would try first.

The Jupiter C was modified by von Braun's team into a four stage rocket with a 30lbs satellite fitted with sensors to measure temperature, record micrometeorite impacts and a cosmic ray counter devised by Dr James Van Allen. The first Vanguard launch exploded on the pad with the world watching and the grapefruit size satellite rolling clear still beeping. The media had plenty of names for it; *"Kaputnik!" "Dudnik!" "Goofnik!"*

Khrushchev loved it, but the Jupiter C team was ready by the 29<sup>th</sup> of January 1958, but high altitude winds postponed the launch for two days. Just before launch a possible fuel leak was found, and a young engineer ran out to the fully fuelled rocket to check, disappearing into clouds of vapour venting from the fuel tanks. All was well, just a fuel spill and the launch went ahead. It was an hour and a half before confirmation came from tracking stations, it was in a higher orbit than expected but it was working. And James Van Allen's geiger counters had found a belt of radiation. Von Braun and his team were transformed into heroes while Korolev remained anonymous, only referred to as Chief Designer even in Russia.

In March 1958 Korolev told his team that they were *". . . to deliver the Soviet coat of arms to the Moon."* The next Sputnik 3, launched in May weighted in at 1.3 tons, far away



*The Lunar 9 probe display model 1:10 scale left and the Luna 16 lander at 1:3 scale right at the Cosmonauts Exhibition. The Lunar 9 was the first successful soft landing on the Moon on 3<sup>rd</sup> February 1966, in the Oceanus Procellarum. The top of the model is the probe covered in air bags and the lower half the landing stage, this was the Soviets twelfth attempt to soft land on the Moon. The pictures sent back were picked up by Jodrell Bank Observatory and published worldwide. The Luna 16 landed on 20<sup>th</sup> September 1970 in Mare Fecunditatis and became the first robotic mission to send a small (100gm) lunar sample back to Earth.*

heavier than the American 3 lbs of the first Vanguard to achieve orbit. But America wasn't giving up and on July 29<sup>th</sup> formed the National Aeronautics and Space Administration, a civil establishment. During September and October Russia tried twice to launch a probe to the moon, both were failures. America was also failing to get far into space with several attempts to reach the Moon. And it was not until January 1959, when at his fourth attempt did Korolev's Luna 1 pass the Moon at 3,700 miles to go into orbit around the Sun, the first probe to escape Earth's gravity. It was March when Americans Pioneer 4 flew passed the Moon.

### Volunteer Spacemen

In January 1959 a call went out for volunteers for the NASA manned space program, all the many recruits were subject to every test and trial the doctors could think of, and were quickly reduced in number so that by the end only 7 were left. Nobody knew what the effects of prolonged weightlessness would have on the body and mind of the astronaut. While the men were being assessed, work was progressing on the design of the one man Mercury capsule. It was found that the best shape was a blunt bell design. The blunt end creating a cushion of super heated air which flowed around the capsule, the opposite to what seemed right with a streamlined shape as this would speed up on re-entry and get extremely hot. While the blunt design would create shockwaves ahead of it rapidly slowing it down. The Soviet design was for a ball shape which had a similar effect. One main difference was that NASA's capsules would land in the ocean, while the Soviets would land in the USSR.

In April 1959 NASA held a press conference to introduce the 7 Mercury Astronauts to much fanfare and they were later

taken to see the Mercury capsule. They were surprised at how small it was with thin walls and the one-size-fits-all couch, inches away from the heat shield and the instrument panel two feet from their nose. Would it withstand the forces of launch and re-entry? It was completely automatic with no means of controlling the craft and no window. They were not too impressed or happy. With much grumbling on both sides, both controls and a window was added, after all they were all skilled pilots. In May they all went to Cape Canaveral to watch a launch of an Atlas rocket, it rose smoothly before blowing itself to bits in a fireball. Allen Shepard in the bunker said ". . . I sure hope they fix that." They would do, by using von Braun's Redstone to send the first American into space on a suborbital flight of 130 miles.

### The First Manned Flights

Khrushchev was visiting the United States in September and told Korolev to do something to coincide with his visit. With the Jodrell Bank Radio Telescope tracking its progress Luna 2 crashed into the Moon's Mare Imbrium, the first spacecraft to reach the Moon. Three weeks later Luna 3 equipped with a camera and a film processing unit photographed 70% of the far side of the Moon, revealing it to look

quite different from our side. The Americans looked on with grudgingly admiration as each Russian feat was more spectacular than the last, not knowing how many failures there were between each success. Also in October 1959 saw the transfer of von Braun's team from the army to NASA, and he was to be the director with a staff of over 4,000 with the creation of the Marshall Space Flight Center.

In the Soviet Union recruiting teams toured airforce bases looking for pilots to form a program called "Theme No. 6". Just as the Americans had done each was subjected to numerous tests and measurements to find the best they had. No mention was made of space flight. Many of the tests involved the subjects to long periods of sensory deprivation in a dark windowless cell and low oxygen levels to test their psychological strength in case of problems in orbit. In January 1960 the Cosmonaut Training Centre was formed in Moscow. One young recruit was a 26 year old Yuri Alexeyevich Gagarin, selected for a special flight of something new along with Gherman Titov. Both were equal in ability and both met with the "Chief Designer" who told them of his dreams to reach other planets and talked to them in turn. They were taken to see their spacecraft: Vostok meaning 'east'. It was a surprise for them to see a shining silver sphere with no wings and strange controls. Who would like to sit in the ship asked Korolev and Gagarin stepped forward, took off his shoes and climbed into the silver ball.

The first Vostok test was in May 1960 and at first all went well for 64 orbits but when the retrorockets fired for re-entry the attitude control system was faulty and the craft skimmed off the upper layers of atmosphere into a higher orbit. Two months later the next Vostok was launched with two dogs aboard, 30 seconds after liftoff the rocket exploded. The next





broke down on the way.

On May 5<sup>th</sup> Alan Shepard at last lifted off from the Cape to become the first American into space, if only for 15 minutes. Less than 3 weeks later on the 25<sup>th</sup>, President Kennedy made his speech to Congress *"I believe this nation should commit itself . . . of landing a man on the moon . . ."* Von Braun thought it was too ambitious, but it was his Redstone rocket which had launched Shepard and it would be his Saturn rockets that would get to the Moon. Soon plans were underway to build the worlds largest hanger, the 'Vehicle Assembly Building' and development of the Cape into a large rocket launch facility. While von Braun had the wealthiest nation behind him Korolev was still trying to do space exploration while the military took precedence. He had plans for space stations, flights to the Moon and Mars and beyond and an idea for a larger rocket, the N-1; 295 feet high with a payload of 40 tons. It would be a 'universal launch vehicle' for the military and well as research.

Gherman Titov at last got launched on Vostok 2 on the 6<sup>th</sup> August and spent 24 hours doing 17 orbits. It wasn't a happy flight for him, he felt sick and could not work the instrument panel, after a few hours he recovered and then the heating failed and he nearly froze. The re-entry was as bad as Gagarin's with the capsule spinning uncontrollably until the heat burnt through the attached cables, then after ejecting and parachuting down he was nearly hit by a train! Just a week later Khrushchev started to build the Berlin Wall to stop the flow of East Germans heading west and in October the Soviets exploded a nuclear bomb with a force of 50 million tons TNT, surpassing all the explosives used in WW2.

It was around this time that Korolev fell out with his main engine designer Valentin Glushko in a heated argument. They had worked with each other from the earliest days before the war and had designed the motors for the first Soviet rockets and the Vostok series. But Glushko wanted to use more powerful fuels and refused to design motors to use the cryogenic fuels Korolev needed for his N-1. Glushko pointed out mistakes made and said Korolev was holding up progress. Korolev thought them to be dangerous and pointed out the R-16 disaster. After they never worked together again.

In America, January 1962 von Braun got approval for an even larger rocket than the Saturn I with its 1.3 million pounds trust, the Saturn V with 7.5 million lbs trust. The F-1 engines would be twice as big as any previous engine burning 40,000 gallons a minute. The upper stages would be burning liquid hydrogen which must be kept extremely cold and was known to shatter metal with thermal shock. Even if he made this



Proudly displayed at the Cosmonauts Exhibition in its own pink corner was Valentina Tereshkova's Vostok 6 capsule from her June 16<sup>th</sup> 1963 three day stay in orbit. At left is the Vostok navigation console which can be seen through the open hatch, the rotating globe showed the position of the spacecraft.

huge rocket how could a Moon landing be done? In the 1950 film *"Destination Moon"* a silver V-2 like space ship with wings took off from Earth and landed tail first on the Moon. But this was Hollywood and real rockets were different.

### How Do You Get to the Moon?

Von Braun's early thoughts were to build a space station and use that as a stepping stone with 'space taxis' to ferry astronauts around the solar system. He still thought that a Moon landing would require a ship to be assembled in Earth orbit from parts ferried up. This had the advantage of a smaller launch vehicle to get into orbit the sections needed, this approach was called Earth Orbit Rendezvous. But no one had yet proved you could rendezvous in orbit and the Mercury capsule was not complex enough for such a task. While design and development work could start on the large rockets and engines, the way to get to and land on the Moon wasn't decided. Most favoured the Earth orbit approach as it offered a safety net in case anything went wrong but if any problems happened at or on the Moon it would be impossible to rescue the crew.

John Glenn at last made an orbit in February 1962 to everyones relief. Mariner 2 was launched towards Venus and would flyby in December. While stormy meetings were going on how to reach the Moon, John Houbolt from Langley Research Center had proposed a Lunar Orbit Rendezvous back in 1960. At first this was dismissed out of hand as way too dangerous, but as the idea developed it was thought possible to launch a double space craft to the Moon with one part as a command vehicle and the other as the landing craft

in one liftoff. Other problems were how to build a landing craft when nobody knew what the lunar surface was like, was it hard or a dust bowl which would swallow the landing craft. The arguments for LOR or EOR went on for a year and no basic design was possible until it had been decided. In the end LOR won as it offered the way to build a small landing craft and a return module to get back into lunar orbit to rendezvous with the command ship. All the used parts of the lunar craft would be discarded in turn to save weight to return to Earth. It was not until April 1962 after many stormy meetings that von Braun came down in favour of the LOR approach.

The F-1 engines were proving more difficult than expected with some blowing up in seconds on the test rigs. The huge pumps had to supply 15,000 gallons of kerosene and 24,000 gallons of liquid oxygen a minute to the combustion chamber in a smooth flow or instabilities would damage the engine, *"it might just be too big to make it work,"* was one comment.

Korolev was being pressured by Khrushchev for another daring feat. On August 11<sup>th</sup> Vostok 3 launched and next day Vostok 4, on the first orbit both got to within 3 miles of each other and 2 days later both landed safely. The Soviets seemed to be years ahead with their rockets, later in September Korolev got permission to build his N-1 rocket and to use liquid oxygen and kerosene as propellents. The engine designer was to be Nikolai Kuznetsov and his NK-15 engine was to have 154 tons of thrust with the first launch three years away in 1965.

October 1962 was the month of the Cuba Missile Crisis when the world held its breath and von Braun and 50 engineers was still trying to get his F-1 engines to work. While Korolev was developing his rocket he knew that the Americans could spend any amount to get the designs right and he had no plans for how to get Russia to the Moon. He had read how the NASA work was progressing and they were going for LOR with contracts signed to build the different space craft. He was hoping his rocket with 24 NK-15 engines in the first stage would prove to be a larger rocket than the Saturn V. But owing to the lack of funds was forced to cut back on the testing program. Khrushchev was more interested in missiles than unproductive Moon landings and also the cost of the rockets would buy a great deal of grain to help feed the country. In June 1963 Korolev, Glushko and their wives holidayed at Khrushchev dacha and Korolev told Khrushchev of his ideas for a Moon landing. At first Khrushchev was enthralled until he asked how much it would cost, *"10 to 12 billion roubles,"* was Korolev's estimation.

Back at Baikonur another launch on the 14<sup>th</sup> of Vostok 5 and two days later the first woman in space, 26 year old Valentina Tereshkova: both landed safely on the 19<sup>th</sup> June. The world was impressed with her 3 day mission and she went on a world tour. She married Andrian Nikolayev (Vostok 3) on November 3<sup>rd</sup> with Hollywood style fanfare. Everyone went to the wedding, even Korolev and Glushko and a few days later the New York Times named them both as the designers of the Soviet rockets; but there was more information about Valentina's dress than the mysterious designers.

President Kennedy visited the Cape Canaveral site to stare in awe at the size of the Vehicle Assembly Building and the construction of the launch pads on November 16<sup>th</sup>. From there he went to Houston and on to Dallas. The US space program lost its most powerful supporter.

## "The Soviets are Ahead"

Korolev was having problems with chronic underfunding of the lunar program, he knew that the Americans would soon launch the two man Gemini and Khrushchev was wanting to upstage this with a three man flight. The Gemini would be able to manoeuvre, rendezvous and stay in space for about 14 days, the same length of time as a lunar mission. The first unmanned test of Gemini 1 was in April with a 4 day, 64 orbit flight and Korolev was uncertain how he could fly three cosmonauts in the time available. So 4 Vostok flights were cancelled and all effort was put into preparing the Voskhod (a modified Vostok) for flight. There would be no room for the bulky spacesuits and the ejector seats, so they would fly in ordinary coveralls, but the landing would be hard and extra retro rockets were fitted to bring down the landing speed to 3 feet per second. It would be dangerous with no room for any error, but it would give the impression of the Russians being far ahead in the race. By then Korolev knew he was not in a position to challenge the Americans as time and again the budget was cut and he was competing with other teams building missiles. Also his heart and bowels was giving him problems with the long hours and constant workload not helping him get any rest.

Finally he got his lunar landing programme approved using his N-1 rocket with testing to start in 1966. By October 1964 the Voskhod was ready, it was really a two man capsule like the Gemini but the three cosmonauts just fitted in and was launched on the 12<sup>th</sup> to an altitude of 250 miles and did 16 orbits before landing safely. The Voskhod only flew once more manned, in March 1965 when Alexey Leonov made the first spacewalk. The test flight for this had not gone well: the Voskhod was equipped with a flexible tube to form an airlock to permit exit in orbit, but the test had gone wrong and it had exploded. With no time or money for further tests the flight went ahead to beat the Americans. Leonov crawled into the airlock tunnel and opened the outer hatch to space and pulled himself out attached by a 18 foot rope. *"I'm feeling perfect,"* he told the live TV feed of him floating above the Earth. Getting back in was a problem as his suit had stretched in the vacuum and was now too big to fit into the narrow tube airlock. He had to let most of the air out of his suit to get back in and spent 12 minutes wriggling in the tube before closing the outer door and entering the Voskhod capsule. Even then their problems were not over, the exit hatch had not fully closed and the automatic guidance system failed so they had to align the capsule manually and fire the retro-rockets. Again on re-entry the equipment module did not detach properly swinging them about violently. They overshot the landing area, it took two days to find them in the Siberian forest.

Once again Russia seemed ahead of the Americans with the first Gemini flight not until the same month when Gus Grissom and John Young did three orbits. The first success of the NASA Ranger series, the 7th, (in contrast to the Soviets of only numbering successful missions) hit the Moon at the end of July sending back 4,308 pictures in its final 17 minutes before crashing into the lunar mare. All the photographs helped to show that the surface wasn't a thick layer of dust and were a precursor to the 5 Lunar Orbiters which photographed and mapped all of the lunar surface to find the best landing sites for the Apollo missions. In June 1965 Edward White made a spacewalk from Gemini 4 and two months later Gordon Cooper and Pete Conrad set a record 8 day stay in orbit. By now there were hundreds of companies working on hardware for the Saturn V and the Apollo spacecraft and the Lunar landing module.

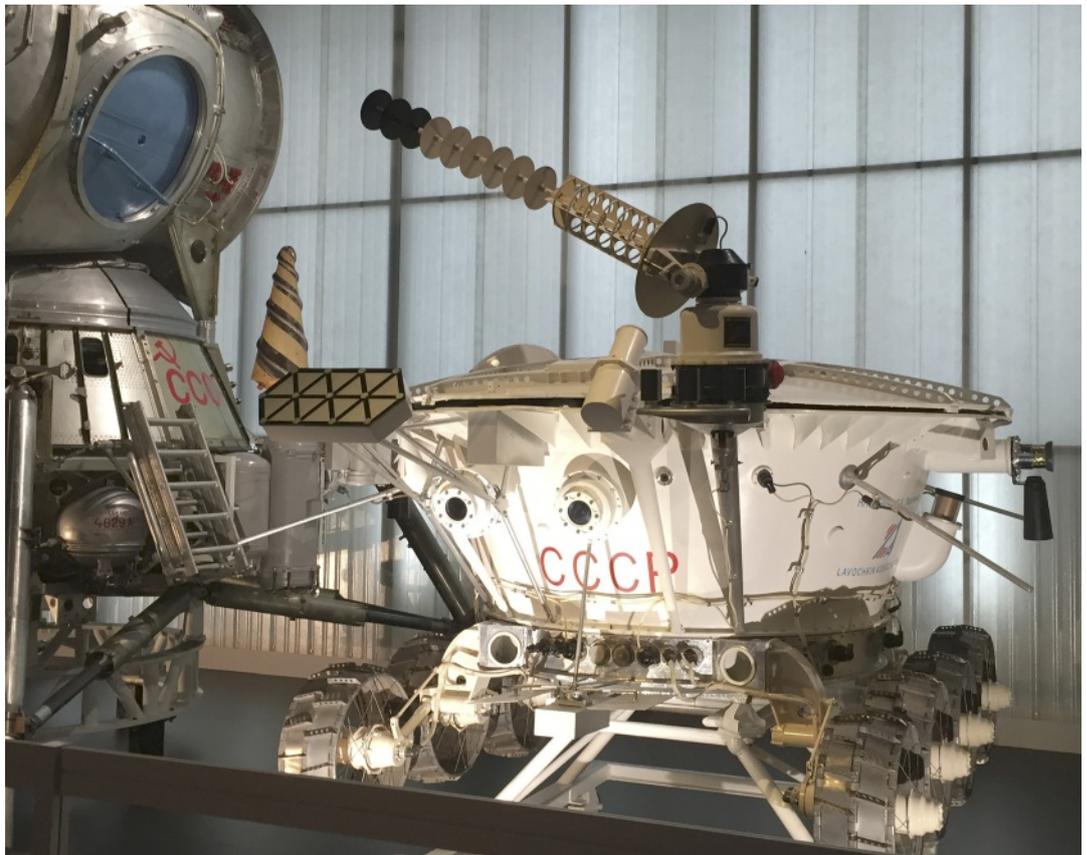
Korolev was working on the Soyuz three man capsule and equipment module which would have a weight of around 7 tons and be equipped with solar panels for power for longer stays in space. All who saw it marvelled at the size and how complex it was compared with the older Vostok's. During December the flights of Gemini 6 and 7 took place with the two craft orbiting a just few feet apart. Over the new years holiday Korolev became increasingly tired with intestinal bleeding and he consulted a doctor who told him to slow down and rest as it was a polyp and a small operation would get rid of it. He went into the Kremlin hospital to have the polyps removed but the bleeding would not stop and a operation was booked for the 14<sup>th</sup> January 1966. Korolev's high status meant he would have the best surgeons and doctors available for the operation, during which they

discovered a large malignant tumour in his abdomen. The frantic surgeons tried for 8 hours to save him, but then his weak heart gave out. The shock of Korolev dying was devastating news to all of his colleagues and the news was broadcast across the nation on the 17<sup>th</sup> January as he lay in state, a Hero of the Soviet Union. At long last the world knew the name of the Chief Designer and a large state funeral took place of the visionary who had dreamed of visiting the planets. Von Braun was saddened that he would never now be able to talk to his opposite number and he realised this was the person who had designed nearly all the Russian space hardware and had a similar vision to his. His death was a "heavy blow" to the Soviet space program and it would never quite recover.

Korolev's death left his deputy in charge, Vasily Mishin as the new Chief Designer and he was struggling with getting the N-1 payload down to 95 tons. Work on reducing weight was paramount. Another first for the Soviets was the landing of Lunar 9 at the end of January 1966 on the Oceanus Procellarum and two months later by the Lunar 10 orbiter. The next Voskhod flight was with two dogs to test the life support systems and for 22 days the two dogs circled the Earth, but on return it took a week or more for them to recover. Mishin decided that no more manned flights would go ahead until the Soyuz was ready.

### New Developments

Meanwhile the work on the large F-1 Saturn engines was



*Engineering prototype of the two Lunokhods that soft landed on the Moon. Lunokhod 1 landed 17<sup>th</sup> November 1970 and travelled about 6.5 miles, operating for nearly a year, the first remote-controlled rover to operate away from Earth. Lunokhod 2 landed 15<sup>th</sup> January 1973 and travelled about 23 miles during the 4 months it operated. This distance record has only just been broken by the NASA Mars Opportunity rover. They were both equipped with TV cameras, soil testing, x-ray and UV and visible light experiments. Both operated on solar power during the lunar day and kept warm at night by a polonium-210 radioisotope heater unit. They returned thousands of photographs and TV images.*

*On the left is the hatch of the lunar landing craft, the ladder to climb down to the surface is folded up.*

showing results and they were proving reliable. The flight of the Gemini 8 in March proved docking could take place and was to prove how cool Neal Armstrong was in an emergency. After rendezvous and docking with an Agena satellite launched earlier the pair started rolling and they undocked the Gemini before it became too dangerous, to find they were starting to spin even faster. Armstrong managed to switch off the manoeuvring thrusters and using the attitude controls stop the spin. One of the thrusters had jammed in the 'on' position, it was a near disaster. June proved that America could land on the Moon too with Surveyor 1 and two months later by the first of the 5 successful Lunar Orbiters. In July cosmonaut Vladimir Komarov announced at a press conference that they were on target to beat the Americans to the Moon. The NASA Gemini programme ran until November 1966 with 10 manned launches in all, where they practiced rendezvous manoeuvres and space walks, with Buzz Aldrin spending 5 hours 30 minutes outside on the final Gemini XII flight. The Soviet Luna 13 lander, again landed in the Oceanus Procellarum at the end of 1966.

August saw the first Apollo command module delivered to NASA with the first flight due in February 1967. Thousands of design changes had taken place during the build and Gus Grissom, the captain wanted more modifications, the capsule wiring looked like spaghetti and problem after problem did nothing to help the mood of the crew. And on January 27<sup>th</sup> 1967 the worst happened. With the crew, Gus Grissom, Ed White and Roger Chaffee strapped in during a full ground test

of the countdown procedures they were killed in a fire. It took 6 minutes to open the hatch and bring out the bodies, the heat had reached 2,500°C and melted most of the inside. They had been on pure oxygen for over 5 hours and it had been caused by a small spark somewhere in the wiring. This led to major design changes to the capsule and probably saved the Moon programme. The report on the tragedy was more than 3,000 pages long and more than 1,400 faults were found on the next Apollo module.

On April 20<sup>th</sup> Surveyor 3 landed in Mare Cognitum, part of the Oceanus Procellarum, and two and a half years later Apollo 12 landed a few hundred meters away. A few parts were returned to Earth to check for exposure damage and bacteria. The first manned launch of the three man Soyuz spacecraft with just one crewman, Komarov took place on the 23<sup>rd</sup> of April. Once in orbit things started to go wrong, one of the two solar panels failed to open leaving the Soyuz without sufficient power for a long flight. By the fifth orbit more problems had made controlling the craft almost impossible and it was decided to try to re-enter on the 18<sup>th</sup> orbit using manual control. By some skilful flying he managed to get the angle for re-entry correct and the retro rockets worked but when the time came, the parachute didn't open and neither did the reserve. He hit the ground at 400 mph, the retro rockets exploded blowing the capsule to pieces. At this point both the Americans and Russia had no operational manned spacecraft.

One of the first probes to reach another planet's atmosphere, Venera 4 launched on June 12<sup>th</sup> and reached Venus in October, returning some data but didn't survive to reach the surface.

November 9<sup>th</sup> 1967 was the first launch of a full Saturn V with a redesigned Apollo Command Module and a mockup lunar module the size and weight of the real thing. It all worked. In September, in November the day before the Saturn V test and January 1968, NASA landed three Surveyor's, 5, 6 and 7, on the Moon and proved the surface to be hard. The Apollo 5 test on January 22<sup>nd</sup>, launched a mockup lunar landing craft with a Saturn 1B into Earth orbit and demonstrated the engine restart and tested the high speed re-entry of the Command Module heat shield.

The Soviets suffered another death on March 27<sup>th</sup> as a training plane co-piloted by Yuri Gagarin crashed, killing both pilots. It had been two years of deaths, disasters and crashes and they were falling behind the Americans with Mishin the 'Chief Designer' struggling, not able to fill Korolev's role in keeping the whole project moving forwards.

### **The Apollo and Soyuz Programs Start**

The Apollo 6 launch on April 4<sup>th</sup>, was the last unmanned test to try for a trans-lunar injection, there were some problems with the Saturn V engines that caused further problems to the second and third stages but the flight was a success. Next to the Moon was Luna 14, an orbiter to test mainly the communications systems. During May 1968 Neil Armstrong almost died while flying a jet powered "Bedstead", a lunar landing test vehicle when it went out of control and he ejected less than a second before the altitude would have been too low for his chute to open. The Russians had another first on September 22<sup>nd</sup> with the first live creatures to reach the Moon and return to Earth in Zond 5, a modified Soyuz spacecraft. Two tortoises, wine flies, meal worms and plants and seeds were returned safely and recovered after flying round the Moon and splashing down in the Indian Ocean. The next lunar flyby, Zond 6 in November was not so lucky

and the capsule depressurised and then crashed with another parachute failure. The success of the Zond 5 probe to the Moon made the Americans nervous about the possibility of a Soviet lunar flyby that year, so on October 11<sup>th</sup> the launch of Apollo 7 with a three man crew tested the Command and Service Modules with a 11 day stay in orbit. One of the American spy satellites had by now spotted a large rocket in a launch complex the same size as the Saturn V and it looked like the Soviets were on course for a Moon shot of some sort.

On 21<sup>st</sup> December 1968 one of the epic Apollo missions launched on the Saturn V, the first time man had gone to the Moon and left the pull of Earth. Apollo 8 was one of the most dangerous missions yet, if anything went wrong there would be no help. It took three days to reach the Moon and the Service Module engine fired to slow the craft to 3,700 mph to let the Moon's gravity pull them into an orbit. Frank Borman, Jim Lovell and Bill Anders became the first humans to see the rear hidden face of the Moon. The Apollo made 10 orbits of the Moon and took one of the most famous photographs of all time, Earthrise over the lunar surface. On Christmas Eve they made a broadcast to Earth "*This is Apollo 8 coming to you from the moon. . .*", then each of them described the view. This mission was brought forwards because it was thought that with the Zond 5 success a Soviet manned flight to the Moon was just weeks away.

The Russians were not giving up and on January 14<sup>th</sup>, Mishin launched Soyuz 4 with a single crewman, next day Soyuz 5 launched with 3 crew aboard and successfully docked in orbit, two of the Soyuz 5 transferred to the Soyuz 4 and returned to Earth. Next day Soyuz 5 returned with its lone crew member and again the service module failed to separate properly, then the parachute wouldn't open with tangled straps until just before the last minute! Also in January two probes were launched to Venus, Venera 5 and 6, they arrived in May and radioed back information about the atmosphere. In February the Soviets tried to launch a lunar rover but it exploded less than a minute after launch. Korolev's massive N-1 rocket was wheeled out of the assembly building for a test launch and slowly lifted into a vertical position. It stood 344 feet high and weighed 4,500 tons, 24 engines were arranged in a circle around the first stage base with 6 in the centre, it could beat the Americans to the Moon. On the 21<sup>st</sup> the launch started but within seconds some of the engines cut out, still it rose into the sky, then all the first stage engines cut out and it crashed 17 miles away in a ball of fire.

Two Mars flyby probes were launched by NASA, Mariner 6 and 7 on 24<sup>th</sup> February and 27<sup>th</sup> March to arrive in July and August. These were the last Mars flybys, all the following probes were orbiters or landers.

March 3<sup>rd</sup> was the launch of Apollo 9 with the Lunar Module into Earth orbit for a full test proving it could do what they intended. Two EVA's were done and separation and docking manoeuvres performed, at one point the Lunar Module was over 110 miles from the Command Module when they dropped off the descent stage and flew back with the ascent stage. After 10 days in orbit the Apollo 9 was the last spacecraft to splash down in the Atlantic Ocean.

### **To The Moon**

The next Apollo flight on May 18<sup>th</sup> was a full lunar 'dress rehearsal' to the first landing. It was the fourth manned Apollo flight and the second to reach the Moon, but this time with a fully equipped Lunar Module landing craft. Thomas Stafford, John Young and Eugene Cernan were the crew, all

had flown on the Gemini missions and all would fly again on Apollo missions. Shortly after reaching the Moon, the Lunar Module (called Snoopy), separated from the Command Module (called Charlie Brown) and made a powered descent dropping to within 8 miles of the surface. Then dropping off the descent stage they powered back up to the Apollo Command Module in the ascent module, they only had enough fuel to get back from the 8 miles high position and not a landing! They did 31 lunar orbits and the mission lasted until May 26<sup>th</sup>, splashing down in the Pacific.

During April and May, Vasily Mishin's teams were frantically trying to get a N-1 rocket ready to launch, they all knew that the Americans had a Moon landing planned for a July 16<sup>th</sup> launch. The N-1 rocket did not have the lift capacity of the Saturn V, but was powerful enough to lift 2 cosmonauts in a modified Soyuz called Zond and a small Moon landing craft into lunar orbit with just one cosmonaut descending to the surface while the other stayed in orbit. To get into the lunar lander it was necessary to spacewalk from one to the other, and after undocking using its descent motor to fly down to the surface. After landing the descent part would be left on the surface and just the ascent section lifting off, the same idea as the NASA LM design. After docking with the orbiting Zond module the cosmonaut would then spacewalk back into the Soyuz capsule to rejoin his companion for the return to Earth.

At last on July 3<sup>rd</sup> at 11.18pm in the evening dusk, launch began with a storm of brilliant light from the 30 engines in the first stage. As it cleared the 400 foot tower there was a flash of light from the bottom and all the engines but one cut out causing the N-1 to lean over at 45 degrees and to start dropping back onto the launch pad. The escape rockets fired as the engines cut out lifting the modified Zond capsule clear of the N-1 to land just over a mile away. At T+23 seconds the N-1 landed back on the launch pad 110 East and 2,300 tons of propellant triggered one of the largest non-nuclear explosions ever made. The pad was completely devastated and took 18 months to rebuild. It was nearly two years before the next N-1 launch.

The Russians could still get the first lunar soil samples back before the Americans with a robotic Luna 15 lander and return mission. So three days before the Apollo 11 lift off, on the 13<sup>th</sup> July, after so many failures, a Proton rocket soared into the sky above Baikonur heading for the Moon. It went into lunar orbit the day after Apollo 11 liftoff and spent 2 days and 52 orbits of the Moon before Luna 15 fired its retrorocket to descend.

Meanwhile Apollo 11 had arrived in lunar orbit and Neil Armstrong and Edwin 'Buzz' Aldrin had transferred to the Lunar Module 'Eagle' leaving Michael Collins in the Command Module 'Columbia'. They started their burn descent and after 5 minutes at 6,000 feet the "1202" and "1201" alarms started going off due to an error in the check list, with a radar switch in the wrong position. Ignoring the alarms they continued down and dodging a bolder strewn area they landed on the Mare Tranquillitatis with less than 20 seconds of fuel left. "*Houston, Tranquillity Base here. The Eagle has landed.*" Radioed back Armstrong, they were on the Moon! It was nearly 6 hours later when Armstrong descended down the ladder onto the LM footpad and then gingerly stepped off with his "*That's one small step for man, one giant leap for mankind.*" Soon after Aldrin joined him on the surface, "*Magnificent desolation*" were his first words of their 2 1/2 hour Moon walk. They picked up 47.5lbs of lunar rock and soil samples and set up several science experiments before climbing back into the LM to eat and sleep.

After nearly 22 hours on the surface it was time to return to Columbia, but just two hours before firing the LM ascent engine the Soviet Luna 15 lander crashed into the Mare Crisium at 300 mph. Its lunar orbit and landing approach was kept clear of the Apollo 11 flight plan so as not to endanger the crew. At the Soviet control centre they had burst into applause as the grainy fuzzy TV images came in of Armstrong stepping off the LM and his words helped to unite all the world in the truly unique adventure.

It was July 24<sup>th</sup> when the Command module splashed down in the Pacific Ocean and the three astronauts spent 21 days in a Mobile Quarantine Facility aboard the USS Hornet, in case they had picked up any Moon Bugs. This was continued for Apollo 12 and 14 before being stopped as the Moon proved lifeless. So it was August 13<sup>th</sup> that they were given open top motor parades in their honour in New York, Chicago and Los Angeles.

Again that year on November 19<sup>th</sup>, the Apollo 12 LM landed within walking distance of the Surveyor 3 probe which had arrived 2 1/2 years earlier. Charles 'Pete' Conrad and Alan Bean, leaving Richard Gordon in orbit in the Command Module, became the second crew to beat Kennedy's decade deadline by walking on the Moon.

America had won the race to the Moon and von Braun was the engineering hero who had beaten Korolev with his Saturn V, still the largest rocket yet made. Would the N-1 have worked if Korolev had not died and he had continued work on it? The next N-1 launch was not until June 26<sup>th</sup> 1971 and it failed too at T+48 seconds when it disintegrated, the last attempt was on November 23<sup>rd</sup> 1972 and it exploded at T+107 seconds. In the following years von Braun has been criticised for being linked to the German SS but I think it was his way of surviving the horrors of the war and he had no control over what his designs were used for by the military. Korolev was always short of funds and was limited on testing his designs by the leadership pressing for ever more space spectaculars. His largest rocket built, the N-1 never worked for even 2 minutes before exploding with its 30 engines never working in harmony. But his legacy is the Soyuz spacecraft and launcher that is still being used today to fly to the International Space Station 50 years after he first designed it.

But both will be remembered as the geniuses who reached for the stars.

### Further Information

"*Space Race*", Deborah Cadbury, Fourth Estate, 2005

"*Encyclopaedia of the Universe*", Ed. Ian Ridpath, HarperCollins, 2001, chapter on 'Space Exploration' contains a good short description of the history of the subject, both USSR and USA.

"*The Atlas of the Solar System*", Patrick Moore & Garry Hunt, Mitchell Beazley, 1985, good list of probes, with descriptions and illustrations, to the Moon and planets as of 1985.

The Wikipedia web site has good articles on all aspects of the lunar programs of both Russia and America with descriptions of launch vehicles and histories.

**Note:** Most older books on the Space Race have very little or no information of the Soviet effort as it was not until the late 1990's that much was known in the west.

## Reverend Dr William Pearson's Sundial

By Mike Frost



*The house and sundial in 1960 and at right, now in the Market Harborough Museum*

In MIRA 71, I told the story of the Revd Dr William Pearson (1767-1847), one of the co-founders of the Royal Astronomical Society. His portrait hangs in Burlington House, the home of the RAS; he can be seen demonstrating an Orrery, built to his design, to his wife Frances (nee Low), and his daughter, also Frances.

At the time of the RAS's foundation in January 1820, William Pearson was a successful member of London society, running a preparatory school, Temple Green, in East Sheen. Yet in 1821, whilst he was still RAS treasurer, Pearson moved to South Kilworth, Leicestershire, to take up the Rectorship of St Nicholas's church, which he had been awarded in 1817. From this quiet country village Pearson made decades of astronomical observations; first from the Rectory, where he built a west wing to house his telescopes, and then from a purpose-built Observatory on the south side of the village (so that the smoke from village houses would not affect his meridian timings).

Both these buildings are still extant; both are now private dwellings, but the Observatory has had a varied history. After Pearson's death it became first a granary and later a cowshed; by 1960 it was in a derelict state. The south wall of the Observatory housed a large Swithland slate sundial, annotated with the latitude and longitude of the observatory, the motto "Sine pede curro, sine lingua dico" (I run without feet, I speak without a tongue), and "William Pearson dd". The sundial was taken into safekeeping by Leicestershire County Council at this time.

The dial remained in storage for over 50 years. I went to see it in 2011 when it was held at Snibston Discovery Museum in Coalville, Leics. I was able to verify that the sundial was safe and unharmed (barring the loss of its gnomon), but only by climbing over other undisplayed

exhibits until I could tilt the dial away from the wall it was leant against!

You can imagine therefore that I was dismayed to learn of the demise of the excellent Discovery Museum, which closed its doors for the last time at the end of July this year (2015). I was very worried that Pearson's sundial would be lost in the upheaval, and so I made enquiries to Leicestershire County Council, and prepared to marshal the big guns of the RAS to ensure the sundial survived.

Fortunately, the story has a happy ending! The County Council were able to tell me that the sundial has been transferred to a museum in Market Harborough, less than ten miles from South Kilworth. The sundial now stands prominently on display by the entrance to the Harborough Museum (indoors, but therefore protected from the elements). Although Pearson's ownership is acknowledged, there is currently no mention of his connections to the RAS. I hope that society members will take the opportunity to visit the museum and view this unusual connection to an eminent local Victorian astronomer.

### Further information:

*"Reverend Doctor William Pearson in South Kilworth, Leicestershire"*, M.A.Frost (The Antiquarian Astronomer (2006) 3, 49-56)

*"Revd Dr William Pearson (1767-1847): a Founder of the Royal Astronomical Society"*, S.J.Gurman and S.R.Harratt (Q.J.R. astr. Soc. (1994) 35, 271-292)

The Reverend William Pearson's obituary appeared in the Report to the Twenty-eighth Annual General Meeting of the Royal Astronomical Society. (Monthly Notices of the Royal Astronomical Society. 1847, 8, 69-74)