

End of a space odyssey

LAST RITES FOR MANKIND'S FIRST SPACE STATION

Mir milestones

On February 20, 1986, the Soviet Union announced the launch of its new space station called Mir (which means "peace" and "world" in Russian). A 20-ton core module with six docking ports for a transport craft and add-on modules became the first piece of the space colony, which would be constructed over the next decade and endure to set several records in space history. Below are highlights from Mir's long life:

March 13, 1986... The first crew, Leonid Kizim and Vladimir Soloviev, is launched to Mir.

March 1987... Mir's second component, the Kvant 1 module, arrives at the station. Crew members Yuri Romanenko and Alexander Laveikin conduct a space-walk to remove trash (left behind by a previous cargo ship) blocking the port and the docking is completed.

December 1988... French astronaut Jean-Loup Chretien, on a month-long mission aboard Mir, conducts the first non-US/non-Russian space-walk.

December 1989... The Kvant 2 module docks to Mir on its second attempt. The module furnishes Mir with a large airlock.

June 1990... The Kristall module, carrying materials-processing equipment, successfully docks with Mir after some rendezvous glitches.

December 1990... In the first major effort to commercialize Mir, a crew - including Japanese cosmonaut-reporter Toyohiro Akiyama - visits the station. Akiyama conducts live reports from Mir for a Tokyo-based television channel.

January 1991... Mir's crew installs a 46-foot (14-metre) boom called Strela (Arrow) on the exterior of the station, which will later serve as a crane used for transferring cargo and crew members around construction and repair areas on the outpost.

March 1991... A robotic Progress cargo ship loses control during its final approach to the station, nearly colliding with Mir.

While Mir operations continue as usual, on Earth below, the Soviet Union collapses.

March 1995... The first American astronaut to visit Mir, Norman Thagard, arrives aboard a Soyuz spacecraft. Russian cosmonaut Valeri Polyakov returns from Mir after a 438-day mission, the longest human space flight ever.

June 1995... The Spektr module docks with Mir. It carries US equipment for medical experiments. A solar panel on the module fails to deploy, requiring a space-walk to finish the job.

After 105 days in orbit, a US space shuttle docks with the station's Kristall module, creating a 209-ton complex in space.

March 1996... Space Shuttle Atlantis drops off NASA-astronaut Shannon Lucid for a 179-day mission on Mir. Her stay sets a US record for long-duration space flight.

April 1996... The Priroda module, carrying primarily remote-sensing equipment, docks with the complex, finally completing the assembly of the space station.

February 1997... A lithium "candle" used to generate oxygen sparks a fire onboard the station. It takes the crew more than an hour to extinguish the fire.

June 1997... During a manual-docking test, a seven-ton Progress cargo ship veers off course and collides with the Spektr module, causing a loss of air pressure. The crew inside, including commander Vasily Tsibliev, flight engineer Alexander Lazutkin and US astronaut Michael Foale, manages to sever the cables leading to the module and seal it off before pressure inside the station falls dangerously low.

July 1998... Russian space agency chief Yuri Koptev and then Deputy Prime Minister Boris Nemtsov sign a document that initiates a plan to deorbit Mir.

August 1999... Mir is abandoned by two cosmonauts and a French astronaut during the 27th human expedition due to a lack of government funding to continue its piloted operations.

January 2000... US entrepreneur Walt Anderson makes a commitment to put up 20 million US dollars to start MirCorp, a private company to finance continued human missions to the station. MirCorp reaches an agreement to lease Mir.

April 2000... Two cosmonauts are flown to Mir on the first commercial mission funded by MirCorp. The mission concludes in June.

June 2000... California businessman Dennis Tito announces he plans to spend 20 million US dollars to become the first tourist aboard Mir.

September 2000... Producer Mark Barnett announces development of Destination Mir - a TV show that would send a contest winner to the space station.

November 2000... The Russian space agency, claiming a lack of funds from MirCorp, announces Mir will be brought out of orbit and plunged into the Pacific Ocean in February 2001.

December 2000... Russian Prime Minister Mikhail Kasyanov signed a decree to deorbit the aging Mir space station. Tito starts planning for a trip instead to the International Space Station.

January 2001... The deorbit is delayed until March 2001.

SOURCE: SPACE.COM

Mir's fall into Pacific: Is it safe?

SIMON SARADZHANYAN

THE Mission Control Centre (MCC) in Korolyov chose to shorten and simplify the Mir deorbiting plan in an effort to minimise risks, despite safety concerns expressed by an independent think tank.

Rather than begin deorbiting the station once it reached an altitude of 155 miles (250 kilometres), the centre opted for a new plan which provides for a controlled descent of the outpost once it passes the 137-mile (220-kilometer) mark, the centre's chief ballistics expert Nikolai Ivanov revealed. Between March 11 and 12, the 15-year-old station dropped by a little more than a mile (two kilometres) to an orbit of 152.6 miles (245.6 kilometres).

However, officials at the Russian Aviation and Space Agency (Rosaviacosmos), and experts at the Moscow-based Centre for Analysis of Strategies and Technologies believe the station's lower altitude may impact the MCC's ability to control the engine burns necessary to bring the station back to Earth.

The station is to pass the 137-mile mark sometime on March 19 and will hit a designated area in the Pacific Ocean some 1,200 to 1,500 miles (1,930 and 2,415 kilometres) east of Australia either on Tuesday, March 20 or in the early hours of March 21, Ivanov said. He said these two dates "can shift back or forth by one or two days."

The centre booted up Mir's main computer on Monday in order to run a series of tests prior to the planned deorbiting of the outpost. According to Viktor Blagov, deputy flight control chief at Korolyov, the station has been descending by an average of more than a half-mile (0.8 kilometre) a day over the last week.

The recently selected plan provides for the station to be sunk in one day rather than three as initially planned, according to Ivanov and Blagov.

The plan was selected at a March 6 meeting in Moscow of space station specialists chaired by Yuri Koptev, the director general of Rosaviacosmos. It provides for the Progress supply ship, which docked with Mir in January, to be used for three braking impulses, rather than four as previously announced, to slow the aged station so it drops out of orbit, Ivanov said.

Once Mir hits the 137-mile mark, the centre will verify that the Progress cargo ship's engines are pointed in the exact opposite direction of the station's flight path, according to Ivanov.

When it reaches this altitude, Mission Control in Korolyov will wait for Mir to pass above the equator at 20 degrees east longitude. They will watch the station over another 14 orbits before firing the cargo ship's engines; the first of the so-called braking impulses. The second impulse will occur during the 16th orbit, Ivanov said.

The centre will then wait for the station to descend to an altitude of some 130 miles (210 kilometres) before firing the engines of the cargo ship again somewhere above Africa for a third and final time.

This impulse will last some 20 minutes and end while the station still remains within the MCC's zone of radio visibility. It will then take the station anywhere between 45 and 60 minutes

to crash into the Pacific Ocean, according to the new plan. "We have chosen this scheme because it allows us to use standard schemes without shifting back and forth between inertial and orbital modes. It is safer that way," Ivanov said, though he would not elaborate on why the new plan is safer.

According to one of Koptev's staff, the new scheme was chosen because Rosaviacosmos and the MCC doubted whether there would be enough fuel in the Progress tanks for an additional impulse if anything went wrong during implementation of the previous three-day deorbiting plan.

"The reason is that we need more fuel," the Rosaviacosmos official said.

The official, who asked not to be named, said the deorbit plan has "some risk" since the atmosphere is thicker at an altitude of 137 miles than at 155 miles. There is a possibility that this could make it more difficult for MCC to orient the station for the first impulse.

Experts at the Moscow-based Centre for Analysis of Strategies and Technologies also believe that the lower Mir descends the more difficult it will be to control the station.

"It is easier to aim and calculate the descent trajectory at higher altitudes, whereas trying to orient the station at 137 miles may prove too difficult," the centre said in a March 12 written statement.

According to Ivanov, however, the Korolev centre can keep the station under control as long as it remains above 124 miles (200 kilometres). "Only lower can such problems begin," he said.

However, Ivanov admitted that the centre has never tried to issue descend commands to stations, such as Salyut, at 137 miles in the past, opting to begin the deorbiting sequence at higher altitudes. The Korolev control centre lost contact with the Salyut 7 station in 1991 as it orbited the Earth unmanned.

As a result, the station's solar-power panels lost their orientation toward the Sun and Salyut 7 froze before the Korolev centre could send an emergency crew to the station.

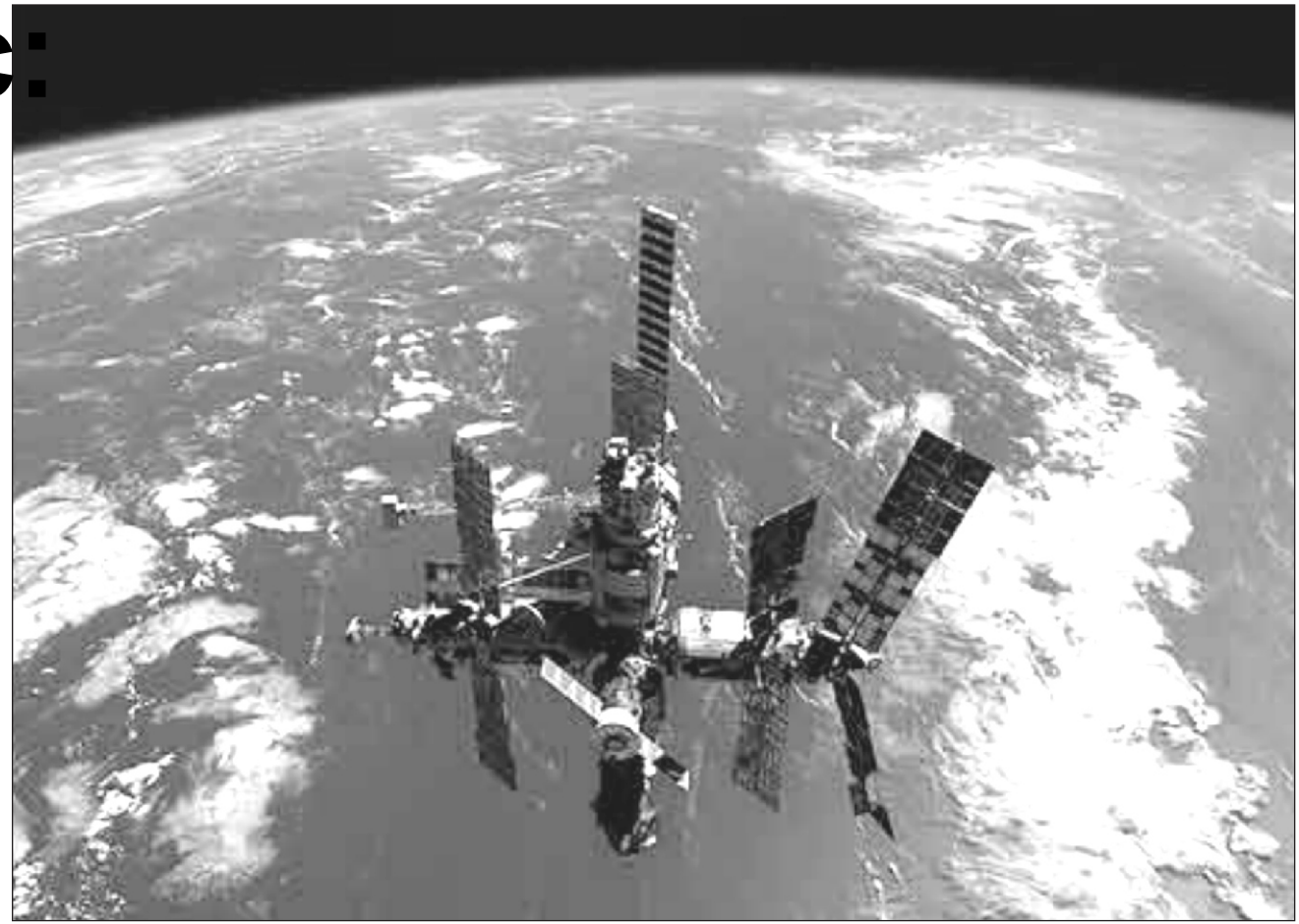
Unable to send a rescue team, Korolev controllers could not keep fragments of the 40-ton spacecraft from crashing in the Argentine Andes near the Chilean border.

According to Ivanov, there is a two per cent chance that Mir will veer off and crash outside the designated area that is some 3,000 miles (4,830 kilometres) long and 300 miles (480 kilometres) wide.

And if Mir goes into an uncontrolled dive, there would be a 10 per cent chance that debris would crash on land, including a 1.7 per cent chance that it would hit the continental United States, according to estimates of Koptev televised in Moscow on February 2.

Whatever happens to Mir after it drops below 125 miles (200 kilometres), the Korolyov centre will know only after the fact, Ivanov said. The MCC has no means to download telemetry after the third and final impulse, but he hopes the US military and European Space Agency will keep tracking Mir further and feed data to the centre.

"Fortunately or unfortunately, we will not see it," Ivanov said. It will be the US Army station at Kwajalein Atoll in the



Marshall Islands that will be the last to track Mir as it begins its fiery re-entry into Earth's atmosphere.

Deorbiting of the station will be rather spectacular, according to Nikolai Anfimov, director general of the Central Machine-Building Scientific Research Institute, which incorporates the Korolev control centre.

The station will start disintegrating somewhere between 55 to 70 miles (90 and 115 kilometres) in altitude, Anfimov said at a recent press conference in Moscow.

He said the station would rapidly heat up as it enters the planet's atmosphere. The heat and friction will first tear away the station's solar panels and cause its fuel tanks to explode.

Then, said Blagov, Mir's hermetic modules will be splintered, torn away from each other to disintegrate as the station plunges deeper into the atmosphere. Most of the fragments will burn up before hitting the water.

Some parts, however, such as the heat-resistant spherical gas tanks, parts of the station's engines and some of its gyroscopes will probably survive the overheated plunge and smash into the ocean, he said.

Up to 1,500 fragments, weighing a total of some 13 to 19 tons, said Ivanov, will survive the planned burning dash through the Earth's atmosphere and hit the surface.

SOURCE: SPACE.COM

How to deorbit a space station

AP

Here are the highlights of the Russian plan to bring down the Mir space station:

Mir is to be brought down by a cargo spaceship attached to the station. The ship will fire its thrusters four times at brief intervals to bring the complex down over a stretch of the south Pacific, about halfway between Australia and Chile.

Space officials haven't yet set an exact date for the operation. The station is expected to drift down to an orbit about 155 miles (250 kilometres) above Earth sometime between March 7 and March 12. Then space officials will take a series of steps over the course of about a week to prepare for the final push.

When Mir is at the highest point of its final orbit, the cargo ship will fire its engines, sending the station hurtling down. When the station falls to an altitude of about 70 miles (112 kilometres) into the thicker part of Earth's atmosphere, it will start to heat from friction.

Light aluminum parts will completely burn up, but stronger aluminum and titanium parts will survive the fiery re-entry and reach Earth's surface.

Some 1,500 fragments weighing in total up to 27.5 tons are expected to fall over an ocean area 120 miles (193 kilometres) wide by 3,600 miles (4,185 kilometres) long. Some surviving pieces could weigh up to 1,500 pounds (680 kilograms).

After the cargo ship gives Mir the final push, it will take about a half-hour for the fragments to reach Earth's surface.

NASA and European Space Agency radar stations will help Russian space officials track the final flight.

End of space for Mir

AP, KOROLYOV, Russia

A BATTERED symbol of Soviet might, the Mir space station is counting down the final days of its 15-year history - and perhaps of the nation's space glory.

"Mir could stay in orbit for another three, maybe even up to 10 years," mused Sergei Avdeyev, a lean, soft-spoken former cosmonaut. "But we have no means to preserve it."

Now a space engineer, he holds the world record for accruing the longest total time spent in space - 747 days, equal to just over two years, during three stints on Mir.

After trying for years to split its scarce resources between Mir and the new, 16-nation International Space Station project, Russia has grudgingly made its choice. The government said Mir, whose name is Russian for both "peace" and "world," must be dumped due to its worsening condition and the lack of funds to keep it going. The craft will be brought down in the south Pacific Ocean this month, March 12 at the earliest.

It's a far cry from the Russians' heyday, when between 1957 and 1961 they lofted into space the first satellite (Sputnik), the first dog (Laika) and the first human (Yuri A. Gagarin).

A descent sequence begun in January will bring Mir to 155 miles (250 kilometres) above Earth, whereupon a cargo ship already docked with the station will fire its engines and give it a final push down.

Up to 27 tons of fragments of the 143-ton station are expected to rain on Earth after the re-entry. Space officials have pledged to try to direct them to a remote stretch of sea about halfway between Australia and Chile.

However, Mir's patchy safety record has raised doubts about the ground controllers' ability to guide the station accurately. "We don't have a 100 per cent safety guarantee," said Yuri Semyonov, the head of the state-controlled RSC Energia company that built and has been running Mir.

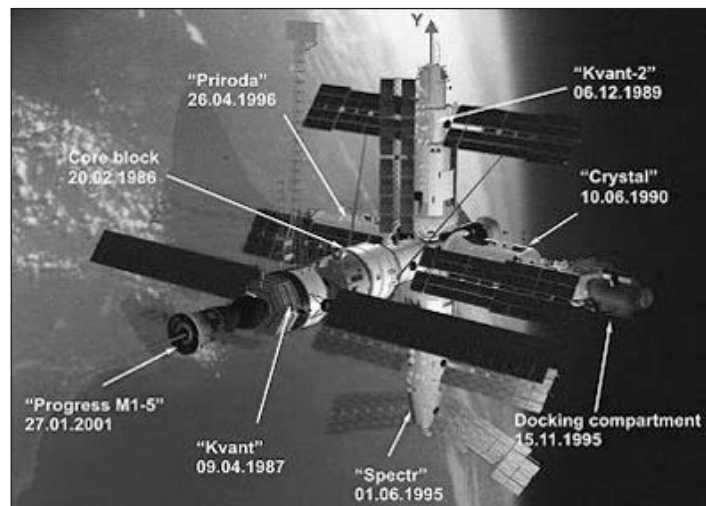
Mir's core module was launched on February 20, 1986. It has been upgraded with five additional segments during its flight and set a longevity record, far outliving its predecessors. Along with the US

space shuttle, it has helped make space missions routine events rather than heroic exploits, and it paved the way for the International Space Station.

Continuously occupied from September 1989 to August 1999, Mir swarmed with cosmonauts and foreign astronauts through most of its tenure. The station holds about 13 tons of Russian and Western scientific equipment, used to conduct 23,000 scientific experiments ranging from production of rare

1991 collapse of the Soviet Union. It very likely would have been dumped eight years ago if the Americans hadn't offered a helping hand, said Russian Aerospace Agency chief Yuri Koptev.

Eager to learn from Russian experience in long-term flights, the National Aeronautics and Space Administration leased time on the station and sent seven astronauts to Mir in 1995-1998. But despite the extra money, Mir developed the wear-and-tear that made 1997 the worst year in its history.



materials to biological research to studies of gravity's impact on human body in long-term flight.

"We spent a long time trying to grow wheat, and were exultant when it finally yielded grain," Avdeyev recalled.

His one-time crewmate, Viktor Afanasyev, said that the station provided a unique observation post for watching atmospheric conditions and could serve as a tool for predicting earthquakes.

"No satellite can do that," he said proudly.

But as Mir aged, the cosmonauts increasingly had to make repairs. Avdeyev acknowledged that he spent a large part of his latest mission, in 1998-99, trying to spot a minor air leak and fixing other flaws that often made life unpleasant for the crew.

Mir's core module was originally intended to last only three to five years. But the development of its successor was frozen when once-generous government funding began withering shortly before the

Memories of Mir

IRENE BROWN

IT began as a political initiative to busy the nuclear-savvy Russians with high-paying work. Initially, neither side was particularly tickled with their new partner. Optimistically, and perhaps naively, NASA's favoured story line was that the opportunity to work with the Russians on Mir would provide invaluable insights into operating a space station. Furthermore, the addition of the former Soviets would save the US taxpayers more than a billion US dollars in hardware and transportation costs for the planned International Space Station. The shuttle-Mir programme, known as "Phase One" in NASA-speak, was to be the baby step before the United States and Russia teamed up for Phase Two: the joint operation and assembly of the new station.

The Russians, however, clearly considered America a junior partner in space. Phase One's opening act was the exchange of a few astronauts and cosmonauts. Sergei Krikalev and Vladimir Titov came to the United States to learn English, NASA operating procedures and shuttle safety systems. Norman Thagard, Bonnie Dunbar and Ken Cameron moved to Moscow. They had a chilly reception.

Thagard, a decorated Vietnam jet fighter pilot, medical doctor and veteran astronaut, was to become the first American to visit Mir. Thagard and Dunbar, his backup, spent their days in classrooms absorbing technical books and lectures on Russian spacecraft. By night, they worked to become more proficient in Russian.

The Americans were isolated culturally as well, eating at a separate table in the Star City cafeteria, unable to routinely telephone family and friends back home, and denied even a map of Star City, which was considered classified information.

On March 14, 1995, Thagard said goodbye to his family and rocketed into orbit for the fifth time in his 20-year NASA career. This time, he made history, becoming the first American to ride aboard a Russian Soyuz rocket.

At first, Thagard was busy. There was equipment to set up and experiments to run and always a hunt for the proper tools to do the job. Mir had the look of a well-used utility closet, with dozens of items placed for convenience - not tidiness - floating in zero gravity.

Thagard's flight was the pathfinder for the series of joint US-Russian missions intended to pave the way for the International Space Station. He was sent to scope out the problem areas and report his findings back to NASA managers. But, by the end of the year, Thagard left NASA.

Thagard's D-Day came on June 29, 1995, when the shuttle Atlantis slipped into a berthing port at Mir to begin the first jointly controlled US-Russian space flight since the Apollo-Soyuz linkup two decades earlier. The docking was the first full-court demonstration of the technical compatibility of the two countries' space programmes and it was a vision of their futures. The American-Russian space partnership may not have been a match made in heaven, but the orbital liaison showed it was more than a marriage of convenience.

Until Atlantis arrived at Mir, the US space shuttle had only been used to reach satellites and low-Earth orbit. Until Atlantis arrived, the Russians, the world's acknowledged masters of long-duration space flight, had never been able to return viable samples of cosmonauts' blood, urine and saliva to help scientists unravel the biochemical effects of micro-gravity on the human body. The Russians also hadn't had the ability to return unneeded and broken equipment for analysis and repair.

The docking displayed an uncanny technical compatibility. For example, the docking port Atlantis occupied was intended for the Russian shuttle Buran, which was mothballed after one showcase flight. And the water produced by the shuttle's fuel cells - routinely dumped overboard as waste - was carefully bagged and transported to Mir, a precious and life-sustaining commodity that previously could only be delivered by expensive Russian cargo carriers.

After Thagard's groundbreaking flight, six more American astronauts lived on the Mir space station between March 1996 and the scheduled end of the Phase One programme next month.

Shannon Lucid's mission on Mir, from March to September 1996, began an unbroken two-year presence of US astronauts in orbit. She and her successor, John Blaha, had an easier time on Mir, largely as a result of Thagard's early reports. Lucid broke the US record for long-duration space flight when her ride home was held up two months because of a technical

problem with the shuttle. She took the delay in stride, displaying the same good-natured manner with which she handled shortcomings in her science programme and her lack of fluency in Russian.

Scientist by training, Lucid enjoyed the peace and solitude of having her own laboratory to work in. She built a bookcase in a nook of the Spektr module and stocked the shelves with novels and other favourites. Her time on Mir was productive and peaceful.

Lucid was the only female US astronaut stationed on Mir. Colleague Wendy Lawrence, who was to have flown the sixth increment, was removed from flight status after Russian space officials added space-walks to the list of requirements for US participants in the Mir programme. Standing 5 feet 4 inches, Lawrence was too small to fit into the available supply of Russian spacesuits. The ability to conduct a space-walk became an issue after a series of accidents occurred on Mir and medical concerns were raised about one of the Mir commanders, which prevented the cosmonaut from making a space-walk.

John Blaha took over Lucid's post in September. A former shuttle commander, Blaha was intrigued by the prospect of long-duration space flight and accepted the position of researcher to fly on Mir. Although his experiences on Mir were unmarred by the accidents and equipment failures that plagued his successors' flights, Blaha was forced to fly with a Russian crew he barely knew. Just before they were set to launch to Mir, the primary crew was bumped from the flight when a medical exam revealed the intended Mir commander, Gennadi Manakov, had a possible heart problem. Blaha had difficulty adjusting psychologically to the isolation and repeatedly said he missed his wife, Brenda.

Lucid, who stayed with NASA, and Blaha, who has since left the agency, were both married with grown children. The highly publicised troubles on Mir coincided with the flights of two men with young wives and pre-school-age children. Jerry Linenger relieved Blaha in January 1997. A month later, a defective chemical oxygen candle caught fire, setting off a string of problems on Mir and igniting a crisis on Earth. NASA used the incident to improve the lines of communication between Russian flight controllers and NASA managers, who were not told of the fire until several hours later. The reports also downplayed the seriousness of the accident, which nearly prompted the crews on Mir to evacuate. NASA learned later that the fire blocked access to one of the ship's two emergency escape craft and that fire-fighting equipment was not readily available.

Mir also developed problems with its cooling system, leading to the release of toxic antifreeze into the station's air. Linenger learned to sleep with his face by a ventilator. He let his hair grow out and wrote poignant letters home addressed to his year-old son. Linenger's wife was pregnant with their second child during his four-and-a-half-month flight. Upon returning to Earth, Linenger questioned the wisdom of continuing to send US astronauts to Mir if no productive science could be done. He also left NASA and returned to his home state of Michigan.

The problems on Mir were only beginning. Linenger's replacement, Michael Foale, weathered a dangerous cargo ship crash in June. The unmanned Progress, which was being remotely controlled by the Mir commander, smashed into the Spektr module and pierced the outer hull of the ship's skin.

Working quickly to contain the leak, the Mir crew sealed off the damaged lab and saved the station. The accident halved Mir's available power and set off a wave of equipment problems that raised questions and congressional inquiries about the station's health, productivity and safety.

Independent commissions looked into the incident and reported to NASA Administrator Dan Goldin, who waited until the night before Foale's replacement, David Wolf, was to be launched to approve the flight. Saying he was personally responsible for the lives of the astronauts, Goldin accepted the panels' findings that Mir was safe. Wolf was shuttled to Mir in September 1997 and was able to resuscitate the stalled US science programme.

When it came time to launch Wolf's successor, Andrew Thomas, the critics had evaporated.

The author is a Florida-based wire service reporter and freelance writer, who has covered US and international space programmes for 10 years. SOURCE: INTERNET