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The U.S.-Russia Space Experience: A Special and Unique Partnership

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This past July marked the second year since the space shuttle last flew in space. Yet there were two Americans on board the International Space Station (ISS). For the first time in the 50-plus years of spaceflight history, the United States is relying on another nation to fly its astronauts to space. One can lament and complain that this is the case, but this is the reality—a surprising reality for many Americans but a fortunate reality for our civilian space program. Born in the shadow of a Cold War, the American civilian space program has haltingly moved into an international collaborative venture. However, it is the Russians with whom we share a legacy of manned space flight. Perhaps, it is this legacy that makes this partnership surprisingly supportive. Our new partner now ferries our astronauts to the ISS, a laboratory built in space at considerable cost by this nation and our international partners. The men and women who work under this collaborative partnership seem oblivious to the many international diplomatic conflicts between the U.S. and Russia. It truly has become a very special and unique partnership. Like it or not, American astronauts are now launched to space from Baikonur, Kazakhstan, on Russian Soyuz spacecraft. Baikonur is located over 1300 miles southwest of Moscow, east of the Aral Sea on the route of the Moscow-Tashkent railway. It lies near the Syrdarya River, one of the major rivers of Central Asia, in a semi-arid zone with a sharply continental climate. It has hot dry summers and frosty winters with strong winds and little precipitation. In the summer, temperatures can go as high as 113° F, and in the winter it can drop down to -40°F. The yearly average temperature is about 55°F. I have had the opportunity to visit Baikonur a number of times and observe launches. In July 2012, I returned to Baikonur to observe the launch of yet another crew to the ISS. The preparations and activities leading up to this launch were typical of past flights from Baikonur, and future crews can expect the same.

It was July 15, 2012, about 8:00 am in Kazakhstan on launch morning, and the Soyuz launch vehicle was in the final stages of its countdown. The temperature was in the 80s with a light breeze blowing. The sky was clear with only one fairly thin high cirrus cloud. Two astronauts and a Russian cosmonaut were waiting to be launched on a flight to rendezvous with the orbiting ISS. The spacecraft and launch vehicle had been rolled out to the launch pad horizontally by rail three days earlier. The rail car had backed up to the launch pad, and the launch vehicle and the spacecraft were erected vertically on the launch pad—the same one that Yuri Gagarin had been launched from more than 51 years earlier, on April 12, 1961.

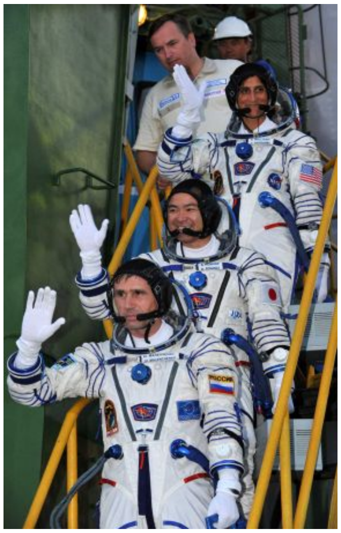
The crew had been awakened just after midnight. After eating breakfast they departed from the Cosmonaut Hotel, waving to a large crowd of well-wishers as they headed toward the launch complex and Building 254. They underwent their final medical check-ups and donned space suits in preparation for launch. At a little after 6:30 am they marched from the building and presented themselves to Vitaly Alexandrovich Lopota, president of Energia, and Vladimir Popovkin, director of Roscosmos, and received a formal "go" for launch, a longstanding tradition going all the way back to Gagarin's historic flight.

Photo 1.

Expedition 32 crew members receive a formal "go" for launch from Vitaly Alexandrovich Lopota, president of Energia (left) and Vladimir Popovkin, director of Roscosmos (right), prior to their launch onboard the Soyuz TMA-05M on July 15, 2012, at the Baikonur Cosmodrome in Kazakhstan. Credit: NASA/Victor Zelentsov

Following the formal approval for launch, with about two hours to go before lift-off, the crew departed from Building 254 for the launch pad. Upon arriving, they waved to the launch team and mounted the ladder leading up to the elevator that would take them to the spacecraft.

Photo 2.



Expedition 32 crew members prepare to board the Soyuz launch vehicle.

Credit: NASA/Victor Zelentsov

The countdown proceeded smoothly and precisely at 8:40 am, the Soyuz TMA-05M was launched carrying Yuri Malenchenko, Sunita Williams, and Akihiko Hoshide into space to rendezvous with the ISS. It was a flawless launch with the spacecraft silhouetted against a bright blue sky as it climbed ever higher until it pierced through the one high cirrus cloud and became only a bright glow. It had been almost a year since the last space shuttle, Atlantis, had touched down at the Kennedy Space Center on July 21, 2011. Soyuz TMA-05M was the fourth flight of a Russian spacecraft that transported crews to the ISS since that last space shuttle flight.

Photo 3.

The Soyuz TMA-05M mission lifts off to the ISS.

Credit: NASA/Victor Zelentsov

Today, the road to space for the United States and its international partners on the space station goes through Baikonur, Kazakhstan, and its Soyuz launch pad. The Soyuz spacecraft launched that Sunday morning is the only means, other than flying in a Chinese spacecraft, to fly Americans to space. Unfortunately (or fortunately), it will remain this way for a very long time to come. It might not have turned out this way had leadership and vision prevailed.

Another U.S. spacecraft could have been operational seven years before the space shuttle program ended in 2011. However, considering the leadership and vision that did prevail, we are indeed most fortunate to have a partner in Russia that provides the means for U.S. astronauts to continue to fly in space. It is representative of the cooperation in space that was envisioned by a visionary young president, John F. Kennedy, over 50 years ago.

Since I observed that launch on that morning in July, Yuri Malenchenko, Sunita Williams, and Akihiko Hoshide returned from the Station on November 19, 2012, and four more crews have flown to the ISS, with three of those crews also returning successfully to Earth. The flight on October 23, 2012, included American astronaut Kevin Ford and Russian cosmonauts Oleg Novitskiy and Evgeny Tarelkin. A second flight launched from Baikonur on December 19, 2012, carrying the first Canadian commander of the ISS, astronaut Chris Hadfield. That crew included

American astronaut Tom Marshburn and Russian cosmonaut Roman Romanenko. A subsequent flight on March 28, 2013, carried Pavel Vinogradov, Aleksandr Misurkin, and Christopher Cassidy to the Station. A launch from Baikonur on May 28, 2013, took Fyodor Yurchikhin, Luca Parmitano, and Karen Nyberg to the Station. A total of five American astronauts, including Sunita Williams, have flown to the space station since July 2012, with both Chris Cassidy and Karen Nyberg still on the Station this past July. Cassidy returned to earth on September 11, 2013, along with cosmonauts Pavel Vinogradov and Aleksandr Misurkin. On September 25, 2013, another American astronaut, Mike Hopkins, will be launched from Baikonur, along with two Russian cosmonauts, Soyuz Commander Oleg Kotov and flight engineer Sergey Ryazanskiy. By May 2015, seven more Americans, in addition to Hopkins, will have followed the road to space and the ISS that runs through Star City and Baikonur.

The Russians have proven to be a good partner, and the ISS would not be flying today without their capabilities and their cooperation. They not only provide transportation to and from the space station, but they also provide the Soyuz spacecraft that remains docked to the ISS for six month periods and serves as the rescue vehicle for our astronauts aboard the Station. Now with a crew of six astronauts, they are providing two Soyuz spacecraft to serve as rescue vehicles. Their Progress spacecraft also routinely supports the Station logistically with cargo. They clearly are providing significant support to the ISS. A much different support scenario has evolved with our Russian partnership than the support concept when the Station program was in its infancy in the 1980s. The leadership that conceived and produced the Station program envisioned that the Station elements would be flown to orbit via the space shuttle. The shuttle would then support the Station's orbital assembly and the shuttle would continue to fly astronauts to the Station and support it logistically.

Rescue vehicles, such as the Soyuz spacecraft currently docked to the ISS, and the dual access capability to the Station provided by Russia, were never intended to be a part of the Space Station Freedom program. This optimistic view continued even after the Challenger accident in 1986, which grounded all shuttle flights for almost three years, although concerns were expressed about the lack of a docked rescue vehicle and the dependence on the expected continued availability of the space shuttle. The Aerospace Safety Advisory Panel (ASAP) commented in its 1988 report to NASA that it was concerned about NASA's ability to maintain the currently manifested launch rate required for assembly of the space station Freedom. The panel felt that depending upon the space shuttle alone to accomplish this task was too risky, and the use of expendable launch vehicles (ELVs) could alleviate pressure to achieve overly optimistic flight rates for the space shuttle. The ASAP in its 1988 report also reiterated its position on assuring the availability of a crew rescue vehicle (CRV), and stated "that a single-purpose crew rescue vehicle or lifeboat should be an essential part of the space station's design." Such a rescue vehicle was never made a part of the Space Station Freedom design.

By 1988, NASA had formed international partnerships for the Station with Canada, the European Space Agency (ESA), and Japan. However, it wasn't until September 1993, that Vice President Al Gore and Russian Prime Minister Viktor Chernomyrdin announced plans for Russian participation in the ISS. Russia had a great deal to offer the partnership. Its involvement would assure dual access to the Station, and in the event of a problem with the shuttle or the Soyuz launch vehicle, continued access to the Station. Russian involvement also assured the availability of a docked CRV, the Soyuz spacecraft, during manned operations. Dual access and the availability of the Soyuz as a CRV addressed both of the concerns previously identified by the ASAP in its 1988 report. In October 1993, all the space station partners—Canada, the ESA, and Japan—formally extended an invitation to Russia to participate as a partner in the ISS program. The inclination of the ISS was changed to 51.6 degrees in order to ensure their cooperation and launch vehicle support. An inclination of 51.6 degrees is the lowest inclination orbit into which the Russians can directly launch their Soyuz and Progress spacecraft without encountering over flight limitation with their launch vehicles. The new inclination also provided the added benefit that the Station now flew over most of the habitable areas on the Earth. The wisdom of that decision provided the redundancy to ensure the presence of essential capabilities in the face of technical failures. After successive Russian Proton rocket failures in 1999, which temporarily halted Russia launches of ISS components and equipment, the shuttle served as the sole provider of a heavy launch capability.

With the tragic loss of the shuttle Columbia during her voyage home at the end of the STS-107 mission, on February 1, 2003, the U.S. manned space program was essentially grounded for an indefinite period and the construction of the Station was delayed during that period. The benefits of redundant access to the ISS rapidly became apparent. Despite the possibility of leaving the

Station uninhabited during the hiatus in the U.S. manned space program, Russia committed to keep the outpost manned. The Russian Soyuz spacecraft, having previously played the role of a "lifeboat," re-emerged as the only link to the Station. At the same time, the Russian Progress cargo ships became the only supply line from Earth to the Station. In order to save resources onboard the Station in the absence of the shuttle, partners agreed to reduce the long-duration crews from three to two people. With the demise of the space shuttle in 2011, these Russian capabilities now have become essential for the U.S. human spaceflight program.

When the U.S.-Russian partnership was formed, it consisted of two phases. Phase I provided for U.S. involvement with Russia's ongoing Mir space station program. Phase II covered the two nations working together on the ISS. During Phase I, space shuttles would take part in the transportation of supplies and crews to and from the Mir space station and U.S. astronauts lived on the Mir for extended periods. The shuttle-Mir program proved to be a great learning experience for the U.S., and it would be a major factor in helping to assure the success of the ISS program.

In February 1995, shuttle mission STS-63 rendezvoused with Mir but did not dock. Phase I continued with a total of nine shuttle-Mir docking missions—the first, STS-71, in June 1995 and the last, STS-91, in June 1998. The shuttle rotated crews and delivered supplies and on one mission, STS-74, carried a docking module and a pair of solar arrays to Mir. Various scientific experiments were also conducted, both on shuttle flights and during long-term stays aboard the Mir station. During the course of the shuttle-Mir Phase I program, seven American astronauts flew long-duration flights aboard Mir. The project also saw the launch of two new modules to Mir: Spektr and Priroda. These were used by American astronauts as living quarters and laboratories to conduct the majority of their science aboard the Station. These missions were a great learning experience for the U.S. and Russia on working together as international partners in space. These missions also provided the experience needed to minimize the risks associated with assembling a large space station in orbit, namely the ISS.

On November 20, 1998, the first component of the ISS, the Zarya module, was launched on an unmanned mission. Following this launch, and prior to Expedition 1, there were five manned space shuttle flights and two unmanned Russian flights to the ISS. These flights delivered large modules, the pressurized Unity and Zvezda modules, and the first piece of the integrated truss structure. The manned flights were used for partial assembly of the ISS as well as unpacking supplies and equipment that were being delivered. The first long-duration crew, Expedition 1, launched on October 31, 2000, from Baikonur aboard the Russian spacecraft Soyuz TM-31 and docked with the ISS two days later. The three-person Expedition I crew stayed aboard the Station for 136 days. It was the beginning of what has become an uninterrupted human presence on the. As the space station increased in size and capability, it could support additional crew members and in July 2009, the crews on each expedition mission were increased to six. Because a Soyuz spacecraft can carry only a crew of three, since July 2009, Russia has been providing two Soyuz spacecraft docked to the space station to support the larger crew. As of September 2013, a total of 37 Expedition missions will have been flown to the space station with an average stay time of approximately six months for each crew member.

In an effort to avoid needing a second Soyuz spacecraft should a six-member crew be desired, in early 1995, a small in-house study was initiated at NASA's Johnson Space Center (JSC) to explore the possibility of developing a CRV that would be able to hold up to seven crew members. This new vehicle concept was designated the X-38. The vehicle as conceived and designed could either be taken to the space station in the payload bay of the shuttle or could be launched on an expendable launch vehicle. This study subsequently became a program conducted under the leadership of JSC.

The X-38 design used the wingless lifting body concept originally developed and flown in space by the U.S. Air Force in the mid-1960s. That Air Force vehicle was designated the X-24. With the capability of being launched on an expendable launch vehicle, there was great interest on the part of the ESA. In an unusual move for an X-plane, an offer was made to ESA to become a part of the program and contribute their resources to the development of the spacecraft. Both ESA and the German Space Agency (DLR) subsequently became partners in the program. The X-38 was a smaller version of the 1960s X-24 lifting body and used a parafoil for landing.

Commercial off-the-shelf equipment and components were used for 80 percent of the spacecraft. The vehicle was developed in-house by JSC at a fraction of the cost of previous human space vehicles. NASA intended to break all precedents by developing the manned vehicle and delivering four flight units for under $500 million.

Photo 4.

The X-38 "lifeboat" flies free from its B-52 mother ship.

Credit: NASA

Later, more elaborate life support, altitude control, and avionics systems could be added to the basic airframe to provide a manned spacecraft that could be launched from the Ariane 5, Atlas 2, Delta 3, H-2, Proton, or Zenit launch vehicles. The X-38 was also designed to be able (with a propulsion unit and added systems) to carry crews from Earth orbit to rendezvous with exploration vehicles in higher orbits for flights to the moon. About 100 people worked on the project at JSC, Dryden Flight Research Center (DFRC), and the Langley Research Center in Hampton, Virginia. This was the first time a prototype vehicle had been built-up in-house at JSC rather than by a contractor. It was an approach that had many advantages. By building-up the vehicles in-house, engineers had a better understanding of the problems contractors experienced when they built vehicles for NASA. JSC's X-38 team had a detailed set of requirements for the contractor to use to construct the CRVs for the ISS. This type of hands-on work had been done by the National Advisory Committee on Aeronautics, NASA's predecessor, before the space age began.

Photo 5.

X-38 sails to a landing at NASA Dryden Flight Research Center.

Credit: NASA

In early 1996, a contract was awarded to Scaled Composites, Inc., of Mojave, California, for the construction of three full-scale atmospheric test airframes. The first vehicle airframe was delivered to JSC in September 1996. Engineers at NASA's DFRC in Edwards, California, and JSC in Houston, Texas, were involved in the flight testing of the X-38, the first new human spacecraft built in two decades. Full-scale, unpiloted "captive carry" flight tests began at DFRC in July 1997, with the vehicle flown while attached to NASA’s B-52 aircraft. Unpiloted free-flight drop tests from the B-52 began in March 1998. The X-38 CRV was targeted to begin operations aboard the ISS in 2004, seven years before the end of the space shuttle program. On March 5, 1999, the X-38 successfully deployed its parafoil, tested the rudders and flaps, and glided to a landing on the lakebed after a nine-minute flight. On November 2, 2000, the updated vehicle was successfully drop-tested over Edwards Air Force Base. On its first flight in space, an unmanned X-38 vehicle was to be deployed from a space shuttle and descend to a landing on Earth. The X-38 CRV was targeted to begin operations aboard the ISS in time to support a larger Station crew of six astronauts and cosmonauts. On April 29, 2002, NASA announced the cancellation of the X-38 program. The first X-38 to be tested in space was nearing completion.

Two years later, in January 2004, President George W. Bush announced a new program to carry Americans back to the moon as early as 2015 and to establish a long-term base there as an eventual springboard to Mars and beyond. The ISS would continue and its assembly would be completed. Following its completion, the space shuttle fleet would be retired in 2010. The die was cast and the U.S. was destined to become dependent on our Russian colleagues for our human ventures into space. We are indeed fortunate to have Russia as a partner in our human spaceflight endeavors. As we look to the future and human exploration flights beyond Earth orbit, we should not only retain our existing partnership but also work together in planning and implementing a collaborative exploration program.

On September 20, 1963, President John F. Kennedy gave an address to the General Assembly of the United Nations. He said the task of building peace was the responsibility of leaders from every nation, large and small. Then he spoke of cooperation in space:

> Finally, in a field where the United States and the Soviet Union have a special capacity in the field of space, there is room for new cooperation, for further joint efforts in the regulation and exploration of space. I include among these possibilities a joint expedition to the moon. Space offers no problems of sovereignty; by resolution of this Assembly, the members of the United Nations have foresworn any claim to territorial rights in outer space or on celestial bodies, and declared that international law and the United Nations Charter will apply. Why, therefore, should man's first flight to the moon be a matter of national competition? Why should the United States and the Soviet Union, in preparing for such expeditions, become involved in immense duplications of research, construction, and expenditure? Surely we should explore whether the scientists and astronauts of our two countries—indeed of all the world—cannot work together in the conquest of space, sending some day in this decade to the moon not the representatives of a single nation, but the representatives of all of our countries.

We have already come a long way in our partnership with Russia on the ISS. Perhaps this unique rapport may serve as a model for other more contentious areas of our bilateral relationship.

Let us not lament our present situation relative to the lack of a U.S. human launch capability, but be thankful we have a good partner that can support our human spaceflight endeavors. As we look to the future, we should heed the lessons we are learning on the ISS, be realistic about space exploration beyond Earth orbit, build on the foundation of the Station and our partnerships, and do human exploration from the onset together. By embarking on such an exploration program together in this new decade, we could finally make President Kennedy's words spoken to the General Assembly 50 years ago a reality in this new century.