Imagine you’re a NASCAR racer zipping around the racetrack at 200 miles per hour (mph), but – just to make it more interesting – you are also building your car during the race. That would be a challenge, right?

Mission Specialist Soichi Noguchi moves along an International Space Station truss during the first STS-114 spacewalk. During this excursion, he and fellow spacewalker Steve Robinson worked on one of the Station’s control moment gyroscopes.

All ARTICLES CREDIT: NASA

RACING THROUGH SPACE

HUMAN ACHIEVEMENT REACHES A PINNACLE ON THE INTERNATIONAL SPACE STATION

BY ADAM MORGAN & MELISSA MATHEWS
In his 1984 State of the Union speech, U.S. President Ronald Reagan directed NASA to build a permanently-crewed space station. “America has always been greatest when we dared to be great,” he told Congress. “We can reach for greatness again. We can follow our dreams to distant stars, living and working in space for peaceful economic and scientific gain.” He invited international participation.

Russia (then the Soviet Union) began constructing MIR in 1986. It was the world’s first consistently inhabited long-term research station in space. The United States planned to follow the MIR space station with a Space Station Freedom in the 1990s, while the United States planned to build a station called Freedom – an effort that included partnering with space agencies in Europe, Canada, and Japan. Funding difficulties brought the U.S.-led international team and the Russians together in 1993 to build a combined station – the International Space Station.

Conceived as an international undertaking from the beginning, the ISS was designed, built, and launched from locations spanning the globe. Space exploration is “one area of human endeavor in which we are indisputably continuing to lead the world,” said U.S. President Bill Clinton in 1993. Science and technology partnerships, he said, “are the keys to our future as a people, to our standard of living, to our quality of life as well as to our ability to continue the American tradition of exploration.”

Recently recognized by the National Aeronautics Association with the 2009 Collier Trophy “for the design, development, and assembly of the world’s largest spacecraft,” an orbiting laboratory that promises new discoveries for mankind and sets new standards for international cooperation in space, “the ISS is an undertaking in a class by itself. It shatters the mold as an engineering, scientific, management, and diplomatic achievement.

“Nothing this complex has ever been attempted before – plain and simple,” said Joe Bryant, vice president and program manager for Boeing’s International Space Station program. As the largest spacecraft ever built, its “wingspan is larger than a 747, yet it travels at Mach 25. Its pressurized cabin area is the size of a five-bedroom house but stores three times as much, because all surfaces – top, bottom, and sides – are utilized in the weightlessness of space.

Over the next four issues of AD Astra, we will tell the amazing story of the International Space Station. Starting with this overview, we will highlight the many successes as well as the many challenges of one of NASA’s, and mankind’s, most ambitious projects. Keep an eye out for the next three installments in the series including an in-depth look at how engineers and astronauts overcome obstacles 220 miles above Earth with limited logistical opportunity, bringing 15 nations together with a common goal, as well as the impact of the International Space Station on the future of space exploration.

WHERE DID IT ALL START?

Inhabited space stations go back as far as the early 1970s when the Soviet Union launched the world’s first space station, Salyut 1, in 1971 – a decade after launching the first human into space. The United States was not far behind with the launch of its Skylab in 1973.

Now imagine you’re flying 220 miles above the Earth, traveling at speeds of 17,500 mph and orbiting the Earth every 90 minutes. But this time, you’re building your house at those speeds. Oh, yeah, did I mention you’re also living in the house while you’re building it? That’s a challenge.

Well, that is exactly what has been happening over the past 10 years on the International Space Station (ISS). Fifteen nations from five major space agencies have been working together to design and build what has been coined “one of the greatest engineering feats of all time.”

To prepare for the project, space shuttles flew to Mir from 1995 to 1998 with U.S. astronauts serving on board the Russian station as researchers for as long as six months. A Russian Proton rocket launched the first ISS module from Baikonur Cosmodrome in Kazakhstan on November 20, 1998. The module was a Russian-built and United States-funded unit called Zarya. The second module, Unity, was built by the United States and was launched aboard NASA’s Space Shuttle Endeavour from Kennedy Space Center on December 4, 1998. The two were joined together in orbit.

Innovation has been a key factor in every aspect of the ISS development. Breakthroughs in round-the-clock multinational virtual design and construction took advantage of the latest communications and design software, forever changing international technical collaboration. Quality and attention to detail had to be perfect. Physical tolerances, for example, could not exceed three one-thousandths of an inch or risk an air leak. Since the major components could not be fit checked first on the ground, there was simply no room for error.

Boeing is NASA’s prime contractor for the design, development, integration, testing, delivering, and now sustaining all the U.S.-built elements of the ISS. The U.S. elements include three connecting modules, or nodes; a laboratory module; two solar array modules; three mating adapters; a cupola; and an unp pressurized logistics carrier. Boeing developed the thermal control system; life support system; guidance, navigation, and control system; data handling systems; power systems; and communications and tracking systems.

“Boeing and its heritage firms have had a leading role in every U.S. crewed spacecraft to date,” added Bryant. “The International Space Station work gave us an opportunity to harness that expertise and push ourselves to the next level as an aerospace firm.”

Boeing also integrates vehicle elements provided by the international partners. International partner components include: a Canadian-built 55-foot-long robotic arm and mobile servicing system used for assembly and maintenance tasks on the space station; a pressurized European laboratory called Columbus and logistic transport vehicles; a Japanese laboratory called Kibo, with an attached exposed exterior platform for experiments, as well as logistics transport vehicles; and two Russian research modules, an early living quarters called the Zvezda Service Module with its own life support and habitation systems, logistics transport vehicles and Soyuz spacecraft for crew return and transfer.

“GO FOR RESEARCH”

The International Space Station is, in every sense, now an orbiting laboratory and, as NASA literature puts it, “It’s GO for research.” The ISS has integrated over 20,000 kg of hardware and software, supporting over 200 unique research investigations by more than 1,500 scientists – all while ISS assembly and construction was still underway.

“...there are great expectations and initiatives underway for even more improved scientific return now that ISS assembly is complete,” added Bryant.

In 2005, the U.S. Congress authorized NASA to establish the American segments of the station as a National Laboratory, and encouraged NASA to open research opportunities to other federal entities, as well as private researchers. The full capability of initial ISS resources are in place – and the crew complement has grown from two to three...
Without the space shuttle to service the space station, how would it survive?

The partnership came together, and – with a sense of determination and innovation not seen in the space program since Apollo 13 – came up with solutions. Further assembly of the station would be put on hold, until the shuttles could once again ferry up the giant parts. Crew would be transported on the much smaller, but reliable, Russian Soyuz. The crew size would be reduced from three to two, to cut down on the need for food, water, and other consumables.

The partnership quite literally saved the International Space Station. But despite its obvious benefits, there were technical challenges that came with internationalization. Engineers were responsible for integrating all the elements, whether U.S.- or foreign-made, and getting them ready for flight.

“Here’s the kind of situation we were dealing with,” explained Mulqueen. “Because of the nature of the ISS agreements, an Italian aerospace company may have built a NASA element that had to integrate seamlessly with a piece of Russian hardware. This was new territory for space programs.”

But internationalization also made the space station program, well, more fun. Suddenly, astronauts and engineers were also expected to be linguists and diplomats. During spacewalks, astronauts and cosmonauts would have to switch seamlessly between English and Russian as they communicated with mission control in either Houston or Moscow. U.S. astronauts became conversants of freeze-dried Russian space fare.

The diploma and cross-cultural exchanges may someday prove to be one of the most significant by-products of the International Space Station, but today the space station’s raison d’être continues to be hardcore science and technology.

Nearly a decade after its first residents climbed on board, the International Space Station is nearly complete and ready to enter its most exciting phase. In the U.S., the Obama administration just proposed supporting research on the station through the end of the decade, five years longer than originally envisioned. The International Space Station can now teach us to find our way back to the stars.

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The international Space Station is featured in this image photographed by an STS-128 crew member on space shuttle Endeavour after the station and shuttle began their post-undocking relative separation. Undocking of the two spacecraft occurred at 7:54 p.m. (EDT) on February 19, 2010. Preparing for re-boost was Japan’s H-II Transfer Vehicle (HTV-2), which undocked from the International Space Station at 11:43 p.m. (EDT) on February 20, 2010. The spaceship, along with cargo and trash, was returned to Earth for disposal.

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