

National Aeronautics and Space Administration



# Roundup

Lyndon B. Johnson Space Center

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**SPECIAL EDITION**  
The International Space Station  
celebrates **10 years** of continuous habitation

# Guest Column



## On the cover:

*This November Roundup celebrates 10 years of continuous human habitation aboard the International Space Station and what that milestone means for the future of spaceflight.*



PHOTO: JEN SCHEER

## Photo of the month:

*Chapter One begins for the International Space Station. This high-angle image of the Space Shuttle Atlantis was photographed by the three-man Expedition One crew aboard the station shortly after the shuttle undocked from the outpost.*

**The** assembly of the International Space Station is an extraordinary achievement that began with the launch of the first component of the station on Nov. 20, 1998. The assembly of the space station has strengthened the international partnership between five space agencies and its 15 nations. We at NASA, and especially Johnson Space Center, have worked together with them to achieve one of the greatest technological, geopolitical and engineering accomplishments in human history.

Since Nov. 2, 2000, humankind has maintained continuous existence in space onboard station with the arrival of the first station crew: William Shepherd, Yuri Gidzenko and Sergei Krikalev. This November, we celebrate 10 years of continuous existence at station with the 25th crew.

As we look forward to the next 10 years, taking us through 2020, the space station will serve many roles. With a permanent human presence, it will serve as a foothold for long-term exploration into space, being an integral part of human endurance testing, equipment reliability and processes essential for space exploration. The partnership, which constructed the station, will serve as the foundation for the international technological collaboration needed to further man's reach into space.

In these next 10 years and closer to home, the space station, as a national laboratory, will provide opportunities to academia, commercial entities and other government agencies to pursue their research and development needs in support of a wide range of scientific inquiries in biology, human physiology, physical, materials, Earth and space sciences. Station will also be the first destination of commercial endeavors in low-Earth orbit with the safe delivery of cargo and crew.

These pursuits of knowledge at the station, through the research from scientists all over the world, will develop and test the means to enable long-duration human spaceflight and improve life here on Earth for people of all nations. Thank you for the role you have played in making the International Space Station a reality.

Michael T. Suffredini  
International Space Station Program Manager

## In this edition ...

- 3** Open for business: Research on the International Space Station National Laboratory
- 4** Johnson Space Center team members weigh in ...
- 6** Ten years and counting
- 8** Human research aboard the International Space Station
- 9** Setting a shining (green) example
- 10** Meet Gregory Tobeck, Manager
- 11** Top 10 International Space Station challenges
- 12** Special deliveries



NASA PHOTO

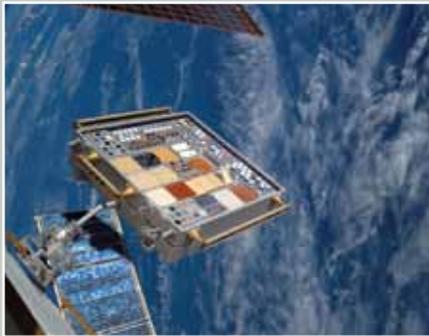
# Open for business: Research on the International Space Station National Laboratory



By Sean Elizabeth Wilson

**Assembly** complete for the International Space Station is on the horizon, and with it comes a wealth of new resources for scientific research. The agency intends to use just half of its assets for NASA research, leaving the rest to users eligible under National Laboratory guidelines established by Congress in 2005.

“The point of the National Laboratory is to open up the use of station for non-NASA requirements,” said Marybeth Edeen, National Laboratory manager. “It’s a significantly different approach than how we have used station in the past for exploration or extending human presence in space. This is really for the applications that will benefit the economy or life on Earth or education that are not typically what NASA would use the station for.”



NASA/PHOTO ISS015E22410

**Results from MISSE tests have led to changes in materials used in dozens of spacecraft built over the last five years.**

Under National Laboratory agreements, NASA currently works with a number of other government agencies and commercial customers who are using the station for commercial, research or business objectives. Two of the early pathfinders for National Laboratory research were Bioserve Space Technologies out of Boulder, Colo., and Astrogenetix out of Austin, Texas.

With research led by Dr. Timothy Hammond at the Durham Veterans Affairs Medical Center and Dr. Cheryl Nickerson at Arizona State University, BioServe and Astrogenetix have both flown experiments using microgravity in their search for therapeutic agents or vaccines against Salmonella bacteria.

“They looked at Salmonella and developed a candidate vaccine that’s being evaluated as an investigational new drug under the Food and Drug Administration,” said Dr. Julie Robinson, program scientist for the space station.

Additional legislation was added in 2007 to incorporate science, technology, engineering and math education into the National Laboratory’s activities. In late 2009, Bioserve flew larvae of Monarch and Painted Lady butterflies to the station so students could watch how the butterflies develop in the weightless environment of space.

“It had a huge impact,” Robinson said. “There were tens of thousands of students watching the butterflies’ life cycles in orbit.”

In addition to biotechnology research and education, the National Laboratory is heavily involved in technology testing. With the Materials International Space Station Experiment (MISSE) - 6a, 6b and 7 experiments, teams comprised of Marshall Space Flight Center, Langley Research Center, the Department of Defense, the Naval Research Laboratory and Boeing, have tested materials on pallets located outside of the station for use in future satellites to determine how they withstand the space environment.

“Boeing has told us that by testing materials they are considering for future spacecraft on the station first as a part of MISSE, they can cut development schedules for some of these materials as much as 50 percent,” Robinson said. “They’ve looked at solar cells, blanket materials and paints and all kinds of different materials to make sure they work well in space before they use them.”

*The station’s assets include: freezers for the preservation of biological samples; glove box to handle hazardous materials; small centrifuge to introduce artificial gravity; window for remote sensing; and Earth- and space-facing external science platforms.*



NASA/PHOTO s128e007560

**STS-126 Mission Specialist Shane Kimbrough works with the Group Activation Pack for the National Lab Pathfinder Vaccine-2 experiment.**

During station Expedition 25/26, there are 25 investigations ongoing that are National Laboratory payloads. For Expedition 27/28, there are closer to 30 National Laboratory payloads planned. With this much science happening onboard the station, it is inevitable to question accessibility following the shuttle’s retirement. However, accommodations are being made to ensure National Laboratory payloads in the future.

NASA is funding the partial development of two U.S. commercial transportation providers, SpaceX and Orbital Sciences Corp., while at the same time coordinating with the Europeans, Japanese and Russians for the launch of science payloads in the Automated Transfer Vehicle, H-II Transfer Vehicle and Progress.

“We have an integrated plan and all of the current vehicles in a common pool, and we all work together to optimize a research plan,” Robinson said. “That plan will utilize the upmass from all of those vehicles to get the science to orbit at the right time.”

*The National Laboratory and its capabilities support experiments in fields ranging from fundamental biology and physics to biotechnology and Earth observations. Advances in the fight against food poisoning, new methods for delivering medicine to cancer cells and better materials for future spacecraft are among the many findings so far.*

# Johnson Space Center team members weigh in ...

*What's one thing most people don't realize about the space station?*



Compiled by Jenny Knotts

*There are as many answers to this question as there are people to ask.*

*This month, the International Space Station celebrates 10 continuous years of humans living onboard the orbiting outpost and 12 years since the first element, Zarya, launched. We wanted to find out from team members some of the little-known facts about the space station.*

"The International Space Station made television history in November of 2006 by downlinking live HDTV from space in conjunction with NASA, the Japanese Aerospace Exploration Agency, Discovery Channel and NHK (Japanese Broadcasting Company)."

– Dylan Mathis, OX, NASA

"An astronaut ran the Boston Marathon in space. She finished, unofficially, four hours, 23 minutes and 46 seconds later as the station traveled over Russia."

– Nicole Cloutier-Lemasters, AD93, NASA

"The International Space Station is larger than a football field, including end zones, and weighs almost 1 million pounds, which is about what more than 320 automobiles weigh."

– Rose Rodriguez, OX, Rede Critique



NASA/PHOTO ISS02005E22365

*Expedition 11 Station Science Officer and Flight Engineer John L. Phillips testifies via a video screen before the House Subcommittee on Space and Aeronautics as he orbited Earth aboard the International Space Station. Astronauts Peggy A. Whitson and Michael Fincke, former station residents, are visible at left.*

"I keep encountering people who don't realize that the International Space Station has been manned continuously for 10 years. They think we have people in space (only) when the shuttle flies."

– Kenneth G. Ransom, OC7, Barrios Technologies

NASA/PHOTO ISS01EG264



*Expedition 1 crew members build their own table out of spare parts.*

"When the Expedition 1 crew arrived onboard, they did not have a kitchen table. The eating area table that was supposed to be set up in the Service Module was scheduled to arrive on a later flight. So, Commander Bill Shepherd and Flight Engineer Sergei Krikalev built their own table out of spare parts. This table was later brought back to Earth and was transferred to the Smithsonian National Air and Space Museum."

– Ginger Kerrick, DA8, NASA

"Each day the space station travels the equivalent distance to the moon and back."

– Elisa Morales, AD94, Rede Critique



NASA/PHOTO ISS011E12415

*Aurora Borealis and lights in Finland, Russia, Estonia and Latvia are featured in this digital still picture taken by the Expedition 11 crew aboard the station. The cluster of stars to the lower right of the thin crescent moon is the Praesepe, or Beehive Cluster, in Cancer. Just to the right of that is the planet Saturn.*

NASA/PHOTO STS105-346-007



**Astronaut Patrick G. Forrester, during the second STS-105 spacewalk, prepares to work with the Materials International Space Station Experiment. The experiment was installed on the outside of the Quest Airlock during the first spacewalk of the STS-105 mission.**

“From what I’m told, building the International Space Station in space is like trying to change a spark plug or hang a shelf wearing roller skates and two pairs of ski gloves with all your tools, screws and materials tethered to your body so they don’t drop.”

– Linda Matthews-Schmidt, AD94, NASA

“Back in May 2001, during the Expedition 2 crew’s stay onboard the International Space Station, they had a very special delivery ... a pizza delivery! In a collaboration between Pizza Hut and Russian nutritionists, the Expedition 2 crew of Yuri Usachev, Jim Voss and Susan Helms enjoyed a freshly baked salami pizza delivered via a Progress supply vehicle.”

– Ginger Kerrick, DA8, NASA

“They are amazed at how small the ‘bedrooms’ are.”

– Sabrina Gilmore, DX351, NASA

NASA/PHOTO ISS020E043681



**Canadian Space Agency astronaut Robert Thirsk, Expedition 20 flight engineer, assembles and installs the Combined Operational Load Bearing External Resistance Treadmill (COLBERT) in its temporary place in the Harmony node of the space station.**

“In the International Space Station’s U.S. segment alone, 1.5 million lines of flight software code will run on 44 computers, communicating via 100 data networks transferring 400,000 signals (e.g., pressure or temperature measurements, valve positions, etc.).”

– Peggy Carruthers, OX, NASA

“Crews have eaten about 22,000 meals since the first Expedition in 2000. Approximately four tons of supplies are required to support a crew of three for about six months.”

– Jennifer McCarter, OX, NASA

“How immense it is. When you’re on final approach in the shuttle you can’t see it all out one of the windows; it dwarfs the shuttle. It’s like the Millennium Falcon approaching the Death Star ... it blows you away.”

– Garrett Reisman, CB, NASA



NASA/PHOTO ISS024E007390

**NASA astronauts and Expedition 24 Flight Engineers Doug Wheelock, Tracy Caldwell Dyson (center) and Shannon Walker pose for a photo with an American flag while aboard the International Space Station.**

“Living and working on the International Space Station is like building one room of a house, moving in a family of three and asking them to finish building the house while working full-time from home.”

– Vickie Rawls, OX, *Rede Critique*

“Most don’t realize how many or what countries are in the partnership. There are five space agencies and 15 nations that participate in this state-of-the-art vehicle.”

– Blake Ratcliff, OX, NASA

“The number of laptops onboard is astounding. Laptops are used for everything—vehicle command and control, caution and warning, procedures, Internet access, e-mail, personal use, robotics, payload ops and even playing music and movies while the crew is exercising. There are 82 laptops on the station, more than there are PCs in the flight control room in Houston. The crew gets very handy at keeping the network running onboard.”

– Michael Lammers, DA81, NASA

**What kind of fun facts do you know? Learn more about the space station at: [www.nasa.gov/station](http://www.nasa.gov/station)**

# Ten years and counting



By Jenny Knotts

**Ten** years ago, astronaut Bill Shepherd and cosmonauts Yuri Gidzenko and Sergei Krikalev launched into history as the first Expedition crew to live aboard the International Space Station. They blasted off from the Baikonur Cosmodrome in Kazakhstan on Oct. 31, 2000, and docked with the station two days later.

Their launch began a new era in history where not every human being lives on Earth. There will always be people living and working in space 24 hours a day, seven days a week, 365 days a year.

During his preflight interview, Expedition 1 Commander Shepherd was asked why it is important to build a space station. He said, "It gives us unique access to the space environment where we hope we can do very interesting and productive research, but it really means we (will) develop a lot of the capabilities and technology that'll allow humans to go elsewhere away from the planet."

Fast forward 10 years, and the space station has truly become that orbiting laboratory for research while keeping an eye to the future as a platform for testing new technologies and operations for the

***"The International Space Station is a magnificent laboratory, but also a very practical demonstration of what international cooperation can accomplish. It is the largest habitable volume likely to be seen in space for many decades, and needs to be carefully utilized to realize its full potential. It is an incredible venue for world space interests to come together, either in person or vicariously."***

***– Expeditions 19 and 20 Flight Engineer Dr. Michael Barratt***

next era of human spaceflight. As a research outpost, the station is a test bed for future technologies and a research laboratory for new, advanced industrial materials, communications technology, medical research and much more.

"The International Space Station represents an incredible international engineering accomplishment," said NASA Chief Astronaut Dr. Peggy Whitson. "The construction, assembly and operations could even be viewed as miraculous if you don't consider the huge efforts of our teams to make it look easy.

"To have constructed something on orbit greater than a football field in length, with more internal pressurized volume than a 747, with parts and pieces and participation from (15) countries around the world, (with) full-time 24-hour, seven days per week operations and human presence for 10 years, fills me with an incredible sense of pride in what our organization can accomplish," Whitson, also the station's first female commander, said.

While people on Earth have come together to build and operate the complex, the resident crews from around the world have also come

together in space. In May 2009, the station became home to its first six-person crew, Expedition 20, which also marked the first time at least one crew member from each of the supporting space agencies was onboard at the same time.

When asked what his favorite memory on station is, Expeditions 19 and 20 Flight Engineer Dr. Michael Barratt said, "The Earth views were stunning and microgravity is incredible, but my strongest memories were gathering around the galley table for food, music and wardroom conversation. Everyone who wasn't on the planet ate dinner there!"

Dr. Garrett Reisman, a flight engineer on Expeditions 16 and 17, said one of his favorite memories is spending a week sleeping in the Columbus Module.

"There's a window in the node about the size of a small dinner plate," Reisman said. "As I lay in my bunk, the Earthshine would come through the window and light up the ceiling of Node 2, and I could see the reflection of the Earth. There wasn't a lot of detail, but enough that I could see clouds and land formations."

What started out as a crew of three "turning on the lights" continues today with a crew of six conducting science experiments and maintaining their home away from home.

NASA currently uses about half of the station's assets for its own research, which leaves the other half for users eligible under National Laboratory guidelines established by Congress in 2005.

"We work with a number of other government agencies," said National Laboratory Manager Marybeth Edeen. "And we have a number of commercial customers who are using station for their objectives, be they commercial or research or business."

"The NASA mission-driven research includes some microgravity, physical and life sciences, the Human Research Program (HRP), NASA exploration technology development and the Science Mission Directorate," said Space Station Program Scientist Dr. Julie Robinson. "For example, our HRP is evaluating the effects of space on the human body and what you might need to do for astronauts to go beyond Earth orbit safely."

The station is an unprecedented, state-of-the-art, orbiting laboratory complex that continues to expand the boundaries of space research. The unique capabilities of its laboratories will lead to discoveries that will benefit missions farther into outer space. These discoveries will also benefit people all over the world, now and in the future.

"With another 10 years of operating a mature International Space Station, we should expect and realize the science returns for which the station was built," Barratt said. "We owe the world answers on questions of basic science and medicine, and the (station) can deliver abundantly if utilized carefully. In addition we must come out with the mature and tested technologies and systems to go further with confidence. All of the partner agencies and nations hold stake in these, and the International Space Station becomes a unique, high-tech glue that holds the international space community together in ways unimaginable without it."

NASA/PHOTO ISS01E5463



*Expedition 1 crew members (from left to right): Commander Bill Shepherd and Flight Engineers Yuri Gidzenko and Sergei Krikalev pose with a model of their home away from home.*

NASA/PHOTO ISS01B605730



*Expedition 16 Commander Dr. Peggy Whitson prepares the Capillary Flow Experiment (CFE) Vane Gap-1 for video documentation. The CFE is positioned on the maintenance work area in the Destiny laboratory of the space station.*

NASA/PHOTO ISS020E005082



*The Expedition 20 crew members share a meal in the Unity node of the International Space Station.*



NASA/PHOTO ISS024E012554

*NASA astronaut Tracy Caldwell Dyson, Expedition 24 flight engineer, replaces a tray containing biological samples in the Minus Eighty Laboratory Freezer in the Kibo laboratory of station.*



NASA/PHOTO ISS020E008898

*The six-person Expedition 20 crew poses in "starburst" formation for an in-flight portrait in the Harmony node. Pictured clockwise from the right (center) are cosmonaut Gennady Padalka, commander; Canadian Space Agency astronaut Robert Thirsk; Japan Aerospace Exploration Agency astronaut Koichi Wakata; NASA astronaut Michael Barratt; cosmonaut Roman Romanenko; and European Space Agency astronaut Frank De Winne, all flight engineers.*

# Human research aboard the International Space Station



By Rachel Kraft

**It's** taken thousands of years for humans to adapt to the Earth's environmental factors that manipulate how the body functions. Space poses a unique set of features that can affect the health of astronauts, especially during long-duration flights aboard the International Space Station. Crew members can lose up to two percent of bone density per month, even when they are healthy. Muscle fiber can begin to degrade in a matter of days. Sensory organs like the ears, skin and eyes can change in ways that affect the perception of the spatial environment, and lunar dust, bacteria and radiation can create hazardous chemical responses. The psychological health of even the heartiest astronauts can also be impaired by spending months in a controlled environment.

The list of space hazards is lengthy, but thanks to the Human Research Program (HRP), part of the Exploration Systems Mission Directorate, scientists are constantly producing cutting-edge research that enables humans to counteract the wear and tear of space and function in top physical and psychological form during long-duration stints aboard the space station.

"Long-term human research, like what's been happening on the International Space Station over the last (10) years, allows researchers to study the many variables that contribute to spaceflight adaptations in an effort to address them as we look toward exploration-class missions," said Dr. Tara Ruttley, associate program scientist for the orbiting laboratory.

According to Dr. Clarence Sams, the lead scientist for the International Space Station Medical Project, an element of the HRP that integrates human research on station, executing sound human research in space helps scientists figure out how to counteract the deleterious effects that space has on the body when it adapts to an environment without gravity.

"We're not built to be space-faring creatures," Sams said. "We're built to be here in one G."

The space station provides a unique opportunity for experimentation because it is a controlled place where astronauts can readily repeat trials and tests.

"We haven't been able to have that sort of calm and ability to repeat prior to station flight," Sams said.

Within the past year, scientists have produced numerous critical findings about the human body's reaction in space as a direct result of research aboard the laboratory. In July, a paper published in the *Journal of Physiology* by space station investigator Robert Fitts found that even though astronauts regularly use exercise equipment while aboard station, the effects of space can decrease crew members' ability to perform work by more than 40 percent.

Another paper published in December in the *Journal of Bone and Mineral Research* used crew member diet to show that ingesting more fish is associated with a lower decrease in whole body bone mineral density after flight. This finding was confirmed by bed-rest studies, which verified that a greater intake of omega-3 fatty acids can potentially diminish bone loss.

"Not only is that beneficial to astronauts, but it has implications in understanding osteoporosis on Earth," Ruttley said.

Advanced research will continue as part of Expeditions 25 and 26. For the first time, crew members will be able to measure their true VO2max, an indicator of aerobic capacity, instead of simply estimating it during submaximal exercise. The measurement is an integral part of preparing astronauts for spacewalks, since physical fitness is an essential part of successfully completing extravehicular activities.

Crew members will also monitor their heart rates, heart rhythms and blood pressure for up to 48 hours before, during and after exercise to help scientists investigate heart muscle atrophy and the risk of abnormal heart rhythms during six-month station tours. They will perform ultrasound scans on each other to examine how the heart fills with blood and pumps to the rest of the body.

"We train the crew how to do it, and you actually have someone in real time (on the ground) guiding the crew member," Sams said. "Station is a unique place where that can happen."

For more information about science aboard the International Space Station, visit:

[http://www.nasa.gov/mission\\_pages/station/science/index.html](http://www.nasa.gov/mission_pages/station/science/index.html)



**Astronaut Nicole Stott exercises aboard the space station.**

NASA/PHOTO



NASA/PHOTO

**Astronaut Cady Coleman performs a remotely guided echocardiogram on a test subject using integrated cardiovascular protocols in the same manner she will while in orbit. Betty Chen, a training coordinator, observes.**

# Setting a shining (green) example



By Catherine E. Williams

**Whizzing** along more than 200 miles above Earth, usually isolated even from other spacecraft, the International Space Station cannot afford to be wasteful. Every resource a crew consumes is precious, from the water they drink to the oxygen they breathe. Earthlings could learn a thing or two about green living by emulating the practices already in place for sustainable living aboard the orbiting laboratory.

## Harvesting the sun

“Station power is 100 percent solar,” said Richard Fair, system engineer in the station Program Integration Office.

Power is collected by eight solar array wings, each using 32,800 crystal silicon solar cells to generate about 30 kilowatts each. The space station garners about 240 kilowatts of power from its eight solar arrays.

When in the presence of the sun, power is split between charging batteries and supporting electrical requirements. When operating in the shadow, or

**While anchored to a foot restraint on the end of the Orbiter Boom Sensor System, STS-120 Mission Specialist Scott Parazynski assesses his repair work as the solar array is fully deployed during the mission's fourth spacewalk while Space Shuttle *Discovery* is docked with the International Space Station.**

eclipse, the batteries are used to support the station's power needs.

“International Space Station technologies are a great lesson in resourcefulness and innovation,” Fair said. “The (station) power system was designed and is operated to a delicate balance of limited resources within a stark and unforgiving environment. Likewise, on Earth, we have long struggled to balance the systems of civilization given limited resources and environments. For the space environment, the (station) electrical system requires many specialized components that were a challenge to design and demand vigilance in operation. The same resourcefulness and innovation is required of Earth-based power generation as resource limitations are better understood and operating environments continue to change.”

## An environment fit for a ... crew

The Earth nurtures humankind with its natural life support system. However, in space, we must replicate an environment that gives station crews air to breathe, water to drink and a way to handle metabolic waste products. The Environmental Control and Life Support System (ECLSS) fields those needs when a crew is no longer in the Earth's biosphere.

Functions of ECLSS include: atmosphere revitalization; atmosphere

**Fun fact: Unlike Earthbound solar arrays, which may or may not adjust to the sun's seasonal position ( $\pm 23.5^\circ$  from equinox), International Space Station solar arrays can maintain perfect pointing through a “seasonal” angle (referred to as beta range), which varies from  $+75^\circ$  to  $-75^\circ$ .**

control and supply; temperature and humidity control; water recovery and management; waste management; and fire detection and suppression.

“ECLSS is a ‘green’ technology because it provides direct insight into the recycling and resupply processes necessary to support human life and new ways to balance those processes,” said Chris Matty, Atmosphere Revitalization subsystem lead. “The eventual design philosophy for the station's ECLSS is to have a closed loop, meaning that nothing is coming into the station—and nothing is going out. Water, atmosphere and waste products are recycled and reused as much as possible.”

The closed loop is an essential component of long-duration spaceflight—and missions to even further, exotic destinations.

“Resupplying new resources is very difficult now, and may be impossible when humans begin to venture away from the planet,” Matty said. “Resource management is essential to the ECLSS.”

The space station is not only making scientific breakthroughs, but green advancements that serve as a stellar example of sustainable living.

“ECLSS is a direct benefit to us on Earth because the (station) is essentially a smaller model of our planet,” Matty said. “By better

understanding how to manage and clean air and water resources (aboard the station), we can gain valuable information about managing and cleaning air and water here on Earth.”

With exponential population growth and decreasing natural resources, engaging in smart stewardship is essential.

“Practically utilizing renewable natural resources (with zero emissions), in balance with real constraints, is the challenge of our time,” Fair said.



**Expedition 22 Commander Jeffrey Williams installs a Urine Processor Assembly (UPA)/Distillation Assembly in the Water Recovery System rack in the Destiny laboratory of station. The UPA is one component of the Environmental Control and Life Support System.**

NASA/PHOTO ISS016E008937

NASA/PHOTO ST30E006844

# Spotlight Gregory Tobeck

## Manager, International Space Station Assessments, Cost and Scheduling Office

**Q: Coolest part of your job?**

**A:** Being able to see the inner workings of the International Space Station on a daily basis. Sometimes when we get in the daily grind, you just have to step back and take it all in—it is truly awe inspiring.

**Q: Favorite hobbies or interesting things you do away from the office?**

**A:** Fishing, traveling with my wife, Fantasy Football.

**Q: What would you be doing if you weren't in your current job at Johnson Space Center?**

**A:** Working in some sort of financial position. I like numbers.

**Q: What did you want to grow up to be when you were a child?**

**A:** A farmer. My grandfather was a farmer, and I spent summers on the farm in Illinois with him and my grandma.

**Q: What would people be surprised to know about you?**

**A:** I talk to my dog, Denver, like he is a person. But in my defense, he has a broad vocabulary.

**Q: What is your favorite quote or motto?**

**A:** Patience is a virtue.

**Q: What is your favorite food?**

**A:** Red River BBQ.

**Q: What is your favorite sport?**

**A:** Football. (Specifically Mountaineer and Texan football. I should say Aggie football, too, or my wife will be upset!)

**Q: Last good book you read?**

**A:** Any book in the David Baldacci series.

**Q: Favorite movie and why?**

**A:** "Hoosiers"—no explanation necessary!

**Q: Favorite music, artist or band and why?**

**A:** Toss-up between Rush, Pearl Jam and Foo Fighters.

**Q: Who are your heroes and why?**

**A:** My parents. They have worked hard in life and set an example for me.

**Q: What quality do you most admire in people?**

**A:** Hard work, loyalty, strong faith and giving hearts.



PHOTO COURTESY OF GREGORY TOBECK

**Q: What do you most look forward to at NASA?**

**A:** Seeing humans explore beyond low-Earth orbit.

**Q: What is your best memory at NASA or JSC?**

**A:** Spending time at Kennedy Space Center (KSC) for the STS-122/1E launch. The launch did not go off as planned, but getting to tour KSC and the launch site with 122 on the pad was very memorable.

## WANTED!

Do you know a JSC colleague or team that does something extraordinary on or off the job? Whether it's a unique skill, interesting work, special professional accomplishment, remarkable second career, hobby or volunteerism, your nominee(s) may deserve the spotlight!

The Roundup shines the light on one special person or team each month, chosen from a cross section of the JSC workforce. To suggest "Spotlight" candidates, send your nomination to the JSC Roundup Office mailbox at [jsc-roundup@mail.nasa.gov](mailto:jsc-roundup@mail.nasa.gov). Please include contact information and a brief description of why your nominee(s) should be considered.

# Top 10 International Space Station challenges

**Logistics Resupply Post *Columbia*.** The loss of Space Shuttle *Columbia* drove a philosophy change in vehicle operations and resupply, including a reduction in crew members from three to two. Many changes made during that time of space station operations, without shuttle resupply support, have remained in effect. These changes drove how NASA interacts with International Partners and provides support to one another.

**Six-person Crew Capability.** Increasing the space station human support capability from three to six crew members required additional logistics, regenerative life support systems, crew health-monitoring systems and flight crew systems. The transformation of the station to maintain six crew members was a tremendous undertaking, on the ground as well as onboard. The greatest milestone was to restructure the U.S. laboratory module to a temporary regenerative module until Node 3 was completed and launched. Ground teams spent years designing systems for oxygen generation, water recovery and quality monitoring, waste and hygiene, food consumption, exercise and sleep, as well as a series of interconnecting hoses and wires to tie it all together. After Node 3 was installed and activated, the U.S. laboratory module was again restructured to move all regenerative equipment from its temporary location to its designated location in Node 3.



NASA/PHOTO S120E008602

**A repaired solar array is featured in this image photographed by a STS-120 crew member onboard the Space Shuttle Discovery as it moves away from the International Space Station.**

**Regenerative Environmental Control and Life Support Systems (ECLSS).** The current regenerative ECLSS capabilities used daily on the International

Space Station are a stepping stone for exploration beyond low-Earth orbit. The space station hosts a space regenerative environment system that includes processing collected excess cabin humidity and urine into drinkable water and splitting water into oxygen for breathing and hydrogen, which is further processed with collected carbon dioxide to produce water.

**Solar Alpha Rotary Joint Anomaly.** In September 2008, the space station experienced a major systems malfunction that while generic in nature, severely altered station operations for two years and drove changes to future system requirements and operations for the life of the vehicle.

**Pump Module Failure.** Following the loss of one of two station cooling loops, the vehicle was zero fault tolerant to continued survival for three weeks while three spacewalks were conducted to remove and replace the failed cooling pump. During the planning and execution of the spacewalks, the station operated in a severely degraded state. However, engineers gained valuable insight into the station's operability that can be called upon in case of future events of this nature.

**Loss of All Command and Control Computers.** During International Space Station 6A (STS-100), station suffered from the failure of all three command and control computers. The shuttle remained docked for two additional days while station ground teams regained control of the computers and systems.

**Torn Solar Array.** During International Space Station 10A (STS-120) and the redeploy of solar array P6 4B, the panel experienced a tear. The space station ground teams put together a plan to assemble "cuff links" from grounding bolts, wire, flight data file binder pieces and kapton tape for the astronauts to install on the solar panel, providing enough structural support to complete the redeploy of the array. The repair was successful, and the 4B array currently operates as designed.

**The Space Station as a Multi-lateral Endeavor.** The International Space Station was the first manned spacecraft built that overcame numerous seemingly insurmountable obstacles: it required the cooperation of 15 countries to launch, integrate and assemble more than 28 elements—all in low-Earth orbit—while dealing with technology-sharing, language barriers and time zones.

**HTV1 Mission.** First robotic capture and berthing of a free-flying resupply spacecraft.

**Shuttle Retirement Planning.** Pending completion of ULF5-6, the station team successfully designed, built and delivered four external stowage platforms, flight-support equipment and more than 40 critical spare external Orbital Replacement Units to sustain the space station through 2020 without the services of the space shuttle.



NASA/PHOTO STS100-342-010

**The International Space Station required the cooperation of 15 nations to launch, integrate and assemble more than 28 elements. Astronaut Chris A. Hadfield, mission specialist representing the Canadian Space Agency, is seen near the Canadarm2 as the station grasps the Spacelab pallet.**



NASA/PHOTO S127E007461

**Eight of a total aggregation of 13 astronauts and cosmonauts are pictured at meal time aboard the International Space Station. Seven STS-127 astronauts joined up with the six Expedition 20 crew members on the orbital outpost to continue work on it. The crew of Expedition 20 ultimately expanded the station to six crew members.**

## Roundup

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# Special deliveries



By Catherine E. Williams

**Just** in time for the holidays, Space Shuttle *Discovery* will gift the International Space Station with some hardware that can only be scientifically classified as very cool.

The first such present under the stars is the Permanent Multipurpose Module (PMM), which was converted from the multipurpose logistics module Leonardo. The PMM will give the station additional storage capacity for the crew. Experiments may also be conducted inside the module, including studies on fluid physics, materials science, biology and biotechnology.



At Kennedy Space Center, technicians prepare to move the STS-133 payload from the rotating service structure on Launch Pad 39A to Space Shuttle *Discovery's* payload bay.



**Robonaut 2 is amped up to be the first humanoid resident aboard station.**

*Discovery* will also have the Express Logistics Carrier 4 (ELC4) in its sleigh—er—payload. Express, which stands for Expedite the Processing of Experiments to the Space Station, is an external platform that holds large equipment that can only be transported using the shuttle's unique capability. ELC4 will carry several spare parts: a heat rejection system radiator, flight support equipment and a mechanical system support component for a cargo carrier attached to the truss.

The gift that will most likely have all the astronauts clamoring to play with it is Robonaut 2 (R2). R2 is grasping its one-way ticket to space with its dexterous fingers to become the station's first humanoid robot resident. The robot will initially undergo operational testing in the Destiny laboratory. However, with time and further observation, these

tests will reveal R2's true potential—and in turn, expand the extent of its functionality with future upgrades.

The conclusion of the STS-133 mission marks the last planned pressurized volume to be added to the station. If only there was a bow big enough to perch atop this international marvel ...

**Fun fact:** As of the human habitation anniversary on Nov. 2 at 9:21 GMT, the space station has completed 68,519 total orbits and 57,361 orbits with a human presence. That equals approximately 1.5 billion statute miles, the equivalent of eight round trips to our sun.