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KENNEDY SPACE CENTER'S

SPACEPORT magazine

SpaceX Commercial Resupply Mission Heads to Space Station

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SPACEPORT MAGAZINE

CONTENTS

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The two-stage SpaceX Falcon 9 launch vehicle lifts off from Space Launch Complex 40 at Cape Canaveral Air Force Station, carrying the SpaceX Dragon resupply spacecraft to the International Space Station. Liftoff was at 5:42 a.m. EDT on Friday, June 29, 2018. On the company's 15th Commercial Resupply Services mission to the International Space Station, Dragon is filled with supplies and payloads, including critical materials to support several science and research investigations that will occur during Expedition 56. Photo credit: NASA/Tony Gray and Tim Powers

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I am KENNEDY SPACE CENTER

DEREK MITCHELL

Safety and Mission Assurance (S&MA) Engineer
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I serve as a Safety and Mission Assurance Engineer for International Space Station (ISS) ground processing as well as Research and Technology (R&T) projects. I monitor the development of system safety products for ISS ground support equipment and support planning for upcoming work. I've worked at Kennedy for three years, two of them in my current role.

One challenge of my job is that various NASA centers, industry, academia and international partners process ISS payloads in the Space Station Processing Facility. This diverse set of cultures and approaches offers many benefits, but it also presents challenges for assessing the safety of operations. I keep an open mind and communicate with partners often.

I served in the U.S. Army for more than five years as an armor officer and completed one 11-month tour of duty in Afghanistan. I've served as a scout platoon leader, cavalry troop executive officer and a cavalry squadron planner. I started work at NASA as a Pathways Intern while studying for a master's degree, and was converted to a permanent employee after graduation.

My favorite memory while working at Kennedy Space Center is watching my first rocket launch, SpaceX CRS-6. I looked out across the Banana River from the NASA Causeway during twilight. The fiery exhaust from the Falcon 9 lit the entire landscape. I'd recently finished a rocket propulsion course in graduate school, and this moment took an academic subject and made it real and visceral.

Special Delivery

SpaceX CRS-15 delivers new cargo to International Space Station

BY ANNA HEINEY

A new shipment of research, crew supplies and vehicle hardware bound for the International Space Station got a boost into orbit Friday, June 29. The SpaceX Falcon 9 rocket and Dragon cargo spacecraft lifted off at 5:42 a.m. EDT from Space Launch Complex 40 at Florida's Cape Canaveral Air Force Station.

The craft arrived at the station Monday, July 2, carrying more than 5,900 pounds of vehicle hardware, crew supplies and science research.

"We work with international and commercial partners developing spacecraft systems, technologies such as artificial intelligence, experiments, understanding the physics of our planet — all to advance human knowledge," International Space Station Program Manager Kirk Shireman said during a post-launch news conference at the agency's Kennedy Space Center.

"Microgravity is the key to unlocking all of these things, and we have a unique laboratory, a National Laboratory, the International Space Station, to explore that."

The company's 15th commercial resupply services mission to the station put on a dazzling show as the trail left behind by the rocket's first-stage engines caught the light from the rising Sun.

"Pre-sunrise or post-sunset launches make for a spectacular show in the sky," said Jessica Jensen, SpaceX's director of Dragon Mission Management. "It's still dark outside, but you have the sun illuminating the plume as it's in space."

Both the Falcon first stage and the Dragon launched on CRS-15 have been used before. The first stage provided the initial boost to NASA's Transiting Exoplanet Survey Satellite, or TESS, on April 18 of this year, and the Dragon flew to the station in July 2016 during SpaceX CRS-9.

Some of the research and science materials traveling to the station include **Micro-12**, a cellular biology investigation; ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station, or **ECOSTRESS**, an Earth science instrument; **Rodent Research-7**, which examines how space effects microorganisms in the gastrointestinal tract of mice; and Crew Interactive Mobile Companion, or CIMON, a pilot study of the effects of an artificial intelligence on crew support.

Investigations that will enable U.S. National Lab research, managed by the **Center for the Advancement of Science in Space**, or CASIS, include the **Space Algae** investigation; BCAT-CS, a physical sciences investigation seeking to improve our understanding of the physical interactions between soil and sediment particles of quartz and clay; the **Angiex Cancer Therapy** investigation; and the biology investigation CASIS PCG 8.

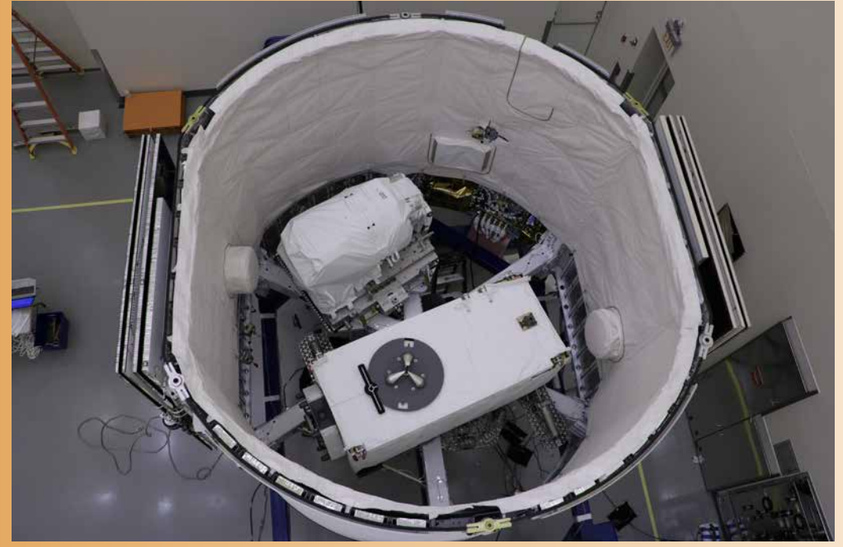
Among the hardware delivered to the station is a new Canadian-built Latching End Effector (LEE) for the station's Canadarm2, which is outfitted with two LEEs, used as "hands," at each end of the arm.

Dragon carried supplies and treats for the space station crew, too, including coffee, Texas blueberries and a little surprise.

"Don't tell the crew, but there are some frozen treats that will be up there as well," Shireman said. "A few ice cream bars — very few, unfortunately, because most of the frozen space is for science."

The Dragon spacecraft will remain at the station until August, when it will return to Earth carrying more than 3,800 pounds of cargo.

The trail left by the SpaceX Falcon 9 rocket catches early morning sunlight during liftoff. Photo credit: NASA/Kim Shiflett



The ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), pictured at the bottom, and the Latching End Effector (LEE), pictured at the top, are integrated into the unpressurized SpaceX Dragon truck June 2, 2018, at the SpaceX facility on Cape Canaveral Air Force Station in Florida. The payloads were carried to the International Space Station on SpaceX's 15th Commercial Resupply Services mission. Photo credit: SpaceX

The SpaceX Falcon 9 rocket carrying the Dragon spacecraft launches from Space Launch Complex 40 at Cape Canaveral Air Force Station on the company's 15th commercial resupply mission to the International Space Station. Photo credit: NASA/Tony Gray and Tim Powers

The nine Merlin engines powering the SpaceX Falcon 9 rocket's first stage burn brightly as the company's 15th commercial resupply mission to the International Space Station begins. Photo credit: NASA/Kim Shiflett

Journey to the Sun

Parker Solar Probe readied for launch

Technicians and engineers perform light bar testing on NASA's Parker Solar Probe in the Astrotech processing facility in Titusville, Florida, near the agency's Kennedy Space Center, on June 5, 2018. Photo credit: NASA/Glenn Benson

NASA's Parker Solar Probe will be the first-ever mission to "touch" the Sun.

LAUNCH:
No earlier than Aug. 4, 2018

LIFT OFF:
On a United Launch Alliance Delta IV Heavy rocket from Space Launch Complex 37 at Cape Canaveral Air Force Station in Florida.

MISSION:
The spacecraft, about the size of a small car, will travel directly into the Sun's atmosphere about 4 million miles from our star's surface. During its seven-year mission, the Parker Solar Probe will get closer to our star than any spacecraft has gone before. The probe will face brutal heat and radiation conditions and ultimately provide humanity with the first-ever samplings of a star's corona.

FACTOID:
The probe will carry more than 1.1 million names submitted by the public on a memory card.

Parker Solar Probe is part of NASA's Living With a Star Program managed by the agency's Goddard Space Flight Center in Greenbelt, Maryland, for NASA's Science Mission Directorate in Washington. The Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, designed, built and manages the mission for NASA. Instrument teams are led by researchers from the University of California, Berkeley; the University of Michigan in Ann Arbor; Naval Research Laboratory in Washington, D.C.; Princeton University in New Jersey; and the Smithsonian Astrophysics Observatory in Cambridge, Massachusetts. United Launch Alliance of Centennial, Colorado, is the provider of the Delta IV launch service for Parker Solar Probe. Northrop Grumman is providing a fully integrated third stage. NASA's Launch Services Program, based at Kennedy Space Center in Florida, is responsible for launch service acquisition, integration, analysis and launch management.

NASA's Commercial Crew Partners
Photo credit: NASA

FOCUS ON TRAINING

Team simulates commercial crew flights to space station

BY MADISON TUTTLE

A joint commercial provider and NASA team will help ensure astronauts will be able to safely travel to and from the International Space Station aboard Boeing and SpaceX spacecraft.

The Joint Test Team for NASA's Commercial Crew Program pulls expertise from across the key human spaceflight areas to design, test, assess, and plan missions aboard the Starliner and Crew Dragon spacecraft.

NASA works closely with the teams at Boeing and SpaceX to provide technical expertise, problem-solving, and independent assessment to key test activities that verify critical human interfaces and crew training.

"If you look at an organizational chart, you won't see the joint test team on there, because its members represent a diverse group of individuals across multiple departments," said Mike Good, program manager assistant for Crew Operations and Testing at NASA's Johnson Space Center in Houston.

When human spaceflight returns to the U.S., astronauts and members of the joint team will have logged hundreds of hours of simulations and tests on both commercial crew spacecraft.

"The simulators are a great tool to train and test the flight hardware before we fly," said Good, a veteran astronaut who flew on space shuttle missions STS-125 and STS-132.

"We work with this team to make sure we get all the testing done with the providers," said NASA astronaut Suni Williams.

NASA Commercial Crew Program astronauts Eric Boe, left, and Bob Behnken joined flight director Richard Jones and his NASA/Boeing flight control team in the first Mission Control Center, Houston, on-console simulation of Boeing's CST-100 Starliner launch, climb to orbit and post-orbital insertion timeline. Photo credit: NASA

"One of the key parts of the Commercial Crew Program is the joint test team. So whenever the providers want to do a test requiring human interaction with their systems, the team gets together to understand the test parameters and go through the safety review process so no one gets hurt during the testing," said Williams.

They also ensure the companies are meeting NASA's safety and performance requirements.

"Our goal is to be 'value added.' We try to provide useful feedback," said Good. "What we can bring from our side is our experience with test flying and with human spaceflight."

The joint team provides input ranging from cockpit layout and controls to flight crew suits and mission planning.

"We're getting great insight on the systems, the training, the procedures, the hardware and the software," said Good.

The team has recently worked with Boeing on several tests including manual piloting, human factors, workloads and usability.

The team also has worked closely with SpaceX on spacecraft development and design, spacesuit fit and comfort, displays and training material.

"Really the whole mission, from pre-launch through docking and undocking, entry, landing and post-landing, all of those need to be verified in the simulator. So we'll have our astronauts going through each flight phase making sure all the tasks they have to do meet our workload, usability and error-rate requirements," said Good. "We're also contributing by helping the provider complete their verification testing so that they can close requirements and we can go fly safely."

Before Boeing and SpaceX will be able to begin flying regular missions to the space station, they must make sure all of the systems onboard the capsule meet NASA's safety requirements. These criteria are designed to ensure a safe journey for the crew and the capsule.

"Spaceflight and test flight experience are very important to our team. It gives us valuable insight back to the program," said Good.

Even during test flights without a crew, astronauts on board the International Space Station will interact with the capsule during and after docking. For this interface to work as planned, the commercial crew astronauts play a large role in making sure the systems in both capsules are user-friendly on Earth and in low-Earth orbit.

This team's work will come to fruition when Boeing and SpaceX complete their uncrewed test flights later this year. The test flights will validate the capsules' capabilities and will help lead to flights with crew on board.

NASA astronauts Bob Behnken, Eric Boe and Doug Hurley conduct a fully suited exercise in Boeing's CST-100 Starliner mockup trainer during early May at the agency's Johnson Space Center in Houston. Photo credit: Boeing

During a tour of SpaceX headquarters in Hawthorne, California, commercial crew astronauts Suni Williams, left, and Doug Hurley participate in joint test team training using mockup components of the Crew Dragon on Feb. 23, 2017. Crew Dragon is being developed and manufactured in partnership with NASA's Commercial Crew Program to return human spaceflight capabilities to the U.S. Photo credit: SpaceX

Commercial Crew astronaut Bob Behnken, center, watches during an evaluation visit for the Crew Dragon spacecraft at SpaceX's Hawthorne, California, headquarters as astronaut Mike Good, right, looks on. Photo credit: SpaceX

LOOK ONLINE

Students participate in Fairchild Challenge events held at the Fairchild Tropical Botanic Garden in Miami, Florida. Photo credit: Fairchild Tropical Garden/Maureen Tan

Students help select two of four new plants heading to space

BY LEEJAY LOCKHART

Four new varieties of plants are headed to the **International Space Station** on **SpaceX CRS-15** for testing in the **Veggie** growth chamber. NASA researchers had help on this mission from middle and high school students who identified 'Dragoon' lettuce and 'Extra Dwarf' pak choi in experiments for the **Growing Beyond Earth** portion of **The Fairchild Challenge**. 'Red Russian' kale and 'Wasabi' mustard, along with 'Outredgeous' red romaine lettuce, which astronauts have already grown in space, round out the 18 plant growth pillows going to the station.

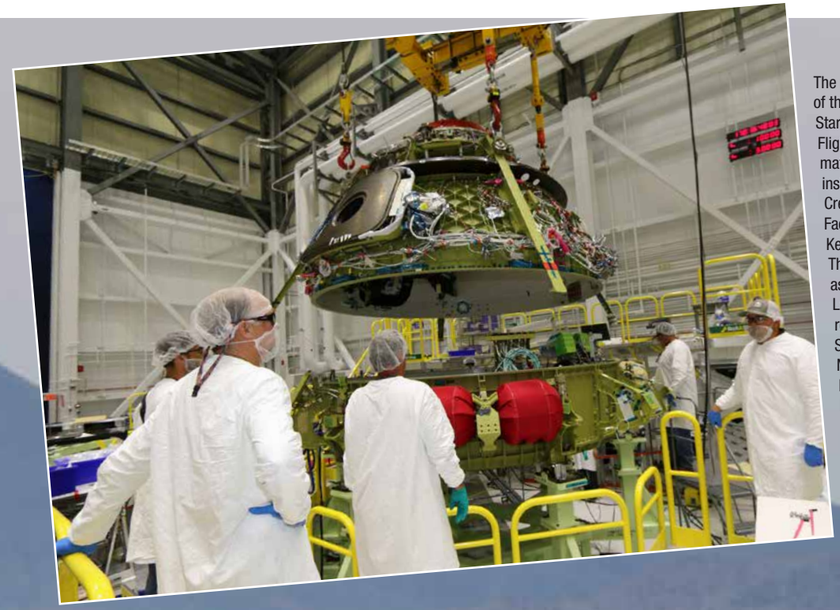
"We're using Veggie to answer questions of science about the types of plants we can grow in space for astronauts to eat," said Trent Smith, Veggie project manager at NASA's Kennedy Space Center in Florida. "We want astronauts to be able to grow fresh food to supplement their diets."

NASA's partnership with Fairchild Tropical Botanic Gardens in Miami, Florida, has engaged thousands of students with the space program and taught them science, technology, engineering and mathematics, or **STEM**, skills through the citizen-science competition. The students construct and use a plant growth system that approximates conditions found in the Veggie growth chambers on the space station, such as having LED lighting and watering systems similar to the plant pillows. They followed research protocols to measure and record valuable data, which astronauts will put to the ultimate test in space.

Read the full feature at **https://go.nasa.gov/2tK4DTR.**

(Above) NASA astronaut Suni Williams, fully suited in SpaceX's spacesuit, interfaces with the display inside a mock-up of the Crew Dragon spacecraft in Hawthorne, California, during a testing exercise on April 3, 2018. Photo credit: SpaceX

(Right) SpaceX's Crew Dragon is at NASA's Plum Brook Station in Ohio, on June 13, 2018, ready to undergo testing in the In-Space Propulsion Facility—the world's only facility capable of testing full-scale upper-stage launch vehicles and rocket engines under simulated high-altitude conditions. The chamber will allow SpaceX and NASA to verify Crew Dragon's ability to withstand the extreme temperatures and vacuum of space. This is the spacecraft that SpaceX will fly during its Demonstration Mission 1 flight test under NASA's Commercial Crew Transportation Capability contract with the goal of returning human spaceflight launch capabilities to the U.S. Photo credit: SpaceX

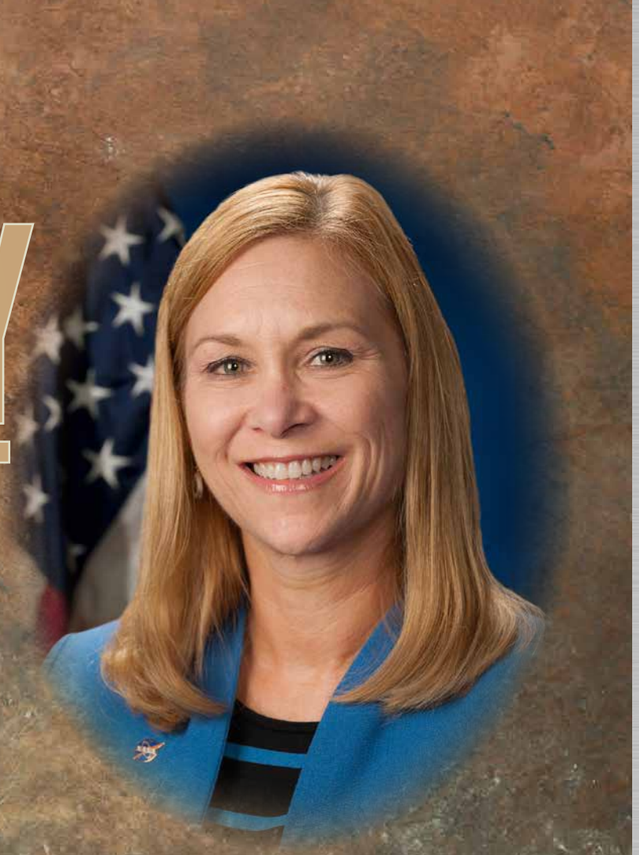


The upper and lower domes of the Boeing CST-100 Starliner Spacecraft 2 Crew Flight Test Vehicle were mated June 19, 2018, inside the Commercial Crew and Cargo Processing Facility (C3PF) at NASA's Kennedy Space Center. The Starliner will launch astronauts on a United Launch Alliance Atlas V rocket to the International Space Station as part of NASA's Commercial Crew Program. Photo credit: Boeing

Boeing, NASA and U.S. Army teams rehearse safely bringing the CST-100 Starliner spacecraft home to Earth on June 6, 2018, at the U.S. Army's White Sands Missile Range in New Mexico. During the detailed landing simulation, engineers, technicians and spaceflight specialists worked through tight timelines and intense heat running through simulations of the spacecraft's landing and recovery, an operation that will cap each Starliner mission. For flight controllers at Mission Control in Houston, the simulation offered the chance to evaluate their own processes and rehearse everything from undocking the Starliner from the space station to communicating with the recovery teams in the field. Photo credit: Boeing

Making HISTORY

NASA's Janet Petro selected for induction to Florida Women's Hall of Fame



BY LINDA HERRIDGE

Kennedy Space Center Deputy Director Janet Petro will be inducted into the 2018 Florida Women's Hall of Fame. Petro is one of three women selected by Florida Governor Rick Scott to receive this honor. The Florida Commission on the Status of Women recommended Petro among ten other nominees.

"I am very honored and humbled to be nominated for induction into the Florida Women's Hall of Fame representing Kennedy Space Center," Petro said.

Petro will be inducted during a ceremony in Orlando in September. The induction will be held in conjunction with the **Florida Chamber Foundation's 2018 Future of Florida Forum**. Honorees are immortalized on an honorary wall in the Florida Capitol.

The Commission selects candidates for their significant contributions to the improvement of life for women and all Florida citizens. They are pioneers who have broken down barriers, created new opportunities, and championed issues to better Florida and its people. The Governor customarily selects up to three individuals for induction into the Hall of Fame each year.

"The Florida Commission on the Status of Women, in the true spirit of celebration, is proud to honor these outstanding women who have had such a meaningful impact on our state and its history," said Commission Chair Lady Dhyana Ziegler, Ph.D., DCJ. "This year marks the thirty-sixth year of the Florida Women's Hall of Fame and the Commission is proud to ensure that the stories of Florida women will be shared for future generations."

Petro was appointed to the deputy director position at KSC in April 2007. She shares responsibility with the center director in managing the Kennedy team of civil service and contractor employees, determining and implementing center policy, and managing and executing Kennedy missions and agency program responsibilities.

"I can't think of anyone more deserving of this honor," said Bob Cabana, director of Kennedy Space Center. "She has been a role model for women throughout her career and has played a critical role in our success in building a premier multi-user spaceport in Florida. Janet has been integral to making our center the Bridge to the Future and all of us at the center are proud to see her receive this recognition."

As Kennedy transitioned into a multi-user spaceport, Petro led cross agency initiatives with the Federal Aviation Administration and U.S. Air Force to streamline government processes and support commercial space operations, to increase government efficiency and limit redundancy.

Petro began her career as a commissioned officer in the U.S. Army after graduating in 1981 from the U.S. Military Academy at West Point, New York, with a Bachelor of Science in engineering. She served in the U.S. Army's aviation branch. She also holds a Master of Science in business administration from Boston University's Metropolitan College.

Before joining NASA, Petro served in various management positions for Science Applications International Corp., also known as SAIC, and McDonnell Douglas Aerospace Corporation.

Outstanding Service

Manning honored with prestigious Eagle Scout Award

BY JIM CAWLEY

As a member of the Central Florida Council of the National Eagle Scout Association (NESA) committee, Bill Gnan always has his eye out for deserving NESA Outstanding Eagle Scout award candidates. He didn't have to look far for his most recent nomination; in fact, one evening last year, he was seated at the same table.

In June 2017, Gnan and his wife, Bobbi Gnan, who serves as chief of the Launch Services Program (LSP) Business Office at NASA's Kennedy Space Center, attended a United States Air Force Academy (USAFA) appointee brunch in Orlando. Their son is a cadet at the USAFA. The keynote speaker at the event was Kennedy associate director and USAFA graduate Kelvin Manning, whom the Gnans learned also is an Eagle Scout. The nomination for the NESA Outstanding Eagle Scout Award was a no-brainer.

"Kelvin has always had the whole package of being a really good family man, having risen to the highest level of his career and having done so much in the community," Bill Gnan said. "He's a class act."

Bill Gnan submitted the nomination paperwork in February. Manning was selected in May, and then honored the following month as one of six recipients of the 2018 NESA Outstanding Eagle Scout Award for the Boy Scouts of America's Central Florida Council. The ceremony took place on June 1 at the Rosen Centre Hotel in Orlando. Again, the Gnans were in attendance.

"I was really proud to be a part of it," Bobbi Gnan said. "Kelvin won the award, but the space center was getting recognized, too."

With a little help from his own wife, as well as Manning's wife, Judy, and secretary, Debbie Douglass, Bill Gnan was able to keep the nomination a secret. So his phone call notifying Manning that he'd won the prestigious award certainly was unexpected.

"He was kind of stunned. It came as a total surprise," Bill Gnan said. "When he sincerely thanked me, I knew that meant he was really touched."

To be considered for an Outstanding Eagle Scout Award, candidates must be Eagle Scouts who have made significant contributions to their profession and/or their community. They also are known to inspire others through their actions. Bobbi Gnan, who has had multiple opportunities to work with Manning over the years, has experienced this firsthand.

"Kelvin is a real kind and humble person–a fabulous role model," she said. "He lets people know that he cares about them."

Douglass said Manning is always approachable and personable, pointing to his penchant for knowing people by name, even after one encounter.

"He is very much respected and admired because he takes time to invest in others," Douglass said. "He is always positive and makes the best of any day, no matter how many challenges he faces."

Manning, who began his career at Kennedy in 1992, earned his Eagle Scout in Maryland in 1974. He graduated with a B.S. from the USAFA, and earned an M.S. in engineering management from the University of Central Florida. He completed the Senior Executive Fellows Program at the John F. Kennedy School of Government at Harvard University.

Manning has received several awards, including the NASA Exceptional Achievement Medal, NASA Exceptional Service Medal, the astronauts' Silver Snoopy Award, National Black Engineer of the Year Award for Outstanding Technical Achievement in Government, NASA Public Service Award, and the Department of Defense Joint Service Commendation Medal.

Kelvin Manning was awarded the National Eagle Scout Association Outstanding Eagle Scout Award medal. Photo credit: National Eagle Scout Association

Kelvin Manning, Kennedy Space Center Associate Director
Photo credit: NASA

AMERICAN HEROES

Alan Bean, Don Peterson honored in spaceport ceremonies

BY BOB GRANATH

Two veteran NASA astronauts who recently passed away were honored on May 30, 2018, in separate wreath-laying ceremonies at the Kennedy Space Center Visitor Complex. Alan Bean, who flew during the Apollo and **Skylab** programs, was remembered in a ceremony at the Apollo-Saturn V Complex. Space shuttle astronaut Don Peterson was honored at the Atlantis exhibit. Bean was the fourth person to walk on the Moon as lunar module pilot on **Apollo 12** in November 1969. He went on to command the 59-day Skylab 3 mission in 1973. After his retirement from NASA, Bean became an accomplished artist capturing spaceflight from the eyes of one who has flown in space and walked on the lunar surface. He died in Houston on May 26, 2018, at the age of 86.

Speaking of Bean, Kennedy Director Bob Cabana stated, "Today we honor a great American.

"I sure learned a lot from him," he said, recalling his experiences with Bean. "The world is a lot better place for having had Al in it."

Peterson served as a mission specialist on **STS-6**, the maiden flight of the space shuttle Challenger in April 1983. During the six-day mission, Peterson and fellow mission specialist Story Musgrave performed a four-hour spacewalk, the first of the shuttle program.

At the ceremony to honor Peterson, Cabana noted that spacewalks played a crucial role in construction and ongoing operations aboard the International Space Station.

"Don and Story Musgrave performed that first shuttle spacewalk testing out those new pressure suits," he said. "They set the standard of how we built the space station."

A native of Wheeler, Texas, Bean earned an aeronautical engineering degree from the University of Texas in 1955. He attended flight training as a naval aviator and spent four years with a jet attack squadron. He went on to become a Navy test pilot, flying several types of aircraft before being selected among NASA's third group of astronauts in October 1963.

Bean went on to lead the Astronaut Candidate Operations and Training Group within the Astronaut Office before leaving NASA in June 1981 to devote his full time to painting.

But Bean and other NASA retirees would return, speaking on the space program in Enrichment Lectures for incoming astronaut candidates.

"Alan Bean was the most extraordinary person I ever met," said former astronaut Mike Massimino, who benefited from Bean's mentoring and flew on two space shuttle missions. "What was truly extraordinary was his deep caring for others and his willingness to inspire and teach by sharing his personal journey."

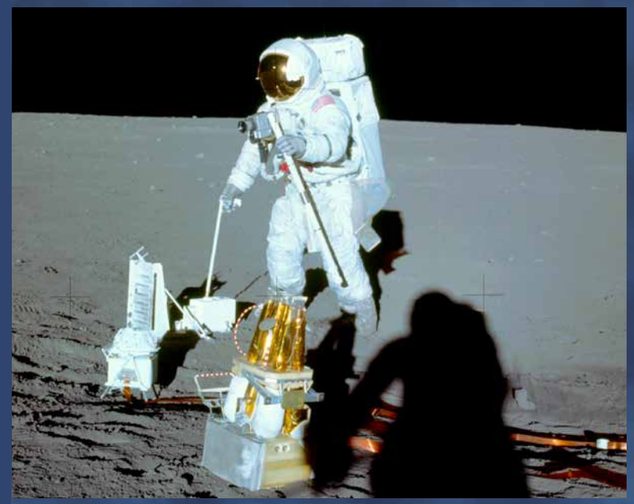
Born in Winona, Mississippi, Peterson received a bachelor's degree from the U.S. Military Academy at West Point in 1955. He went on to earn a master's in nuclear engineering from the Air Force Institute of Technology at Wright-Patterson Air Force Base in Ohio in 1962. Originally selected for the U.S. Air Force **Manned Orbiting Laboratory** Program, he became a NASA astronaut in September 1969.

Peterson resigned from NASA in November 1984, after that working as a consultant in human aerospace operations.

As a part of the agency's Oral History Project, Peterson looked back on his career explaining that he considered it an honor to be an astronaut,

"I've had the privilege of working with a tremendous number of really good people," he said. "The workforce at NASA, the engineering and technical people are just superb."

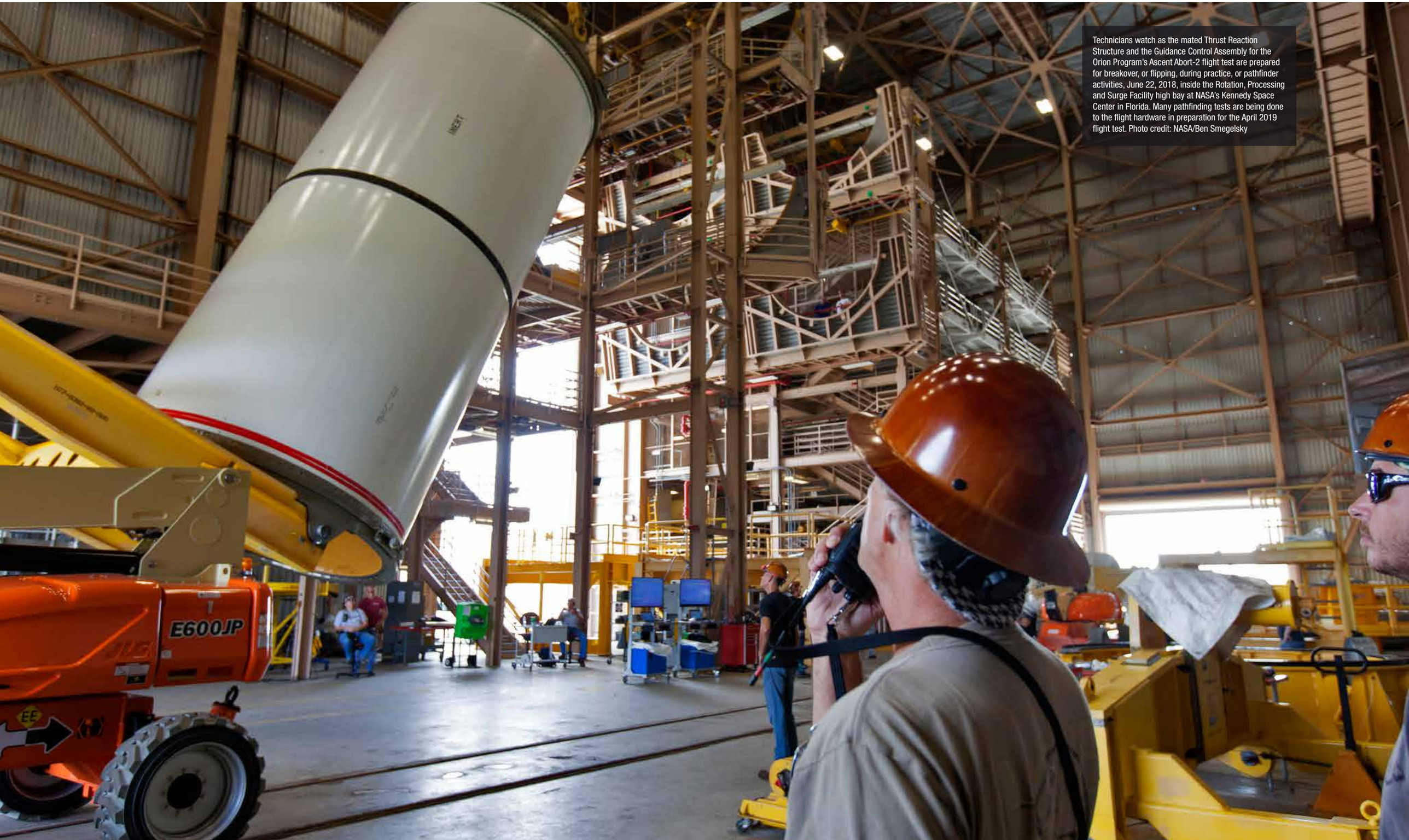
(Opposite page) (Page opposite) Backdropped by a large mural of a painting by Alan Bean, Kennedy Space Center Director Bob Cabana speaks to guests gathered to remember the Apollo and Skylab astronaut on May 30, in the Apollo-Saturn V Center at the center's visitor complex. After leaving NASA, Bean became an accomplished artist creating paintings to capture his view of humankind's first exploration of other worlds. Photo credit: NASA/Ben Smegelsky



Apollo 12 lunar module pilot Alan Bean deploys components of the Apollo Lunar Surface Experiments Package during the first Apollo 12 moonwalk. Photo credit: NASA/Pete Conrad

STS-6 commander Paul Weitz, left, points out an item in the crew activity plan to mission specialist Don Peterson during the mission taking place between April 4-9, 1983. Photo credit: NASA

A memorial wreath was placed in the Space Shuttle Atlantis exhibit at the Kennedy Space Center Visitor Complex on May 30, honoring former NASA astronaut Don Peterson, who passed away May 27, in El Lago, Texas. Photo credit: NASA/Leif Heimbold



Technicians watch as the mated Thrust Reaction Structure and the Guidance Control Assembly for the Orion Program's Ascent Abort-2 flight test are prepared for breakover, or flipping, during practice, or pathfinder activities, June 22, 2018, inside the Rotation, Processing and Surge Facility high bay at NASA's Kennedy Space Center in Florida. Many pathfinding tests are being done to the flight hardware in preparation for the April 2019 flight test. Photo credit: NASA/Ben Smegelsky

Pathway to Space

Launch Pad 39B flame trench nears completion

BY LINDA HERRIDGE

The nearly nine million pounds of thrust expended during lift-off of the agency's new Space Launch System (SLS) rocket would cause quite a bit of damage if it wasn't for modifications made to Launch Pad 39B. Exploration Ground Systems at NASA's Kennedy Space Center in Florida achieved a significant milestone on the path to supporting the agency's **first integrated launch** of the SLS and Orion spacecraft by completing the major construction on the main flame deflector in the upgraded flame trench at Pad B.

"With a lot of hard work, a lot of bricks, and tons of steel, we now have a flame trench and deflector system ready to support SLS," said Regina Spellman, EGS pad senior project manager. "It has been truly exciting to see the main flame deflector come together."

The new main flame deflector is critical to safely deflecting the plume exhaust from the massive rocket during launch. Measuring approximately 57 feet wide, 43 feet high and 70 feet long, the deflector's north side is slanted at about a 58-degree angle and will divert the rocket's exhaust, pressure and intense heat to the north at liftoff. Two side deflectors soon will be installed. They will help to contain and protect the vehicle and surrounding pad structures from the solid rocket boosters during liftoff.

Construction began on the main flame deflector in July 2017. The deflector incorporates several novel design approaches, including steel cladding plates, an open structure on the south side, and a configuration that maximizes functionality with commercial launch vehicles. The open south side allows easy access for inspection, maintenance and repair.

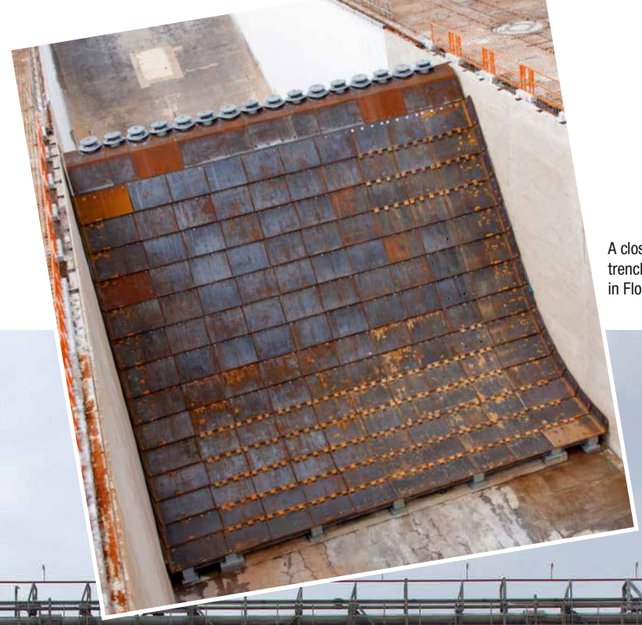
"The thick steel plates are designed to withstand the exhaust and heat from several launches," said Nick Moss, EGS pad deputy project manager. "There is flexibility of maintenance; as steel plates closest to the exhaust plume begin to erode, they can be replaced."

New water pipes used for sound suppression were installed on the crest of the main flame deflector. At launch, thousands of gallons of water flow from a tank through the pipes and out to cool the main flame trench and absorb and re-direct shock waves while reducing sound levels that can damage the vehicle and surrounding structures.

The flame trench beneath the pad was completely upgraded in 2017. All of the Apollo-era wall bricks were removed and new heat-resistant bricks were installed from the flame deflector to the northern extent of the walls. Approximately 100,000 heat-resistant bricks, in three different sizes, were secured to the walls using bonding mortar, and where required, steel plate anchors. In areas where significant temperature and pressure will occur, steel plate anchors were fastened into the walls at intervals to reinforce the brick system.

"We're one step closer to launching the world's most powerful rocket," Moss said. "I'm happy to be a part of it."

EGS is preparing Kennedy's infrastructure to support not only SLS and Orion, but several different kinds of spacecraft and rockets that are in development. A key aspect of the program's approach to long-term sustainability and affordability is to make processing and launch infrastructure available to commercial and other government customers, thereby distributing the cost among multiple users and reducing the cost of access to space.



A close-up view of the main flame deflector in the flame trench at Launch Complex 39B at Kennedy Space Center in Florida. Photo credit: NASA/Kim Shiflett

Construction is complete on the main flame deflector in the flame trench at Launch Complex 39B at Kennedy Space Center in Florida. The flame deflector will safely deflect the plume exhaust from NASA's Space Launch System rocket during launch. It will divert the rocket's exhaust, pressure and intense heat to the north at liftoff. The Exploration Ground Systems Program at Kennedy is refurbishing the pad to support the launch of the SLS rocket and Orion on Exploration Mission-1, and helping to transform the space center into a multi-user spaceport. Photo credit: NASA/Kim Shiflett

View a time-lapse video at **https://youtu.be/9matDigB2w4**

Crawler-transporter 2 (CT-2) arrives on the surface of Launch Pad 39B for a fit check on May 22, 2018, at NASA's Kennedy Space Center. The test drive to the pad confirmed that all of the recent modifications to CT-2 and Pad 39B are operational to support the launch of the agency's Space Launch System rocket and Orion spacecraft on Exploration Mission-1. In view, at right, is one of three lightning protection towers positioned around Pad 39B. Exploration Ground Systems managed the modifications and upgrades to CT-2 and Pad 39B to prepare for EM-1 and deep space exploration missions. Photo credit: NASA/Nick Moss

Exploration Ground Systems achieves milestones on path to Exploration Mission-1

Exploration Ground Systems continues to develop the infrastructure needed to support the Space Launch System (SLS) rocket and the deep space aspirations of NASA and the nation. Kennedy Space Center is beginning to buzz as the program marches closer to supporting the initial launch of the SLS rocket. The uncrewed mission is known as Exploration Mission 1 (EM-1). Here is quick look back at some of the recent milestones achieved by the EGS program in support of EM-1.

(Bottom Right) Crawler-transporter 2 (CT-2) is underneath the mobile launcher May 31, 2018, at NASA's Kennedy Space Center. Three lifts were performed to practice lifting procedures, validate interface locations, confirm the weight of the mobile launcher, and develop a baseline for modal analysis. The mobile launcher is equipped with a number of lines, called umbilicals, which will connect to NASA's Space Launch System (SLS) and Orion. CT-2 has been upgraded to handle the weight of the mobile launcher with SLS and Orion atop. Exploration Ground Systems is preparing the ground systems necessary to support the SLS and Orion spacecraft for Exploration Mission-1 and deep space missions. Photo credit: NASA/Kim Shiflett

About 450,000 gallons of water flowed at high speed from a holding tank through new and modified piping and valves, the flame trench, flame deflector nozzles and mobile launcher interface risers during a wet flow test on May 24, 2018, at Launch Pad 39B at NASA's Kennedy Space Center. At peak flow, the water reached about 100 feet in the air above the pad surface. The test was performed by Exploration Ground Systems to confirm the performance of the Ignition Overpressure/Sound Suppression system. During launch of NASA's Space Launch System rocket and Orion spacecraft, the high-speed water flow will help protect the vehicle from the extreme acoustic and temperature environment during ignition and liftoff. Photo credit: NASA/Leif Heimbold

Digging Deep

Students meet challenge of NASA's 9th Annual Robotic Mining Competition

BY LINDA HERRIDGE

More than 40 one-of-a-kind robots mined in simulated regolith, called BP-1, during NASA's 9th Annual Robotic Mining Competition (RMC), May 14-18, at the agency's Kennedy Space Center Visitor Complex in Florida. Undergraduate and graduate students from universities around the U.S. spent the last year designing and building their robots and converged at the visitor complex to dig deep in the mining arena.

The teams participated in other competition requirements. They submitted a systems engineering paper, and demonstrated and explained how they designed their robots. Teams also were required to perform science, technology, engineering and mathematics (STEM) outreach in their communities throughout the year and report on their efforts.

Kennedy Director Bob Cabana welcomed the teams during the opening ceremony in the RobotPits inside the Center for Space Education at the visitor complex.

"Robots are the precursor for humans to Mars," Cabana said. "This is an exciting time for NASA and Kennedy. You are the future. We learn from you sometimes."

In previous years' competitions, the robots were required to mine and collect as much of the BP-1 near the surface as possible during two 10-minute runs and deposit the material into a collector. This year's competition had a new mining requirement–a little twist–to dig and mine for the icy regolith simulant (gravel) buried at least a foot below the surface and deposit it into the collector bin to be weighed.

The reason for the mining rule change? If we can mine it here, we can mine it on other worlds, which give us water, hydrogen and oxygen, all components of In-Situ Resource Utilization (ISRU), to start living off the land.

"It was time to dig well below the surface in the arena to simulate what it would be like to search for the icy regolith that may be below the Moon's surface," said Rob Mueller, a senior technologist in the Exploration Research and Technology Programs Directorate at Kennedy. "This is their reward for a year's worth of work."

Mueller was one of the creators of the Robotic Mining Competition and has served as lead mining judge for all nine years of the annual event.

When the regolith settled and all of the team's collections were weighed in, the first place award for On-Site Mining went to Team Astrobotics of The University of Alabama during an awards ceremony May 18 at the visitor complex's Apollo/Saturn V Center. The team also was awarded the top prize, The Joe Kosmo Award for Excellence, which is given to the team that scores the most points overall during the competition. They also received first place in the Caterpillar Award for Autonomy, meaning that their robot mined for the rocks and traversed the arena to deposit it in the collector bin without sending signals from a computer.

"If you consider how long it takes to communicate between planets and where Earth and Mars are in relation to the Sun, autonomy is vital in keeping robots safe and operational to support the mission," said Rich Johanboeke, NASA project manager.

Team members cheer during their robot miner's turn in the mining arena on the third day of NASA's 9th Robotic Mining Competition, May 16, at NASA's Kennedy Space Center Visitor Complex in Florida. Photo credit: NASA/Leif Heimbold

On the third day of NASA's 9th Annual Robotic Mining Competition, May 16, two robot miners dig in the simulated Lunar regolith, called BP-1, in the mining arena at NASA's Kennedy Space Center Visitor Complex in Florida. Photo credit: NASA/Leif Heimbold

"It's a great feeling to know that our team was able to overhaul our entire robot system for this significant rule change and step up to the challenge," said Maxwell Eastepp, team leader for the University of Alabama. "It feels good to be able to follow in my predecessors footsteps." Eastepp is a junior majoring in electrical and computer engineering.

Along with many veteran teams returning this year, several new teams joined the roster, including from Saginaw Valley State University in Michigan, the University of Minnesota-Twin Cities, and the University of Maine.

Waqas Qureshi, is a graduating senior and team leader from Saginaw Valley's Tie Dye Fighters. Their robot, Wall-E, did not qualify in the mining arena, but Qureshi said they learned a lot and will return for next year's competition.

According to the University of Maine's Black Bear Robotics team leader, Billy Bessette, they spent about two months designing and building their robot named Crush. They were able to enter this year's competition thanks to assistance from a Maine Space Grant and kept the robot's design simple.

Bessette is a junior majoring in mechanical engineering. His sister was on a team from Florida Tech in Melbourne, which is how they learned about the competition. "One lesson we learned, you can never do enough testing," Bessette said.

Though the University of Minnesota had its challenges, they managed to earn an honorable mention with their systems engineering paper, and a new award, the Golden E-Stop Award. Every robot's design needs to include an emergency stop button, which was shown during their slide presentation and demonstration, and used during a run in the mining area.

Many of the designs incorporated 3D-printed parts. For example, The University of Utah's robot, named Sandcrawler, included 3D-printed flexible wheels and nylon digging elements. In their fourth year at RMC, the team earned the Regolith Mechanics Award for devising a system that vibrated to shake out the dirt, leaving only the mined rocks and gravel to deposit in the collector bin.

"We used a 3D-printed screen with a weave in it to sift the sand out and catch the gravel and rocks," said Utah team leader Justin Schramm, a graduating senior majoring in mechanical engineering. "Each of the wheels took about 20 hours to 3-D print."

The Milwaukee School of Engineering Space Raiders team robot, named Icarus, included 3D-printed wheel covers, collection bucket, gear covers and trench guard. With an all new robot design and practically all new team members, team lead Dan Schuler said they saw things that worked and others that didn't work for their robot in the mining arena.

In its 8th year of competition, the South Dakota School of Mines & Technology robot, named Calamity, included 3D-printed wheel covers, antenna cover and conveyer belt gear.

Returning for its ninth year, Iowa State University's Cyclone Space Mining Club repaired a motor and motor controller on-the-spot just before their robot, Pavonis, was scheduled for its second run in the mining arena. Taylor Meyer, a junior majoring in mechanical engineering, said they took a risk with their design this year.

"Our teamwork culture was very good and everyone remained calm while we worked through the challenges," she said.

Returning team The Fighting Cardinals from York College - CUNY (City University of New York) worked through the

Winners List 2018

JOE KOSMO AWARD FOR EXCELLENCE
The Joe Kosmo Award for Excellence is given to the team that scores the most points during the competition.
Grand Prize: The University of Alabama

ON-SITE MINING AWARD
First Place: The University of Alabama
Second Place: North Dakota University in collaboration with James Madison University
Third Place: Kent State University

SYSTEMS ENGINEERING PAPER
First Place: The University of Alabama
Second Place: Case Western Reserve University
Third Place: The University of Akron
Honorable Mention Award: University of Minnesota - Twin Cities
Leaps and Bounds Award: University of Colorado Boulder

OUTREACH EDUCATION PROJECT REPORT
First Place: The University of Alabama
Second Place: Iowa State University
Third Place: The University of Akron

SLIDE PRESENTATION AND DEMONSTRATION
First Place: North Dakota State University in collaboration with James Madison University
Second Place: The University of Utah
Third Place (Tie): Case Western Reserve University and The University of Alabama
Golden E-Stop Award: University of Minnesota - Twin Cities

IEEE JUDGES' INNOVATION AWARD
The team with the most innovative design receives the Judges' Innovation Award at the discretion of the mining judges.
North Dakota State University in collaboration with James Madison University

EFFICIENT USE OF COMMUNICATIONS POWER AWARD
The University of Alabama

REGOLITH MECHANICS AWARD
Awarded to the team with the best example of a real granular innovation that identified a specific regolith mechanics problem and intentionally improved their design to deal with it. Courtesy of the Center for Lunar and Asteroid Surface Science (CLASS), part of NASA's Solar System Exploration Research Virtual Institute (SSERVI) Network.
The University of Utah

CATERPILLAR AWARD FOR AUTONOMY
First Place: The University of Alabama
Second Place: North Dakota State University in collaboration with James Madison University
Third Place: The University of North Carolina at Charlotte

NASA's 9th Annual Robotic Competition concluded with an awards ceremony May 18, 2018, at the Apollo/Saturn V Center at the Kennedy Space Center Visitor Complex in Florida. The University of Alabama Team Astrobotics received the top award, the Joe Kosmo Award for Excellence, which is given to the team that scores the most points during the competition. At far left in front is retired NASA astronaut Jerry Ross. At far right is Richard Johanboeke, NASA education specialist and project manager for the Robotic Mining Competition. Photo credit: NASA/Wayne Saxer

challenge of locomotion or movement through the BP-1 with their robot York Bot 4. Team adviser Daniel Phelps said the school is a minority serving institution (MSI). It was through a NASA MSI grant that they were able to enter the RMC four years ago.

Participation can produce some positive results for the students. This year, a graduating team member received a job offer with Honeybee Robotics in Brooklyn, New York. He credits this directly to his involvement in RMC. In previous years, The University of Alabama team members received internships and job offers after graduation, including from RMC sponsor Caterpillar.

NASA's Robotic Mining Competition is a university-level competition designed to encourage and retain students in science, technology, engineering and mathematics (STEM) academic and career fields. RMC provides a competitive environment to foster innovative ideas and solutions that could be used on NASA's deep space missions.

Teams 2018

Case Western Reserve University
College of DuPage
Colorado School of Mines
Embry-Riddle Aeronautical University
Illinois Institute of Technology
Iowa State University
John Brown University
Kent State University
Milwaukee School of Engineering
Mississippi State University
Montana State University
Montana Tech of the University of Montana
Morgan State University
New York University
North Dakota State University, in collaboration with James Madison University
Oakton Community College
Purdue University
Saginaw Valley State University
South Dakota School of Mines & Technology
Temple University
Texas A&M International University
The University of Akron
The University of Alabama
The University of North Carolina at Charlotte
The University of Utah
University of Alaska Fairbanks
University of Arkansas
University of Colorado Boulder
University of Houston
University of Illinois at Urbana Champaign
University of Maine
University of Michigan
University of Minnesota - Twin Cities
University of Nebraska - Lincoln
University of New Hampshire
University of North Dakota
University of Portland
University of Tulsa
University of Virginia
University of Washington-Bothell
Vanderbilt University
Virginia Polytechnic Institute State University
Virginia State University
Worcester Polytechnic Institute
York College CUNY

On the first day of NASA's 9th Annual Robotic Mining Competition, set-up day on May 14, team members from the Illinois Institute of Technology work on their robot miner in the RobotPits at NASA's Kennedy Space Center Visitor Complex in Florida. Photo credit: NASA/Leif Heimbold

First-time participants from Saginaw Valley State University in Michigan pause with their robot miner in the RobotPits on the fourth day of NASA's 9th Annual Robotic Mining Competition, May 17, at NASA's Kennedy Space Center Visitor Complex. Photo credit: NASA/Leif Heimbold

New Ideas

Students assist in space farming challenges

BY LEEJAY LOCKHART

Astronauts have lived and worked on the **International Space Station** continuously for more than 17 years, expanding on the earlier short-duration missions of the Apollo and Space Shuttle Programs, but going beyond those achievements will require new technology. One way NASA is working to solve the challenges of extending human presence beyond Earth's orbit is with the **eXploration Systems and Habitation (X-Hab) Academic Innovation Challenge**, which provides college students the opportunity to participate in the development of new technologies that increase the viability of long duration deep space missions.

For the past eight years, teams of students have submitted proposals for specific research questions posed by the X-Hab Academic Innovation Challenge. Once selected, NASA awarded the schools grants ranging from less than $17,000 to more than $150,000 for supplies and necessities, which the university matched. Sponsoring programs included **Space Life and Physical Sciences Research and Applications**, **Human Research Program**, **Human Exploration and Operations Mission Directorate** and **Advanced Exploration Systems**. Then the students spent months working as a team with support from NASA subject matter experts as the team developed solutions to their topic. Four of the eight projects for the 2018 X-Hab involved students working with NASA researchers at Kennedy Space Center's Exploration Research and Technology Programs' Utilization and Life Sciences Office, developing new ideas for growing plants in space.

"What we're really focusing our attention on right now is how do we get nutrition in play, and how do we get automation, and use smart systems," said Charles Quincy, a NASA researcher at Kennedy.

Microgravity, growing plants in a closed loop during the voyage, and an environment very different from Earth are all complications to growing food in space that challenged X-Hab 2018 participants.

Students from the University of Michigan worked on designing and prototyping a substrate, a material in which a plant grows, that uses 3D printing to achieve effective plant growth in microgravity. Students from the Ohio State University Agricultural Technical Institute attempted to improve the sustainability of food crop production by producing substrate using 3D printing technology and reusing the same substrate for multiple crops. Temple University students developed a fresh produce sanitation system to manage microbial growth in space. Finally, Utah State University students designed a 3D printed matrix system for integration into the **Veggie** growth platform on the space station to better understand providing water and nutrients to plants.

Quincy said the ideas and the entire experience of participating in X-Hab is a positive one for both the students and NASA. The teams develop design projects that have the potential of shaping future NASA missions. In turn, those teams must meet engineering milestones, conduct outreach, and attempt to leverage funding from other organizations, providing them with hands-on experience in cutting-edge research.

Kimberly Simpson, a NASA engineer at Kennedy, said that as the students reached out to experts at NASA, invariably there comes a point when the questions move beyond current knowledge, and the students had to go through the process of trying to find an answer.

One of the best things about X-Hab, from Simpson's perspective, is that the challenge opens students to the possibility of doing research they had never considered before. In addition to bringing new ideas and technology to enable humans to travel deep into space to NASA, the challenge also develops a pipeline of young scientists and engineers.

Gioia Massa examines one of the plant samples for X-Hab 2018, on March 12, 2018, when students from Ohio State University Agricultural Technical Institute came to Kennedy Space Center to meet with subject matter experts from NASA. The students' design project focused on increasing the sustainability of crop production by using 3D printing. Photo credit: NASA

Kennedy Space Center Director Bob Cabana retrieves a car key from the kiosk in the center's Headquarters Building lobby. Photo credit: NASA/Glenn Benson

'Key-osk' upgrades pave the way for smooth vehicle check-out

BY JIM CAWLEY

We are all familiar with kiosks, but have you tried the new and improved employee "key-osks" at Kennedy Space Center?

Kennedy's system for signing out government vehicles has received a significant upgrade since it was implemented in October 2017. Though the signs on the structures read "Car key kiosk," some at the center have taken a more light-hearted approach by referring to them as "key-osks."

"We want people to have fun with it," said Spencer Davis, a transportation specialist at Kennedy who works directly with the car key kiosks at the center.

Things have been a lot more fun since the upgrade. A test run featuring the new improvements took place on April 20, with the current system going live on Memorial Day weekend. The feedback so far has been overwhelmingly positive.

"Everything that I have heard has been great," Davis said. "People are saying, 'I can read it easier' and 'it is very intuitive.'"

The first improvement that is immediately noticeable is the tablet, which is larger, brighter and more user-friendly overall than the original pin pad access. The pin pad is still there — below the new tablet — but is not utilized in the check-out or return process. Users just follow the simple steps prompted on the tablet and retrieve their keys in seconds.

Before the upgrade, a couple of recurring issues had emerged. One was usage: keys from the top row were regularly selected, meaning the same vehicles were getting used over and over again. Conversely, other vehicles were being underutilized to the point where they had dead batteries in some cases. Now the system assigns the key of longest retention, based on the vehicle type selection.

Another issue eliminated by the improved process is mileage. Previously, if someone entered incorrect mileage — for example, 94,000 instead of 9,400 — the next user had to enter at least one mile over 94,000 on the pin pad, or they would have to contact an administrator to go into the system and change it. The user can now easily adjust mileage mistakes.

"Since we got all the kinks ironed out, it's been pretty flawless so far," Davis said. "We had some growing pains in the beginning, but now it seems like everybody loves it."

Davis said he will continue to work with the vendor on future enhancements. There are currently five key-osks at Kennedy: one each at Headquarters, Neil Armstrong Operations and Checkout Building, Space Station Processing Facility, Operations Support Building I and Operations Support Building II. More could be added in the future.

Government vehicles at Kennedy are available for check out to all civil servants. Contractors should check with their management.

Our Refuge

NASA'S KENNEDY SPACE CENTER NATIONAL WILDLIFE REFUGE

BY REBECCA BOLT
WILDLIFE ECOLOGIST
INTEGRATED MISSION SUPPORT SERVICES LLC

The raccoon, also known as "the masked bandit," is one of the most commonly seen mammals on Kennedy Space Center and elsewhere. They are considered by many to be cute and harmless. However, raccoons can be troublemakers, occasionally even dangerous, and are often considered to be a nuisance animal.

A raccoon takes a late-night stroll near one of the waterways in Kennedy's Launch Complex 39 area. Photo credit: NASA/Tony Gray

Where do raccoons live?

Raccoons are native to the U.S. and occur throughout most of the states. The first known description of raccoons is said to have been written by Christopher Columbus. During the 20th century, raccoons were introduced to places outside the U.S. and can now be found in Russia, Germany and Japan.

What do they eat and what habitats do they use?

Raccoons belong to the Order Carnivora, but they are not strictly carnivores. They eat a wide variety of foods, including plants, berries, seeds, invertebrates, small amphibians and reptiles, small rodents, eggs and our garbage. Raccoons are able to take advantage of many different habitats, a trait that has enabled their populations to spread from the tropical hardwoods of the southern U.S. all the way to Alaska.

Why do raccoons wash their food?

Raccoons depend on their acute sense of touch, and the five fingers on their front paws can easily manipulate food. Water increases their ability to feel, so when they appear to be washing their food, they are actually examining it.

What predators do they have?

Raccoons can be vicious when threatened, and there are not many animals that eat them. Panthers/mountain lions, large bobcats and large coyotes have been known to attack raccoons. Most raccoon mortality comes from vehicles and disease. They also are considered by many people to be a nuisance animal, and are actively trapped by pest control companies.

Are raccoons really smart?

Intelligence tests that began in 1913 and were conducted for many subsequent years have shown that raccoons are smarter than dogs and even some toddlers. They can remember specific, complicated tasks for up to three years.

How long can they live?

Raccoons typically live two to three years in the wild, and up to 20 years in captivity.

Are raccoons dangerous?

They are wild animals and should always be treated with respect. Never approach or try to touch a raccoon. They also carry a number of diseases and parasites that can infect humans, including rabies and roundworms.

Why are there so many raccoons?

Raccoons are a perfect combination of many traits that make them very successful. They will eat just about anything, live just about anywhere, are nocturnal, are smart, have few predators, and can begin reproducing at age 1, having up to 5 kits per year. Most importantly, they take advantage of humans by eating their garbage and using their shelters. The result is a flourishing, expanding raccoon population.

A raccoon pauses while foraging in the underbrush near Launch Pad 39B. Photo credit: NASA/Tony Gray

From its vantage point in tall grass, a raccoon keeps its eyes on the photographer. Photo credit: NASA

How can I help control raccoon populations so they do not become a nuisance or a danger?

The most helpful thing you can do is not provide food. This means making garbage inaccessible by closing dumpsters and securing garbage cans. Also, do not leave pet food outside. Limiting food will do two things: convince the raccoons to find natural food sources and not artificially boost their reproductive potential.

Seaman Jr. visits Kennedy Space Center in Florida with the iconic Vehicle Assembly Building in the background. The toy dog, which represents the Newfoundland that accompanied Lewis and Clark on their famous expedition in the 1800s, launched to the International Space Station on SpaceX CRS-15 to help celebrate NASA's 60th Anniversary and the National Trail System's 50th anniversary. Photo credit: NASA/Wendy Neuerburg

National Aeronautics and Space Administration

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