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COVER: Praxair trucks carrying their loads of liquid oxygen, or LO2, line up at Launch Pad 39B at NASA's Kennedy Space Center in Florida prior to offloading into the giant storage sphere located at the northwest corner of the pad. The sphere will gradually be chilled down from normal temperature to about negative 298 degrees Fahrenheit during the first major integrated operation to prepare for the launch of the agency's Orion spacecraft atop the Space Launch System (SLS) rocket. The Ground Systems Development and Operations Program is overseeing upgrades and modifications at the pad to support the launch of the SLS and Orion spacecraft for Exploration Mission-1, deep space missions and NASA's journey to Mars. Photo credit: NASA/Kim Shiflett

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NASA'S LAUNCH SCHEDULE

Date: Nov. 10
Mission: NOAA Joint Polar Satellite System-1 (JPSS-1)
Description: JPSS is a next-generation environmental satellite system. It is a collaborative program between the National Oceanic and Atmospheric Administration (NOAA) and NASA. The polar-orbiting weather satellite will launch from Vandenberg Air Force Base in California on a United Launch Alliance Delta II rocket.
<https://go.nasa.gov/2rW4DCf>

Date: Dec. 8
Mission: Ionospheric Connection Explorer (ICON)
Description: The Ionospheric Connection Explorer will study the frontier of space, the dynamic zone high in our atmosphere where Earth weather and space weather meet. ICON will launch from Kwajalein Atoll aboard an Orbital ATK Pegasus XL rocket.
<https://www.nasa.gov/icon>

Want to see a launch?
 The Kennedy Space Center Visitor Complex offers the closest public viewing of launches from Kennedy Space Center and Cape Canaveral Air Force Station. Launch Transportation Tickets are available for some, but not all, of these launches.
Call 321-449-4444 for information on purchasing tickets.



A juvenile bald eagle watches for prey in the grass at NASA's Kennedy Space Center. More than 330 native and migratory bird species, 25 mammals, 117 fishes and 65 amphibians and reptiles call Kennedy and the Merritt Island National Wildlife Refuge home. Photo credit: NASA/Bill White

FUELING THE FUTURE

Liquid oxygen tanking operations begin at Launch Pad 39B

BY LINDA HERRIDGE

The first major integrated operation at Launch Pad 39B at NASA's Kennedy Space Center began with the initial tanking of a cryogenic fuel into a giant sphere at the northwest corner of the pad. The tanking operation is one of the steps needed to bring the center closer to supporting the launch of the agency's **Orion** spacecraft atop the **Space Launch System** rocket on its first uncrewed test flight.

"When I think of launch operations, there are distinct pictures that come to mind," said NASA Launch Director Charlie Blackwell-Thompson. "One of them is during the tanking operations as the cryogenic propellants are loaded into the Space Launch System rocket."

Several Praxair trucks arrived at the center and offloaded their liquid oxygen, or LO2, slowly, one at a time, into the cryogenic sphere to gradually chill it down from normal temperature to about negative 298 degrees Fahrenheit. Praxair, of Danbury, Connecticut, is the company that provides the agency with liquid oxygen and liquid hydrogen.

Another wave of trucks arrived and offloaded their LO2 all at the same time. During the next several months, trucks will continue to arrive from Praxair and offload about 40,000 gallons of fuel two days per week into the sphere that can hold about 900,000 gallons of liquid oxygen.

The procedure to fill the liquid hydrogen storage sphere will begin in November and will be completed in the same way. When both tanks are filled to about halfway, engineers in a firing room in the Launch Control Center will perform pressurization tests. Additional tests will be performed with the mobile launcher around mid-2018. The cryogenic fuels will remain in the tanks.

Blackwell-Thompson said it is not uncommon during tanking to see vapors and mist in the cryo storage area and near the vehicle. This week, she got a preview, when the trucks offloaded the first round of LO2 and once again, cryo vapors were visible. Because some of the liquid oxygen boils off during tanking, additional LO2 is required.

"This is a very important step in our path to launch, and we are thrilled to have cryo propellant return to the pad," Blackwell-Thompson said.

The Ground Systems Development and Operations Program is preparing the pad for the launch of **Exploration Mission-1**, deep space missions and the **Journey to Mars**. Significant upgrades to the pad include a new flame trench beneath the pad and a new flame deflector.



NASA Launch Director Charlie Blackwell-Thompson, center, talks to representatives from Praxair at Launch Pad 39B at NASA's Kennedy Space Center on Sept. 16, 2017. Blackwell-Thompson observed the first major tanking operation of liquid oxygen, or LO2, into the giant storage sphere at the northwest corner of the pad. Photo credit: NASA/Kim Shiflett

Several Praxair trucks carrying their loads of liquid oxygen, or LO2, arrived at Launch Pad 39B at NASA's Kennedy Space Center. A mist is visible as LO2 is offloaded from one of the trucks into the giant storage sphere located at the northwest corner of the pad. Photo credit: NASA/Kim Shiflett

DROPPING IN

Drop tests at NASA Langley help Boeing's Starliner prepare to land astronauts

BY ERIC GILLARD

NASA LANGLEY RESEARCH CENTER

At NASA's Langley Research Center in Hampton, Virginia, a mock-up of the Boeing Starliner spacecraft has endured a series of land landing qualification tests to simulate what the actual spacecraft and crew members may experience while returning to Earth from space.

The Starliner is being developed in collaboration with NASA's Commercial Crew Program. Along with SpaceX's Crew Dragon, the spacecraft is part of the agency's effort to return America's capability to launch astronauts from Florida's Space Coast to the International Space Station, or ISS.

The team recently kicked off a new series of land landing tests designed to measure the vehicle's airbag systems and how the crew responds to land landing scenarios.

"The accommodations inside the test article have become incrementally more flight-like throughout our test campaign," said Boeing test engineer Preston Ferguson. "And the test dummies simulating crew members are very sophisticated, allowing us to identify responses through instrumentation on the head, neck and lumbar areas."

The capsule – designed for landing on land, making it reusable up to ten times with a six-month turnaround time between launches – can accommodate up to five passengers to and from the space station. For NASA missions to the station, the Starliner will carry up to four astronauts and about 220 pounds of cargo.

"The first test series verified that the vehicle would be stable in all landing conditions," said Richard Boitnott, Langley project test engineer. "We are constantly reaching higher levels of fidelity with our testing, and have flight-representative parts in critical locations."

The Starliner program has performed more than 20 landing tests to determine how the vehicle would fare on land at NASA Langley's Landing and Impact Research Facility and in water at the Hydro

Impact Basin under different conditions. These scenarios simulated landing velocities and angles the capsule could encounter during a typical land landing or an **unlikely emergency water landing**.

"All of the tests were defined through the analysis of worst-case situations," said Jim Gaspar, Langley project test engineer.

"We perform landing tests at the edge of the envelope to anchor analysis models and enhance crew safety for all potential flight scenarios," Ferguson said.

In addition to testing the Starliner when it contains a simulated crew, the airbags used for landing were put through their paces as well.

The airbags, which contain a mixture of compressed nitrogen and oxygen gas, might appear to the untrained eye like larger versions of automobile airbags. However, these airbags have key differences in how they handle occupant loads.

"The Starliner airbags have to be very robust compared to an automotive airbag to meet the requirements for landing and have an active venting system," Ferguson said.

"An automotive airbag would just need to worry about the safety of its occupants. The airbags on the Starliner are tasked to protect the crew and the vehicle itself," Boitnott said. "You're dissipating thousands of pounds instead of just the mass of the occupant in a car."

The Starliner comes equipped with six outer landing airbags, which have inner airbags. There is a seventh airbag in spacecraft's center, but it would only be used in a water-landing scenario.

"The outer bag vents at impact. Then, the inner bag absorbs the impact and stays inflated," Gaspar said.

The airbags and other systems verified throughout the land landing test series will help ensure a soft return for the astronauts aboard.



The Boeing Starliner spacecraft undergoes testing at the Landing and Impact Research Facility at NASA's Langley Research Center. Photo credit: NASA/Dave Bowman



The Boeing Starliner program has performed more than 20 landing tests to determine how the vehicle would fare on land. Photo credit: NASA/Dave Bowman



Testing crewmembers at NASA's Langley Research Center give a thumbs-up after a test of the Boeing Starliner spacecraft. Photo credit: NASA/Dave Bowman

INCLUSION DRIVES INNOVATION

Dr. Temple Grandin Headlines Kennedy's Disability Employment Awareness Month

BY ANNA HEINEY

"Career comes first; labels come second. It's an important part of who I am; I wouldn't want to change and become non-autistic. But what I do comes first."

-Dr. Temple Grandin



Dr. Temple Grandin addresses employees as the keynote speaker at Kennedy Space Center's annual National Disability Employment Awareness Month event. Photo credit: NASA/Kim Shiflett

Not all frontiers to be conquered are in outer space. Some have been identified right here on Earth. NASA's Kennedy Space Center prides itself on finding solutions to hard-to-handle tasks and has made great strides in conquering both. October is National Disability Employment Awareness Month (NDEAM), and this year's theme - "Inclusion Drives Innovation" - has long been exemplified at the Florida spaceport.



Paul Mogan, program system engineer. Photo credit: NASA/Kim Shiflett

"There is an acceptance of people with disabilities and the recognition that we can contribute significantly to what [Kennedy] is all about," said Paul Mogan, a program system engineer in NASA's Ground Systems Development and Operations Program. "People with disabilities are now widely accepted and really embraced by the workforce."

The center's Disability Awareness and Action Working Group, known as DAAWG, partnered with the Kennedy Networking Opportunities for Women (KNOW) group to host an NDEAM event featuring Dr. Temple Grandin as the keynote speaker. A professor of animal science at Colorado State University in Fort Collins, Colorado, Grandin is a renowned author and speaker on both autism and animal behavior.

Grandin spoke about the variety of ways humans think and process information, and the importance of recognizing that these differences complement each other -- and that focusing too much on disability labels creates unnecessary limits. It's much better to focus on what a person can do well, and let that be the starting point for success.

"Career comes first; labels come second. It's an important part of who I am; I wouldn't want to change and become non-autistic," Grandin said. "But what I do comes first."

NASA engineer Rachel Cox was excited to hear Grandin speak after having seen the film about her life several years ago.

"It's inspiring to me to see someone who is super successful, and that a label doesn't have to put limits on you," Cox said. "You can be really good at something despite society putting a label on you. When you hear her whole life story and all the things she did, that label breaks down and goes away, and you don't think about her as

someone who is autistic."

The "Inclusion Drives Innovation" theme is especially fitting at Kennedy this year. The DAAWG organization is celebrating its 25th year of providing support and assistance to employees.

Creation of the group in 1992 was a significant step on the journey to providing access to persons with disabilities to employment at Kennedy. Its enduring influence is reflected in the form of upgraded facilities, helpful tools and a dedication to raising awareness among all employees.

"Partial paralysis due to a spinal cord injury requires that I use



Andi Meyer, lead management analyst. Photo credit: NASA/Kim Shiflett

bilateral ankle-foot orthotics to walk," explained lead management analyst Andi Meyer. "DAAWG has played a role in ensuring I have accessible parking so that I can make it into work safely."

DAAWG also works tirelessly to foster an environment of encouragement and inclusion, so everyone can work to their full potential in advancing NASA's goals.



Dr. Temple Grandin, second from left, pauses for a photo after giving the keynote presentation at Kennedy Space Center's annual National Disability Employment Awareness Month event. From left are Chief Financial Officer Susan Kroskey, executive champion of Kennedy's Disability Awareness and Action Working Group, or DAAWG; Grandin; Joette Feeney, chair of the Kennedy Networking Opportunities for Women group, or KNOW; and DAAWG Co-chairs Nicole Delvesco and Annie Williams. Photo credit: NASA/Kim Shiflett

"DAAWG has really helped shape the culture here at the Kennedy Space Center with a focus on diversity and inclusion. My peers, my management, my co-workers -- they all focus on my technical and cognitive behavioral abilities instead of focusing on some of my physical disabilities," said lead program analyst Christine Shepperd. "It really can be seen in our facilities across the space center, from the Vehicle Assembly Building to the labs, to the launch complexes -- all of them are accessible and point to Kennedy Space Center valuing me as part of the workforce."



**CELEBRATING
25 YEARS AT
KENENDY SPACE CENTER**

NASA employees share successes in National Disability Employment Awareness Month webcast

BY ANNA HEINEY

With the challenges involved in space exploration, NASA understands the need to fill its workforce with innovative employees and to help them maximize their capabilities.

On Oct. 5, schools, organizations and individuals from around the globe participated in a special webcast to learn from NASA employees with disabilities who have found rewarding, successful careers in the space program, including the agency's Kennedy Space Center in Florida. October is National Disability Employment Awareness Month.

"We need people of different backgrounds and different experiences to help create innovation to solve those challenging problems that will allow us to go to the Moon, Mars and beyond," said Kennedy Space Center Associate Director Kelvin Manning.

Employees shared their backgrounds, challenges and triumphs in pursuit of their dreams, highlighting how they have pushed NASA to meet the needs of every individual.

"In all my life, I never imagined that I would be working for NASA. I have been here for 26 years and I can say how proud I am to work here," said Nicole Delvesco, a NASA systems accountant. Delvesco is co-chair of Kennedy's Disability Awareness and Action Working Group, currently in its 25th year at the spaceport. "The agency is wonderful about hiring people with disabilities, and helping people with disabilities so that they can be successful in their jobs."

According to the final tally, there were 456 webcast views from 23 states, Washington, D.C., and eight countries. Using a standard classroom ratio, it's estimated the event reached 11,400 people.

"The best part of this event was that most of the questions coming in were from students who had disabilities similar to our experts, who never thought NASA was within their reach," said NASA Project Coordinator Bethanne Hull. "I am still in awe of the amazing people across our agency. We reached the audience we hoped to inspire."



NOAA's Joint Polar Satellite System-1, or JPSS-1, remains wrapped in a protective covering after removal from its shipping container at the Astrotech Processing Facility at Vandenberg Air Force Base in California. The spacecraft is being prepared for its upcoming liftoff aboard a United Launch Alliance Delta II rocket from Vandenberg's Space Launch Complex-2W. JPSS-1 is the first in a series of four next-generation environmental satellites in a collaborative program between NOAA and NASA. Photo credit: NASA/Rodney Speed

CHECKING THE FIT

New umbilical for mobile launcher to support NASA's deep space exploration missions

BY LINDA HERRIDGE

Engineers lifted and installed a third umbilical on the mobile launcher at NASA's Kennedy Space Center for a fit check. The tower on the mobile launcher will be equipped with several connections or **launch umbilicals** like this one. After the fit check was completed, the umbilical was lowered down and will be installed permanently at a later date.

The umbilicals will provide power, communications, coolant and fuel. They will be used to connect the mobile launcher to the agency's Space Launch System (made up of the core stage, twin solid rocket boosters, and the interim cryogenic propulsion stage) and the Orion spacecraft mounted on top of SLS.

An area on the SLS between the liquid hydrogen and liquid oxygen tanks is known as the core stage inter-tank. The core-stage inter-tank umbilical is the third in a series of five new umbilicals for the mobile launcher. Its main function is to vent excess gaseous hydrogen from the rocket's core stage. This umbilical also will provide conditioned air, pressurized gases, and power and data connection to the core stage.

The Orion service module umbilical and the core stage forward skirt umbilical were previously installed on the tower. The service module umbilical will connect from the mobile launch tower to the Orion service module. Prior to launch, the umbilical will transfer liquid coolant for the electronics and purge air/gaseous nitrogen for environmental control. The SLS core stage forward skirt is near the top of the core stage, and the forward skirt umbilical provides connections and conditioned air/gaseous nitrogen to the core stage of the rocket. All these umbilicals will swing away from the rocket and spacecraft just before launch.

Several other umbilicals were previously installed on the mobile launcher. These include two aft skirt purge umbilicals, which will connect to the SLS rocket at the bottom outer edge of each booster and provide electrical power and data connections, remove hazardous gases, and maintain the right temperature range with a nitrogen purge in the boosters until SLS lifts off from the launch pad.

The **Ground Systems Development and Operations Program** at Kennedy is preparing ground support equipment, including the launch umbilicals, for NASA's deep space exploration missions.

High up on the mobile launcher (ML) tower at NASA's Kennedy Space Center, construction workers assist as a crane moves the Core Stage Inter-tank Umbilical into place for a fit check of the attachment hardware Oct. 14, 2017. The swing-arm umbilical will be located at about the 140-foot level of the ML tower. It will connect to the Space Launch System core stage inter-tank and provide conditioned air, pressurized gases and power and data connection to the core stage. The Ground Systems Development and Operations Program is overseeing installation of the umbilicals. Photo credit: NASA/Glenn Benson



A variety of space hardware for the Orion crew module is in view in the Neil Armstrong Operations and Checkout Building high bay at NASA's Kennedy Space Center. Orion is undergoing processing to prepare it for its first uncrewed integrated flight atop the Space Launch System rocket on Exploration Mission-1. Photo credit: NASA/Ben Smegelsky



VETERANS DAY SALUTE



NASA's military astronauts

BY BOB GRANATH

Each year, Americans pause on Nov. 11 to celebrate Veterans Day. While the date marks the anniversary of the end of World War I, the annual holiday is designed to honor everyone who served and is serving in the armed forces of the United States. Many of those include NASA astronauts.

When the agency selected the first groups of U.S. astronauts, all were military pilots. That held true until selection of the fourth group, selected in 1965. They were scientists, three of whom served in the military.

As NASA approached the space shuttle era, scientists, doctors and engineers were needed along with pilots. The 35 selected in 1978 included the most diverse group to date, including the first women and ethnic minorities. The selections included 13 pilot astronauts along with 22 mission specialists.

All of the pilots served in the military, as well as 13 of the mission specialists.

With the 12 NASA astronauts selected in the group announced in June this year, the total number of individuals selected by the agency totals 375 -- 216 served in one of the branches of the U.S. armed services.

During the April 9, 1959, news conference in which NASA's "Original Seven" astronauts were announced, John Glenn commented on the sense of duty he felt serving in the Marines and as an astronaut.

"I think we would be almost remiss in our duty if we didn't make full use of our talents," he said. "Every one of us would feel guilty, I think, if we didn't make the fullest use of our talents in volunteering for something that is as important as this is to our country and the world."



The Mercury astronauts stand beside a Convair 106-B aircraft. From the left are: Lt. Scott Carpenter, U.S. Navy.; Capt. Gordon Cooper Jr., U.S. Air Force; Lt. Col. John Glenn Jr., U. S. Marine Corps; Capt. Virgil "Gus" Grissom, U.S. Air Force; Lt. Cdr. Walter Schirra Jr., U.S. Navy; Lt. Cdr. Alan Shepard, U.S. Navy; and Capt. Donald K. Slayton, U.S. Air Force. Photo credit: NASA



The 2017 NASA Astronaut Class stands beside a T-38 aircraft. From the left are: Zena Cardman, graduate research fellow at Pennsylvania State University; U.S. Marine Corps Maj. Jasmin Moghbeli; Jonny Kim, resident physician at Massachusetts General Hospital; U.S. Army Maj. Frank Rubio; U.S. Navy Lt. Cdr. Matthew Dominick; Warren Hoburg, assistant professor at Massachusetts Institute of Technology; Robb Kulin, launch chief engineer at SpaceX; U.S. Navy Lt. Kayla Barron; Bob Hines, NASA research pilot at Johnson Space Center; U.S. Air Force Lt. Col. Raja Chari; Loral O' Hara, research engineer at Woods Hole Oceanographic Institution; and Jessica Watkins, postdoctoral fellow at California Institute of Technology. Photo Credit: NASA/Robert Markowitz

CROWDSOURCED CROPS

Students help solve space-farming challenges

BY AMANDA GRIFFIN

College students working with NASA are helping devise solutions that may make living on other worlds possible.

Short for eXploration Systems and Habitation Academic Innovation Challenge, the **X-Hab Challenge** represents one of several platforms NASA leverages to crowdsource solutions to complex challenges in order to keep humans healthy and productive in deep space. Universities submit their ideas and NASA's technical experts review and select the proposals. NASA surveys the agency for issues that need solutions to enable exploration.

"There are key issues needing solutions for food production in microgravity during exploration missions. These issues are water and nutrient delivery to the root zone and the recycling of nutrients from inedible plant materials and waste," said Charlie Quincy, Kennedy Space Center's Life Science maturation manager. "This year, two projects tackled both watering plants in space and nutrient and material recovery."

Ohio State University in Wooster, Ohio, recently finished its project, entitled "Passive Watering and Plant Biomass Recycling Systems for eXploration Habitat." This project was two projects in one — while one team focused on designing a reliable, low-energy, low-maintenance water delivery system using wicking and **capillary** forces, a second team examined how to incorporate recycled inedible plant matter, including root and stems, into a rooting structure for the next plant growing cycle. The passive water delivery portion examined alternate water delivery methods for the **Veggie** experiment on the International Space Station. The addition this year was to use a collapsible reservoir and a device to aid fluid flow in microgravity. The recycling team designed a bioreactor and a process of shredding and dehydrating plant matter to transform plant waste into plant-growth substrate that could be used to grow plants for food.

The University of Michigan in Ann Arbor tackled turning urine into plant nutrition. Its project, entitled "Space Life and Physical Sciences: Wastewater to Plant Nutrient Solution," extracts water and plant nutrients along with edible sodium from the wastewater and urine generated by a human space habitat. The

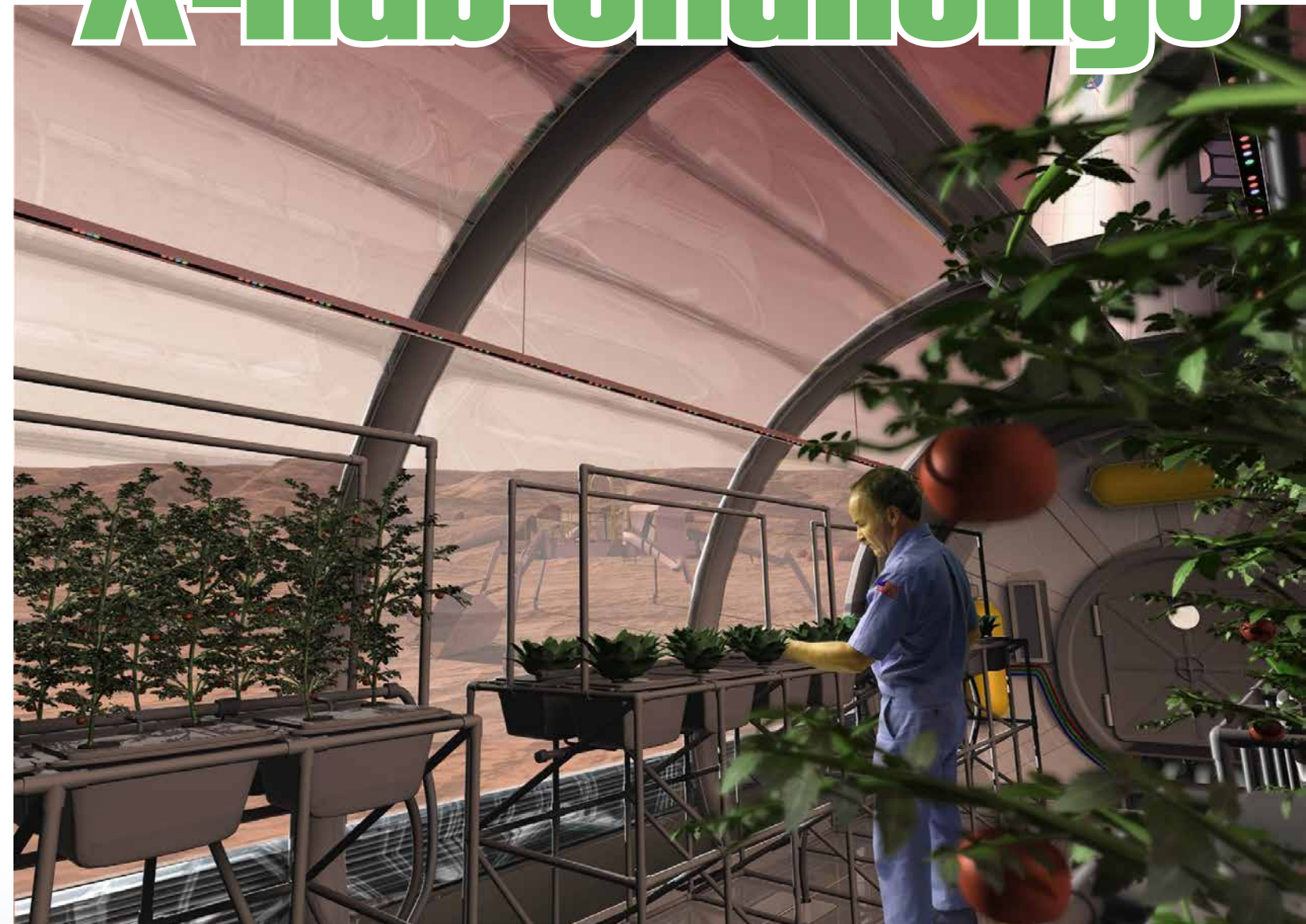
student team members presented the design process, construction and testing of the sub-components of their hardware and software, and demonstrated how the hardware works. The system involves a multistage setup of pretreatment ultrafiltration to separate materials, electro dialysis to remove inorganic salts, and finally ultraviolet light to remove bacteria and viruses. The resulting water and nutrients could then be recycled to grow plants for food. The students were able to demonstrate that water and plant nutrient output from their system could be used to grow plants that are safe for human consumption.

X-Hab is sponsored by Advanced Exploration Systems (AES), a division in NASA's Human Exploration and Operations Mission Directorate. AES develops strategic partnerships and collaborations with universities to help bridge gaps and increase knowledge in architectural design trades, capabilities and technology risk reduction related to AES activities. NASA Space Life and Physical Science Research and Applications Division provided food production research topics and funding for materials, parts and services for selected projects to address real spaceflight issues and inspire the future NASA workforce.



Students from Ohio State University examine equipment at NASA's Kennedy Space Center that is used for research. Photo credit: NASA/Glenn Benson

X-Hab Challenge



An artist illustration of a Mars greenhouse. Image credit: NASA

FULL SPECTRUM

Space Station unit to study genetics of model organisms

BY BOB GRANATH

Scientists and engineers are developing new hardware destined for the **International Space Station** to support experiments demonstrating how different organisms, such as plants, microbes or worms, develop under conditions of microgravity. Results from the Spectrum project will shed light on which living things are best suited for long-duration flights into deep space.

According to Dr. Scott Shipley, project engineer for Spectrum at NASA's Kennedy Space Center, what makes this system unique is it will allow scientists to observe how different genes are turned on and off while the organisms grow in space. In ground testing using plants, the device works by exposing the plants to different colors of light while a camera records fluorescent light emitted from the plants with time-lapse imagery.

In these experiments, plant seeds are placed on agar gel (a jelly-like substance obtained from algae) in a Petri plate set up in the Spectrum unit. The seeds germinate, and as the seedlings develop, they are exposed to any combination of red, green, blue, white or infrared light to investigate different aspects of their growth and physiology.

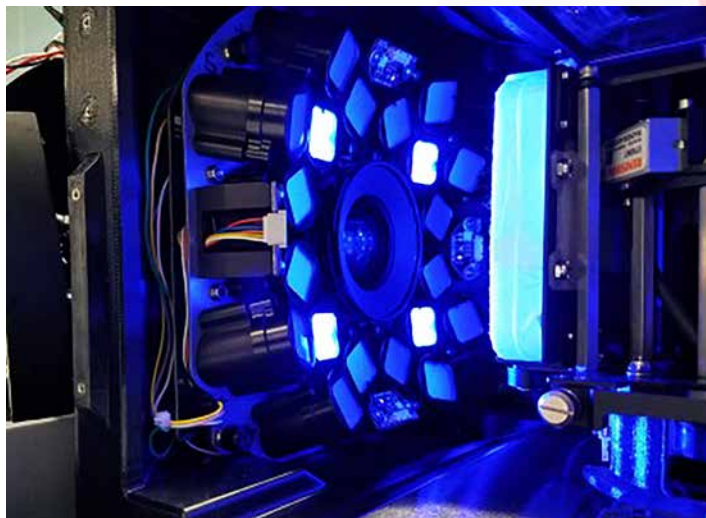
In a typical experiment, an astronaut will load a Petri plate with seeds into the Spectrum unit, the system then runs on an automatic script controlling temperature and changing the lights according to



Arabidopsis thaliana seedlings were placed in a Petri plate loaded inside the Spectrum prototype unit for testing prior to the critical design review in September 2017. The small plant is a popular model organism to study plant biology and genetics. Photo credit: NASA

a desired program, and the camera takes pictures about every hour. Scientists on Earth will receive regular photographs of the plants growing in the Petri plate. The results will shed light on how plants grow differently in the microgravity environment of space.

The Spectrum experiments will be important because genes control the physical and functional similarity between generations of plants. However, genes do not determine the structure of an organism alone. Environmental factors such as lighting and microgravity are other influences that can determine what types of plants are best suited for long spaceflights.



Inside the Spectrum prototype unit, plant seedlings in a Petri plate are exposed to blue excitation lighting for the green fluorescent protein. The device works by exposing plants to different colors of fluorescent light while a camera records what's happening with time-lapse photography. This allows researchers to focus on different gene structures of plants germinating in microgravity. Photo credit: NASA

Recently, the team conducted a 14-day test with plant seedlings to evaluate whether the Spectrum prototype met NASA's design specifications. At the end of the test, NASA managers and subject-matter experts conducted a critical design review to determine if the performance of the unit demonstrated it was ready for full-scale fabrication and assembly.

"There were a lot of smiles all around," Shipley said. "The prototype passed the review and was judged to exceed all requirements. We also were given a 'go' to proceed with building the Spectrum unit."

Aboard the space station, the flight version of Spectrum will be inserted into an **EXpedite the PProcessing of Experiments for Space Station**, or EXPRESS, rack. EXPRESS racks support research aboard the station by providing structural interfaces, power, data and other elements needed to run science experiments.

Plans call for the flight unit to be launched to the space station aboard a **commercial resupply services** spacecraft.

"Our goal now is to have the Spectrum unit ready," he said, "for a space station resupply mission in mid-to-late 2018."



Dr. Scott Shipley of Ascentech Enterprises makes an adjustment to the Spectrum unit. He is the project engineer for the effort working under the Engineering Services Contract at NASA's Kennedy Space Center. The device is being built for use aboard the International Space Station and is designed to expose different organisms to different colors of fluorescent light while a camera records what's happening with time-lapse imagery. Results from the Spectrum project will shed light on which living things are best suited for long-duration flights into deep space. Photo credit: NASA/Cory Huston

The second and third stages of an Orbital ATK Pegasus XL rocket are offloaded from a transport vehicle at Building 1555 at Vandenberg Air Force Base in California. The rocket is being prepared to launch NASA's Ionospheric Connection Explorer mission, or ICON, from the Kwajalein Atoll. ICON will study the frontier of space - the dynamic zone high in Earth's atmosphere where terrestrial weather from below meets space weather above. The explorer will help determine the physics of Earth's space environment and pave the way for mitigating its effects on our technology, communications systems and society. Photo credit: Rodney Speed



LEADING THE NEXT FRONTIER

National Space Council focuses on goals for America's space exploration

NASA UPDATE

The re-established National Space Council had its first meeting Oct. 5, 2017, at the Smithsonian National Air and Space Museum's Steven F. Udvar-Hazy Center in Chantilly, Virginia. The council was chaired by Vice President Mike Pence and included participation by Acting NASA Administrator Robert Lightfoot, as well as a number of U.S. cabinet members and senior officials, and aerospace industry leaders.

"It was my pleasure to attend the first meeting of the new National Space Council. The council includes government leaders from civil and military space, and the group also heard from space industry leaders. The council has historic roots in the earliest days of the Space Age, and it has been established by the president to streamline and coordinate national space policy," said Lightfoot.

During the meeting, the vice president made it clear that space is a national priority.

He also announced a call for renewed U.S. leadership in space -- with a recommendation to the president that NASA help lead and shape the way forward.

Specifically, NASA has been directed to develop a plan for an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system, returning humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.

"The recommendation to the president would modify the existing National Space Policy to provide focus and direction to some of NASA's current activities and plans, and remove a previous guideline that NASA should undertake a human mission to an asteroid as the next human spaceflight milestone beyond low-Earth orbit," Lightfoot said.

The National Space Council acknowledged the strategic importance of cis-lunar space -- the region around the Moon -- which will serve as a proving ground for missions to Mars and

beyond and advance our stepping-stone approach to going farther into the solar system.

Lightfoot said based on a number of conversations he has had with the council, there are a number of initiatives underway in this important area, including a study of an orbital gateway or outpost that could support a sustained cadence of robotic and human missions, as well as ensuing human missions to the lunar and Mars surfaces, and other destinations.

"The direction builds on the hard work we have already been doing on the Space Launch System rocket and Orion spacecraft, our efforts to enable our commercial partners and work with our international partners in low-Earth orbit at the International Space Station, and what we have been learning from our current robotic presence at the Moon and Mars," Lightfoot said. "It adds further definition to the exploration plan we have been implementing, and strengthens and provides a context for studies and planning efforts underway across our human spaceflight, science and technology directorates."

Among new areas, NASA will work with industry and the international community on robotic lunar landers that explore the nature of the Moon and its resources, such as water. Lightfoot said the agency already has been planning human missions to cis-lunar space beginning with Exploration Mission-2, and with the upcoming budget process, it will look to solidify this work with the new goals in place.

"Working in close coordination across government through the new National Space Council and with our commercial and international partners, we are going to chart a new future in space with opportunities for all," Lightfoot said.

The council heard testimony from expert witnesses who represent the sectors of the space industry, including Civil Space, Commercial Space and National Security Space. President Donald Trump signed an executive order re-establishing the National Space Council on June 30.



Vice President Mike Pence delivered opening remarks during the National Space Council's first meeting, Oct. 5, 2017, at the Smithsonian National Air and Space Museum's Steven F. Udvar-Hazy Center in Chantilly, Virginia. The National Space Council, chaired by the vice president, heard testimony from representatives from civil space, commercial space, and national security space industry representatives. Photo Credit: NASA/Joel Kowsky

FLIGHT OF FIRSTS



The Apollo 4 mission lifted off on time at 7:00 a.m. EST on Nov. 9, 1967. The launch created one of the loudest-ever human-made sounds, rattling windows at the Launch Control Center and Press Site three miles away. The flight was a major milestone in NASA's efforts to land humans on the Moon. Photo credit: NASA

Apollo 4 was first-ever launch from Kennedy Space Center

BY BOB GRANATH

Fifty years ago this month, NASA's Kennedy Space Center experienced the roar of a rocket from Launch Complex 39 for the first time. Looking ahead to that milestone, President John F. Kennedy spoke to a crowd at Rice University in Houston on the hot afternoon of Sept. 12, 1962, explaining some of the challenges of going to the Moon.

"If we shall send to the Moon, 240,000 miles away ... a giant rocket, ... made of new metal alloys, some of which have not yet been invented, capable of withstanding heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch -- then we must be bold."

On the morning of Nov. 9, 1967, the ambitious effort to develop that rocket was achieved. The first flight test of the 363-foot-tall **Saturn V** lifted off as the uncrewed **Apollo 4** mission. The rocket's power of 7.5 million pounds of thrust reached the Launch Control Center (LCC), Press Site and spectators, all three miles away, shocking even veteran launch viewers.

From his broadcast structure, CBS News commentator Walter Cronkite reported that the building was shaking and that he and a producer were holding the glass window behind him.

NASA's Public Information chief, Jack King, who served as countdown commentator, expressed a similar reaction.



In the early evening of Nov. 8, 1967, the 363-foot tall Saturn V launch vehicle stands ready for liftoff. The first uncrewed flight test of the Saturn V, Apollo 4 also was the first rocket to liftoff from the Florida spaceport. Photo credit: NASA



On Aug. 26, 1967, the first operational Saturn V rolled out of the Vehicle Assembly Building at NASA's Kennedy Space Center. After several months of checkouts, the massive launch vehicle was ready for the uncrewed Apollo 4 mission, helping pave the way for the first landing on the Moon less than two years later. Photo credit: NASA

"At liftoff, the vibration from the Saturn V showered us with dust and debris from the ceiling of the Launch Control Center, which was brand new at the time," he said.

Dr. Hans Greune, director of Kennedy Launch Vehicle Operations, also was in the LCC.

"I hope the **Vehicle Assembly Building** (VAB) doesn't get any cracks," he said afterward. "It rattled pretty hard and a cheer went up in the control room after liftoff."

The celebration followed years of development for the launch vehicle required to meet President Kennedy's goal to land on the Moon. With it, humankind could take its first trips beyond low-Earth orbit, expanding the frontiers of knowledge and opportunities in space.

The three-stage rocket was stacked in the VAB and was the first to take off from the new Launch Complex 39.

After the successful liftoff, Kennedy's director, Dr. Kurt Debus, spoke of that achievement.

"After long years of preparing, designing, building and constructing a new type of facility, it was put to the test for the first time and it was done extremely well," he said.

The Saturn V's third stage, or S-IVB, and Apollo command/service module were placed into a nearly circular 115-mile orbit, as would be the case on lunar missions. After two orbits, the S-IVB's first reignition put the spacecraft into an elliptical orbit with a high point of 11,200 miles.

The command module's service propulsion system engine then fired to increase re-entry speed to about 24,900 miles per hour, simulating a return from the Moon. After 8 hours and 36 minutes of flight, the command module splashed down in the Pacific Ocean, approximately 10 miles from the U.S. Navy aircraft carrier, USS Bennington, the prime recovery ship.

"It was really an expert launching all the way through from lifting off exactly on time to performance of every single stage," said Dr. Wernher von Braun, director of NASA's Marshall Space Flight Center in Huntsville, Alabama.

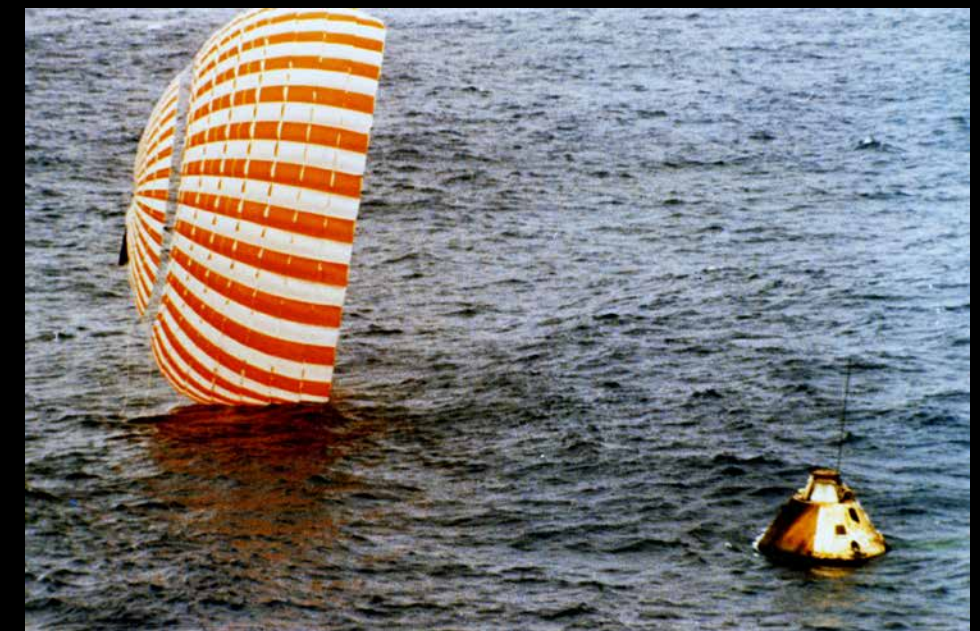
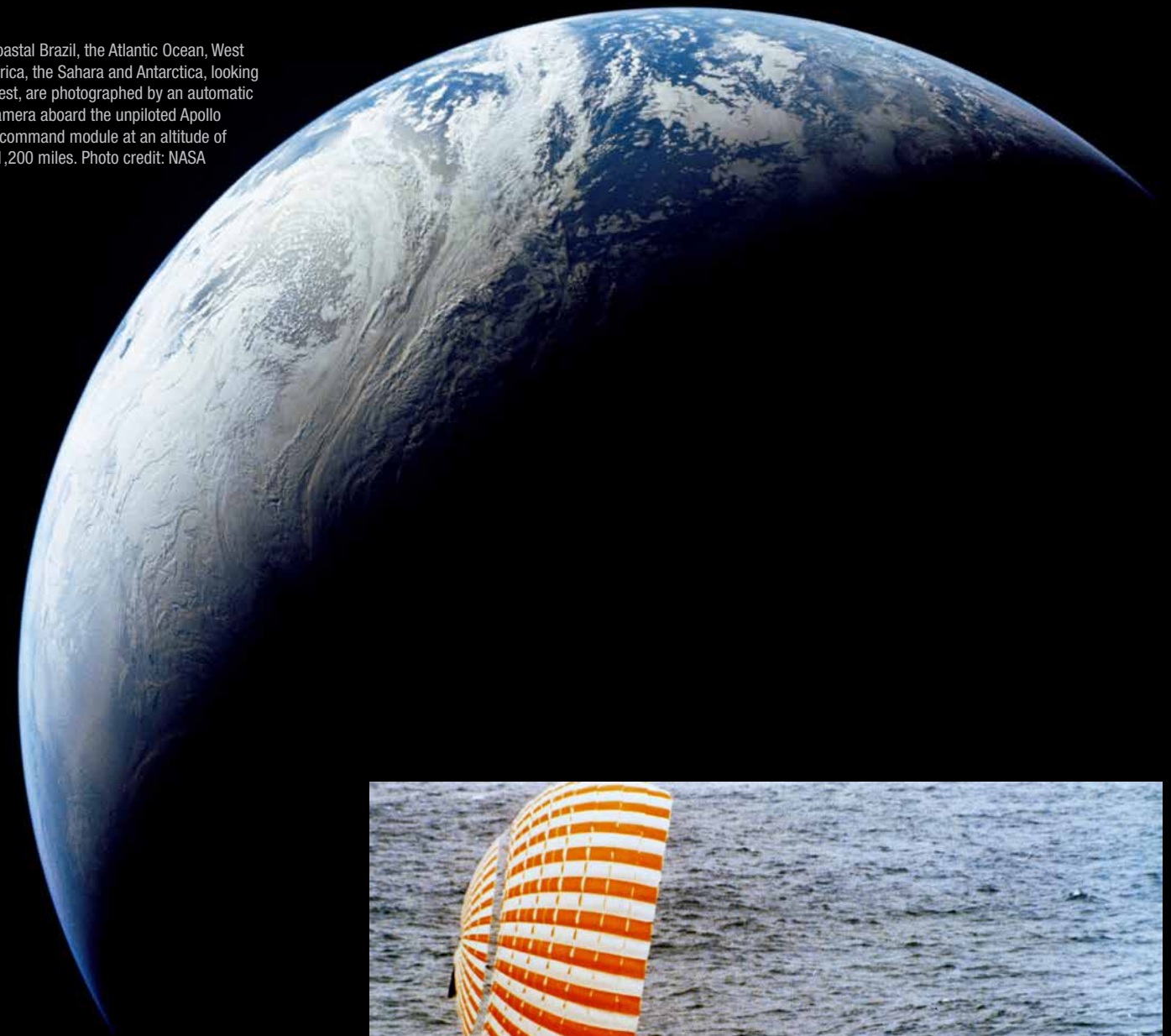
NASA's Associate Administrator for Manned Space Flight, Dr. George Mueller, noted that the successful flight of Apollo 4 showed that NASA was back on track to land on the Moon following the **Apollo 1** fire earlier in 1967.

"The maiden voyage of the Saturn V dramatically increased the confidence of people across the nation in the management of the largest research and development undertaking in which the western world has ever engaged," he said.

Less than two years after Apollo 4, the crew of **Apollo 11** achieved President Kennedy's goal, landing on the moon July 20, 1969. Five more missions landed by the end of 1972.

That spirit of deep space exploration continues as NASA prepares for flights of the **Space Launch System** rocket with the **Orion** spacecraft, also lifting off from Kennedy's Launch Complex 39, as astronauts will again travel beyond low-Earth orbit.

Coastal Brazil, the Atlantic Ocean, West Africa, the Sahara and Antarctica, looking west, are photographed by an automatic camera aboard the uncrewed Apollo 4 command module at an altitude of 11,200 miles. Photo credit: NASA



The Apollo 4 command module and one of its parachutes float in the Pacific Ocean following splashdown near the U.S. Navy aircraft carrier, USS Bennington. The Apollo 4 mission yielded flight information on the structural integrity, compatibility and subsystem operation of the Saturn V launch vehicle and Apollo spacecraft. Additionally, the Apollo command module's heat shield was tested under conditions similar to those that would be encountered during a return from the Moon. Photo credit: NASA



Kennedy's Ecological Program Data Science questions and answers

BY DANNY HUNT

In this Q&A series in past issues, we learned something about the diverse and varied efforts at Kennedy to protect and preserve ecological systems while simultaneously supporting the NASA mission. In this edition, we look behind the scenes at an essential component quietly making the KSC Ecological Program a leader in applied ecosystem science and adaptive ecosystem management.

Kennedy is unparalleled in its diversity of plants and animals in the continental U.S. Combined with its status as a national wildlife refuge, a robust science-based program is required to meet NASA's commitment to a sustainable environment. Enormous amounts of ecologically based data have been collected and cataloged since the early 1980s, supporting the National Environmental Policy Act, the Endangered Species Act and facility operations requirements. This long-term commitment by NASA has elevated Kennedy to be one of the most ecologically data-rich environments in the world today. Our data scientists turn large and complex data sets into actionable management and compliance information, which in turn allow officials to make informed decisions regarding land management and infrastructure resiliency.

Q: What is data science?

Data science is a relatively new discipline first introduced in 2001. Data science uses theory from a variety of scientific fields in order to efficiently and effectively gather and convey information. Largely revolving around computational problem-solving and often steeped in statistical theory, it is an emerging area of work that mainly focuses on the collection, preparation, analysis and visualization of large or difficult sets of data.

Q: What do data scientists do?

Data scientists rely on powerful computers and intricate, often custom-built software along with the scientific method to integrate large amounts of dissimilar digital data. They develop and employ mathematical and statistical models and/or computer algorithms to extract meaningful information from these data, which can then be used to create visualizations or reports. Data scientists often work alongside subject-matter experts and other scientists to carry out these tasks.

Q: Why is data science always performed in teams?

For any given project, one person rarely performs the entirety of the data science tasks. "Data science is a team sport," as the saying goes. These tasks typically require interdisciplinary teams to carry out the various aspects involved in designing a study; collecting, preparing, analyzing and synthesizing the data; and accurately communicating what the data tell us.

Q: What categories of data are collected by the Ecological Program?

Here at Kennedy, our data science projects involve electronic data that are most often used in some combination of these three basic forms. Tabular data consist of rows and columns, commonly found in spreadsheets and databases. An example would be the count of threatened beach mice that left footprints in a series of tracking tubes along the beach. Spatial data

consist of observations made at a specific location or area that can be identified on a map and analyzed for patterns. An example would be the coordinates of a protected sea turtle nest on the beach that had disoriented hatchlings. Imagery consists of complex digital aerial and satellite images encoded with certain properties that allow them to be used with mapping software. Spatial data are often superimposed over imagery, providing visual context for management decisions. An example would be vegetation characteristics and controlled burn history.

Q: What are some of the tools used in Ecological Program data science initiatives to support environmental compliance, planning and operations at Kennedy?

Data science primarily involves computing. Ecological Program data science initiatives commonly use the following types of tools. R is a leading statistical computing language that provides an environment for data scientists to prepare data and perform data analysis and visualization. Database Management Systems (DBMS) are used for storing and retrieving large amounts of tabular data. We have more than one billion rows of ecological-based data stored in databases. Geographic Information Systems (GIS) software systems handle geographical information derived from spatial data in order to make maps and locate items of interest.

Q: How are environmental data and the data science tools used to support NASA launch operations and environmental monitoring actions?

A good example is determining the risk of launch exhaust plumes at Kennedy, from the space shuttle era into the next generation of spaceflight. For each crewed NASA launch, Ecological Program staff utilize a computer simulation model to forecast in advance where the rocket motor exhaust cloud will travel, potentially exposing people, facilities, wildlife and ecosystems to launch byproducts. These model simulations use math to predict how launch vehicle exhaust will rise, disperse and deposit. Model outputs are visualized on GIS maps showing which facilities, viewing sites and ecosystems run the highest risk of potential exposure. This information is then shared with the launch team, including Safety and Medical Operations,

reducing risks to the crew, workforce and public. After launch, teams conduct field surveys based on the model output to document and assess potential impacts to the ecosystem.

Q: How do Ecological Program data scientists use simulation to help generate information for the management of natural resources at KSC?

With advances in computing power, simulation -- the use of mathematical models to reproduce or predict changes in a natural system -- has become an important tool for data scientists in Kennedy's Ecological Program. Using information from pilot studies or previous investigations, data scientists simulate potential data and use it to plan future studies to be more efficient and have a higher probability to answer important questions. For example, modeling the impacts of prescribed fire on scrub vegetation height helps land managers with their efforts to conserve Florida scrub-jays.

Data scientists also use simulation to validate analysis procedures and results. Finally, simulation modeling also enables KSC Ecological Program data scientists to better understand assumptions and existing knowledge while learning about complex ecological systems at KSC.



The Florida scrub-jay's bright blue and gray plumage stands out against a backdrop of scrub oaks in the Merritt Island National Wildlife Refuge. Listed as a threatened state species since 1975 and as a threatened federal species since 1987, the Florida scrub-jay thrives in an extremely dry habitat called a scrub. Data scientists use computer modeling to evaluate the impacts of prescribed fire on scrub vegetation, helping land managers with their efforts to conserve the birds. Photo credit: NASA/Ben Smegelsky



On Aug. 26, 1967, the assembled Apollo Saturn V launch vehicle arrives at Launch Complex 39A at NASA's Kennedy Space Center. The vehicle was transported to the launch pad on the mobile launcher platform atop a crawler-transporter. Photo credit: NASA

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