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KENNEDY SPACE CENTER'S

SPACEPORT magazine

SpaceX CRS-16 Final 2018 U.S. Resupply Mission Launches to the Space Station

KENNEDY SPACE CENTER'S

SPACEPORT MAGAZINE

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The two-stage Falcon 9 launch vehicle lifts off Space Launch Complex 40 at Cape Canaveral Air Force Station carrying the SpaceX's Dragon resupply spacecraft to the International Space Station. Liftoff was at 1:16 p.m. EST, Dec. 5, 2018, on its 16th commercial resupply services mission to the space station. Photo credit: NASA/Kim Shiflett

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Kennedy Space Center has its own monthly podcast. Welcome to the "Rocket Ranch." Listen to **Episode 6: Starting Up the Space Station**. In this episode we sit down with the Space Shuttle commander who officially began construction of the ISS in space. Our own Center Director Bob Cabana recounts his experiences as the first American on station and turning on the lights. Read the full transcript and catch up on missed episodes at **https://www.nasa.gov/kennedy/rocketranch**.

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Photo credit: NASA

International Space Station yielding important science for 20 years

The first elements of the International Space Station now have been in orbit for 20 years. Assembly of the largest spacecraft ever built was a global, cooperative effort and started with the STS-88 space shuttle mission launched Dec. 4, 1998.

Kennedy Space Center Director Bob Cabana, a former space shuttle astronaut, commanded the flight that began one of history's landmark engineering achievements. The orbiting outpost now serves as a unique laboratory where teams from around the world are performing scientific research only possible in the microgravity environment of space.

In the photo at left, a large-format IMAX camera shows the view from the space shuttle Endeavour's cargo bay as the crew of STS-88 began construction of the space station. In the image on the right, mission specialist Nancy Currie uses Endeavour's Canadarm remote manipulator system to grapple the Russian Zarya module and join it to the U.S.-built Unity node connecting modules in the shuttle's cargo bay.

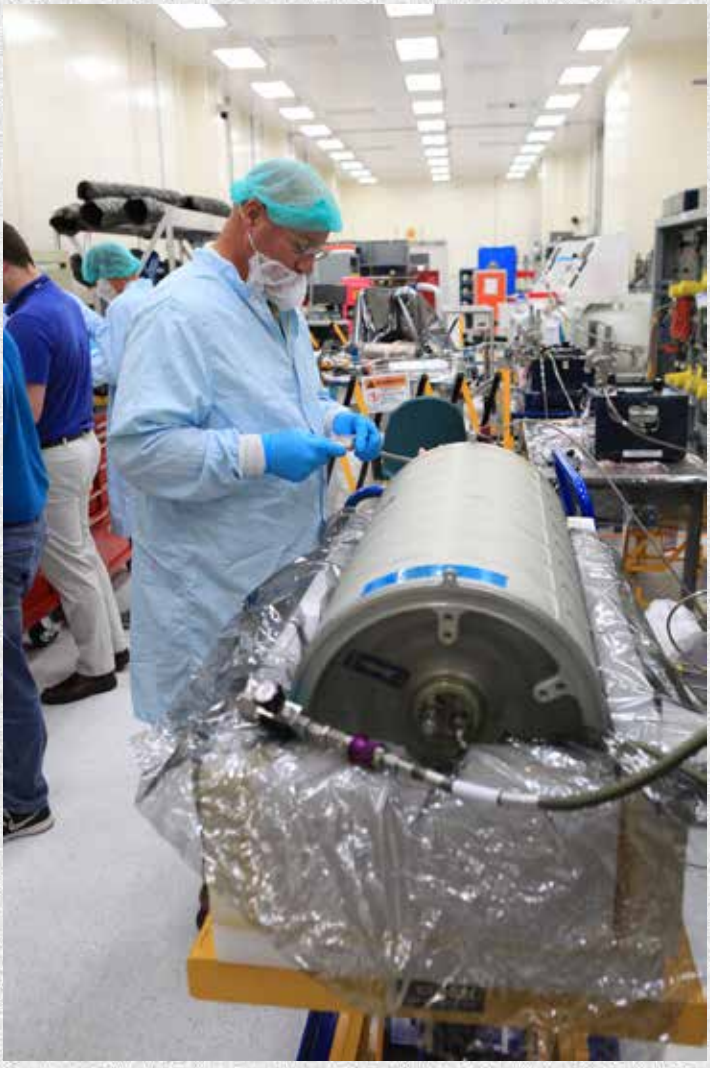
Space Station

Successful Launch Sends SpaceX Dragon to International Space Station

BY LINDA HERRIDGE

A nearly 6,000-pound care package was delivered to the International Space Station aboard a SpaceX Dragon spacecraft. The company's 16th commercial cargo mission to resupply the space station began at 1:16 p.m. EST on Dec. 5, 2018, with liftoff aboard a SpaceX Falcon 9 rocket from Space Launch Complex 40 at Cape Canaveral Air Force Station in Florida.

"It was an incredible launch," said Joel Montalbano, deputy ISS program manager, NASA's Johnson Space Center in Houston. "This was the fourth launch in three weeks to the space station."



Inside the Space Station Processing Facility high bay at NASA's Kennedy Space Center in Florida, a technician works on the pump package assembly (PPA) on Aug. 30, 2018. The payload was carried to the International Space Station on SpaceX's 16th Commercial Resupply Services mission. The PPA will be used to continuously drive the cooling water in the space station's thermal control system. The PPA also will provide a reservoir used for makeup of coolant if leakage occurred. Photo credit: NASA/Glenn Benson

After a successful climb into space, the Dragon spacecraft deployed its solar arrays to draw power for a series of maneuvers to reach the space station.

"This is a great day. We had a beautiful launch." said Hans Koenigsmann, vice president of Build and Flight Reliability at SpaceX.

The Dragon spacecraft delivered science, supplies and hardware to the orbiting laboratory. Science experiments include the Robotic Refueling Mission 3 (RRM3) and the Global Ecosystem Dynamics Investigation (GEDI).

RRM3 demonstrates the storage and transfer of cryogenic fluid, which is critical for propulsion and life support systems in space. While the Robotic Refueling Mission Phase 2 (RRM2) demonstrated tasks leading up to coolant replenishment, the actual transfer of cryogenic fluid in orbit will be carried out for the first time with RRM3, using liquid methane.

GEDI will make high-quality laser ranging observations of Earth's forests and topography required to advance the understanding of important carbon and water cycling processes, biodiversity and habitat. GEDI will be mounted on the Japanese Experiment Module's Exposed Facility and will provide the first high-resolution observations of forest vertical structure at a global scale.

Also, the Growth of Large, Perfect Protein Crystals for Neutron Crystallography (**Perfect Crystals**) crystallizes an antioxidant protein found inside the human body to analyze its shape. This research may shed light on how the protein helps protect the human body from ionizing radiation and oxidants created as a byproduct of metabolism. For best results, analysis requires large crystals with minimal imperfections, which are more easily produced in the microgravity environment of the space station.

Hardware for the station includes Orbital Replacement Unit

Resupply

(Above) The two-stage Falcon 9 launch vehicle lifts off Space Launch Complex 40 at Cape Canaveral Air Force Station carrying the SpaceX's Dragon resupply spacecraft to the International Space Station. Liftoff was at 1:16 p.m. EST, Dec. 5, 2018, on its 16th commercial resupply services mission to the space station. Photo credit: NASA/Kim Shiflett

(Below) Jill McGuire, project manager for the Robotic Refueling Mission 3, or RRM3, experiment, describes RRM3 hardware for members of the media Dec. 3, 2018, in the Kennedy Space Center's Press Site auditorium. The briefing focused on research planned for launch to the International Space Station. Photo credit: NASA/Kim Shiflett

#2, an additional spare required for sufficient gas analysis capability; an external high definition camera assembly; two oxygen tanks necessary to support upcoming spacewalks as well as nominal operations; a Microgravity Science Glovebox video drawer to support further payload operations in orbit; and a rodent research transport assembly and support hardware to support operations for Rodent Research-8.

Dragon reached the space station on Saturday, Dec. 8. Astronauts aboard the station captured the Dragon using the space station's robotic arm and then installed it on the station's Harmony module. The Dragon spacecraft will spend about five weeks attached to the space station, returning to Earth in January 2019, with more than 4,000 pounds of research, hardware and crew supplies.

For updates during the mission, visit **https://www.nasa.gov/commercialresupply.**

NASA and European Space Agency (ESA) senior managers answer questions during a "Powering Exploration Mission-1" ceremony in the Neil Armstrong Operations and Checkout Building high bay at NASA's Kennedy Space Center on Nov. 16, 2018. From left, are Bill Hill, deputy associate administrator for Exploration Systems Development; Phillippe Deloo, European Service Module program manager at ESA; Mark Kirasich, Orion Program manager at the agency's Johnson Space Center in Houston; Sue Motil, Orion European Service Module integration manager at the agency's Glenn Research Center; and Jan Worner, ESA director general. Photo credit: NASA/Kim Shiflett

European Service Module will power Exploration Mission-1

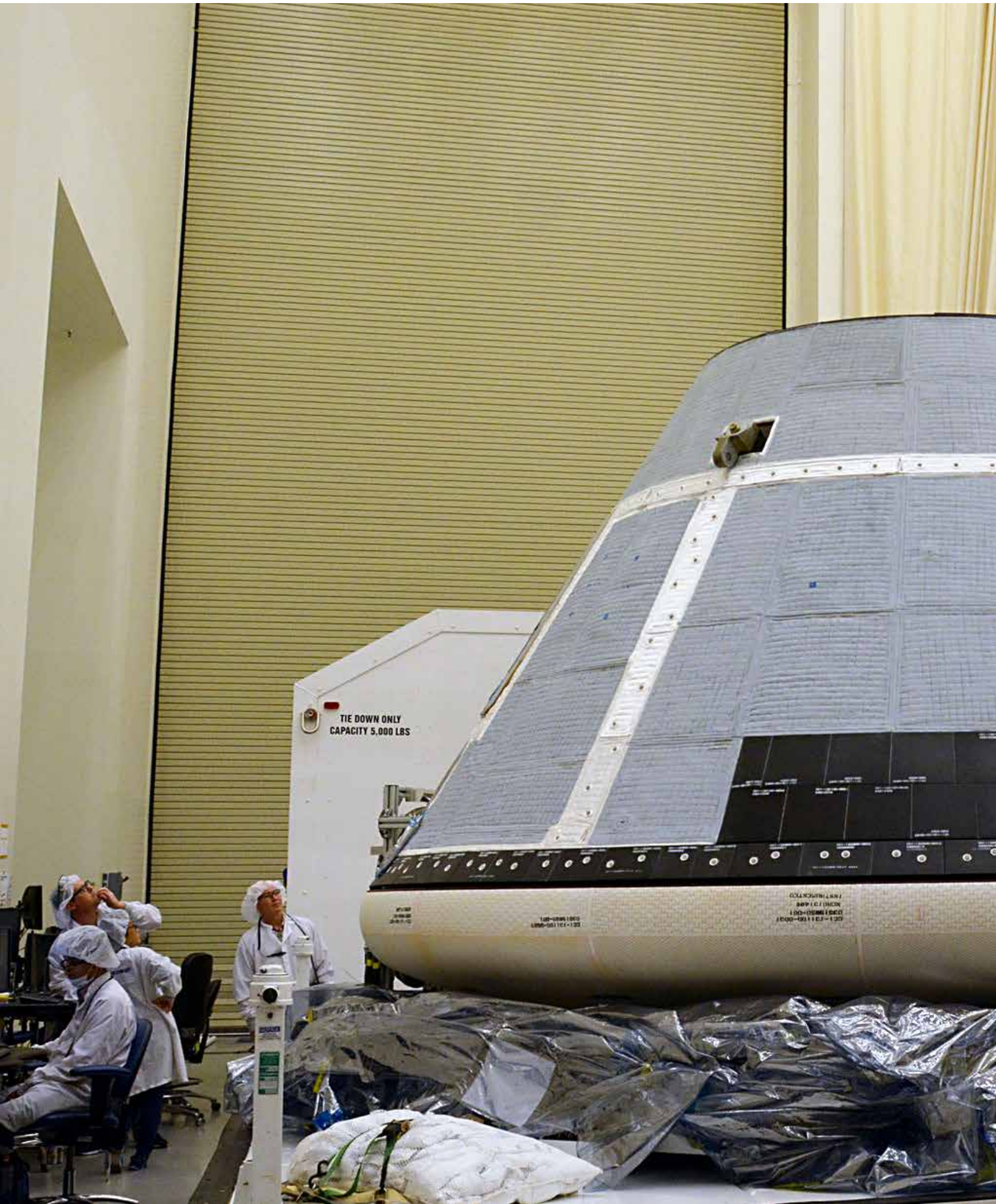
By Linda Herridge

Bill Hill, NASA deputy associate administrator, Exploration Systems Development, and Jan Worner, European Space Agency (ESA) director general, along with senior leaders from both agencies, marked a major milestone with the arrival of the European Service Module to Kennedy Space Center in Florida, during a "Powering Exploration Mission-1" ceremony Nov. 16, 2018, inside the Neil Armstrong Operations and Checkout Building High Bay at the center.

The European Service Module for Exploration Mission-1 (EM-1) will supply NASA's Orion spacecraft with electricity, propulsion and thermal control. The module also will house air and water for astronauts on future missions. EM-1 will be the first integrated test of NASA's Space Launch System, Orion and the ground systems at Kennedy.

The module is a unique collaboration across space agencies and industry including ESA's prime contractor, Airbus, and 10 European countries. The completion of service module work in Europe and shipment to Kennedy signifies a significant step forward in NASA's return to the Moon and other deep space destinations.

The European Service Module (ESM) is unpacked inside the Neil Armstrong Operations and Checkout Building high bay on Nov. 7, 2018, at NASA's Kennedy Space Center in Florida. The ESM is provided by the European Space Agency, and built by ESA contractor Airbus Defence and Space. Photo credit: NASA/Ben Smegelsky


TIE DOWN ONLY
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The spacecraft destined to fly astronauts to the International Space Station in Boeing's Crew Flight Test (CFT) is inspected following removal from its shipping container inside the company's testing facilities in El Segundo, California, on Nov. 21, 2018. The company's CST-100 Starliner is undergoing a series of environmental tests designed to simulate what it will experience during different stages of flight as part of NASA's Commercial Crew Program (CCP). The agency's CCP will return human spaceflight launches to U.S. soil, providing safe, reliable and cost-effective access to low-Earth orbit on systems that meet our safety and mission requirements. Photo credit: Boeing

SpaceX rehearses helicopter landing and patient loading on its recovery ship, GO Searcher, Oct. 18, 2018, practicing how the aircraft will pick up astronauts and fly them to a nearby hospital in the unlikely event of a medical emergency. The company outfitted the ship with a medical treatment facility and a helipad in the center of the vessel. When astronauts splash down into the ocean after their journey to the International Space Station on SpaceX's Crew Dragon spacecraft, NASA and SpaceX doctors will work together to evaluate the crew onboard the vessel. Should astronauts need to be airlifted to a hospital, the helicopter also will pick up paramedics and doctors from the ship who will care for the astronauts in-flight. Photo credit: SpaceX

NASA's Kennedy Space Center Innovators' Launchpad:

Paul Hintze

Please explain your job in a single sentence.

I develop technologies for gathering resources in space, thus enabling long-duration human spaceflight.

What do you find most exciting about your job as a chemist with NASA's Kennedy Space Center's Exploration Research and Technology programs?

As a chemist, I think it is fascinating trying to figure out how we get resources in space, whether it's developing an instrument to find water on the **Moon**, methods to **recycle waste**, or making propellant on **Mars**. It's incredible to think that these technologies will help guide the future of humanity as we move **further into space**.

What is a typical day like for you?

I spend time doing some hands-on technical work in the lab, time planning and interpreting experiments, and the rest managing projects.

Was the work you did your first month at NASA anything like your current work?

The technical work is much the same, even though I have changed areas. Spaceflight presents some unique problems on the ground and in space, and helping to solve those problems is the same now as it was in my first month. When I first started, I worked on projects centered at Kennedy, and I now work on projects across multiple NASA centers. As **technology** development projects get bigger and have more stakeholders, things change dramatically. I tell new researchers it takes five to 10 years to learn how to do things, but after 13 years with NASA I know I am still learning.

What is your educational background and why did you choose to study these areas?

I have a Bachelor of Science and Ph.D. in chemistry. I was first attracted to chemistry in high school. I tried a couple of other majors as an undergraduate before realizing chemistry was for me. Chemistry is the fundamental science and I enjoy how it can be applied to many things. It's a great combination of theoretical and applied science.

How do the era and place in which you grew up shape how you approach your work?

I am an optimist. I always believed I could do anything, and that is how I approach my work.

What motivated you to want to work for NASA?

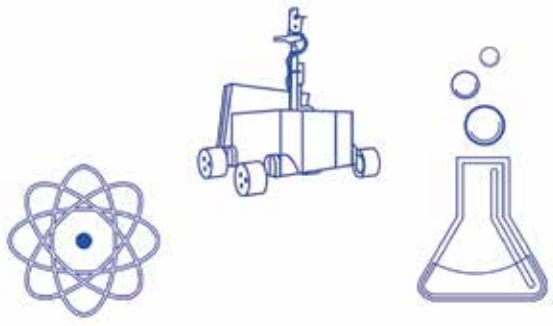
I had no idea I would end up at NASA when I was young. When I first started, and realized that what we do helps define the future of the human species, I was hooked.

Why does conducting research and developing new technology matter to you?

I was eight or 10-years-old when we got our first computer in our house. Eight-year-old Paul never could have imagined the computational tools I use today. Research and development is important because it can solve near-term problems, but sometimes you can't really imagine the impacts. When I was young, the internet was not a thing. In a similar fashion, collecting **resources in space** could impact humanity's future in ways we can't predict right now.

Do you have any advice for people trying to foster innovation in the workplace?

Innovate by example. Don't be afraid to try new things and listen to others when you do – get both positive and negative feedback. Provide good honest feedback when others try to be innovative. Be open to new ideas even if they contradict your own. If people see you trying to do the right thing, they are more likely to do the right thing as well.




SIG 1
SIG 2
SIG 3
SIG 4

A harvest of dragoon lettuce netted a mid-afternoon snack for astronauts aboard the International Space Station on Nov. 28, 2018. Astronaut Serena Auñón-Chancellor, after using a little Balsamic vinegar, reported the lettuce was “Delicious!” Photo credit: NASA

ERT members place second in 35th Annual SWAT Round-up International

Several members of Kennedy Space Center's Emergency Response Team recently competed and placed second overall in this year's SWAT Roundup International, held at the Lawson Lamar Firearms and Tactical Training Center in Orlando.

Kennedy's ERT members competed in five tactical challenges that were physically and mentally demanding. They competed with more than 50 teams from the U.S. and around the world.

The team also engaged in specialized training and operational debriefs, met to discuss common issues and challenges facing law enforcement, compared training and operational methods, and built relationships with neighboring agencies that can support each other during real-life critical incidents.

Emergency Response Team members participate in various challenges during the International SWAT Roundup competition in Orlando, Florida.

Retired NASA astronaut Bob Springer, center, poses for a photograph with top scholars from Brevard County high schools near the Rocket Garden at the NASA Kennedy Space Center Visitor Complex in Florida, on Nov. 7, 2018. The high school seniors were invited to Kennedy Space Center for a tour of facilities, lunch with an astronaut, and a roundtable discussion with engineers, scientists and business experts at the center. Photo credit: NASA/Cory Huston

Inspiring Top Scholars

High school students tour Kennedy Space Center, lunch with an astronaut

BY LINDA HERRIDGE

Seniors from Brevard County area high schools were treated to a behind-the-scenes tour of NASA's Kennedy Space Center, ate lunch with an astronaut, and participated in roundtable discussions with Kennedy engineers, scientists and business experts during the Brevard Top Scholars event on Nov. 7, 2018.

At the Kennedy Space Center Visitor Complex, the students heard from retired space shuttle astronaut Bob Springer, a member of the second class of NASA astronauts, who flew on the STS-29 and STS-38 missions. Mixing pertinent information with humor, Springer shared his experiences in training and flying on a space shuttle, and the astronaut selection criteria.

"We've had an exciting past, but we're going to have an even more exciting future." Springer said.

The annual event, hosted by the NASA Academic Engagement Office at the center, also provided information about NASA's internships and scholarships. At the end of the day, each student received a certificate of recognition. From there, they were invited to tour the visitor complex and view the Space Shuttle Atlantis exhibit.

"Each year, the schools select a superb group of students to participate," said Denise Coleman, Education Program specialist. "They were engaged and eager to see and hear as much as possible about Kennedy, NASA missions, and how all of that might relate to their future."

The students interacted with this year's career panel mentors: Dr. Tiffaney Alexander, Safety Branch chief, Safety and Mission Assurance; Dr. Jose Nunez, Flight Technology Branch chief,

Exploration Research and Technology; Anna Henderson, deputy chief financial officer for resources, CFO Office; Jo Pereira, deputy, Human Resources Integration and Pathways Program supervisor; and Rebecca Baturin, project engineer, Exploration Ground Systems.

"The students were a joy to talk to and share with, and they had some really great questions, too," Alexander said.

Spencer Moulds is a senior at Rockledge High School. The aspiring aerospace engineer is in the process of selecting a college. "Being here is a dream come true," Moulds said. "Seeing the Vehicle Assembly Building and Launch Pad 39B up close is life-changing for me."

For Dylan Geiger, a senior at Bayside High School in Palm Bay, having an in-depth tour of the center has inspired him. "I'm having a fantastic time," Geiger said. He wants to be an electrical engineer and is currently looking at prospective colleges.

Carmen Ohlinger, a senior at Space Coast Junior/Senior High School, wants to join the U.S. Air Force and major in geospatial science. "The tour was very interesting–seeing all of the buildings and meeting people who work here was inspiring," Ohlinger said. "It's a completely different world here. I'm still processing all of the information."

Alex Hudgins, a senior at Titusville High School, is interested in working at Kennedy someday. But for now, he would like to join the U.S. Navy and become a helicopter pilot with an aeronautics background.

"I've toured the center before, but not like this," Hudgins said. "I saw some new things, including going inside the Vehicle Assemble Building and seeing Launch Pad 39B."

Holly Jordan, a senior at Eau Gallie High School, would like to attend Florida State University and major in physics or math, because she likes the concepts they provide.

"You can't get to space without them," Jordan said. "It's important to continue space exploration."

Jordan would like to do an internship at Kennedy someday. "Touring the center was so wonderful. Seeing the crawlerway and the very tall Vehicle Assembly Building was so inspiring," Jordan said.

Retired NASA astronaut Bob Springer, at left, talks with students from Brevard County high schools during "Lunch with an Astronaut" at the NASA Kennedy Space Center Visitor Complex in Florida, on Nov. 7, 2018. Photo credit: NASA/Cory Huston

Rebecca Baturin, center, a project engineer in Exploration Ground Systems, speaks to students from Brevard County high schools during a panel discussion session at the NASA Kennedy Space Center Visitor Complex in Florida, on Nov. 7, 2018. Photo credit: NASA/Cory Huston

STEM Growth

Students inspired by extraordinary educational event

BY JIM CAWLEY

A storm that temporarily knocked out power to parts of the **Kennedy Space Center Visitor Complex** in Florida was no match for the enthusiasm, inspiration and knowledge-sharing that took place during NASA's STEM Girls Night In event Nov. 2-3.

About 50 Kennedy employees and college mentors treated 75 Brevard County middle school students to a special science, technology, engineering and math experience as part of an overnight program started by **Goddard Space Flight Center** in 2016. It was the first involvement for Kennedy — and for Rebecca Baturin, a project engineer for Exploration Ground Systems (EGS) who served as the event lead. Goddard and Glenn Research Center also participated.

"We were able to work through it," Baturin said of the power outage, which lasted about three hours. "The girls were engaged and excited to be there. They were definitely enjoying the event."

Participants were treated to a video conference Q&A with astronaut **Jeanette Epps**, a presentation by former astronaut **John Blaha** and a recorded message from **Dr. Serena M. Auñón-Chancellor**, an astronaut who is currently living on the International Space Station. The evening included STEM activities, demonstrations and a dinner with mentors, wrapping up with a one-of-a-kind sleeping arrangement — underneath the Space Shuttle Atlantis.

In the morning, students were provided breakfast and heard words of encouragement from a Kennedy leadership panel that featured Communication and Public Engagement Acting Director Hortense Diggs, EGS Deputy Program Manager Jennifer Kunz and EGS Associate Program Manager Kim Carter.

"It was an experience that I won't forget, and it reminded me of sleeping under the stars," said 12-year-old Patricia, a seventh-grader at Cocoa High School who is interested in technology and engineering.

Maria, 14, an eighth-grade student at Cocoa High, said the "candlelight" dinner (courtesy of the storm) with mentors was her favorite part of the program, adding that she felt honored to participate.

Cocoa High teacher Dr. Debra Ocker, one of the event's 15 chaperones, said her students gained valuable knowledge from the STEM experts. In particular, she praised female engineers for stressing the importance of moving forward, even when the going gets tough.

"I loved the event," Ocker said. "The girls have talked about their experiences … they are so excited to learn about robotics, technology and other areas of math and science. I even had a chaperone so excited that she is now pursuing her masters in mathematics."

Students from Madison Middle School in Titusville participate in an activity during NASA's STEM Girls Night In event Nov. 2-3 at the Kennedy Space Center Visitor Complex in Florida. Photo credit: Madison Middle School

From left to right, Kennedy Space Center's Kim Carter, Exploration Ground Systems (EGS) associate program manager, Rebecca Baturin, EGS project engineer, Jennifer Kunz, EGS deputy program manager, and Hortense Diggs, Communication and Public Engagement acting director, pose during NASA's STEM Girls Night In event at the Kennedy Space Center Visitor Complex Nov. 2-3. Photo credit: NASA

In 2016, STEM Girls Night In caught the attention of **Kennedy Deputy Director Janet Petro**, who was visiting Goddard when the program began. Upon returning to Florida, she contacted Baturin to see how Kennedy could get involved.

"When Janet asked if I wanted to take ownership, I knew it was something I wanted to do," said Baturin, who is co-chair of Kennedy Networking Opportunities for Women (KNOW), which partnered with the Space Coast chapter of Society of Women Engineers (SWE) and the NASA Academic Engagement Office to sponsor the event. "I was excited to hopefully pass that spark on to someone else and maybe see some of them working out here in a few years."

This September, **Kennedy's NASA Academic Engagement Office** sent a letter to four Brevard schools — Cocoa High, Space Coast Jr./Sr. High, Jackson Middle and Madison Middle — offering this program, free of charge, to a select number of middle school students. Administrators at these schools were asked to choose the students, with a strong focus on female and minority participation, "who have shown an interest in STEM studies, have followed the rules of conduct responsibly, have shown their teachers and fellow students courtesy and respect, and have represented their school in an exemplary manner both in and outside the classroom."

"Hopefully, some students got those 'a-ha' moments and this will give them the courage to go for it," said Denise Coleman, an education specialist with Kennedy's Communication and Public Engagement Directorate, who served as the liaison between Kennedy and the schools. "I've seen how the hands-on STEM curriculum can change people's paths."

Baturin is already looking forward to next year, with the goal of expanding the program and increasing attendance.

"We hope to reach out to those girls who maybe haven't had a chance to come out here," Baturin said. "Now they can come and see where STEM could take them in the future."

Boeing's Flight Control Team participated in a rehearsal of prelaunch procedures for the company's upcoming Orbital Flight Test in the White Flight Control Room in the Mission Control Center at Johnson Space Center in Houston on Nov. 7, 2018. Boeing's CST-100 Starliner will fly uncrewed to the International Space Station before NASA will certify the spacecraft to carry astronauts to station. Photo Credit: NASA/Robert Markowitz


MISSION CONTROL CENTER
CAPCOM
CAPSULE COMMUNICATOR

Teams from NASA, the Department of Defense Human Space Flight Support and SpaceX conduct a joint medical triage and medical evacuation (medevac) training exercise Oct. 25, 2018, at NASA's Kennedy Space Center in Florida. It was the second of two emergency medical services simulations performed before commercial crew flight tests, which are scheduled for 2019. As NASA's Commercial Crew Program prepares to begin launching astronauts once again from American soil, teams are sharpening their launch day operations procedures, including responses during the unlikely event of an emergency. Photo credit: NASA/Kim Shiflett

a BOLD Step

Apollo 8 sends first human flight beyond Earth

BY BOB GRANATH

"Apollo 8. You are Go for TLI."

With these cryptic words spoken on Dec. 21, 1968, NASA's Mission Control gave the crew of **Apollo 8** approval for TLI – trans-lunar injection – permission to become the first humans to leave Earth orbit. Their destination, 234,000 miles away, was the Moon.

After Apollo 7 successfully flew the program's command-service module in Earth orbit two months earlier, Lt. Gen. Sam Phillips, NASA's Apollo Program director, announced a bold next step.

"By going into lunar orbit, we make an early flight demonstration of the design mission of the **Saturn V**, the Apollo spacecraft, and understand its operation in translunar space," he said.

Apollo 8 commander Frank Borman was a U.S. Air Force colonel and test pilot. A member of NASA's second group of astronauts, he was command pilot for the **Gemini VII** mission, Dec. 4-18, 1965.

Command module pilot on Apollo 8 was Jim Lovell, a naval aviator and test pilot, also from the second astronaut group. He flew with Borman on Gemini VII and commanded **Gemini XII,** Nov. 11-15, 1966.

A member of the third astronaut class, Bill Anders was a major in the U.S. Air Force and a jet fighter pilot. For Apollo 8, he was designated the lunar module (LM) pilot, although there was no LM on this flight.

The Apollo 8 crew was the first to launch atop the powerful Saturn V rocket, lifting off from Launch Complex 39A at NASA's Kennedy Space Center in Florida.

After liftoff, Kennedy's chief of Operations, George Page, described processing and launch preparations as "fantastic."

"The countdown came off exceedingly well," he said.

For TLI, two hours and 50 minutes after liftoff, the Saturn V's third stage fired, propelling the spacecraft to 24,208 mph.

"The crew is traveling faster than man has ever flown before," said NASA Public Affairs commentator Paul Haney.

Now on a trajectory to the Moon, they separated their Apollo spacecraft from the Saturn V third stage, turned around and saw a striking view.

"We have a beautiful view of Florida now," Lovell said. "We can see the Cape (Canaveral), just the point. And at the same time, we can see Africa. West Africa is beautiful. I can also see Gibraltar at the same time I'm looking at Florida."

As Borman, Lovell and Anders approached the Moon early on Christmas Eve, Apollo 8 and Mission Control prepared for the vital firing of the spacecraft's service propulsion system (SPS) engine. That will place them in lunar orbit.

But that crucial maneuver would take place behind the Moon while out of contact with Earth. As the crew was about to travel out of touch, spacecraft communicator Jerry Carr, a fellow astronaut, passed along reassuring words.

"Apollo 8, one minute to LOS (loss of signal)," he said. "All systems Go. Safe journey, guys."

"We'll see you on the other side," Lovell said.

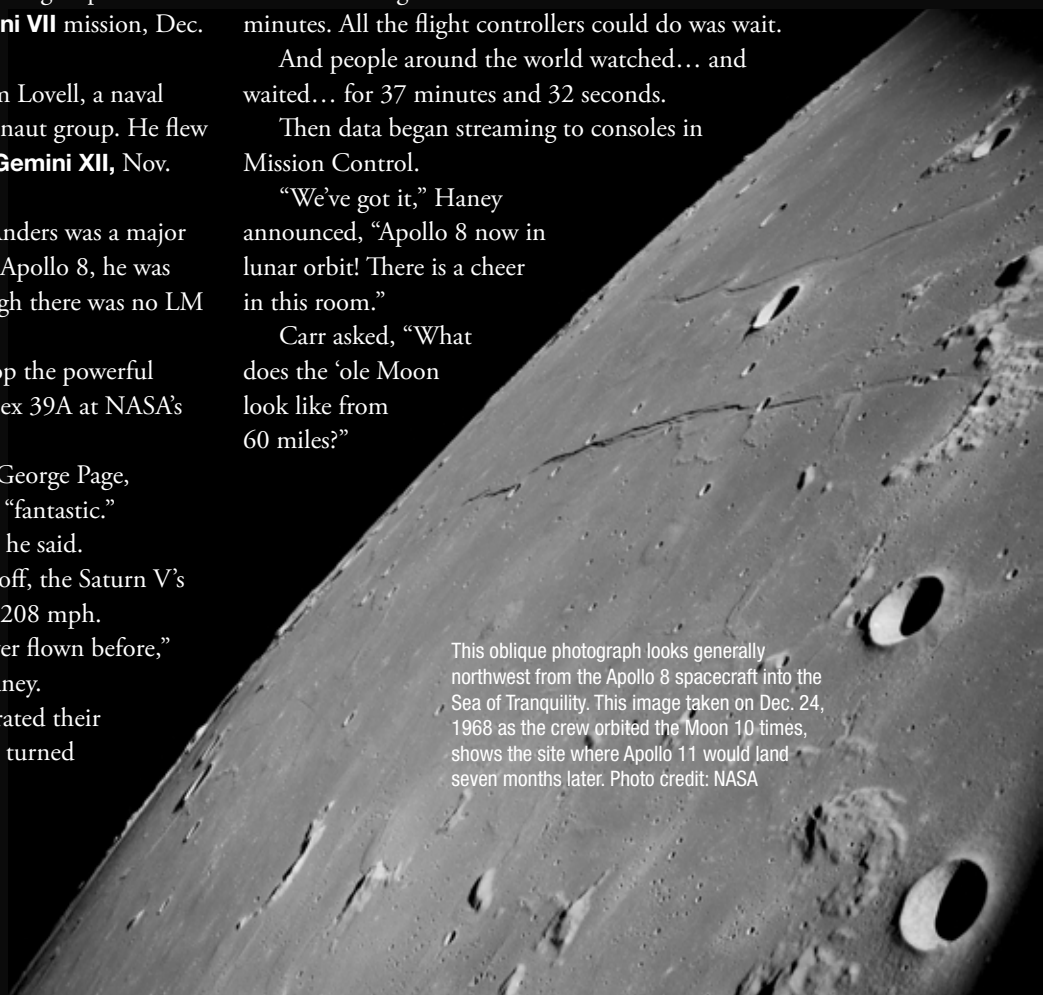
The SPS engine would have to fire for a little over four minutes. All the flight controllers could do was wait.

And people around the world watched… and waited… for 37 minutes and 32 seconds.

Then data began streaming to consoles in Mission Control.

"We've got it," Haney announced, "Apollo 8 now in lunar orbit! There is a cheer in this room."

Carr asked, "What does the 'ole Moon look like from 60 miles?"



This oblique photograph looks generally northwest from the Apollo 8 spacecraft into the Sea of Tranquility. This image taken on Dec. 24, 1968 as the crew orbited the Moon 10 times, shows the site where Apollo 11 would land seven months later. Photo credit: NASA

The Apollo 8 crew became the first astronauts to fly the 363-foot-tall Saturn V rocket, lifting off Dec. 21, 1968 with 7.5 million pounds of thrust. The vehicle had just cleared the tower at Launch Complex 39A at NASA's Kennedy Space Center in Florida. Photo credit: NASA

"Like dirty beach sand with lots of footprints in it," Anders said.

Over the next 20 hours, Apollo 8 orbited the Moon 10 times at an altitude of about 60 miles. The crew took detailed images of the lunar surface that would help flight planners select landing sites for upcoming missions to land on the Moon.

During a television broadcast seen by viewers around the world, the crew related what they were seeing.

"My own impression is that it's a vast, lonely, forbidding-type existence, or expanse of nothing, that looks rather like clouds and clouds of pumice stone," Borman said.

Lovell expressed similar thoughts.

"The vast loneliness up here of the Moon is awe inspiring, and it makes you realize just what you have back there on Earth," he said. "The Earth from here is a grand oasis in the big vastness of space."

"We can see the Earth now, almost as a disk," said Apollo 8 commander Frank Borman as he, Jim Lovell and Bill Anders looked back after leaving Earth orbit for the Moon. This striking view extends from the northern hemisphere to the southern tip of South America. Nearly all of South America is covered by clouds. Photo credit: NASA

Apollo 8 commander Frank Borman, left, addresses the crew of the aircraft carrier USS Yorktown after the crew's splashdown and recovery in the central Pacific Ocean on Dec. 27, 1968. Lunar module pilot Bill Anders, center, and command module pilot Jim Lovell look on. Photo credit: NASA

Apollo 8 mission emblem. Image credit: NASA

During the final orbit, time came for a 3 minute, 23 second trans-Earth Injection burn of the SPS engine to propel Apollo 8 for the trip home. It happened early on Christmas morning and, again, while Mission Control waited and Apollo 8 was behind the Moon.

"Please be informed there is a Santa Claus," said Lovell, announcing that firing worked as planned.

Just before sunrise on Dec. 27, 1968, Apollo 8 splashed down in the Pacific Ocean near the recovery aircraft carrier, the USS Yorktown.

After Borman, Lovell and Anders were safely aboard the ship, Dr. Thomas Paine, then acting NASA administrator, described the mission as "a true pioneering effort" opening the way for greater achievements.

"We are at the onset of a program of space flight that will extend through many generations," he said. "We're looking forward to the days we will be manning space stations, conducting lunar explorations and blazing trails out to the planets."

EARTHRISE

Apollo 8 crew captures iconic image

BY BOB GRANATH

The year 1968 was one of the most turbulent in history. War was raging in Vietnam, Rev. Martin Luther King Jr. and Sen. Robert Kennedy were assassinated and the Cold War included the race to the Moon.

But at Christmastime a half-century ago, millions around the world paused to follow the flight of Apollo 8. For the first time, humans left Earth for a distant destination.

The mission was a key step toward meeting President John F. Kennedy's goal of "landing a man on the Moon and returning him safely to Earth" by the end of the decade.

In addition to gaining the first close-up views of the lunar surface, the cameras of Frank Borman, Jim Lovell and Bill Anders also were focused back toward Earth.

While Borman maneuvered the Apollo spacecraft during the fourth lunar orbit, Anders was taking pictures of the surface. He then glanced at the Moon's horizon.

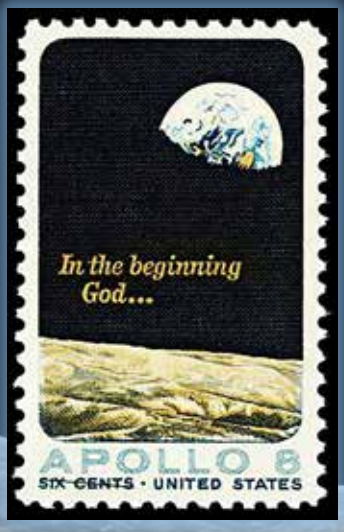
"Oh, my god, look at that picture over there," Anders said. "Here's the Earth coming up. Wow, is that pretty."

No Apollo 8 photograph was more stunning than his image that has come to be known as "Earthrise."

On May 5, 1969, the United States Postal Service issued a commemorative stamp celebrating the first human flight to the Moon. The design is based on Anders' Christmas Eve picture of the lunar surface with the Earth 234,000 miles away.

Anders later put the photography of Apollo in perspective.

"We came all this way to explore the Moon," he said, "and the most important thing is that we discovered the Earth."



The United States Postal Service issued a commemorative stamp celebrating Apollo 8, the first human flight to the Moon. The design is based on the photograph taken by astronaut Bill Anders on Dec. 24, 1968. The inscription recalls the crew reading the opening verses of the Bible's book of Genesis during a live television broadcast. Image credit: U.S. Postal Service

Contrasted against the stark, crater-marked lunar surface, the Earth is seen rising above the Moon on Dec. 24, 1968. As Apollo 8 orbited the Moon, Earth is 234,000 miles away. The sunset terminator is seen crossing Africa. The South Pole is in the white area near the left end of the terminator. Photo credit: NASA/Bill Anders

This mosaic image of asteroid Bennu is composed of 12 PolyCam images collected on Dec. 2 by the OSIRIS-REx spacecraft from a range of 15 miles (24 km). Photo credit: NASA/Goddard/University of Arizona

NASA's newly arrived OSIRIS-REx spacecraft discovers water on asteroid

Recently analyzed data from NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) mission has revealed water locked inside the clays that make up its scientific target, the asteroid Bennu.

During the mission's approach phase, between mid-August and early December, the spacecraft traveled 1.4 million miles (2.2 million km) on its journey from Earth to arrive at a location 12 miles (19 km) from Bennu on Dec. 3. During this time, the science team on Earth aimed three of the spacecraft's instruments towards Bennu and began making the mission's first scientific observations of the asteroid. OSIRIS-REx is NASA's first asteroid sample return mission.

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