

# KENNEDY SPACE CENTER'S SPACEPORT m a g a z i n e



## Cosmic Cuisine

Student-scientists pick crops to grow on space station

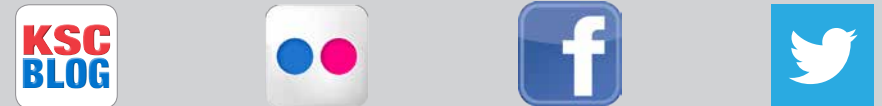


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**Cover:** Students from the Miami-Dade area participate in the Green Cuisine challenge where they had to create a dish fit for an astronaut. Photo credit: Fairchild Tropical Botanic Garden.

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## NASA'S LAUNCH SCHEDULE

**Date:** April  
**Launch Window:** TBD  
**Mission:** Orbital ATK Resupply Mission to International Space Station (CRS-7)  
**Description:** The Atlas V launch of Orbital ATK's Cygnus cargo craft from Cape Canaveral Air Force Station in Florida.  
<http://go.nasa.gov/2jetyfU>

**Date:** April 10  
**Mission:** Expedition 50 Undocking and Landing  
**Description:** NASA astronaut Shane Kimbrough and cosmonauts Sergey Ryzhikov and Andrey Borisenko of the Russian space agency Roscosmos undock their Soyuz MS-02 spacecraft from the International Space Station's Poisk module and land in Kazakhstan.  
<http://go.nasa.gov/2gMg3PR>

**Date:** April 20  
**Mission:** Expedition 51 Launch  
**Description:** Expedition 51/52 crew members NASA astronaut Jack Fischer and cosmonaut Fyodor Yurchikhin of the Russian space agency Roscosmos launch to the International Space Station. Yurchikhin will be the Expedition 52 commander.  
<http://go.nasa.gov/2gMfdmx>

**Date:** No Earlier Than June  
**Mission:** ICON (Ionospheric Connection Explorer)  
**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.  
<https://www.nasa.gov/icon>

**Date:** Aug. 3  
**Mission:** Tracking and Data Relay Satellite M (TDRS-M)  
**Description:** Orbiting 22,300 miles above Earth, the TDRS spacecraft provide near-constant communication links between the ground and orbiting satellites, such as Hubble, and the International Space Station. TDRS-M will launch from NASA's Kennedy Space Center in Cape Canaveral, Florida on an Atlas V rocket.  
<http://go.nasa.gov/2l8Hysg>

**Want to see a launch?**  
 All expendable vehicles launched in Central Florida begin their journeys on the launch pads of Cape Canaveral Air Force Station, next door to Kennedy Space Center. Launch Transportation Tickets are available for some, but not all, of these launches. Call the KSC Visitor Complex at **(321) 449-4444** for information on purchasing tickets.



Continuing the company's tradition, the Orbital ATK Cygnus spacecraft was renamed the S.S. John Glenn, in honor of the late former Project Mercury and space shuttle astronaut John Glenn. Members of the news media had the opportunity to view the Cygnus spacecraft March 9 before it was enclosed in its payload fairing inside the Payload Hazardous Servicing Facility at Kennedy Space Center. The Orbital ATK CRS-7 commercial resupply services mission to the International Space Station will launch atop a United Launch Alliance Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Air Force Station. Photo credit: NASA/Kim Shiflett





Orbital ATK's Cygnus cargo spacecraft is captured using the Canadarm2 robotic arm on the International Space Station on Oct. 23, 2016. This was Orbital ATK's fifth commercial resupply flight to the station. The Cygnus for Orbital ATK CRS-7 will be captured in the same manner. Photo credit: NASA

# UP NEXT

## Cygnus packed with experiments to support future exploration

BY BOB GRANATH

The International Space Station serves as the world's leading orbital laboratory where crews conduct cutting-edge research and technology development. A crucial resupply line of spacecraft keeps work going that will enable human and robotic exploration of destinations beyond low-Earth orbit.

The next mission to the orbiting outpost will be Orbital ATK's seventh commercial resupply services (CRS-7) mission. Liftoff will take place from Space Launch Complex 41 at Cape Canaveral Air Force Station. The actual liftoff date will be determined when United Launch Alliance resolves a booster hydraulic issue that was discovered during prelaunch testing.

Cygnus consists of a pressurized cargo module for crew supplies, scientific experiments and equipment, together with an associated service module providing solar power and propulsion.

When members of the space station's Expedition 50 crew opens the hatch, they will be greeted with a sign noting the spacecraft was named in honor of John Glenn.

The spacecraft will launch on a United Launch Alliance Atlas V. The booster and Centaur upper stage for the mission arrived at Port Canaveral, Florida, on Feb. 6. From the port, the launch vehicle was transported to the hangar at the Atlas Spaceflight Operations Center, located south of pad 41. After the Atlas V completed final

testing in that facility, it was moved to the Vertical Integration Facility for stacking.

The Orbital ATK Cygnus pressurized cargo module (PCM) arrived at the Space Station Processing Facility (SSPF) at Kennedy Space Center on Jan. 9. The Cygnus service module arrived shortly thereafter.

In the SSPF, technicians and engineers loaded supplies, equipment and scientific research materials aboard a Cygnus PCM. Once mated to its service module, the spacecraft was transported to the Payload Hazardous Servicing Facility for propellant loading and final stowage of supplies.

After the Cygnus was encapsulated in its payload faring, it was transported to pad 41 to be mated atop the Atlas booster for final launch preparations.

When Orbital ATK CRS-7 arrives at the space station, Expedition 50 Commander Shane Kimbrough of NASA and Flight Engineer Thomas Pesquet of ESA (European Space Agency) will capture Cygnus with the station's robotic arm. After receiving ground commands, the arm will rotate and install Cygnus on the bottom of the station's Unity module.

The space station crew will unpack the Cygnus and begin working with the experiments that include the following:



On Feb. 7, in the Space Station Processing Facility at Kennedy Space Center, technicians and engineers load thousands of pounds of supplies, equipment and scientific research materials aboard a Cygnus spacecraft's pressurized cargo module for the Orbital ATK CRS-7 mission to the International Space Station. Photo credit: NASA/Bill White

### GENES IN SPACE II

It is well known the rigors of spaceflight induce changes within the human body. The Genes in Space II experiment is designed to study one such change, a shift in the dynamics of telomeres, critical protective caps on the tips of chromosomes. A chromosome is a packaged and organized structure containing most of the DNA, or deoxyribonucleic acid, of a living organism — the instructions each cell in an organism on Earth needs to live. The shortening of telomeres over time, as an individual ages, is natural, but stresses -- such as those experienced by astronauts — can lead to deviations in regulation of telomere length, which has been implicated in a variety of diseases. This investigation seeks to determine whether telomeric DNA can be measured during spaceflight.

### BIOMOLECULE SEQUENCER

The Biomolecule Sequencer investigation is designed to determine if it is possible to establish the order of base pairs in a section of DNA while in Earth orbit. A space-based DNA sequencer could identify microbes, diagnose diseases and understand crew member health and potentially help detect DNA-based life elsewhere in the solar system.

As part of the Biomolecule Sequencer experiment in August 2016, DNA was successfully sequenced in microgravity for the first time by NASA astronaut Kate Rubins during Expedition 48. Sequencing DNA in space may allow astronauts to diagnose an illness, or identify microbes growing in the space station and determine whether or not they represent a health threat.

### SAFFIRE III

The Cygnus spacecraft will spend approximately four months attached to the space station. Cygnus will remain until June 21, when the spacecraft will depart. On June 28, it will return through a controlled destructive re-entry into Earth's atmosphere over the Pacific Ocean. But even the re-entry will offer an opportunity for further research. The third Spacecraft Fire Experiment, or Saffire III, will provide a unique environment for studying fires in microgravity. After Cygnus separates from the station a flame will be lit. The ignition is controlled from a ground station that will activate a hot wire, beginning an experiment that lasts about two-and-a-half hours. These experiments will advance capabilities for flammability tests and provide a testbed for the technology development for devices that detect gases and particulates from a fire, as well as scrub the atmosphere after a fire so it is safe for the crew.

Transformative capabilities and cutting-edge technologies such as those being launched aboard Orbital ATK CRS-7 are examples of expertise being developed, tested and flown today to support human exploration beyond the moon and ultimately, to Mars.



# Taste Test

Student-scientists select menu for astronauts

BY AMANDA GRIFFIN



Students from the Miami-Dade area participate in the Green Cuisine challenge where they had to create a dish fit for an astronaut. Photo credit: Fairchild Tropical Botanic Garden

If you've ever had a cold preventing you from really tasting your food, you've experienced what astronauts aboard the International Space Station encounter at every meal. In a reduced-gravity environment, the fluids in astronauts' bodies shift around equally, filling up their faces, feeling similar to the congestion from a cold, reducing their ability to smell, and ultimately dulling their sense of taste.

But hope is on the way for these taste bud-challenged explorers. Several thousand middle and high school students from Miami-Dade County in Florida are on the case.

For the past two years, plant researchers at Kennedy Space Center have been partnering with Fairchild Tropical Botanic Garden in Miami to create STEM-based challenges for teachers and students in the area. There are two challenges — Growing Beyond Earth and Green Cuisine: The Flavor of Space Travel.



During this past school year, the students participated in Growing Beyond Earth by growing crops in mini botany labs provided to each of the participating schools by Fairchild. Each lab mimics NASA's Veggie plant growth system currently aboard the space station, and the students had to follow research protocols set forth by NASA and Fairchild while testing factors that could influence plant growth, flavor and nutrition — all so they can help NASA pick the next crops to grow for the astronauts aboard the station.

"The Veggie team at KSC is excited to be working with Fairchild Tropical Botanic Garden and middle and high schools groups to help us identify future varieties and best growing practices for use on the International Space Station," said Dr. Gioia Massa, Veggie project scientist. "We plan to use the data from the student research to help us determine what to grow and how to grow it in Veggie experiments in the future."

The second challenge came March 4, where the student-scientists presented flavorful culinary dishes astronauts could eat in space as part of the Green Cuisine challenge. Students were asked to

create dishes with fresh herbs and spices to add variety and flavor to astronauts' daily meals. Students had to research the origins of the chosen herbs and spices, how they are grown and prepared, and the nutritional value of both the herbs and spices and the prepared dish.

One judge, Charlie Quincy, a NASA research advisor in food production, said, "High-quality foods with fresh strong flavors will give astronauts both what they need and what they want during their long exploration missions."

KSC Education's Theresa Martinez, who manages the four-



High-school students participating in the Growing Beyond Earth challenge show NASA judges their growth chambers that mimic the Veggie system that grows plants aboard the International Space Station. Photo credit: Fairchild Tropical Botanic Garden

year NASA Institutional Engagement Fairchild grant from Kennedy's Education Office, is excited for the south Florida student participants. "Eventually, they'll see direct results of their research when astronauts on the ISS try veggies they, in part, helped grow."

During the challenge, the students posted regular updates of their work on Twitter. You can follow their space farming @fairchdchallenge.

In addition to Veggie, a large plant growth chamber called the Advanced Plant Habitat soon will be on its way to the space station — increasing the amount of scientific knowledge needed to dig deeper into long-duration food production for missions farther and farther from home.



# VEGGIES ON THE HI-SEAS

Simulation to impact future space food production

BY AMANDA GRIFFIN



HI-SEAS (Hawai'i Space Exploration Analog and Simulation) is a Habitat on an isolated Mars-like site on the Mauna Loa side of the saddle area on the Big Island of Hawaii at approximately 8200 feet above sea level. Photo credit: NASA

While NASA is conducting psychological studies in a simulated Martian environment here on Earth, one of its eight-month inhabitants is pulling double duty. Joshua Ehrlich, a former NASA co-op, has dubbed himself the Mark Watney of the HI-SEAS.

HI-SEAS, or Hawai'i Space Exploration Analog and Simulation, takes place about 8,000 feet above sea level on the slopes of the Mauna Loa volcano on the island of Hawai'i. The simulation allows the participants to live and work almost like astronauts, in conditions similar to what they would encounter on a planetary mission to Mars. Ehrlich decided to spend his time in isolation growing crops—all while helping NASA.

In addition to his clothes, reading materials and, of course, his space suit, Ehrlich brought two plant growth systems with him. One of them came from Dr. Gioia Massa, NASA's Veggie project scientist. She loaned him an identical Veggie system to what is currently aboard the International Space Station. The results from this study may lead to improvements in growth efficiency and plant harvest production and could be implemented in the Veggie system currently on station or considered for design of future plant payloads.

"I am focusing on the optimization of plant growth parameters through the use of the Veggie ground unit model here in the habitat," Ehrlich said via email—his only form of communication while on simulated Mars. "Veggie has a multitude of parameters in-play when it comes to growing greens and vegetables onboard the ISS. I am looking to create a set of optimal conditions – from water delivery methods and light emission levels to plant-to-LED displacement, for defining the ideal growth scenario for the plant from seed to harvest."

"This real-world test of food production in a closed environment will yield important data that will be relevant as we look toward

growing food for future exploration scenarios," Massa said.

For the second plant growth system, Ehrlich reached back to his Florida roots and is partnering with Fairchild Tropical Botanic Garden and its Growing Beyond Earth (GBE) challenge that is usually just for Miami-Dade area middle- and high-school students. This particular challenge is made possible by a grant from NASA and is managed by Kennedy's Education Office. With thousands of students partnering with Massa to determine the most suitable edible plants for her team to grow in space, she recommended Ehrlich reach out to Fairchild to see how he could work with them, too.

"After meeting with the Growing Beyond Earth team, I knew it was a perfect match, and I am so happy to be working with Fairchild and the students," Ehrlich said. "Calling south Florida home for more than 20 years now, it was nice to bridge that connection with students from there who are just as interested in space as I was at that age."

Fairchild gave Ehrlich a low-tech mini growth chamber they give their students for the challenge, and it is seated right next to the high-tech Veggie system from NASA.

"Fairchild is excited to show the thousands of students who are actively contributing to NASA's Veggie research through the Fairchild Challenge Growing Beyond Earth project how the same system they are using is being utilized to forward plant research for space travel," said Amy Padolf, Fairchild's director of education.

The knowledge Ehrlich is gaining will be beneficial for providing food production to future space colonies and could have important implications for improving plant growth here on Earth. Later this year, the Advanced Plant Habitat will be up and running aboard the space station—providing even more knowledge about plant growth in space.

EHRlich BEGAN HIS EIGHT-MONTH STAY ON "MARS" ON JAN. 19. FOLLOWING IS HIS WATNEYESQUE LOG TO THE GROUND CREWS AT KENNEDY SPACE CENTER AND FAIRCHILD. AS YOU MAY RECALL, MARK WATNEY WAS THE BOTANIST WHO WAS STRANDED ON MARS IN THE BOOK AND SUBSEQUENT MOVIE "THE MARTIAN." AND JUST LIKE IN "THE MARTIAN," EHRlich EXPERIENCES A 40-MINUTE DELAY (20 MINUTES EACH WAY) WHEN COMMUNICATING WITH HIS COUNTERPARTS ON EARTH. SOLS ARE SOLAR DAYS ON MARS, WHICH PUTS A MARTIAN DAY ABOUT 39 MINUTES LONGER THAN OUR EARTH DAY.





## SOL 23 >

HELLO FROM MARS!

THE CREW IS FINISHING UP SOL 23. IT'S BEEN A CRAZY BUSY WEEK, A LOT TO GET EVERYONE CAUGHT UP ON. I'LL LEAVE THE PICTURES DO THE TALKING...



VEGGIE PLANT PILLOWS PREPPED WITH CAP MAT WICKS AND FILLED WITH SUBSTRATE + FERTILIZER MIX. FOLLOWING COMPLETION OF THE BELLWS ASSEMBLY, VEGGIE IS EXPECTED TO BEGIN ITS FIRST GROWTH CYCLE EITHER OVER THE WEEKEND OR AT THE START OF NEXT WEEK.



THIS PICTURE HIGHLIGHTS THE FINAL CONFIGURATION OF THE GROWING BEYOND EARTH (GBE) SETUP PRIOR TO ITS FIRST GROWTH EXPERIMENT. SUBSTRATE, SOIL, AND FERTILIZER HAVE BEEN MIXED TOGETHER, SEEDS PLANTED. THE COLORED MARKERS IN EACH OF THE 16 RANDOMLY CONFIGURED POTS IDENTIFIES THE TYPE OF SEEDS CHOSEN, WHICH ARE THE FOLLOWING: 'OUTREDGEOUS' LETTUCE = GREEN, 'TOKYO BEKANA' CABBAGE = RED, BAK CHOI = BLUE, LEMON BALM = YELLOW. GBE IS READY TO BEGIN, EXPECTED START OF GROWTH THIS SATURDAY, FEB. 11.



LAST BUT NOT LEAST, "THE GARDEN." A MIX OF LEAFY GREENS AND RADISHES STARTING TO GROW, SHOWING DECENT HEIGHT AFTER TWO WEEKS OF GROWTH.

LIFE IS BEGINNING TO TAKE SHAPE HERE ON MARS AS OUR HABITAT IS STARTING TO TURN FROM RED TO GREEN. I EXPECT NEXT WEEK TO BE EVEN MORE EXCITING AS VEGGIE AND GBE WILL BOTH BE RUNNING THEIR PATHFINDER GROWTH EXPERIMENTS. TO TOP IT OFF, THERE WILL BE A THIRD PLANTER BOX INSTALLED IN "THE GARDEN" WITH ADDITIONAL VEGETABLES PLANTED FOR THE CREW.

## SOL 30 >

G'DAY FROM THE RED PLANET!

WE'RE APPROACHING THE END OF SOL 30 HERE ON MARS. THE PAST WEEK WE'VE SEEN SOME GREAT WEATHER HERE.

GREAT NEWS: VEGGIE AND GROWING BEYOND EARTH ARE UP AND RUNNING! IT'S A SPECTACULAR SIGHT, BOTH PLANT EXPERIMENTS OPERATING TOGETHER. THE SEEDS THEMSELVES SEEM TO HAVE BEEN A BIT ANXIOUS TO GET GROWING AS THERE'S ALREADY SIGNS OF GERMINATION WITH EACH.



VEGGIE RUNNING ON DAY 1 (FEB. 13) OF ITS PATHFINDER GROWTH EXPERIMENT. ALL SIX PLANT PILLOWS ARE SPORTING 'OUTREDGEOUS' LETTUCE SEEDS.



GBE SETUP (AS OF FEB. 18) WITH A SLEW OF SPROUTS POKING OUT OF THE SUBSTRATE. HIGHLIGHTED IN YELLOW (UPPER LEFT-HAND, CORNER) IS 'TOKYO BEKANA' CABBAGE SEEDLINGS, THE FIRST SPROUTS TO EMERGE AFTER JUST THREE DAYS BEING PLANTED. IN YELLOW (FRONT ROW, LEFT- AND RIGHT-HAND CORNERS), SMALL SEEDLINGS OF BOK CHOI HAVE EMERGED FROM THE DIRTY DEPTHS.

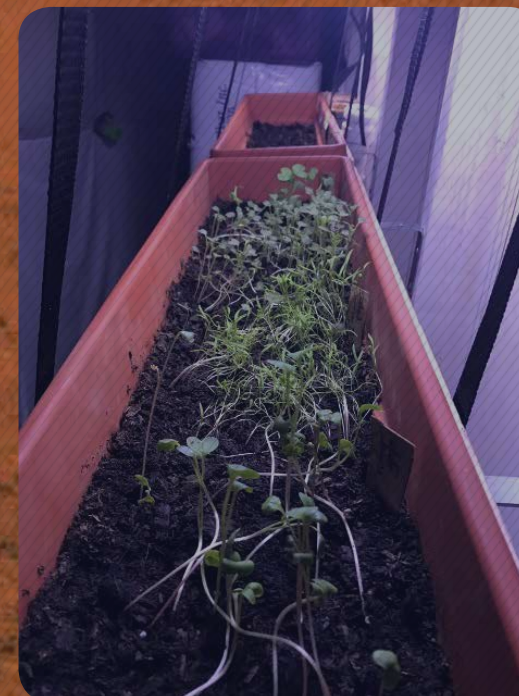


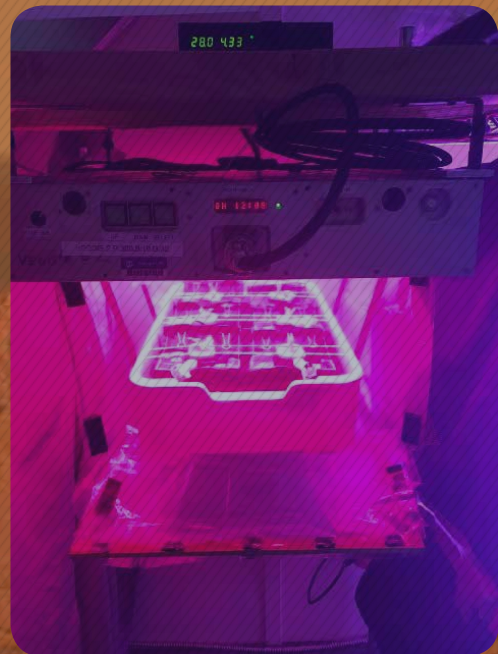
IMAGE FROM "THE GARDEN." BOX 1 WITH SEEDLINGS OF RADISH AND VARIOUS GREENS (ORIGINAL PLANT DATE JAN. 28).





## SOL 46 >

THE PAST TWO WEEKS I'VE LET THE PLANTS KIND OF DO THEIR OWN THING; IT'S ESSENTIALLY BEEN A WAITING GAME FOR THEM TO GET THEIR ACT TOGETHER. VEGGIE WAS SEEING HIGHER THAN ANTICIPATED CHAMBER TEMPS, AS WELL THE RELATIVE HUMIDITY WAS RUNNING A TAD LOW. WITH SOME CHANGES MADE TO THE CONTROL, WHICH WILL LIKELY DRIVE A FOLLOW-UP PATHFINDER EXPERIMENT BE RUN TO VERIFY THE NEW INITIAL PARAMETERS, I'VE SEEN A POSITIVE RESPONSE IN HOPES THAT THE PILLOWS CONTINUE TO MATURE TOWARDS THE EXPERIMENT END DATE ON MARCH 13. GROWING BEYOND EARTH HAS SEEN A WILD TRANSFORMATION OVER THE LAST TWO WEEKS. THE 'TOKYO BEKANA' CABBAGE (RED) IS "HULKING OUT" ESSENTIALLY; INTERESTING TO SEE THE RANDOM LOCATIONS OF ITS GROWTH DIFFER WITH EACH PLANT. PAK CHOI (BLUE) HAS BEEN A CONSISTENT TEAM PLAYER, WITH ALL FOUR POTS GROWING AT ROUGHLY THE SAME RATE WITH VERY SIMILAR LEAF PRODUCTION. THE 'OUTREDEGEIOUS' RED LEAF LETTUCE (GREEN) IS COMING ALONG NICELY, ALTHOUGH ONLY HALF OF THE POTS HAVE FULLY GERMINATED. THE LEMON BALM HAS SUCCUMB TO THE PLAGUE IN THIS EXPERIMENT, WITH NOT A SINGLE POT SHOWING GERMINATION IN THE THREE WEEKS SINCE BEING PLANTED.



FROM LEFT TO RIGHT: VEGGIE BELLOWS CONTRACTED, LED LIGHT LEVELS ADJUSTED; 4 OF THE 6 PILLOWS SEEDS WITH SPROUTS, WITH PILLOWS A1-A3 (LEFT-SIDE) SHOWING THE MOST PROMISE; CABBAGE IS THE FOCAL POINT OF THE GBE CHAMBER, WITH PRODUCTS BY THE PAK CHOI AND LETTUCE LOOKING PLEASING.



IN THE BACK OF THE HAB, "THE GARDEN" CONTINUES TO BE A POSITIVE LOCATION FOR GROWTH AND CREW RECREATION/RELAXATION. BOX 1 CONTINUES TO GROW HEARTY GREENS AND RADISHES.

WE'LL BE EATING FRESH VEGGIES AND HERBS SOON. CAN'T WAIT TO SEE THE SMILES ON THE CREW'S FACES.

# ROBOTS AND ROCKETS

NASA's Eighth Annual  
**Robotic Mining Competition**  
**May 22-26, 2017**  
Kennedy Space Center Visitor Complex



Fifty U.S. university teams will operate their robotic excavators to mine terrestrial soil in a race against the clock!

### HIGHLIGHTS

- K-12 grade students are invited to join us in the Exploration Station in KSC's Public Engagement Center as we build and program **LEGO® Mindstorms® NXT robots!**
- **FIRST® Robotics Teams** will display and demonstrate their **FIRST®** robots.

### Check us out!

Website:  
[www.nasa.gov/nasarmc](http://www.nasa.gov/nasarmc)

Facebook:  
[www.facebook.com/RoboticMiningCompetition](https://www.facebook.com/RoboticMiningCompetition)

Twitter:  
[http://twitter.com/nasarmc](https://twitter.com/nasarmc)

Kennedy Space Center Visitor Complex Website:  
<http://www.kennedyspacecenter.com/index.asp>



Contact Lynn at KSC's Public Engagement Center at (321) 861-3591 to reserve your group's spot. School groups, summer camp groups, clubs, and community organizations are all welcome (minimum of 15 students per group).



# FROM THE ROOTS UP

## Fertilizer technology plants pioneer in hall of fame

BY FRANK GONZALES

Pushing envelopes isn't just for test pilots at NASA -- Ed Rosenthal's agricultural creativity has been so successful that it is getting ready to take its place in the Space Technology Hall of Fame.

A few years ago, Rosenthal reached out to NASA's Space Alliance Technology Outreach Program, or SATOP, designed to help small businesses overcome technological challenges using expertise derived from NASA. NASA helped in his testing and development of polymer coatings for time-release fertilizers for growing plants. His company, Florikan, has been improving and marketing these products to commercial greenhouse growers, and expanding more and more into home (yard) and field agricultural applications -- and now he can add space to this growing list.

"I figured if it works in Florida, it will work anywhere else . . . including space," Rosenthal said.

For years, plant researchers from Kennedy Space Center have been testing this fertilizer named Florikan Controlled Release Fertilizer (CRF) that is blended by Rosenthal's company. Rosenthal's company. Nearly three years ago, Dr. Gioia Massa, Veggie project scientist, reached out to Rosenthal and discussed how the Veggie team had been using a Florikan CRF on ISS and asked if he would like to collaborate on a grant proposal for future Veggie experiments involving Chinese cabbage and dwarf tomatoes.

"The Florikan Controlled Release Fertilizer provided all the nutrients for our plants to grow well," said Dr. Gioia Massa, of NASA's Veggie science team. "It worked exceptionally well in our very unique conditions."

According to Dr. Ray Wheeler, a plant physiologist with NASA,

Florikan has been a great partner in helping develop specific fertilizer formulations that could improve growth of plants in the Veggie growth systems.

"Controlled or time-release fertilizers have advantages for both commercial and home users," said Wheeler. "With Florikan CRF, we now only require a single application, which can last for months. This technology avoids rapid release of nutrients typical for most conventional fertilizers, which can leach through the soil and even get into waterways."

Florikan's CRF fertilizers have been used for Veggie experiments on the International Space Station, and they will be used for the Advanced Plant Habitat that will fly to the space station later this year.

Back in Florida, Florikan set up their new CRF production facility in Bowling Green, providing new jobs to an economically depressed area of the state.

"The induction of Florikan's Staged Nutrient Release (SNR) Fertilizer into the 2017 Space Technology Hall of Fame is a prestigious award that exemplifies the kind of mutually beneficial innovative solutions that can be achieved when industry and government partner to solve common technical challenges," said David Makufka, Kennedy's Technology Transfer Program manager.

Florikan, Kennedy Space Center and SATOP will be inducted as Innovating Organizations into the Space Technology Hall of Fame. In addition, J.R. Simplot will be recognized with a commendation for the significant role they have played in allowing world-wide distribution of SNR Fertilizer, thus providing access of the product and its many benefits.



Ed and Betty Rosenthal, founders of Florikan Fertilizer Corp., left, and Gioia Massa, NASA payload scientist for Veggie, observe ground control experiments in the Veggie Lab at Kennedy Space Center on Feb. 16. Photo credit: Bill White

Gioia Massa, NASA payload scientist for Veggie, center, shows Ed and Betty Rosenthal, founders of Florikan Fertilizer Corp., the ground control experiments in the Veggie Lab at Kennedy Space Center on Feb. 16. Photo credit: Bill White



Gioia Massa, NASA payload scientist for Veggie, left, Betty and Ed Rosenthal, founders of Florikan Fertilizer Corp., observe ground control experiments in the Veggie Lab at Kennedy Space Center on Feb. 16. Photo credit: Bill White





# GROWING INTEREST

Future figures take shape at STEM Day for girls

BY AL FEINBERG

**W**hile Women's History Month may be a time to celebrate the historic professional and cultural achievements of notable females past and present (see Hidden Figures), it also can teach today's girls about the many paths they have — and which to most consider — to personal accomplishment and possible greatness.

On March 4, 100 underserved and underrepresented girls from six schools and organizations in the local and surrounding areas, accompanied by their teachers and chaperones, met in a long and expansive meeting hall inside Kennedy Space Center Visitor Complex's Public Engagement Center.

There, spaced comfortably apart behind a number of long tables, sat some two dozen volunteer members of Kennedy's Education Projects and Youth Engagement team, Kennedy Networking Opportunities for Women, or KNOW, Lockheed Martin, and Siemens.

Led by Kennedy Deputy Director, Janet Petro, these subject matter experts (SMEs), all of them successful women, opened their minds and hearts to offer perspective and advice with which the young girls could better plan their professional futures.

Some of them alone, others in small groups of friends, the fifth-through 12th-graders drifted through the tables, lingering a bit longer before those women whose names and titles sparked interest or curiosity in their respective careers: engineering, psychology, accounting, information technology, business administration, teaching, medicine, physics or human resources.

Standing at one table, listening and intently scribbling notes on a pad, was Makalah Pierre, an eighth grader at Palm Bay Academy Charter School. Makalah had just picked up on data she believed could boost her chances of becoming a NASA astrophysicist and engineer.

"They told me they have offers for internships and other scholarships you could get while applying to these programs, and how you could get a mentor."

Learning data like these, says Makalah, is why she always comes to outreach events like STEM Day for Girls.

It's a mindset that NASA volunteer, Grace Johnson, counsels all these young women to adopt.

"You want to take advantage of the opportunities that you have right now," says Johnson, a physicist and Kennedy Education program specialist. "You have to be responsible for your own success. And, the earlier you do that, the better."

And, stresses Johnson, who's worked in the laboratory and classroom, "Make sure that you're continually challenging yourself, as opposed to just going through the motions and just getting it done."

There's a universality to many of the questions volunteers are asked at a student outreach event, like, "How do you know you're in the right job?"

"This was me five or six years ago!" says STEM Day volunteer Meera Dhawan, a Kennedy Pathways Intern from Rutgers University. Dhawan tells these girls to discover their STEM-field passion, keep working hard at it — and the right job will find you. "I love the idea of empowering other women and what they can do with their brains."

In fact, it was outreach events like STEM Day for Girls that helped Dhawan find her passion.

"I didn't really know about materials engineering at all," she reveals, before adding thankfully, "I wouldn't be a materials engineer



Janet Petro shares details of her job as KSC Deputy Director with several STEM Day for Girls students. Photo credit: NASA

today if I didn't go to those events."

No one is more aware of this fact than Dhawan's mentor, Clara Wright, lead materials engineer at Kennedy. In Dhawan, Wright says she and her lab research team are reaping the reward for interest seeds sown at outreach events like this.

"She has proven herself in our group so many times," boasts Wright of Dhawan. "The communication skills, the technical acumen, being able to do outreach and talk to students at a level that they can relate is very important to being a NASA employee."

As for Angel McCormick, a seventh grader at Titusville's Madison Middle School, STEM Day for Girls didn't necessarily offer any new clues to her career path. Angel's already figured out that, after a stint in the military, she'll take her newly-trained skills as a systems engineer to work at Kennedy. Rather, meeting and talking with these successful NASA women at STEM Day for Girls served to boost her commitment to reaching her goals.

"You just have to work hard and keep going, and that's what I'm going to do."



NASA physicist and education specialist, Grace Johnson, speaks with students at STEM Day for Girls. Photo credit: NASA







## First umbilical installed on mobile launcher for NASA's Space Launch System and Orion

BY LINDA HERRIDGE

**T**he first launch umbilical for NASA's Space Launch System (SLS) and Orion spacecraft was installed on the mobile launcher tower March 16 at the agency's Kennedy Space Center in Florida. The Orion Service Module Umbilical, or OSMU, was installed high up on the tower at about the 260-foot level.

"Installation of the OSMU is a major milestone for the mobile launcher team," said Sam Talluto, deputy project manager. "This is the first of multiple umbilicals and launch accessories that will be installed."

The tower on the mobile launcher will be equipped with several connections, called launch umbilicals, which will connect to the SLS core stage and twin solid rocket boosters, the interim cryogenic propulsion stage and the Orion spacecraft. They will provide power, communications, coolant and fuel.

The OSMU will connect from the mobile launcher tower to the Orion service module. Prior to launch, the umbilical will transfer liquid coolant for the electronics and purge air/GN2 for environmental control to the Orion service module that houses these critical systems to support the spacecraft. The umbilical also will provide purge air/GN2 for environmental control to the Launch Abort System. Before launch, the OSMU will tilt up and the umbilical lines will disconnect.

The first integrated launch of SLS and Orion, Exploration Mission 1, will send the spacecraft to a stable orbit beyond the moon. Orion will return to Earth and be recovered from the Pacific Ocean. The mission will demonstrate the integrated performance of the SLS rocket, Orion and ground support teams.

Photo credit: NASA/Leif Heimbald



# ICPS ARRIVES

## First integrated flight hardware for NASA's Space Launch System arrives

BY LINDA HERRIDGE

The first integrated piece of flight hardware for NASA's Space Launch System rocket, the Interim Cryogenic Propulsion Stage, or ICPS, arrived March 8 at Cape Canaveral Air Force Station in Florida. The ICPS was shipped from the United Launch Alliance (ULA) facility in Decatur, Alabama aboard the Mariner barge.

The ICPS was offloaded and transported to the ULA Horizontal Integration Facility where it was removed from its flight case to begin processing for launch at the ULA Delta Operations Center.

"It's always exciting to see flight hardware arrive at the Cape, and it's especially thrilling that it is the first piece of America's next great rocket to be here," said Chris Calfee, NASA SLS ICPS project manager at Marshall Space Flight Center in Alabama. "We will continue our final checkouts and look forward to mating up with the rest of the SLS and the Orion spacecraft."

The ICPS is the in-space stage that is located toward the top of the rocket, between the Launch Vehicle Stage Adapter and the Orion Spacecraft Adapter, and will provide some of the in-space propulsion. Its single RL-10 engine, powered by liquid hydrogen and oxygen, will generate 24,750 pounds of thrust to propel the Orion spacecraft out of Earth's orbit during Exploration Mission 1 (EM-1).

The initial configuration of the SLS rocket with the ICPS will stand 322 feet tall, which is taller than the Statue of Liberty. The rocket will weigh 5.75 million pounds fueled and produce 8.8 million pounds of thrust at liftoff.

The first integrated launch of SLS and Orion will send the spacecraft to a stable orbit beyond the moon. Orion will return to Earth and be recovered from the Pacific Ocean. The mission will demonstrate the integrated performance of the SLS rocket, Orion and ground support teams.



Inside the United Launch Alliance (ULA) Horizontal Integration Facility at Cape Canaveral Air Force Station in Florida, the Interim Cryogenic Propulsion Stage (ICPS) for NASA's Space Launch System (SLS) rocket is secured on a movable transport stand March 9. The ICPS is the first integrated piece of flight hardware to arrive for the SLS. Photo credit: NASA/Ben Smegelsky



# I Will LAUNCH AMERICA

Restoring America's Human Launch Capability



**Dana Hutcherson**  
Deputy Manager,  
Systems Engineering and Integration  
NASA's Commercial Crew Program

## I Will Launch America: Deputy Manager Systems Engineering and Integration Dana Hutcherson

BY STEVEN SICELOFF

**D**ana Hutcherson is part of NASA's team of engineers working with private industry to bring a new class of spacecraft into operation. A veteran of space shuttle processing, Hutcherson is the deputy manager of Systems Engineering and Integration for NASA's Commercial Crew Program. Her work is vital to the program's goal of returning human spaceflight to U.S. soil using a model that calls for closer cooperation among the agency and the private sector.

"I think everybody was interested in doing something different, being a part of the groundwork to get started and working with the partners on their designs," Hutcherson said. "There are a lot of people with huge hearts, who are very passionate about these systems and this commercial approach."

Previous NASA efforts, including the Space Shuttle Program that Hutcherson worked on, called for the agency to design the spacecraft and detail every aspect of its operation. The Commercial Crew Program model is based on NASA providing a well-defined set of mission and safety requirements, while giving industry professionals room to work the most reliable and cost-effective methods to achieve the requirements.

NASA's expertise is vital throughout the process to help industry partners Boeing and SpaceX work through technical challenges toward certification so development can move ahead. The partners are building separate spacecraft and launch systems, each capable of taking astronauts and critical experiments and supplies to the International Space Station. Boeing is building the CST-100 Starliner to launch on a United Launch Alliance Atlas V rocket, while SpaceX is building its Crew Dragon to fly on the company's Falcon 9 rocket.

"It was definitely a big shift and to this day I think there are people who don't understand that we are not telling them exactly how to dot the 'i' and cross the 't,' we're trying to give them the top-level requirements to build their own rockets," Hutcherson said.

After 6 1/2 years working in the Commercial Crew Program, launch day is again within sight for Hutcherson. Her position requires her and her team to make sure the spacecraft systems and rockets all work toward certification. She keeps in close contact with both of the partners' teams as they verify and validate systems ahead of upcoming flight tests.

"I think it's going to be the same excitement level, the same nervous energy as it was on launch day for shuttle," Hutcherson said. "Everybody's attentive, listening and looking for what's going on. You hold your breath a little bit and then you can take a deep breath after launch and docking."

Hutcherson's interest in spaceflight reaches back to grade-school days spent at her Georgia home, working with her dad to build things – "he would say I always asked questions on how things worked" – and helping her brother launch model rockets.

With a mom who was a math teacher, Hutcherson said she had no choice but to excel in numbers, and from there, engineering was a natural interest. She was accepted into Georgia Tech's engineering school, which over the years turned out a wide number of spaceflight engineers.

"It was probably my first awakening to having to really buckle down and study," Hutcherson said. "One of my mottos is to persevere and keep with it, don't quit, and I kept with it and didn't quit."

After graduation, she applied to United Space Alliance, the contractor team that maintained and prepared space shuttles for their missions. She worked as an airframe engineer, which meant she was doing hands-on work with the spacecraft every day as part of the team solving problems and inspecting the spacecraft.

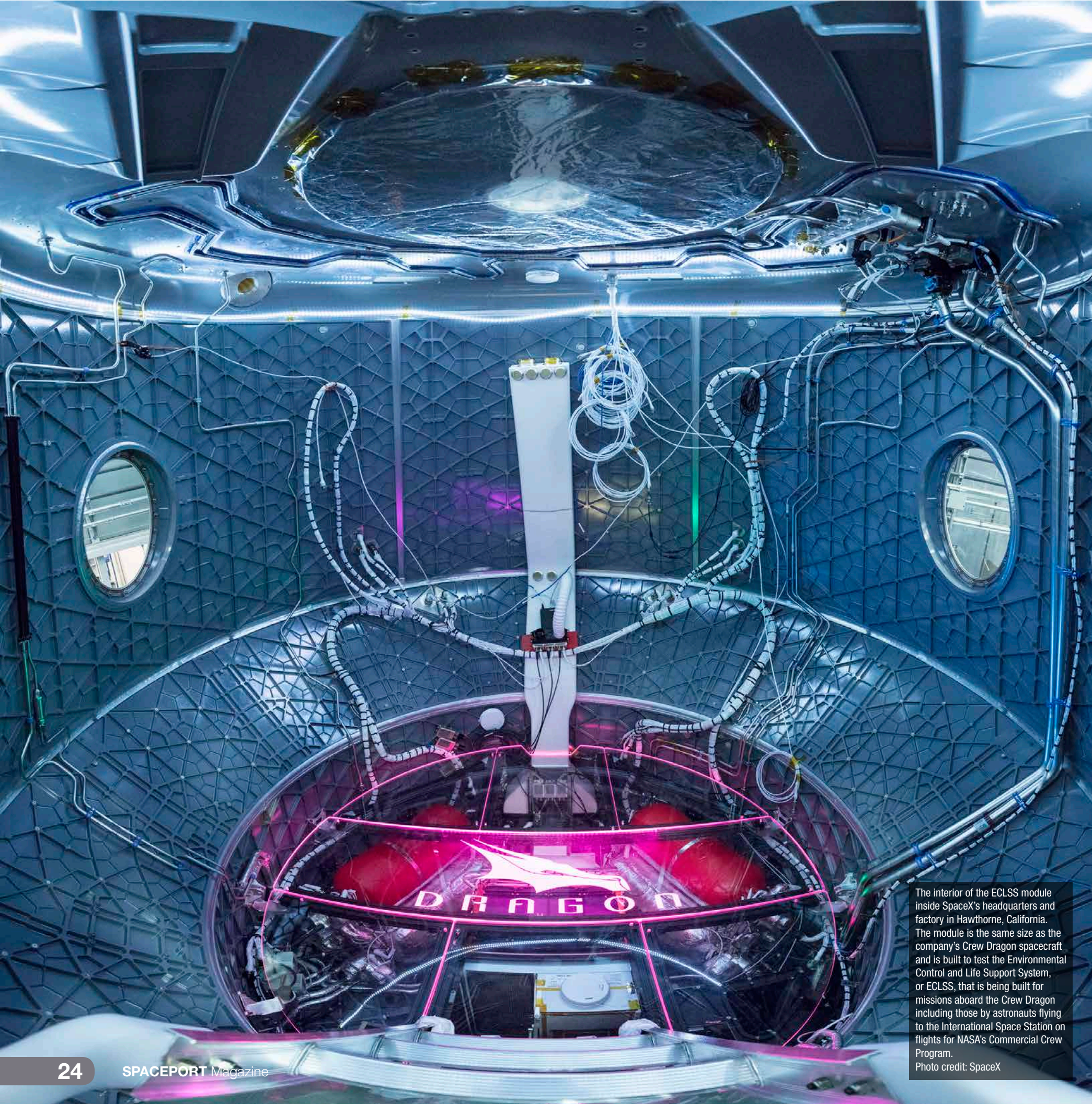
"I'm very thankful that I got the job of working for the contractor first, working with the technicians and working through the issues," Hutcherson said. "It gave me a lot of good experience for when I moved over to NASA."

NASA hired her in 2006, and she went to work managing the processing team for Atlantis and ultimately led the entire team as the flow director for Endeavour.

After Endeavour's final mission — STS-134 — Hutcherson transitioned to a position in NASA's Commercial Crew Program.

Hutcherson said she embraced the new approach to spaceflight as a way to open new avenues for NASA into low-Earth orbit where the space station operates around the clock performing unique research. It also allows other programs in NASA to focus on deep-space exploration with vehicles geared for longer missions farther away from Earth and flying on larger rockets.





# ECLSS

## ECLSS Put to the Test for Commercial Crew Missions

BY STEVEN SICELOFF

**E**xtensive evaluations are underway on the life support systems vital to successful flight tests as NASA prepares to return human spaceflight to the United States. One of the most intensely studied systems is called ECLSS. Short for environmental control and life support system and pronounced ‘e-cliss,’ the system is a complex network of machinery, pipes, tanks and sensors that work together to provide astronauts with air and other essentials during missions for NASA’s Commercial Crew Program to and from the International Space Station.

“ECLSS Systems and Subsystems present unique challenges to a developer,” said Brian Daniel, Crew Systems lead for the Commercial Crew Program. “Such systems must assure tight control of parameters that are important to human safety such as temperature, carbon dioxide levels, oxygen levels, and cabin pressure. The various functions of the life support system must not only be failure tolerant and robust, but also able to perform their function for the whole gamut of the mission, from countdown to splashdown.”

Although tests are run by the companies building the spacecraft, NASA engineers certify the results to see that they meet requirements for safe and reliable operation in flight. NASA also offers insight to head off potential problems and helps solve other dilemmas that show

***“The various functions of the life support system must not only be failure tolerant and robust, but also able to perform their function for the whole gamut of the mission, from countdown to splashdown.”***

up during testing. Both Boeing and SpaceX are building spacecraft, launch systems and operational networks for Commercial Crew Program missions to the International Space Station.

SpaceX built a test version of its Crew Dragon solely for evaluation of the life support system. The ECLSS Module, as the prototype spacecraft is known, was built as close to the specifications of operational spacecraft as possible, SpaceX

**Brian Daniel  
Crew Systems Lead for the  
Commercial Crew Program**

said, so knowledge gained during its manufacture and testing could be passed on smoothly to flight versions of the spacecraft.

The complex network also provides air for the spacesuits, maintains cabin pressure and regulates all the conditions inside the spacecraft such as temperature and humidity. It can also provide fire suppression and scrubs the air of the carbon dioxide that astronauts exhale. The system relies heavily on computer software to automatically adjust conditions for the crew throughout a mission.

Astronauts will still wear launch-and-entry spacesuits while inside the spacecraft during certain phases of their missions to guard against cabin leaks or other emergencies such as a launch abort.

The interior of the ECLSS module inside SpaceX’s headquarters and factory in Hawthorne, California. The module is the same size as the company’s Crew Dragon spacecraft and is built to test the Environmental Control and Life Support System, or ECLSS, that is being built for missions aboard the Crew Dragon including those by astronauts flying to the International Space Station on flights for NASA’s Commercial Crew Program.  
Photo credit: SpaceX





Engineers evaluate the ECLSS system designed for Crew Dragon missions. Photo credit: SpaceX

During an earlier phase of development, engineers were sealed inside the ECLSS Module for four hours while the ECLSS provided them a mix of oxygen and nitrogen. The conditions were closely related to those the spacecraft and astronauts will experience in flight.

“Unlike relying solely on computer simulation and analysis, the ECLSS Module allows us to test and observe Crew Dragon’s life support systems as they autonomously control a real cabin environment,” said Nicolas Lima, a life support systems engineer at SpaceX. “Extensive testing of the ECLSS module has and will continue to contribute to improvements to Crew Dragon’s design and operation, which ultimately leads to greater crew safety.”

Crew Dragons will carry astronauts to the International Space Station on missions for NASA’s Commercial Crew Program. The spacecraft will fly into orbit atop a Falcon 9 rocket lifting off from Launch Complex 39A at Kennedy Space Center. Separately, Boeing is manufacturing a line of spacecraft called CST-100 Starliners that also will take astronauts to the station on Commercial Crew missions. NASA has awarded contracts to both companies for flight tests and operational crew rotation missions to the station.

The ECLSS Module of the Crew Dragon includes a transparent floor panel that will not be duplicated on operational spacecraft. While the rest of the spacecraft was built as closely as possible to a flightworthy Crew Dragon, the see-through panel was placed solely for the testing module so engineers could watch the heart of the ECLSS system itself run through its work.

The ECLSS systems – along with all the others necessary for a safe spacecraft – will see their ultimate tests in orbit once NASA experts certify the spacecraft, launch vehicle and other systems for flight.



# X-HAB

## Project working seventh season of academic-aided innovation

BY STEVEN SICELLOFF

Some of the newest tech that will make living on other worlds possible may come in part from research and imagination of college students working with NASA through a project called X-Hab that is entering its seventh year fostering cooperation between the space agency and universities around the country.



The Habitat Demonstration Unit, Deep Space Habitat configuration with X-Hab loft at the 2011 Desert Research and Technology Studies (Desert RATS) analog field test. Photo credit: NASA/Regan Geesem



Students from Ohio State University listen as a scientist at Kennedy Space Center discusses aspects of the research underway on the International Space Station. Photo credit: NASA/Glenn Benson

Short for eXploration Systems and Habitation Academic Innovation Challenge, the X-Hab challenge series represents one of several platforms NASA leverages to solicit external solutions to complex challenges to keep humans healthy and productive in deep space. Universities submit their ideas and the proposals are reviewed and selected by technical experts at NASA. From there, NASA mentors the team through a process that parallels NASA's engineering processes. The researchers and students complete their designs for thorough evaluations by NASA engineers.

"We are tapping into the creativity and innovation that's in academia," said Tracy Gill, Technology Strategy manager at Kennedy Space Center.

The X-Hab grants span the agency's field centers allowing schools to deal directly with NASA researchers in their specialties. At Kennedy, students from Ohio State University toured the research laboratories of NASA's Veggie project. Gioia Massa, Veggie project scientist, showed the students the enclosures and processes used to grow lettuce, cabbage and zinnia flowers on the International Space Station, and shared the goals for the Advanced Plant Habitat to expand plant research on the station.

The students are developing methods to better distribute water to the plants in weightlessness and processes for recycling old plant matter in space to make nutritious beds for new seeds to sprout inside. Both are important aspects for NASA, because astronauts on deep-space voyages likely will farm some of their own food. The technology the students come up with may become the machinery astronauts take with them on a mission.

"This is the first real experience with hands-on research that will actually be used, so just being able to know I will have

some actual impact with my research is super cool," said Usoshi Chatterjee, a senior food engineering student at Ohio State.

Kennedy also is looking into a project for next year's round to develop devices to be used on a robotic prospector mission to the moon to measure the amount of water condensed. Other centers are working with teams to come up with systems and methods in a range of areas from 3-D food printing to habitat on Mars or the moon, to handling trash safely.

Peter Ling, an associate professor in Ohio State's Food and Biological Engineering Department, said the payoff for him is the enthusiasm his students show in taking part in the work.

"This is the third year I've been doing it and I think what I find most rewarding is when you see the students light up when they see the project," Lee said. "When they see their concept realized by NASA, they get very excited and that makes me excited."

X-Hab is sponsored by Advanced Exploration Systems (AES), a division in NASA's Human Exploration and Operations Mission Directorate. AES pioneers innovative approaches through academic, industry and international partnerships to rapidly develop prototype systems, advance key capabilities, and validate operational concepts for future human missions beyond Earth orbit. 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. Additional challenge support and funding for Veggie and the Advanced Plant Habitat are provided by the Space Life and Physical Sciences Research and Applications Division

Entries are due April 28. For more information about the challenge and how to submit a proposal, visit <http://spacegrant.org/xhab/>.

To view past NASA X-Hab projects, visit [https://www.nasa.gov/exploration/technology/deep\\_space\\_habitat/xhab](https://www.nasa.gov/exploration/technology/deep_space_habitat/xhab).





## Kennedy's multi-user spaceport streamlines commercial launches

BY FRANK OCHOA-GONZALES

In the past, launch pads were used almost exclusively for government missions. To support a growing private sector space economy, NASA's Kennedy Space Center has transformed to a multi-user spaceport capable of handling the needs of a variety of companies from launch processing through recovery. NASA, the FAA, and Air Force Space Command provide diverse launch operations, government and commercial, enabled by the Commercial Space Launch Act. These agencies are working together to simplify the steps to certify commercial launches from Kennedy Space Center's multi-user spaceport.

"We want to drive innovation in the launch and space exploration fields, and that innovation can be balanced on the private side with adjustments on our end," said Janet Petro, deputy director of Kennedy Space Center. "That's why we are taking this opportunity to examine all of the government requirements and eliminate those that are not necessary. We will maintain safety, but if there are requirements that are unnecessary, then no one benefits."

Kennedy does not levy any additional licensing requirements beyond the minimum for commercial launch operations, Petro explained.

"It's been a process that has educated a lot of people in the Air Force and NASA about how commercial operations on Kennedy property can work," said Petro, referring to the dialogue among the Air Force, FAA and NASA regarding government cooperation supporting industry.

Additionally, NASA's Launch Services Program, which procures launch vehicles for NASA spacecraft, has developed processes to shorten the path to launch in recent years as the industry and government work toward making launch processes more efficient and cost-effective.

The interagency approach states there should be one process that will benefit the customer for commercial missions from Kennedy Space Center — that of the FAA. Although Kennedy will independently manage launch schedules and risks associated with hazardous operations, the center also will coordinate with the 45th Space Wing by providing it with prelaunch information so that the launch safety responsibilities of all parties are satisfied.

"We have agreements with our commercial partners for operations on Kennedy, but if the mission includes landing or recovery service from the 45th Space Wing, the partner would develop a separate agreement with the Air Force," said Petro. "We have solidified our relationships with the Air Force and the FAA, clarified roles and responsibilities among all three agencies, and have emphasized that the FAA licensing process is the single process that Kennedy's commercial partners must use to satisfy their launch licensing obligations."

Last year, Florida's spaceport supported 23 launches and expects an even greater number of launches in the next few years.



# SENSORY SKIN

## Invention may give spacecraft improved damage report

BY STEVEN SICELOFF

There are few ways for astronauts to know exactly when the outside of their spacecraft has been damaged, but that may change in the future with an invention that acts like a sensory skin to pick up signs of damage in real-time. The invention uses a series of technologies to create circuits printed on thin layers and that can be embedded in a spacecraft's structure, scientists behind the invention said.

If successfully incorporated, the innovation could also be applied to a host of satellites, aircraft and even habitats on other worlds.

Micrometeoroids and orbital debris pose threats to spacecraft as they travel at speeds of 17,500 mph in orbit, and 24,000+ mph for trips to the moon and deep space. As space shuttle windows revealed, something as small as a paint chip moving at that velocity can punch through several layers of glass.

Under development at NASA's Kennedy Space Center in Florida, the Flexible Damage Detection System technology has been pursued as a possible solution to NASA's problem of figuring out in real-time where a spacecraft is damaged and how seriously.

If something pierces a spacecraft's hull — or the first layer or two — there are very limited ways for astronauts



Jamie Szafran, from left, Mark Lewis and Curtis Ihlefeld work with the prototype of the Flexible Damage Detection System in a laboratory with a prototype at Kennedy Space Center. Photo credit: NASA



Martha Williams, who leads the team inventing the Flexible Damage Detection System, stands in a laboratory with a prototype at Kennedy Space Center. The system uses circuits printed on thin thermal film and specialized software. The system is designed to show where damage to a surface occurs and how severe it may be. It could offer astronauts a real-time update on their spacecraft's condition during a mission without requiring a spacewalk. Photo credit: NASA

aboard a spacecraft to know there might be damage. An impact that goes all the way through and causes a leak would set off alarms, but otherwise, the current methods to detect damage require either a camera inspection or a spacewalking astronaut. Nor is there a precise way to pinpoint exactly in real-time where the damage occurred if not visible to the eye or camera so astronauts can assess it.

"I kind of look at it like a sensory skin," said Martha Williams, the scientist leading the development team. "It's a sensory system that tells us where we are damaged and the level of intensity."

The sensory system comprises several systems from low-voltage electric to circuits printed on Kapton to unique software that tracks the damage.

"There are a lot of technology systems that we leveraged for this," said fellow inventor Tracy Gibson, a scientist with Vencore.

A big part of the work also includes making the manufacturing methods more efficient so the technology can more easily transfer to commercial companies for potential use, Williams said.

Right now for development and demonstration, the largest square of sensory panel is 6 inches by 6 inches and it's connected to wiring and a computer that monitors the system. Scientists and engineers envision tiling the squares together

like a quilt to make a complete sensor network. They could be foldable and could be used in an inflatable or expandable spacecraft in the future.

Depending on the approach, a spacecraft could have a detection layer wrapping it completely, or just covering a certain area over a particularly critical system.

"It's tailorable, so it can be designed to the specifications of the end user," Gibson said. "You can tailor it to detect small damages or to pick up large damages and depth of damage."

The damage detector could also be applied to the outside of a habitat on the lunar or Martian surface to calculate damage from small impacts. On Earth, the system could perhaps also be applied to the outside of airplanes to tell pilots when their airframe has been impacted and may be compromised.

In fact, one of the sensor's early tests saw it demonstrated on the outside of a habitat module prototype for a mission simulation that took place in Flagstaff, Arizona. Depending on funding, the team hopes to perform more tests and build new prototypes that continue to advance the concept closer to a system that can be flight tested and then applied to future spacecraft designs.

"We want to bring solutions to NASA's problems," Williams said. "We like to solve problems, I don't think we can even stop inventing, it's how we think. It's who we are."



# KENNEDY'S 2016 SCIENTIST OF THE YEAR

DR. DAVE BREININGER



**D**r. Dave Breininger has long been a champion of conservation at the Florida spaceport.

Breininger is a senior scientist on the Kennedy Space Center Environmental and Medical Contract supporting Kennedy Space Center's Ecological Program. On March 7, he was recognized as Kennedy's 2016 Scientist of the Year, accepting the award from Bill Gerstenmaier, associate administrator for the Human Exploration and Operations Directorate at NASA Headquarters in Washington, and Kennedy Space Center Director Bob Cabana.

"During the past two years, Dr. Dave Breininger has demonstrated outstanding scientific and leadership skills in support of the KSC Environmental Management Branch Ecological Program," the award citation reads. "His internationally recognized technical expertise has been instrumental in negotiations with the U.S. Fish and Wildlife Service Endangered Species Office for favorable biological opinions and permitting requirements associated with protected species and their habitats at the space center."

"Dave's experience, knowledge and leadership continually contribute to the NASA mission of sustainable space exploration."

Kennedy Space Center shares boundaries with the 140,000-acre Merritt Island National Wildlife Refuge. Here, space technology and a workforce of several thousand people must carefully coexist

with several hundred species of animals and plants.

Breininger began working at Kennedy in 1978 while studying for his master's thesis. His interest in endangered species management and the relationship between population size and habitat quality was piqued in the early years of the Space Shuttle Program when the eastern indigo snake, Florida scrub-jay and southeastern beach mouse all were listed as threatened species. These species were headed toward extinction due to rapid habitat loss as a result of land development and wildfire suppression throughout the state of Florida.

Breininger has studied these species and their habitat requirements at Kennedy and throughout east central Florida, supporting U.S. Fish and Wildlife Service and state recovery efforts while ensuring Kennedy continued to protect and preserve these species.

Today he works closely with the U.S. Fish and Wildlife Service on the development of a prescribed-burn program that enhances the habitat for its resident animals and plants while reducing the chance of wildfires that could impact space program facilities and operations. Breininger is recognized internationally as an expert on this topic, having published more than 70 peer-reviewed scientific articles, book chapters and reports in addition to providing numerous professional and educational presentations.



Dr. Dave Breininger, center, is awarded 2016 Scientist of the Year by Kennedy Space Center Director Bob Cabana, left, and Bill Gerstenmaier, associate administrator for the Human Exploration and Operations Directorate at NASA Headquarters, right.

Breininger received the University of Central Florida Outstanding Alumni Knight Award and the U.S. Fish and Wildlife Service Southeast Regional Director's Conservation Award in 2016.

Actively involved in education outreach and community service, Breininger serves on graduate committees at Florida Institute of Technology in Melbourne and University of Central Florida in Orlando, where he is a research associate.

He has served on several endangered species recovery teams and other conservation organizations, such as the Florida Institute of Conservation Science, Brevard County Environmentally

Endangered Lands Selection and Management Committee, and Allen Broussard Conservancy. Breininger has collaborated with the Brevard Zoo and helped develop education materials for public display and for use by students in kindergarten through 12th grade.

As a senior scientist at Kennedy, he mentors staff in the use of modern statistical practices, modeling techniques, and field experiment design.

"I feel very lucky to work in such a great place surrounded by great people," Breininger said.





## Progress in Central Campus construction adding modern facilities

BY BOB GRANATH

**N**ow that Kennedy Space Center is a premier, multi-user spaceport, ongoing construction is adding new, ultra-modern facilities. A key element of the Central Campus makeover is a new, seven-story, 200,000-square-foot headquarters building that has taken shape in the heart of the spaceport.

The project is taking place in several phases. Phase 1 includes construction and outfitting of a shared services and office building to function as the first half of the new headquarters.

The headquarters building's glass facade, as seen from NASA Causeway, is complete. The exterior skin of the building also is nearly finished. The remainder of the glass components are being installed on each floor. Construction of interior walls and utilities on most floors is well underway.

The construction approach will provide a campus-like setting with several buildings surrounding a pedestrian-friendly outdoor courtyard. The concept, similar to what is used by many educational institutions, provides close proximity and access to several buildings. It also promotes the use of pedestrian walkways instead of vehicle traffic used today because of the distances between buildings.

Construction of the headquarters building is targeted for completion in November 2017 and employees are expected to be able to move in soon after.

Additionally, Central Campus phase 1 construction includes a separate facility to operate as a consolidated Kennedy Data Center which opened in October 2015. This 16,500-square-foot building operates year-round, 24 hours a day, seven days a week.

Kennedy's current headquarters and the Central Instrumentation Facility are among the oldest at the spaceport, more than 50 years of service since they were built in the mid-1960s. The overarching central campus construction will consolidate several buildings and administrative spaces in what is known as the space center's Industrial Area.

Photo credit: NASA/Kim Shiflett



# TANK GOODNESS

## Thermal energy storage system chills Kennedy's electric bill

BY FRANK GONZALES



Sustainability Team Lead Dan Clark addresses the news media and NASA Social participants about the new Thermal Energy Storage (TES) tank at Kennedy Space Center Feb. 17. The TES tank works like a giant battery and is saving the center utility costs. These savings will be applied to new sustainable projects at Kennedy. Photo credit: NASA/Cory Huston

A gigantic water tank recently completed at NASA's Kennedy Space Center in Florida will serve, in a way, as a battery backup for the center resulting in lower energy bills and already producing a \$1.5 million rebate from Florida Power and Light.

Filled with 2.8 million gallons of cooled water, the 80-foot-tall, 78-foot-diameter tank is designed to collect thermal energy – heat – and use it later. The tank is heavily insulated and includes mechanisms to diffuse heat to prevent the water from heating up beyond the 40-degree mark. The process works by chilling the water overnight when it's the coolest outside and electricity is cheapest, then releasing it during the hottest part of the day to cool equipment. The approach is projected to save \$260,000 to \$330,000 a year in electrical costs at the center. The project is expected to pay for itself in 12 to 14 years through cost savings.

"We were attracted to this approach because a great deal of our electricity here at Kennedy goes to cooling all the machinery we have out here," said Ismael H. Otero, Kennedy's project manager on the thermal energy program. "Using this method, our facilities' cooling needs can be met with minimal electricity during peak hours."

Scott Hunt, a NASA mechanical engineer, proposed using this technology on an industrial scale at Kennedy in order to help the center meet goals for sustainable energy systems.

*There are lots of things we can do to save energy, but we have to look at the best use of taxpayer funds and pursue the work that will make the most benefit."*

**Dan Clark**  
Kennedy's Sustainability Team Lead

As for the rebate from Florida Power and Light, Kennedy teams are looking for the best ways to use it. Rules call for such rebates to be used for conservation measures. With plenty of projects to choose from, the choice largely comes down to benefit and how long it would take for the energy savings to pay back the cost, said Dan Clark, Sustainability Team Lead at Kennedy.

"There are lots of things we can do to save energy, but we have to look at the best use of taxpayer funds and pursue the work that will make the most benefit," Clark said.

At the top of the list is replacing many of Kennedy's external lights with amber LED lights, work that has already begun on a small scale. LEDs use much less energy than current lights, and the amber wavelength of LEDs is invisible to sea turtles. That's important because sea turtles can get disoriented quickly by regular outdoor lights and be led away from the ocean they are trying to get to, leaving them stranded on shore.

Other potential projects include upgrading office lights with LED lighting, and replacing select stairwell lighting with LEDs and motion sensors that dim stairwell lights when nobody is present. Plans also are being made for light-sensitive sensors, heating and air conditioning improvements, and looking closely at emerging energy technologies.

The thermal energy project ultimately is saving taxpayer dollars with a lower utility bill. It also is improving the resilience of Kennedy's infrastructure to catastrophic events.

*"We were attracted to this approach because a great deal of our electricity here at Kennedy goes to cooling all the machinery we have out here."*

**Ismael H. Otero**  
Kennedy's Thermal Energy Program Project Manager

Ismael H. Otero, Kennedy Space Center's project manager on the thermal energy program, addresses the news media and NASA Social participants about the new Thermal Energy Storage (TES) tank Feb. 17. The TES tank works like a giant battery and is saving the center utility costs. These savings will be applied to new sustainable projects at Kennedy. Photo credit: NASA/Cory Huston



# ‘CHANGING THE NARRATIVE’

Passion turns NASA engineer toward teaching

BY JIM CAWLEY



Keynote speaker Wanda Harding, left, was presented a plaque by Ledlyne Vazquez at the African American and Women's History Month event at the SSPF Conference Center on March 10. Harding is a former LSP Senior Mission Manager at Kennedy who now teaches underprivileged students in Georgia. Photo credit: Kim Shiflett

**W**anda Harding absolutely loved working for NASA. “The experience here at Kennedy, I would dare say, was probably the highlight of any career that I could ever have imagined or dreamed of,” Harding said, as the keynote speaker for the African American and Women’s History Month Lunch & Learn event at the SSPF Conference Center on March 10.

So why did she leave after 18 years at Kennedy Space Center? It turns out the former Launch Services Program, or LSP, senior mission manager loves working with kids even more.

Harding’s passion for education led her to her current role as a Woodrow Wilson Fellow, teaching at a high-need school in Georgia. While at Kennedy, she was credited with many significant accomplishments, including coining the phrase “Earth’s Bridge

“We’ve been doing a lot of really great things for a very long time, so for the 2017 theme to still be ‘Crisis in Education,’ that means somewhere along the way, we dropped the ball — and we need to figure out the best way to pick it up.”

There are some significant challenges standing in Harding’s way. One of those, she explained, is working with high school-aged students who read at an elementary school level.

“I think as a new educator, what I’m trying to get my students to believe and be convinced of is that you are just as good as anyone else,” Harding said. “You have the capability, but you still have to work at it. Giving them the confidence that their work is not going to be in vain is the challenge that I have embraced and that I’m up against right now.”

Harding’s students are well aware of her NASA background. One of the most frequent questions she gets is “Did you make more money than teachers make?”



Wanda Harding was the keynote speaker at the African American and Women's History Month Lunch & Learn event March 10. Photo credit: Kim Shiflett

to Space” to provide a visual of LSP’s goal. That phrase remains a tagline that is used extensively within the program.

“The two words that come to mind when I think of Wanda are faith and family — those are two of the things that drive what she does,” LSP manager Amanda Mitskevich told a packed room at the event, sponsored by the Black Employee Strategy Team (BEST), Kennedy Networking Opportunities for Women (KNOW) and the Office of Diversity and Equal Opportunity (ODEO). “She has always had huge interest in education. As long as I’ve known her, she has thrown herself into that aspect of talking about NASA, what NASA does and what kids can achieve.”

Harding stressed the importance of “updating the narrative” for the next generation. The 2017 theme for Black History Month was “The Crisis in Black Education.” That’s a problem, Harding said.

“Yes — a lot more,” she tells them.

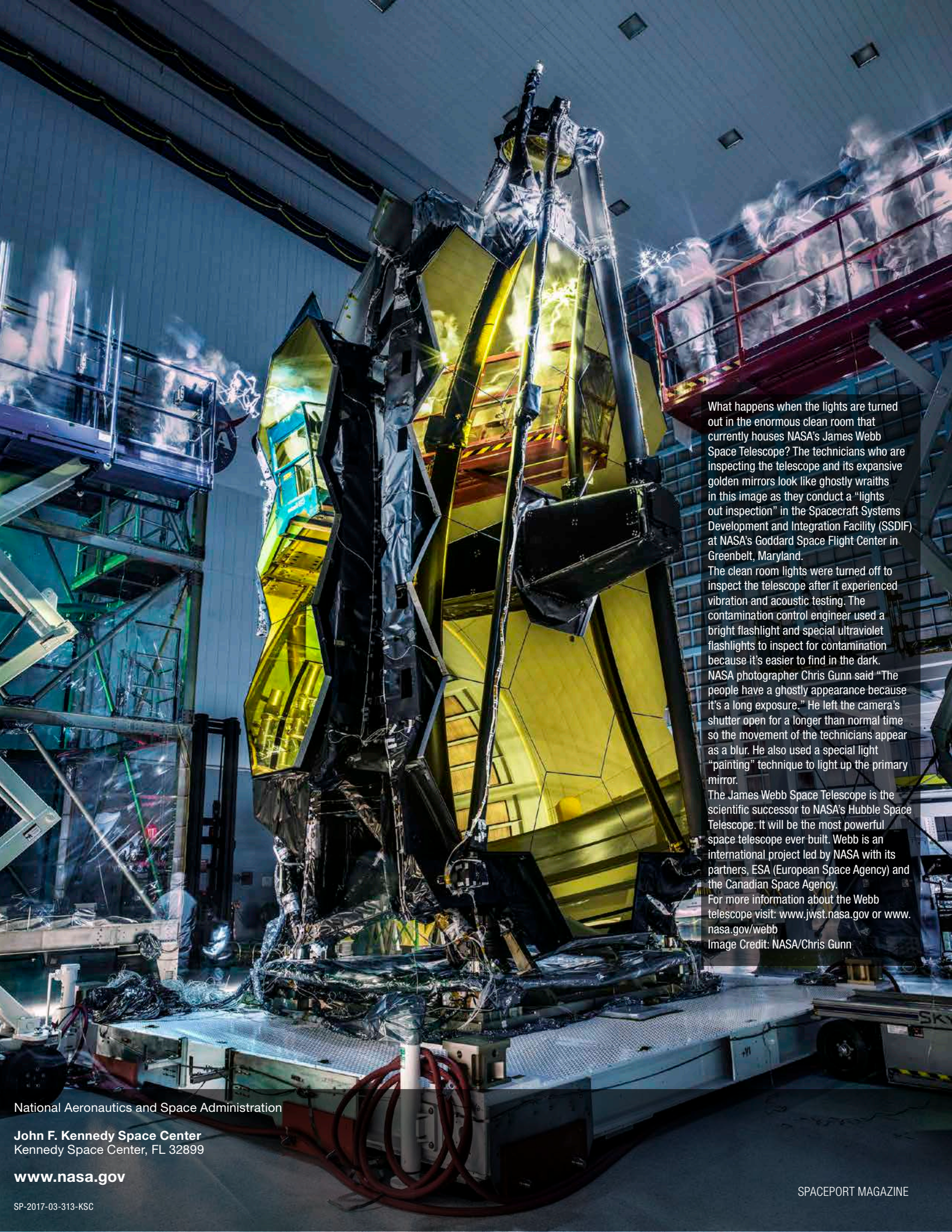
That prompts the follow-up question: “Why did you leave?”

“My constant answer to them is because you are worth the investment,” Harding said.

Harding is charged with creating a new engineering program at her school. And because of her background, expectations are high. That’s where former NASA co-workers come in. Don’t be surprised to receive a request for video conference support or an opportunity to mentor a student, Harding told the crowd.

“I hope leaving here today that you are inspired,” she said. “Get the story out about what you’re doing. The kids need to know . . . that you’ve inspired them to do something better than what they’re doing now.”





What happens when the lights are turned out in the enormous clean room that currently houses NASA's James Webb Space Telescope? The technicians who are inspecting the telescope and its expansive golden mirrors look like ghostly wraiths in this image as they conduct a "lights out inspection" in the Spacecraft Systems Development and Integration Facility (SSDIF) at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

The clean room lights were turned off to inspect the telescope after it experienced vibration and acoustic testing. The contamination control engineer used a bright flashlight and special ultraviolet flashlights to inspect for contamination because it's easier to find in the dark. NASA photographer Chris Gunn said "The people have a ghostly appearance because it's a long exposure." He left the camera's shutter open for a longer than normal time so the movement of the technicians appear as a blur. He also used a special light "painting" technique to light up the primary mirror.

The James Webb Space Telescope is the scientific successor to NASA's Hubble Space Telescope. It will be the most powerful space telescope ever built. Webb is an international project led by NASA with its partners, ESA (European Space Agency) and the Canadian Space Agency.

For more information about the Webb telescope visit: [www.jwst.nasa.gov](http://www.jwst.nasa.gov) or [www.nasa.gov/webb](http://www.nasa.gov/webb)  
Image Credit: NASA/Chris Gunn

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