



Kennedy Space Center's

SPACEPORT

MAGAZINE



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OTHER PLANETS
FOR WATER, FUEL

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FOR NEXT 50 YEARS
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Cover: Two of the four "Swarmies" robots stand in front of the bar code markers they will track as they roll over rough ground near the Launch Control Center at Kennedy Space Center. Engineers at Kennedy are developing programs that tell small, wheeled robots to go out in different directions and randomly search an area for a particular material. Photo credit: NASA/Daniel Casper

Back: The sun emits a mid-level solar flare, peaking at 8:16 a.m. EDT on Aug. 24 as NASA's Solar Dynamics Observatory captures images. Solar flares are powerful bursts of radiation. Harmful radiation from a flare cannot pass through Earth's atmosphere to physically affect humans on the ground. However, when intense enough, they can disturb the atmosphere in the layer where GPS and communications signals travel. Image credit: NASA/SDO

NASA'S LAUNCH SCHEDULE

Date: No Earlier Than Sep. 19 -- 2:38 a.m. EDT
Mission: SpaceX 4 Commercial Resupply Services flight with ISS-RapidScat
Description: Launching from Cape Canaveral Air Force Station, Fla., SpaceX-4 will deliver cargo and crew supplies to the International Space Station. It will also carry the ISS-RapidScat instrument, a replacement for NASA's QuikScat Earth satellite to monitor ocean winds for climate research, weather predictions, and hurricane monitoring.

Date: Sep. 25
Mission: Expedition 41 Launch to the International Space Station
Description: Barry Wilmore, Elena Serova and Alexander Samokutyaev will launch on Soyuz 40 from the Baikonur Cosmodrome in Kazakhstan

Date: No Earlier Than Oct. 14
Mission: Orbital-3 Commercial Resupply Services Flight
Description: Launching on an Antares rocket from Wallops Flight Facility, Orbital-3 will deliver cargo and crew supplies to the International Space Station.

Maneuvering SPHERES



Middle school Zero Robotics finals intrigue students

Energy levels were high as more than 60 middle school students and their teachers from around Central Florida gathered in the conference facility at Kennedy Space Center's Space Station Processing Facility to view the Zero Robotics competition finals Aug. 15 and cheer on the regional winner from the sunshine state.

The regional winners from Carver Middle School in Orlando, part of the Orlando After-School All-Stars, joined other teams around the country via WebEx as Expedition 40 Commander Steve Swanson and Flight Engineer Reid Wiseman oversaw the live competition on the International Space Station.

The students also received a visit from former astronaut and Kennedy Center Director Bob Cabana, and Greg Johnson, former astronaut and executive director of the Center for the Advancement of Science in Space.

-- By Linda Herridge

To read the complete story, visit:
<http://go.nasa.gov/1qwk5vL>

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more online

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Mechanical rovers to mimic ants

BY STEVEN SICELOFF

A small band of NASA engineers and interns is about to begin testing a group of robots and related software that will show whether it's possible for autonomous machines to scurry about the surface of an alien world to search for and gather resources like an colony of ants.

Building on the research conducted at the University of New Mexico, the engineers at Kennedy Space Center have been developing programs that tell small, wheeled robots to go out in different directions and randomly search an area for a particular material.

These tests are meant only to validate the concept and supporting software. The robots will search for nothing more than barcoded pieces of paper. In the future though, robots



**ROBOTS TAKE
WORLD BY
SWARM**



From left, NASA's Kurt Leucht is working with undergraduate intern Gil Montague and post-graduate intern Karl Stolleis on Aug. 6, to develop the software that will control independent robots in a way that mimics the process ants use to scout for and then collect resources. Photo credit: NASA/Dmitri Gerondidakis



The four "swarmies" robots on a table with the software simulation used to develop the program to control the robots Aug 6. Photo credit: NASA/Dmitri Gerondidakis



achieve a task. One of them can roll over and die and it's not the end of the mission because the others can still accomplish the task."

Mako also offered some suggestions for using a swarming robots system on Earth. Assuming testing in the fall goes all right, the system can likely be

called and modified for use in search and rescue tasks, with small robots heading out looking through the wreckage of a natural disaster or crash. They also could make efficient inspectors of pipelines and water mains, she suggested.

"This would give you something smaller and cheaper that could always be running up and down the length of the pipeline so you would always know

the health of your pipelines," Mako said. "If we had small swarming robots that had a couple sensors and knew what they were looking for, you could send them out to a leak site and find which area was at greatest risk." [SPM](#)



NASA's prototype Regolith Advanced Surface Systems Operations Robot (RASSOR) will be incorporated into the "swarmies" tests to see how well the software translates to different robotic vehicles. RASSOR is a concept robotic vehicle evaluating designs for a future craft that could work on another world. Photo credit: NASA

"For a while people were interested in putting as much smarts and capability as they could on their one robot," Leucht said. "Now people are realizing you can have much smaller, much simpler robots that can work together and

working around an asteroid or on the moon or Mars would be equipped to scan the soil for infinitely valuable water-ice or other resources that can be turned into rocket fuel or breathable air for astronauts.

For now, the testing is limited to parking lots around Kennedy's Launch Control Center using four homemade robots called "swarmies" that resemble stripped-down, radio-controlled trucks. There are four of them, each with a webcam, WiFi antenna and GPS device. They are being programmed to work on their own to survey an area, then call

the others over when they find a cache of something valuable. It's identical to the way an ant colony gathers around a food source to divide up the task of collecting the food and taking it back to the nest.

"We're entering the phase where we do a ton of trial runs and collect the data and that's well ahead of schedule," said Cheryle Mako, an engineer at Kennedy who is leading the project. "From an investigation perspective, we are spot-on and have made great strides."

Kurt Leucht, a Kennedy engineer working on the project, considers it possible

that future missions could use this concept in a scaled-up manner to handle any number of robots a mission wants to send into space.

"Assuming this pays off, we know somebody's going to take this and extend it and go beyond the four or five rovers we have here," Leucht said. "So as we design this and work it through, we're mindful about things like minimizing bandwidth. I'm sure there will be a team whether it's us or somebody else who will take this and advance it and scale it up."

The engineers also use a

computer simulator that wrings out their software before they turn on a single swarmie at all. The simulator allows them to test the network with many more robots at the same time without having to build a huge fleet of them.

As the testing proceeds through the coming months, the team plans to include the RASSOR, an experimental mining robot designed at Kennedy to try out different techniques for digging into the lunar or Martian surfaces to gather useful materials.

Compared to scientific robots such as the car-sized Curiosity rover operating on Mars now, the swarmies and RASSOR are much smaller and built with only a couple of instruments and a single purpose.

New song launch



Singer-songwriter Brad Paisley receives a response from astronaut Reid Wiseman, an Expedition 40 crew member in Earth orbit on the International Space Station, after Paisley announced through social media the release of a new song titled "American Flag on the Moon" from Launch Pad 39B at Kennedy Space Center on Aug. 16. Wiseman responded, "Hold on @BradPaisley, we don't usually like leaks at the launch pad." In the background is Launch Pad 39A from which the Apollo moon landing missions were launched. Photo credit: NASA/Daniel Casper

For more on Kennedy Space Center, visit <http://www.nasa.gov/kennedy>

To read more of Wiseman's Twitter posts from the station, go to https://twitter.com/astro_reid

Making a Splash

NASA completes second Orion Underway Recovery Test

BY LINDA HERRIDGE

For NASA's new Orion spacecraft, part of getting ready for its first launch is getting ready for its first splashdown.

Orion is the exploration spacecraft designed to carry astronauts to destinations not yet explored by humans, including an asteroid and Mars. It will have emergency abort capability, sustain the crew during space travel and provide safe re-entry from deep-space return velocities.

After traveling 3,600 miles into space in December on the uncrewed first flight test, Orion will return to Earth at a speed of 20,000 miles per hour and endure temperatures near 4,000 degrees Fahrenheit before landing in the Pacific Ocean. For the team tasked with



The well deck of the USS Anchorage fills with water off the coast of San Diego, California, as NASA, Lockheed Martin and U.S. Navy personnel monitor the Orion boilerplate test vehicle Aug. 4. Tending lines were attached to the test vehicle in preparation for part of Underway Recovery Test 2. Photo credit: NASA/Kim Shiflett

recovering it, that is where the work begins.

NASA and Orion prime contractor Lockheed Martin

teamed up with the U.S. Navy and Department of Defense's Human Space Flight Support Detachment 3 to test

techniques for recovering Orion from the water during Underway Recovery Test (URT) 2, Aug. 1-4, off the coast of San Diego, California.

URT 2 picked up where URT 1 left off. During that first underway recovery test in February, dynamic conditions caused activities to conclude before all of the test objectives were met. Since then, the team has been working on concepts that would allow it to safely recover Orion despite such conditions.

“We learned a lot about our hardware, gathered good data, and the test objectives were achieved,” said Mike Generale, NASA recovery operations manager in the Ground Systems Development and Operations Program. “We were

able to put Orion out to sea and safely bring it back multiple times. We are ready to move on to the next step of our testing with a full dress rehearsal landing simulation on the next test.”

The data gathered during Orion’s first test flight will influence design decisions, validate existing computer models and innovative new approaches to space systems development, and reduce overall mission risks and costs for later Orion flights. The recovery of the vehicle is one of the things the flight will test, and the underway recovery tests prepare the combined NASA, Lockheed, and U.S. Navy team for the task.

For URT 2, the Orion test vehicle was loaded into

the well deck of the USS Anchorage (LPD 23), and the team headed out to sea off the coast of San Diego, in search of sea conditions to support test needs. New support equipment developed for URT 2 accompanied the test vehicle.

New hardware included an air bag system for the Crew Module Recovery Cradle and a load-distributing collar for placement around the crew module. The Prototype Laboratory at Kennedy designed a new device called the Line Load Attenuation Mechanical Assembly (LLAMA) that limited the tending-line forces for the Navy line handlers as Orion was guided into the ship’s well deck.

Tending line snubbers, a kind of commercially available

rubber shock absorbers sailors use for tending lines, also were tested. In case the seas were too rough to secure the crew module in the recovery cradle and a contingency recovery was needed, a set of rubber bumpers were developed to provide a mat on the deck of the recovery ship for use.

During a segment of the recovery test, a lifting sling was attached to Orion and the test vehicle was lifted by crane to test an alternate recovery procedure.

“Each of the new pieces of hardware was evaluated for its relative merits, and the best solutions will be tested during URT 3 in September to discover the limits of their capabilities and suitability for Orion’s first flight test in December,” Generale said.

All of this testing ensures NASA can retrieve the Orion capsule safely because it helps the team understand how to adjust for various water conditions and contingency scenarios. [SPM](#)

A crane aboard the USS Anchorage proves the “basket lift method” concept by raising the Orion boilerplate vehicle from the Pacific Ocean during Underway Recovery Test 2 on Aug. 3. Photo credit: NASA/Kim Shiflett



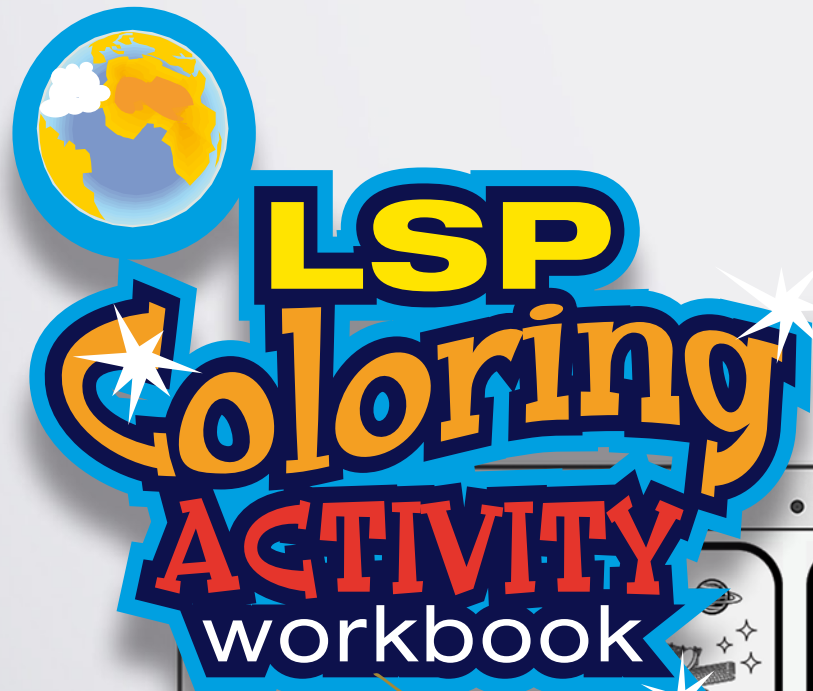
U.S. Navy divers in a Zodiac boat attach tether lines to the Orion boilerplate test vehicle as it floated in the Pacific Ocean off the coast of San Diego on Aug. 4, during Underway Recovery Test 2. Photo credit: NASA/Kim Shiflett



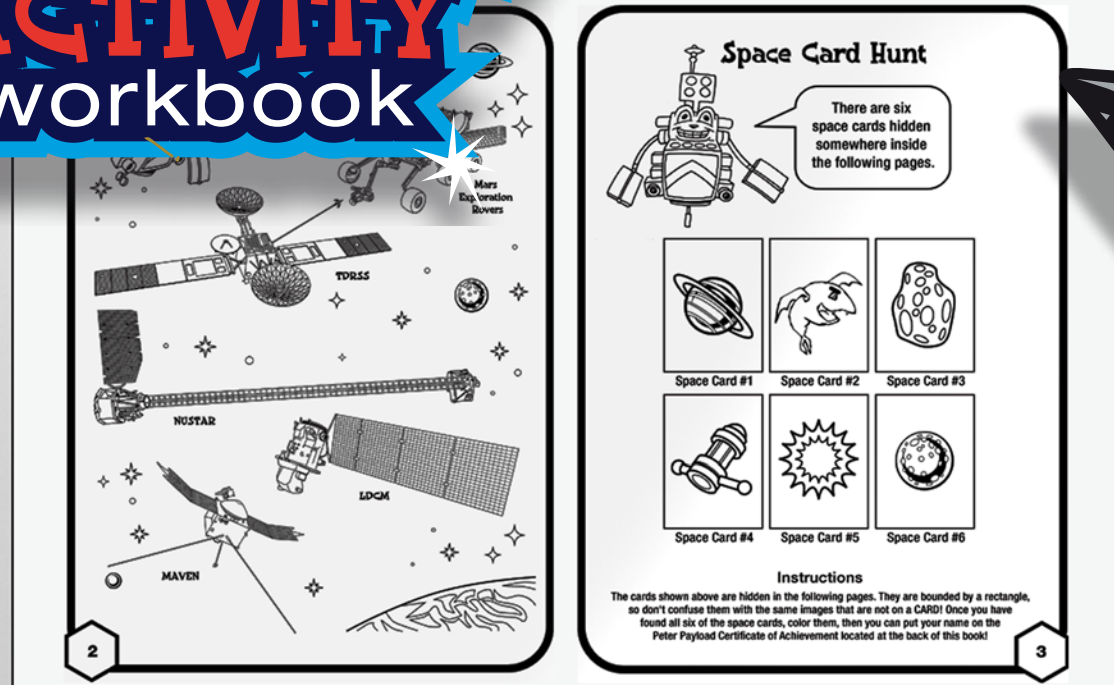
U.S. Naval Sea Cadets sign a banner Aug. 10, on the USS Anchorage docked in the Port of Los Angeles during the Science, Technology, Engineering and Mathematics (STEM) Expo during L.A. Navy Days. In the background is a model of NASA’s Space Launch System heavy-lift rocket, under development. Photo credit: NASA/Kim Shiflett



For more information about Orion, visit <http://www.nasa.gov/orion>



LSP Coloring Activity Workbook



New NASA app encourages kids to play along in adventure of rocketry

The fun and learning experience of processing a rocket and spacecraft for launch aren't limited to the engineers and technicians in special suits thanks to a new digital activity book available for the iPad.

NASA's Launch Services Program, based at Kennedy Space Center, specializes in preparing rockets and their complex scientific payloads for missions that sometimes take them far out into the solar system.

That sense of long-distance adventure with a touch

of precision inspires all the activities in this app. Peter the Payload guides participants through 24 pictures to color and many other activities such as Word Search, Asteroid Maze, Solar System Match and Planet Crossword. Drawing options throughout the app include more than a dozen colors and are adaptable to young participants but also include the freestyle options for markers and crayons that older children crave as they express themselves.

There's even a space-related recipe to take care of

the appetite built up during all the fun!

Successful completions of some activities are met with cheers and congratulations, too, to keep kids coming back. Participants will even be able to get a certificate of achievement for completing the mission.

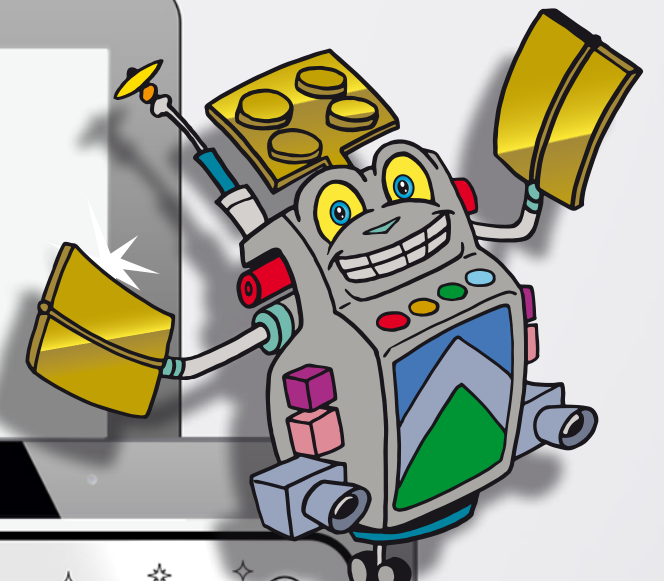
The application was developed by the Kennedy Information Technology Mobile Team in conjunction with LSP.

The LSP Activity Book is available for iPad users via iTunes at <https://itunes.apple.com/us/app/lsp-activity-book/id891308755?mt=8>.

It is also available on GooglePlay at <https://play.google.com/store/apps/details?id=air.gov.nasa.ksc.LSPColoringBook>.

Online, find the LSP Activity Book at <http://www.nasa.gov/externalflash/LSPActivityBookHTML/LSPActivityBook.html> or <http://public.ksc.nasa.gov/lspeducation>.

Please visit www.nasa.gov/lspeducation for additional educational resources and sensational learning activities.



Focus: Future

Kennedy prepping for 50 more years of American spaceflight

BY STEVEN SICELOFF

Multiple launch pads, one long runway and dozens of facilities tuned to specific needs of aerospace operations give Kennedy Space Center everything it needs to thrive following years of transformation work, said one of the architects of the ongoing transition.

The center, which at 144,000 acres is NASA's largest facility by far, recently named a contractor to begin the transition from the current, 1960s-vintage headquarters to a new one complete with modern office efficiencies and a footprint much kinder to the utility bills and environment.

The new headquarters will house a staff overseeing a much different space exploration scene than the one the original building was geared toward.

"Generally, big organizations take several years to change a culture and we're halfway through that," said Scott Colloredo, director of Kennedy's Center Planning and Development directorate. "I think we're embracing what we are doing as a center."

The biggest difference is that NASA itself is not the only customer anymore. There also is a renewed awareness that Kennedy is capable of carrying out a greater diversity of tasks than those related to launching and recovering spacecraft.

The center also unveiled its 20-year master plan recently to detail what the center could become. Three years after the retirement of the space shuttle, planners say the demolition of older structures that are surplus to anyone's

needs and the reassignment of other facilities allowed them to look farther down the road at what Kennedy could become.

With its vast amount of land, infrastructure already in place and a workforce geared toward technical, scientific and research duties, Kennedy can be thought of as the world's only super-spaceport.

That's where the multiple launch pads come in.

The vision of the center does not limit itself to Launch Complexes 39A and B, the pads used by Apollo and shuttles. The master plan points out the vast interest from companies wanting to use the Shuttle Landing Facility for space planes that would lift off on suborbital research and passenger-carrying trips. There is already a partnership with Starfighters Inc. to launch research experiment missions from the company's fleet of supersonic F-104s.

"The runway is a pretty good place to start," Colloredo said. "It takes more than that, but not much more than that."

The unique runway, which

is not only long but inside a protected enclave of land and airspace, has room to add more hangars or other infrastructure, too.

At Launch Complex 39, pad B is deep into refurbishment so it can host NASA's Space Launch System deep-space rocket and Orion spacecraft beginning in a few years.

Pad A has been leased to SpaceX, the Hawthorne, California-based company behind the Falcon 9 rocket and Dragon spacecraft. SpaceX anticipates launching its Falcon-Heavy rocket and human-carrying missions from 39A.

SpaceX also runs Launch Complex 40, where it has launched its Falcon 9 and Dragon cargo-carrying spacecraft to the International Space Station.

United Launch Alliance uses Launch Complex 41 for the Atlas V which has launched NASA interplanetary missions, commercial satellites

and defense department assets. The pad is envisioned as the starting point for future human-rated spacecraft,



This aerial view shows the Vehicle Assembly Building and surrounding facilities at Kennedy Space Center. Image credit: NASA/Kim Shiflett



Launch Complex 39B has been refurbished for use as the launch pad for NASA's Space Launch System rocket and Orion spacecraft. Photo credit: NASA/Kim Shiflett

too. Boeing and Sierra Nevada Corporation have signed on with ULA to launch their spacecraft on the Atlas V.

Launch Complex 37, home of ULA's Delta IV and Delta IV-Heavy, also figures into the plans because it can be used to launch science missions or flight tests like the one coming up later this year. A prototype Orion spacecraft will be launched on a Delta IV-Heavy for a two-orbit mission to evaluate some of Orion's systems.

Many of these facilities have the potential to be used more by a greater number of programs and companies, Colloredo said.

Combining the capabilities of different Kennedy facilities would allow a company to perform every aspect of development, launch processing, launch and mission operations, recovery and evaluations without leaving the

center's boundaries in some cases.

"There's a lot of synergy potential available for small launchers," said Tom Engler, deputy director of Center Planning and Development.

The potential of the center is known throughout a variety of industries, but most of the recognition comes from aerospace companies now.

The center has inked partnership deals for several facilities including the high bay of the Operations and Checkout Building where Lockheed Martin manufactures and processes the Orion spacecraft for launch. Hangar N, a NASA structure at Cape Canaveral Air Force Station, also is in use by another company now that its space shuttle-related efforts have ended.

Kennedy also is deep into negotiations for use of some of the iconic structures at Kennedy

including the 3-mile-long Shuttle Landing Facility.

"All of these interested parties that want to come to Kennedy," Colloredo said, "We want to make sure they can come here and grow together without working against each other."

Boeing anticipates using Orbiter Processing Facility-3, one of the space shuttle's former processing hangars, to process a new generation of spacecraft. The partnership for the building includes the company and Kennedy, along with Space Florida, an organization run by the state to advocate for Florida's unique interests in spaceflight.

"Each of these transitions makes the next one easier," Colloredo said. "OPF-3 is really a pathfinder in the whole transition of Kennedy from a single government program to a multi-

user spaceport supporting numerous programs and companies."

Changing Kennedy's facilities is one thing, but the planning office is well aware that the changes embody fundamental culture changes at the center and throughout NASA, too.

"When you're doing this kind of work, transforming not only Kennedy Space Center, but the whole way government works with industry partners, we have to be very careful how we do this so we can do it methodically," Colloredo said. "I'd say the biggest adjustment is to move at the pace commercial industry wants us to move but still be able to transition assets effectively that have been bought and paid for by the taxpayer." [SPM](#)



The north end of the 3-mile-long Shuttle Landing Facility shows a test area built for NASA's Morpheus experimental lander. The runway and its associated buildings and features make the area attractive to numerous commercial partners for possible future use. Photo credit: NASA



National Aeronautics and Space Administration



LAUNCH AMERICA

10 things to know about **COMMERCIAL CREW TRANSPORTATION**

The Goal: CCtCap stands for Commercial Crew Transportation Capability. It is a contract for one or more American aerospace companies to complete development of a human space transportation system capable of carrying people into orbit, specifically to transport astronauts to the International Space Station and return them safely to Earth. To be certified to carry NASA astronauts, the systems must meet NASA safety standards. It's the last step in a cycle of five separate spacecraft transportation development Space Act Agreements and certification contracts NASA began in 2010.

How it's Done: NASA's Commercial Crew Program (CCP) will implement CCtCap in a similar manner used during each previous stage of the development process – as a public-private partnership. The industry partner is responsible for the development of its own spaceflight system, which it will own and operate. NASA's expert team of engineers and spaceflight specialists are working with the companies and certifying the systems to ensure any new crew transportation system is safe and reliable for NASA astronauts. For previous human spaceflight systems including the space shuttle, NASA designed, owned, and operated the systems, and the agency was responsible for the overall development.

Buying a Service: Once development is complete, NASA plans to buy a service – simply put, like getting a taxi ride to low-Earth orbit. Because the companies will own and operate the systems, they will be able to sell human space transportation services to other customers in addition to NASA, thereby reducing the costs.

Innovation: This new process lets industry partners apply innovations and corporate expertise into their designs. NASA provides a top-level set of requirements the companies must meet, but how they meet those requirements is up to them. Each company thoroughly tests its materials and mechanisms to prove its design is sound, and NASA certifies that the systems meet the agency's requirements.

Commercial Investment: Industry partners are investing their own resources into the development, too. In this way, NASA and industry share the cost of development and both are invested in and committed to a successful outcome.

Contract Terms: NASA's contract, whether with one company or more, will include at least one crewed flight test per company to verify the integrated rocket and spacecraft system can launch, maneuver in orbit, and dock to the space station, as well as validate all its systems perform as expected. Once the test program has been successfully completed and the systems achieve NASA certification, the contractor/s also conduct at least two, and as many as six, crewed missions to the space station, effectively ending the nation's reliance on foreign providers.

Award: NASA has not specified a set number of awards under CCtCap. In late August or September, the agency will select the company or companies that will build an operational space transportation system. While the procurement process is ongoing, the agency cannot answer specific questions about the proposals received or the award decision-making process.

Open Competition: CCtCap is an open competition using FAR-based procedures that will result in a firm fixed-price contract. Any U.S. company could have submitted a proposal for a CCtCap contract. It is not limited to companies that earned previous contracts. However, all companies that submitted proposals should have demonstrated a level of maturity equivalent to the first phase of NASA certification efforts during the agency's Certification Products Contract (CPC)

Safe Haven: The spacecraft must be able to serve as a lifeboat, able to safely and quickly evacuate the space station's crew in an emergency. It also must demonstrate it can serve as a 24-hour safe haven during an emergency in space and be able to stay docked to the station for at least 210 days.

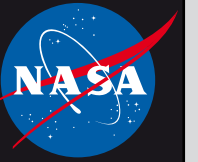
Journey to Mars: By encouraging private companies to provide human transportation services to and from low-Earth orbit – a region NASA's been visiting since 1962 – the nation's space agency can focus on getting the most research and experience out of America's investment in the International Space Station. NASA also can focus on building spacecraft and rockets for deep space missions, including flights to Mars in the 2030s.

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SP-2014-08-218-KSC

SUPER SEAL

Hydrogen leak detection tape earns R&D award

BY BOB GRANATH

A safety innovation developed jointly by the University of Central Florida (UCF) and NASA has been selected for a 2014 R&D 100 Award. The invention is a chemochromic sensor in a tape that can detect hydrogen leaks by changing color, a critical safety technology for the Space Shuttle Program. Its primary application is for use in industries such as oil and gas production.

Jim Nichols, licensing manager of the NASA Research and Technology Management Office in Center Planning and Development, endorsed the nomination for the R&D 100 Awards and noted that safety was the impetus for the innovation.

“NASA was looking for a safe, easy to use, effective and non-powered way of identifying hydrogen leaks,” he said. “Working together, researchers from Kennedy and the University of Central Florida

developed the tape matrix and hydrogen-sensing pigment that formed the basis of the hydrogen tape technology.”

The international R&D 100 competition recognizes the 100 most technologically significant products introduced into the marketplace over the past year. The 52nd annual presentation is scheduled for Nov. 7, 2014, in Las Vegas, Nevada.

Known as the “Oscars of Invention,” the recognition has been presented by R&D Magazine since 1963. The publication features news about advancements in research and development. Past technologies honored have included the automated teller machine in 1973, the halogen lamp in 1974, the fax machine in 1975, the liquid crystal display in 1980, the Kodak Photo CD in 1991 and high-definition television in 1998.

The NASA project that resulted in the invention of the tape that detects leaks by changing color was led by principal investigator Luke Roberson, Ph. D., a NASA research scientist, along with other inventor team members Drs. Janine Captain, Martha Williams, Trent Smith and LaNetra Tate. Other team members included Drs. Robert Youngquist, Mary Whitten, Barbara Petterson, David Smith and, from QinetiQ North

America at Kennedy, Robert DeVor. The University of Central Florida inventors were led by Ali Raissi, Ph. D., director of the Advanced Energy Research at UCF’s Florida Solar Energy Center. Other UCF team members included Drs. Nazim Muradov, Nahid Mohajeri, Gary Bokerman and R. Paul Booker.

Roberson explained that, from time to time during the Space Shuttle Program, tracking down the precise location of a hydrogen leak was a difficult challenge.

Liquid hydrogen is a lightweight and extremely powerful rocket propellant used extensively by NASA. Its characteristics also make it highly flammable and explosive, requiring close attention to avoid leaks.

“Those of us in Research and Technology were originally asked for help in finding a precise way to locate hydrogen leaks during 2004,” he said.

NASA enlisted the assistance of University of Central Florida in developing a pigment that would change color when exposed to hydrogen. Chemochromic materials respond to the exposure to different chemicals with a change in color due to a chemical reaction within the substance.

“After two years of research, the team at UCF came up with

Left: As the space shuttle Endeavour stands on Launch Pad 39A on Feb. 3, 2010, Dr. Luke Roberson applies hydrogen detection tape on a connector joint on a cross-country feed line. The piping connects the liquid hydrogen storage tank with the lines to fill the shuttle’s external fuel tank on launch day. Photo credit: NASA

"There was a hydrogen leak in the OMBUU and Launch Pad 39A," said Dr. Luke Roberson. "It proved to be elusive and we thought the tape could help." The OMBUU, or the Orbiter Midbody Umbilical Unit, is used for loading liquid hydrogen and liquid oxygen into the spacecraft's fuel cells. Connector 34 feeds the liquid hydrogen. Photo credit: NASA



a pigment that could be added to a silicon caulk," Roberson said.

The end result was the development of the innovative "Color Changing Materials for Hydrogen Detection."

What followed was extensive compatibility and flammability testing of the color-changing sensor tape. The checkouts ensured it was safe to use at the launch pads and proved useful in visually notifying technicians of a hydrogen leak.

NASA is the largest consumer of liquid hydrogen in the United States. It has been used with liquid oxygen as propellant for the second

and third stages of the Apollo Saturn V rocket, the space shuttle main engines and is planned for use with the Space Launch System. Beginning with the Gemini program, liquid hydrogen was combined with liquid oxygen to operate electricity-generating fuel cells.

As the lightest element, hydrogen is only seven percent as dense as water and requires large tanks compared to other fuels. Hydrogen has the lowest molecular weight of any known substance and burns with extreme intensity at 5,500 degrees Fahrenheit. It yields the highest specific impulse, or efficiency in relation to the

amount of propellant consumed of any rocket propellant.

While providing a powerful rocket fuel, hydrogen has numerous challenges. Its explosive nature was never more evident than in the 1937 catastrophic fire that destroyed the Zeppelin Hindenburg.

Because liquid hydrogen is cryogenic -- super cold -- it must be stored at minus 423 degrees Fahrenheit and managed with extreme care. During the Space Shuttle Program, efforts began to develop a simple method of detecting hydrogen leaks at Launch Pads 39A and 39B.

One of the first applications

took place as the space shuttle Endeavour was being prepared for the STS-118 mission in the summer of 2007.

"There was a hydrogen leak on the OMBUU and Launch Pad 39A," said Roberson. "It proved to be elusive and we thought the tape could help."

The OMBUU was the Orbiter Midbody Umbilical Unit, a horizontal access arm for servicing the mid-fuselage portion of the space shuttle at the launch pad. It was used for loading liquid hydrogen and liquid oxygen into the spacecraft's fuel cells.

"Sensors were successful in identifying that there was a leak," Roberson said.

"The tape helped pinpoint

the exact location."

The tape works by changing color from beige to high-contrast black in less than three minutes when concentrations as low as 0.1 percent are detected. This is well before reaching the explosive combustion threshold of about four percent. The pigment is completely passive requiring no power and is highly resistive to environmental factors including ultraviolet exposure, salt spray and humidity.

The tape also was added to connectors on the cross-country lines leading from the liquid hydrogen storage tank at Launch Pad 39A during the final years of the shuttle program.

NASA's hydrogen sensing

technology patent was licensed to the University of Central Florida in January 2014. The university in turn combined it with their patents and licensed it to HySense Technology of Rockledge, Florida, to bring the product to commercial consumers as "Intellipigment."

"Realizing the potential benefits and commercial market for such technology, Kennedy and UCF entered into an agreement to combine our patent portfolios and jointly license the technology," Nichols said.

The primary application is for use in the oil and gas production, chemical production and power generation industries. Together,

these lines of work produce and consume a reported 57 million tons of hydrogen gas annually.

The tape is easily applied to joints, flanges and other leak-susceptible areas of vessels transporting, storing or transferring hydrogen gas. Additionally, as the fuel cell market emerges, "Intellipigment" can provide a simple and reliable safety check for applications such as vehicles, where owners or technicians easily can identify a leak. [SPM](#)



A sensor just above this liquid hydrogen feed line at Launch Pad 39A can detect a leak, but the hydrogen detection tape on the connector on the right can, if needed, help pinpoint its exact location. Photo credit: NASA

Super view of 'supermoon'



A "supermoon" is partially obscured by the clouds over Launch Complex 39 at Kennedy Space Center on Aug. 10. At left, the 525-foot-tall Vehicle Assembly Building, illuminated by artificial light, threatens to outshine the moon. The scientific term for the supermoon phenomenon is "perigee moon." Full moons vary in size because of the oval shape of the moon's orbit. The moon follows an elliptical path around Earth with one side about 31,000 miles closer than the other. Full moons that occur on the perigee side of the moon's orbit seem extra big and bright. Photo credit: NASA/Ben Smegelsky

For additional information, visit http://science.nasa.gov/science-news/science-at-nasa/2014/10jul_supermoons/

Mission Success

Flight test preparations draw on Launch Services Program's expertise

BY ANNA HEINEY

The upcoming flight test of NASA's Orion spacecraft will be a mission of firsts. This new crew vehicle, making its debut on Exploration Flight Test-1, will become the first of its kind in four decades to venture beyond low-Earth orbit. The mission also marks the first time a spacecraft designed to carry humans will be lofted to orbit by a modern-day expendable launch vehicle.

Orion, built by Lockheed Martin Space Systems, will fly aboard a United Launch Alliance (ULA) Delta IV Heavy rocket. NASA's Launch Services Program (LSP), based at Kennedy Space Center, specializes in the management of missions flying on expendable rockets, single-

use vehicles that aren't reused. The program is providing its expertise in an advisory capacity for Orion's first flight.

"An advisory role really can be whatever the customer wants it to be, depending on what the needs are," explained John Calvert, a mission manager in the program's Flight Projects Office.

LSP's lead launch site integration manager, Mark Shugg, explained that Johnson Space Center's Flight Test Management Office contacted LSP about four years ago to find out if the program could help.

"They recognized us as the agency's leading subject-matter expert in the field of launching spacecraft on expendable launch vehicles and providing customers with payload processing

facilities for hazardous operations," Shugg said. In the case of Orion's first flight, LSP agreed to provide specific Kennedy facilities, ground support equipment, communications and video capabilities, and computer modeling of the vehicle's guidance, navigation and control (GNC) system.

Asked which key areas could have the biggest impact on mission success, the program identified guidance, navigation, and control of the vehicle as essential. Flight test managers requested Independent Verification and Validation, or IV&V, to build confidence in the unique configuration of the Delta IV rocket for this particular mission.

Jon Bauschlicher leads the GNC group, part of the Flight Dynamics Branch in LSP's Flight Analysis Division. The group took on the massive IV&V computer modeling effort for this test.

"We set about building computer models of the rocket and its systems from liftoff through orbit insertion -- that part of the flight when the rocket's GNC system is active -- factoring in the timing and effects of possible disturbances like wind gusts or variations in engine performance," Bauschlicher explained.

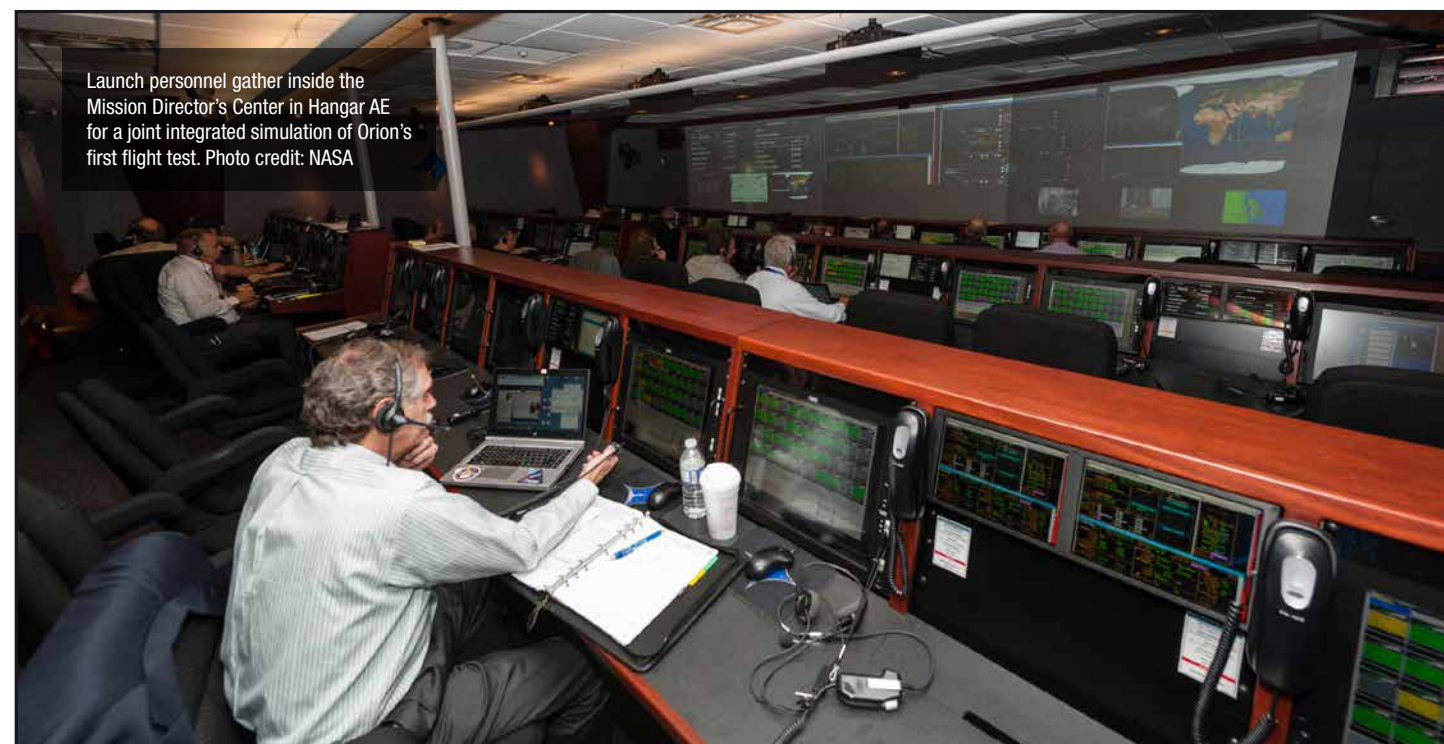
They'll present their results to the Flight Test Management Office through a formal review process.

"We've had four or five engineers working on this full time, building up computer models that predict guidance, navigation, and control system performance while flying this mission and comparisons to ULA's predictions of GNC system performance," Bauschlicher said. "I give full credit to the team for working weekends and off-hours in addition to their standard workloads."

The Orion spacecraft structure arrived at Kennedy in 2012 from NASA's Michoud Assembly Facility in New Orleans and other parts and components arrived from all over the



Kennedy Space Center Director Robert Cabana addresses the audience in Kennedy's Operations and Checkout Building high bay for an event marking the arrival of the Orion capsule July 2, 2012. Photo credit: NASA/Kim Shiflett



Launch personnel gather inside the Mission Director's Center in Hangar AE for a joint integrated simulation of Orion's first flight test. Photo credit: NASA

country. While Lockheed Martin has assembled these to build the crew and service modules in Kennedy's Operations and Checkout Building, LSP has been working to prepare the center's Payload Hazardous Servicing Facility for Orion's arrival this fall.

"In our typical missions, the spacecraft is shipped in from elsewhere. This is unique, because it's the first time the offsite factory is

here at Kennedy,” Shugg explained.

Once United Launch Alliance transports Orion into the servicing facility, though, LSP has a hands-on role in ensuring Lockheed Martin gets the right support during hazardous activities such as pressurizing tanks, ammonia servicing, and loading of hypergolic fuels.

LSP’s Communications and Telemetry Group also is providing communications, telemetry, data, video and voice recording during key processing milestones and throughout the flight.

Cape Canaveral Air Force Station’s Hangar AE is supporting Johnson Space Center’s Mission Management Team with a series of joint integrated simulations. Combined, the rehearsals will take the launch team through the entire mission sequence, from six hours prior to liftoff all the way to the spacecraft’s splashdown and recovery.

The simulations give the look and feel of a real launch day, according to Lois Clutter, an LSP Ground Data Systems aerospace technologist supporting Orion’s first flight. Playback of earlier Delta IV launches add to the authenticity. Each practice run also gives launch personnel the opportunity to figure out what they need during the countdown – before they truly need it.

“These integrated ‘sims’ are helping the Mission Management Team decide which voice,

video and data they need to support their jobs,” Clutter said.

During flight, LSP will separate the spacecraft telemetry data from that of the rocket, then provide both to Johnson’s Mission Control Center.

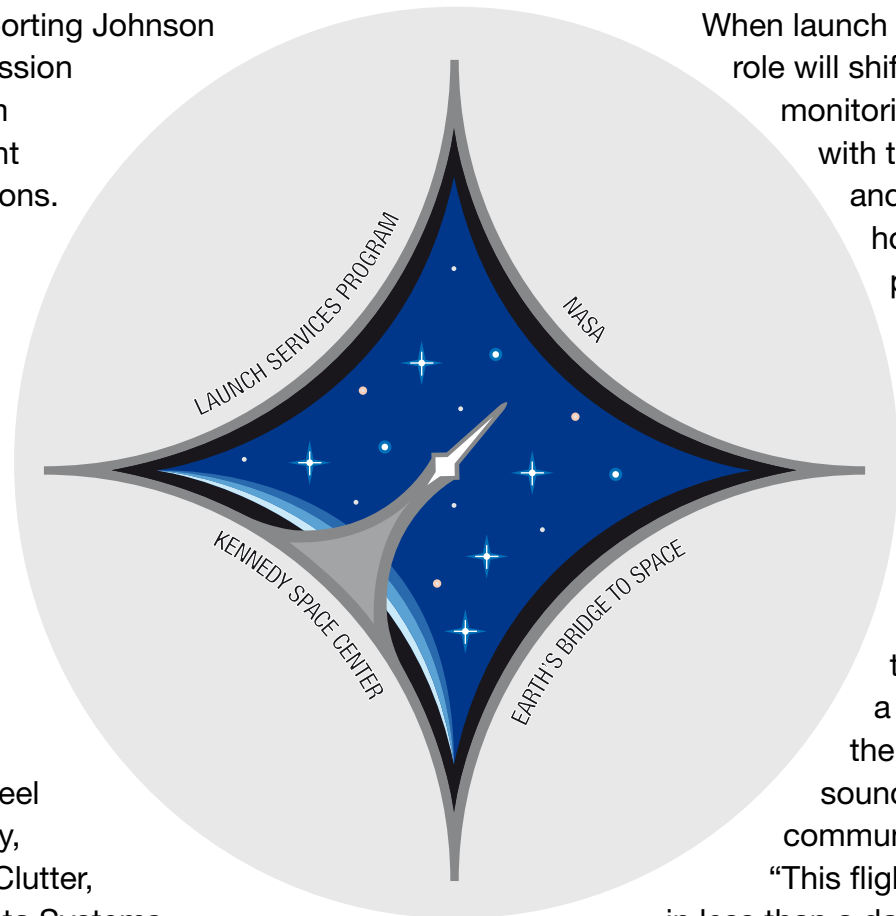
A relatively low number of LSP team members have worked on Orion’s first flight, although support has varied over time and is ramping up as launch approaches, Calvert explained.

“But dozens of our folks have put their fingerprints on the mission in some way,” he added.

When launch day arrives, LSP’s role will shift from advising to monitoring, following along with the countdown and watching to see how the mission progresses. In Hangar AE, Clutter will be stationed at the Mission Operations Director’s console should anyone on the launch team encounter a problem with their console’s sound, video, data or communications.

“This flight will be complete in less than a day. In the course of one or two work shifts, we’ll see the beginning, middle and end of this mission,” Calvert pointed out. “We usually high-five at spacecraft separation; in this case, it will be after the successful Orion re-entry and splashdown.”

“This flight is so important because it’s the next generation,” Clutter said. “This is history.” [SPM](#)



Emergency Response



Team sharpens edge through adaptation

The low-pitched, muffled sound of a helicopter came from a distance, but it didn’t take long before the white shape of a Huey came into sight. It circled a largely empty field at NASA’s Kennedy Space Center before slowing to a hover while camo-clad police officers aboard got to their feet. A few seconds of hovering gave them enough time to throw out two lengths of rope reaching down to the ground. Each of the officers took hold of the rope with gloved hands and booted feet before sliding down single file in a textbook display of fast-roping.

The group disappeared behind some brush before emerging with gear at the ready and moving toward an empty blockhouse that had served as a launch control station in the distant past. The officers converged on one door before working their way methodically through the inside. Their strides purposeful and swift, team members executed the assigned task to be able to declare the area cleared of hostiles and safe.

The whole episode was a rehearsal for Kennedy’s Emergency Response Team, or ERT, as it continues shaping itself into a force adapted for contemporary threats to worker and workplace safety.

-- By Steve Siceloff

To read the complete story, visit <http://go.nasa.gov/1w2WQdz>

Photos by NASA/Dan Casper

a look online



A nozzle extension and deployment test is performed on the second stage of the United Launch Alliance Delta IV Heavy rocket for Orion's first flight test inside the Delta Operations Center near Space Launch Complex 37 on Cape Canaveral Air Force Station in Florida on Aug. 20. During the mission, Orion will travel farther into space than any human spacecraft has gone in more than 40 years. The data gathered during the flight will influence design decisions, validate existing computer models and innovative new approaches to space systems development, as well as reduce overall mission risks and costs for later Orion flights. Liftoff of Orion on the first flight test is planned for fall 2014. Photo credit: NASA/Daniel Casper

Nozzle testing

In Memoriam

NASA weather manager helped develop launch commit criteria

BY BOB GRANATH

Meteorologist John T. Madura, who led development of the lightning launch commit criteria used by NASA and the U.S. Air Force, died Aug. 14, at the age of 71. He served as manager of the Kennedy Space Center's Weather Office since 1993.

The spaceport's Weather Office was established in

the late 1980s after studies showed that 50 percent of all launch scrubs were due to meteorological issues. A part of the spaceport's Ground Processing Directorate, the office coordinates weather support to NASA human spaceflight and expendable launch vehicle operations agency wide, as well as supporting work throughout the

Florida spaceport.

"John worked long hours and maintained many relationships with organizations supporting spaceflight and, indeed, we are all better for his service," said Patrick Simpkins, Ph. D., NASA's director of Ground Processing at the space center. "He bravely fought health issues years ago in order to come back to the team and the

work he loved."

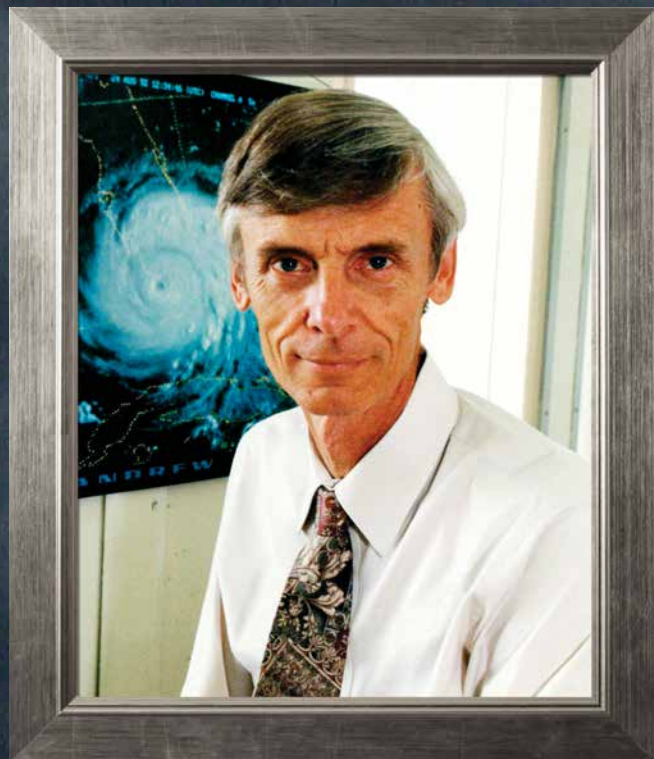
The space center's chief technologist, Karen Thompson, added her praise for Madura's service.

"It has been my pleasure to work with John for many years and to see how visionary he remained," she said. "He recently led a tour for members of the Research and Technology reorganization group to provide an understanding of capabilities related to weather. We will greatly miss him."

Fellow meteorologist, Frank Merceret, Ph. D., explained that his longtime colleague was one of the most hard-working individuals he ever knew.

"John always was dedicated to his job," said Merceret, retired chief of NASA's Applied Meteorological Unit. "He deeply believed in what he was doing."

The Applied Meteorology Unit is a multi-agency cooperative effort for transitioning new techniques from the research arena to improve operational weather forecasting and analysis in support of the space program.



John Madura served as manager of the Kennedy Space Center's Weather Office since 1993. He led development of NASA's extensively used lightning launch commit criteria. Photo credit: NASA

"Central Florida is a veritable storm factory, one of the most active in the world," said John Madura. A menacing thunderstorm hovers over Launch Complex 39 at Kennedy Space Center in a recent photograph. On left are the behemoth Vehicle Assembly Building and the Launch Control Center. Photo credit: NASA/Ben Smegelsky



A Los Angeles native, Madura earned a bachelor's degree in physics from Loyola-Marymount University in 1964, a master's degree in international relations from the University of Southern California in 1967 and a master's in meteorology from the University of Michigan in 1973.

Prior to joining NASA, Madura was commander of the U.S. Air Force's 45th Weather Squadron at Patrick Air Force Base, Florida. The group performs weather assessments for air and space operations specifically focusing on weather observations, forecasts, advisories and warnings.

On March 26, 1987, Atlas/Centaur (AC)-67 carrying a Department of Defense Fleet Satellite Communications F-6 satellite was launched from Cape Canaveral Air Force Station. The NASA investigation board determined that the vehicle was struck by a triggered, cloud-to-ground lightning ultimately resulting in the breakup of the rocket.

"The accident investigation determined that the failure was due, in part, to inadequate and misinterpreted launch commit criteria for lightning," said Merceret.

Madura set up a Lightning Advisory Panel made up of leading experts in lightning

phenomena. The group established new standards for use by NASA, the U.S. Air Force and the Federal Aviation Administration.

Electric field mills are devices that allow scientists to measure the potential for lightning.

After retiring from the Air Force as a colonel in 1993, Madura assumed his role with NASA.

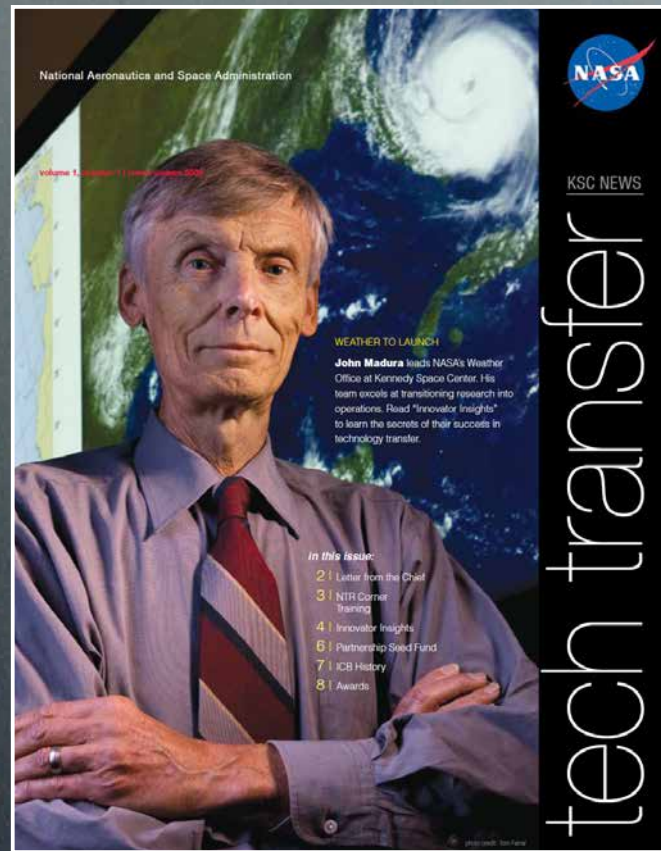
When the agency's Weather Office in Washington closed in 1997, the local Weather Office became responsible for weather support to all Space Shuttle and Expendable Launch Vehicle programs, including support from the Johnson Space Center, Marshall Space Flight

Center, Edwards Air Force Base in California and the Western Range.

“We get involved in a wide spectrum of activity,” Madura said in a March 2000 interview for the Kennedy publication Spaceport News. “We have many interfaces with folks outside the Kennedy realm. I probably spend 70 percent of my time each day focusing the resources of people who are not Kennedy employees or contractors.”

In the Spring-Summer 2008 edition of KSC Tech Transfer Magazine, Madura helped describe the role of the KSC Weather Office.

“Let’s start with what we don’t do,” he said. “We don’t forecast weather. We don’t make go/no-go calls at launch countdowns. At the KSC Weather Office, we help engineers and operators design requirements that make sense, and we make sure those requirements are correctly and effectively communicated to people responsible for meeting them. We have agency wide responsibility for operational weather support for launches



John Madura appeared on the cover of the Spring-Summer 2008 edition of KSC Tech Transfer Magazine. Inside, he described the work of the Kennedy Space Center's Weather Office stating, "We help engineers and operators design requirements that make sense, and we make sure those requirements are correctly and effectively communicated to people responsible for meeting them." Photo credit: NASA's KSC Tech Transfer Magazine/Tom Farrar

and landings of NASA manned spacecraft and launches of NASA expendable launch vehicles.”

Merceret noted that Madura was instrumental in encouraging the Air Force to adopt Lightning Detection and Ranging (LDAR) systems, a Kennedy-developed technology now available as a commercial product.

“John would go out of his way to help us brief the news media on how the weather might impact a rocket launch or

space shuttle landing,” said NASA Public Affairs officer George Diller. “Reporters often expressed appreciation for his insights.”

Merceret pointed out that Madura always had a presentation for the level of any group interested in weather.

“His door was always open,” he said. “It didn’t matter if it was a group of meteorological students or grade school Girl Scouts. John had a pitch at just the right level.”

Madura was awarded the NASA Distinguished Service Medal in 2013. The highest honor bestowed by the agency, the recognition is presented to those who display outstanding

service, ability or courage, and have personally made a contribution representing substantial progress to the NASA mission. In 1999, he was selected as a NASA Space Flight Awareness Honoree, recognizing employees involved in human spaceflight for promoting flight safety and mission success.

A resident of Cocoa Beach, Florida, Madura is survived by his former wife, Jenna, and their daughter, Tiffany Madura. [SPM](#)

Measuring MOISTURE



Pieces coming together for SMAP mission

The second stage of the Delta II rocket for NASA’s Soil Moisture Active Passive mission (SMAP) is transferred into the top of the mobile service tower at Space Launch Complex 2 on Vandenberg Air Force Base in California on Aug. 20. SMAP will launch on a Delta II 7320 configuration vehicle featuring a United Launch Alliance first stage booster powered by an Aerojet Rocketdyne RS-27A main engine and three Alliant Techsystems (ATK) strap-on solid rocket motors. Once on station in Earth orbit, SMAP will provide global measurements of soil moisture and its freeze/thaw state. These measurements will be used to enhance understanding of processes that link the water, energy and carbon cycles, and to extend the capabilities of weather and climate prediction models. SMAP data also will be used to quantify net carbon flux in boreal landscapes and to develop improved flood prediction and drought monitoring capabilities. Launch is scheduled for no earlier than this November. Photo credit: NASA/Randy Beaudoin

To learn more about SMAP, visit <http://go.nasa.gov/1qnfJpM>.

a look online

New Horizons



Probe crosses Neptune orbit on way to Pluto

NASA's Pluto-bound New Horizons spacecraft has traversed the orbit of Neptune. This is its last major crossing en route to becoming the first probe to make a close encounter with distant Pluto on July 14, 2015.

The sophisticated piano-sized spacecraft, which launched in January 2006, reached Neptune's orbit -- nearly 2.75 billion miles from Earth -- in a record eight years and eight months. New Horizons' milestone matches precisely the 25th anniversary of the historic encounter of NASA's Voyager 2 spacecraft with Neptune on Aug. 25, 1989.

Similar to Voyager 1 and 2's historic observations, New Horizons also is on a path toward potential discoveries in the Kuiper Belt, which is a disc-shaped region of icy objects past the orbit of Neptune, and other unexplored realms of the outer solar system and beyond.

Voyager 1 and 2 were launched 16 days apart in 1977. Voyager 1 now is the most distant human-made object, about 12 billion miles away from the sun. In 2012, it became the first human-made object to venture into interstellar space. Voyager 2, the longest continuously operated spacecraft, is about 9 billion miles away from our sun.

New Horizons is the first mission in NASA's New Frontiers program. The Applied Physics Laboratory at Johns Hopkins University manages the mission for NASA's Science Mission Directorate at NASA Headquarters. APL also built and operates the New Horizons spacecraft.

The Voyager spacecraft were built and continue to be operated by NASA's Jet Propulsion Laboratory in Pasadena, California. The Voyager missions are part of NASA's Heliophysics System Observatory, sponsored by the Heliophysics Division of the Science Mission Directorate.

Voyager 1, Voyager 2 and New Horizons were launched from Kennedy Space Center.

To view the Neptune images taken by New Horizons and learn more about the mission, visit: <http://www.nasa.gov/newhorizons>

For more information about the Voyager spacecraft, visit: <http://www.nasa.gov/voyager>



CREATIVE SOLUTIONS

for Space Age Technology

Karen Thompson, NASA's chief technologist at Kennedy Space Center, visits the Swamp Works. In these laboratories agency scientists and engineers work on developing rapid, innovative and cost-effective exploration mission solutions through partnerships across NASA, industry and academia. Photo credit: NASA/Glenn Benson

Chief technologist leads team of exploration innovators

BY BOB GRANATH

Conducting research to create solutions for complex problems has been a life-long passion for Karen Thompson. As NASA's Chief Technologist at Kennedy Space Center, she leads a diverse team developing a myriad of innovations to support the agency's plans for exploration beyond Earth.

A native Texan, Thompson grew up in small towns where her father was in the oil business.

"I was born in San Angelo and moved with my family to different small Texas towns associated with my father's work as a financial advisor for Humble Oil, later the Exxon Corp.," she said. "When I was five, we moved to Premont, Texas, where I lived through high school."

Located in the southern part of the state, Premont was typical small-town America with a population then and now of about 2,700.

"Growing up, I was always fascinated with math and science," Thompson said.

That interest led her to the University of Texas in Austin where she was studying pre-med.

"During my senior year, I changed my major to chemistry because research is what I really wanted to do," she said. "I transferred to what is now Texas State University where I had an opportunity to do research with one of the world's leaders in polymer chemistry, Dr. Patrick Cassidy."

During his tenure at the university, Cassidy founded and directed several institutes and centers, including the Polymer Research Group, and published

and presented papers internationally.

This new direction also presented Thompson with an opportunity to teach undergraduate chemistry lab courses. Her favorite lab course to teach was organic chemistry.

"I loved the work," she said. "I learned a great deal from Dr. Cassidy while working as a research assistant in his lab, and I was honored to be the one selected from ten research assistants to work a special project for the Army."

The new position offered a chance to work with Dr. G. Ronald Husk, the U.S. Army Research Office's director of polymer investigations, during his one-year sabbatical at Texas State. This resulted in Thompson, Husk and



Aboard the International Space Station on Jan. 22, 2014, Expedition 38 flight engineer Mike Hopkins works with the SLOSH experiment developed by engineers at Kennedy. The device is now being used on the space station to better understand how liquid propellants perform in a reduced-gravity environment. Photo Credit: NASA

Cassidy coauthoring a paper in the publication *Macromolecules*, describing polyimide studies with the unpublished goal of protecting the military from chemical warfare agents.

After graduating with honors in chemistry, Thompson was offered several jobs. She

accepted a research position that turned out to be the lowest paying of those offered.

“The job provided the best opportunity to follow my chosen career path,” she said. “When Bob Crippen was Kennedy’s center director, he encouraged me to speak to university students to urge them to select jobs that advance their careers toward their life goals rather than taking a short-term view.”

Thompson worked at the Texas Research Institute in Austin where she developed new materials to solve problems for the Department of Defense. While working on projects funded by the Naval Research Laboratory (NRL), she

co-authored papers with Dr. Corley Thompson of the NRL division in Orlando who later convinced Thompson to move to Florida and marry him.

Thompson moved to Florida where she became a lead research chemist with PCR Corp. in Gainesville. She began her career at Kennedy in 1987, accepting a position with Boeing Aerospace Operations supporting NASA’s Engineering Support Contract.

After joining NASA in 1988, Thompson worked as a research scientist.

“We were trying to develop coatings for corrosion protection,” she said. “The trick was making normally brittle polymers into a coating that

could be sprayed or brushed onto surfaces.”

There were many who thought it couldn’t be done.

“It was challenging,” she said, “but I told them I’d see what I could do.”

She went on to invent the breakthrough technology of electrically conducting polymer coatings that were shown to provide corrosion resistance to the coated surface. The new technology led a team from NASA and the Department of Energy at the Los Alamos National Laboratory to further develop these innovative coatings.

Thompson noted that the novel polymer coatings have led to further work by

many research organizations that have developed coatings to prevent corrosion on steel structures. The American Chemical Society produced a book on electroactive coatings where Thompson and her co-inventors were recognized as pioneers in the field and authored the first technical chapter. The invention received a patent and was the recipient of the 1997 Distinguished Patent Award from the Los Alamos National Laboratory.

Her honors also have included the Kennedy Invention of the Year Award, the NASA Exceptional Service Medal, two Space Act Awards, and the Best of the Best Safety Award among others. In February 2005, she received the Texas State University’s Distinguished Alumna Award for her ongoing accomplishments.

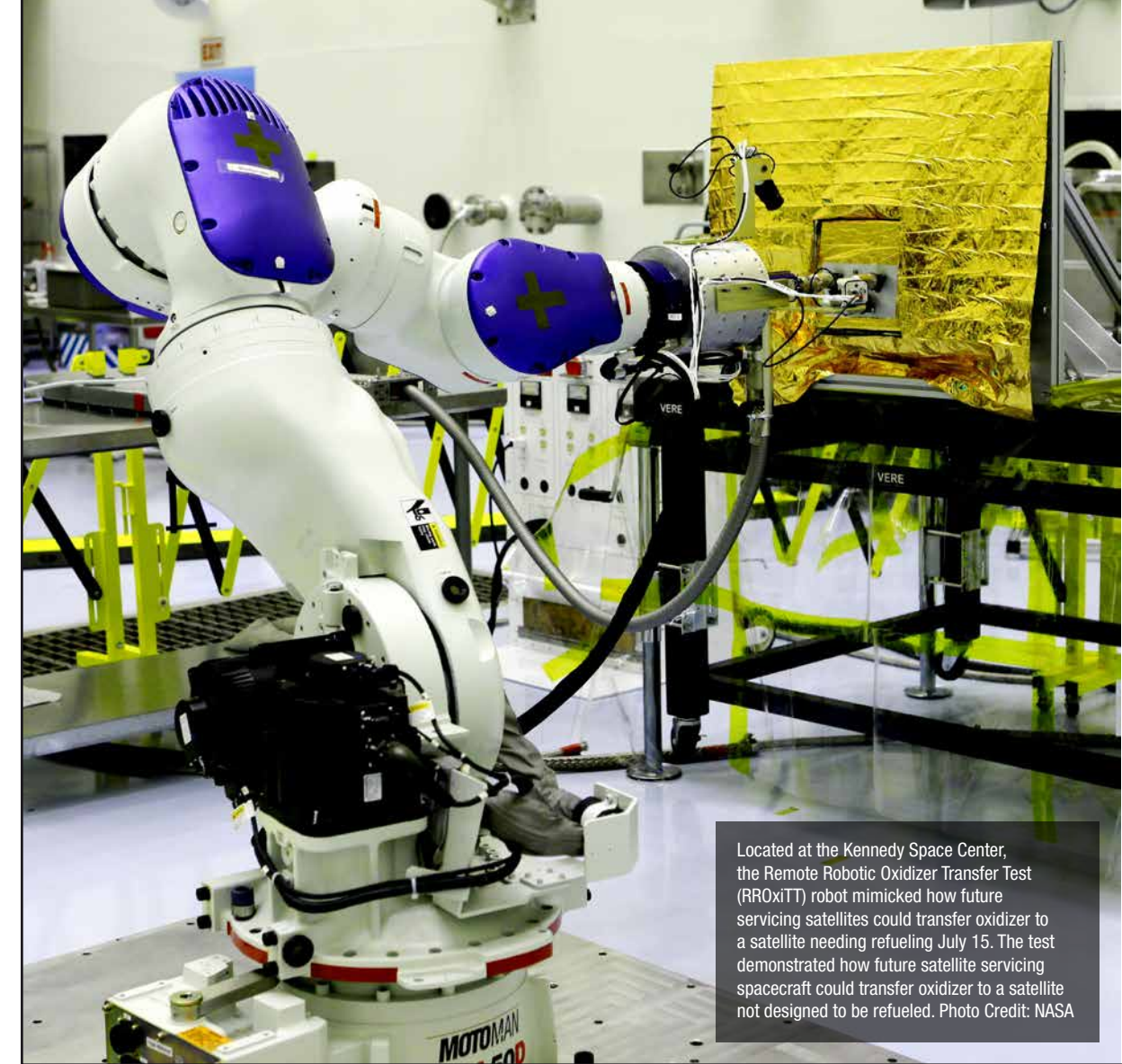
In 1993, Thompson moved into management for NASA where she served in a series of positions, including managing collaborative partnerships

involving NASA and external partners. She also managed advanced technology programs for Kennedy, supervising teams of researchers, serving as the Science and Technology manager of the Kennedy Exploration Office, and serving as associate director of the Applied Research and Technology Directorate prior to assuming her current position in 2010.

Thompson served on the formulation team of the Office of the Chief Technologist as the Space Technology Programs

were formulated.

“In the past few years, I’ve been fortunate to have an opportunity to work with the team in the Office of the Chief Technologist at NASA Headquarters in developing and implementing the agency’s strategic technology planning as we develop research and technology that fills recognized needs for future NASA missions,” she said. “I have enjoyed working with key stakeholders in mission directorates in NASA as well as with collaboration partners



Located at the Kennedy Space Center, the Remote Robotic Oxidizer Transfer Test (RROxiTT) robot mimicked how future servicing satellites could transfer oxidizer to a satellite needing refueling July 15. The test demonstrated how future satellite servicing spacecraft could transfer oxidizer to a satellite not designed to be refueled. Photo Credit: NASA



NASA technology experts at Kennedy Space Center examine a robotic miner July 15 being developed for future exploration missions. From the left, are Rob Mueller, senior technologist, Karen Thompson, chief technologist at Kennedy, and Andrew Nick, robotics engineer. Photo credit: NASA/Glenn Benson

from other centers, other government agencies, industry and academia.”

With new programs such as the Orion spacecraft and Space Launch System rocket being developed, NASA’s goals include ambitious programs such as exploring an asteroid and trips to Mars.

“The new programs have led us to so many different technological areas for research,” said Thompson.

Much of the advanced research is taking place in Kennedy’s Swamp Works where NASA scientists work on developing rapid, innovative and cost-effective exploration mission solutions through partnerships across NASA, industry and academia.

One area of study going on in the Swamp Works is to develop instrumentation that would help astronauts deal with the problem of electrostatic dust phenomena during future planetary exploration missions.

Additionally, destinations for future human exploration will require learning to live off the land. Thompson noted that NASA experts at Kennedy are hard at work developing the technologies that will be needed over the next several decades to send humans to a range of destinations beyond low-Earth orbit.

“Trips to deep space will

require us to reduce weight and only carry the types of payloads we really need for our exploration goals,” she said.

Called “in-situ resource utilization,” the concept involves relying on available resources that will enable more affordable extraterrestrial exploration and operations.

One illustration is a reactor being developed by scientists at Kennedy that converts common trash into usable byproducts. Food wrappers, used clothing, scraps, tape and packaging accumulated by a crew of astronauts can be turned into valuable methane gas, oxygen and even water.

Researchers also are

developing methods to use water that may be available on the moon or Mars. This capability also will minimize the amount of materials carried from Earth. Advanced, autonomous devices could help astronauts benefit from available in-situ resources on Mars or other planets.

Another innovative technology being developed at Kennedy is called “SMASH,” for Shape Memory Alloy Self-Healing. Thompson explained that the technology is designed to create metals that, when damaged, can repair themselves. Aircraft and spacecraft can be subject to material fatigue, the progressive



Clara Wright, a materials engineer in NASA’s Engineering and Technology Directorate, displays one of the Shape Memory Alloy Self-Healing (SMASH) samples. The technology is designed to create metals that, when damaged, can repair themselves. Wright is the principal investigator for the SMASH project. Photo credit: NASA/Bob Granath

and localized structural damage that occurs when a material is subjected to repetitive stress.

“SMASH would provide future spacecraft landing on a distant planet with an improved margin of safety,” she said.

“In many of the ongoing projects, we are collaborating with other centers and the Space Technology Mission

Kennedy is collaborating with counterparts at the agency’s Goddard Space Flight Center in Greenbelt, Maryland, in testing components for a simulated robotic satellite servicing spacecraft. Earlier this year, engineers demonstrated groundbreaking technology that could add additional years of service to satellites

potentially endangering flight crews and mission success. A team of scientists and engineers at Kennedy is studying how to better understand this phenomenon and reduce its potential impacts to flight safety.

Engineers at the Florida spaceport developed the “Slosh” experiment that is now

being used on the International Space Station (ISS) to study how liquid propellants perform in a reduced gravity-environment.

“I’m proud of the efforts our people have made in varied areas of research and technology,” she said. “Our center is focusing on making these R&T areas even stronger as we organize center functions to combine our excellent ISS

organization with R&T programs from across the center. This will optimize synergies and assist with improved R&T strategic planning to better serve the agency. Our teams are developing the technologies that will help us to become more cost efficient and to attain our exploration goals while also developing technologies that will help our own planet Earth. [SPM](#)



Dr. Carlos Calle is the lead scientist in Kennedy’s Electrostatics and Surface Physics Laboratory in Kennedy Space Center’s Swamp Works. He is developing the Electrodynamic Dust Shield for Dust Mitigation that would help astronauts deal with the problem of electrostatic dust phenomena during future planetary exploration missions. Photo credit: NASA/Dan Casper

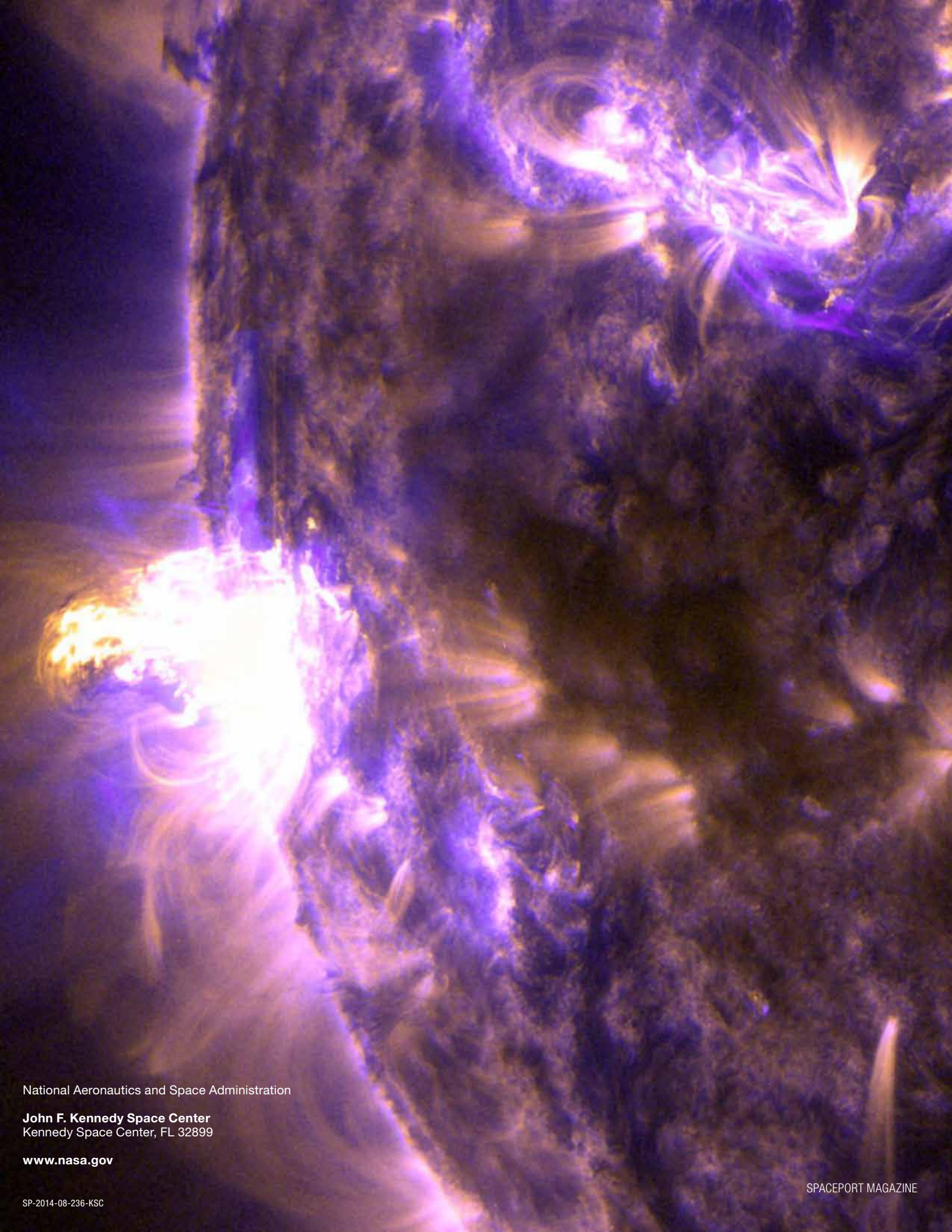
Directorate,” Thompson said. “We also are working with industry and academia.”

The Space Technology Mission Directorate is responsible for developing the crosscutting, pioneering, new technologies and capabilities needed by the agency to achieve its current and future missions.

An example of a joint project is an effort in which a team at

by performing the design, development and qualification testing of the critical hypergolic propellant transfer system.

As launch vehicles have grown in size, fuel and oxidizer tanks have become more complex resulting in unexpected changes in thrust,



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