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National Aeronautics and
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Kennedy Space Center's

SPACEPORT MAGAZINE

SPACEX-3 DELIVERS CARGO TO ISS
PAGE 4

ANCIENT CREATURES ON THE PROWL
PAGE 37

ORIGINAL SEVEN CHOSEN BY NASA 55 YEARS AGO
PAGE 48

KENNEDY SPACE CENTER

SPACEPORT MAGAZINE

CONTENTS

4.....SPACEX-3 delivers cargo to ISS

8.....NASA, SpaceX sign lease agreement for Launch Pad 39A

12.....Firing Room 4 to feature multi-user concept layout

18.....Satellites play vital roles in everyday life

24.....NASA's Path To Mars

29.....Forum focuses on NASA partnerships, plans for multi-user spaceport

32.....Engineering's four lines of business focus on problem-solving

36.....GSDO engineer realizes dream of working at Kennedy Space Center

39.....Alligators thrive amid rockets, space-age facilities

43.....Equipped with new sensors, Morpheus preps to handle landing on its own

48.....Mission to map Venus began 25 years ago with STS-30

52.....Pioneering Mercury astronauts eager to launch 55 years ago

NASA'S LAUNCH SCHEDULE

Date: May 28, 2014
Mission: Expedition 40/41 Launch to International Space Station
Description: Reid Wiseman, Maxim Suraev, Alexander Gerst launch on Soyuz 39 from Baikonur Cosmodrome in Kazakhstan.

Date: June 6, 2014
Mission: SpaceX-4 Commercial Resupply Services flight with ISS-RapidScat
Description: Launching from Cape Canaveral Air Force Station, Fla., on a Falcon 9 rocket, 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: No Earlier Than June 9, 2014
Mission: Orbital 2 Commercial Resupply Services Mission to International Space Station
Description: Launching from the Mid-Atlantic Regional Spaceport at NASA's Wallops Flight Facility, Orbital 2 will deliver cargo and crew supplies to the International Space Station.

THE SPACEPORT MAGAZINE TEAM

Editorial
Managing Editor ..... Chris Hummel
Editor..... Frank Ochoa-Gonzales
Assistant Editor..... Linda Herridge
Copy Editor ..... Kay Grinter

Writers Group
Anna Heiney, Bob Granath, Linda Herridge, Kay Grinter, Steven Siceloff, Frank Ochoa-Gonzales

Graphics Group
Richard Beard, Greg Lee, Lynda Brammer, Matthew Young, Amy Lombardo

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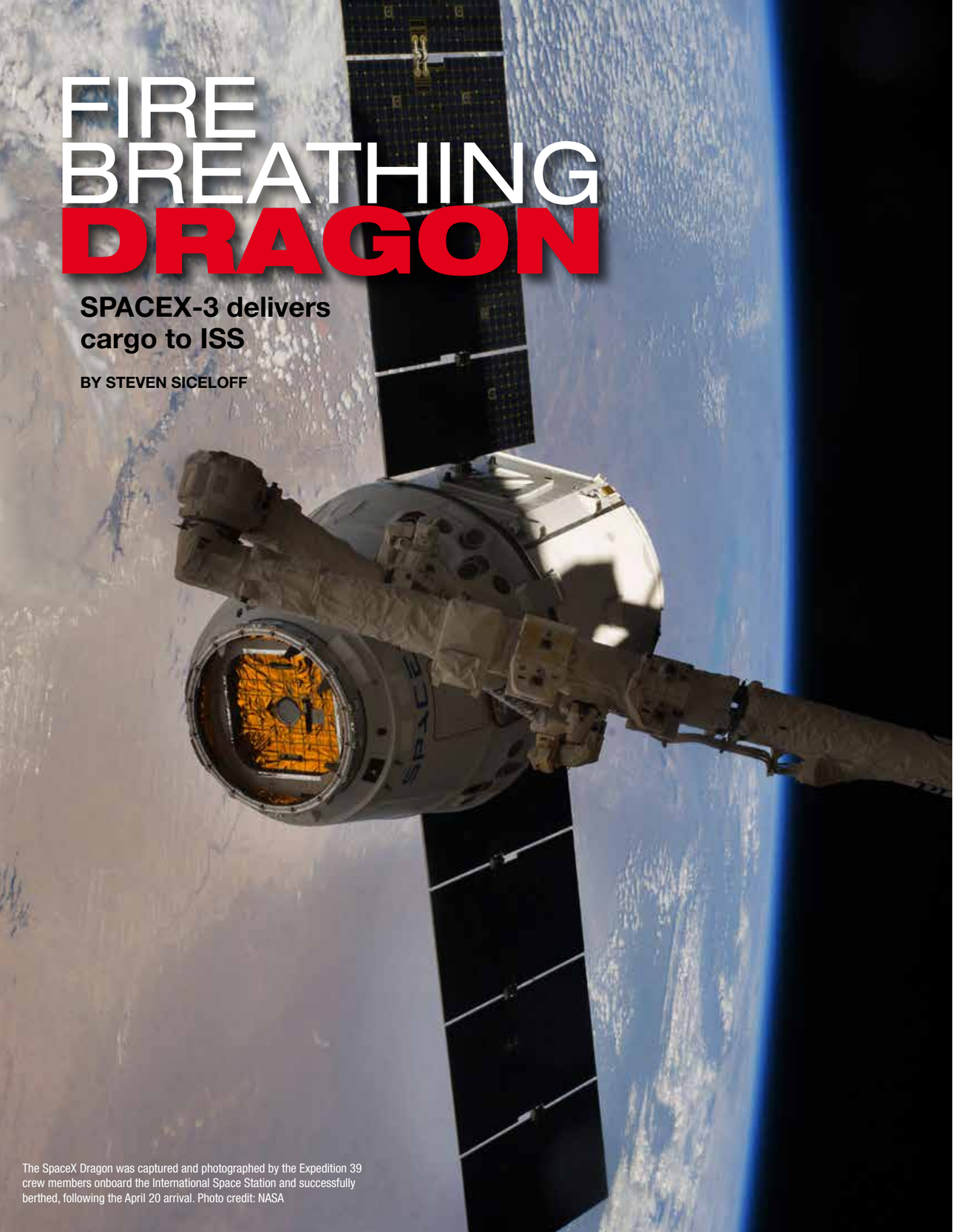
FIRE BREATHING DRAGON

SPACEX-3 delivers cargo to ISS

BY STEVEN SICELOFF



The SpaceX Dragon was captured and photographed by the Expedition 39 crew members onboard the International Space Station and successfully berthed, following the April 20 arrival. Photo credit: NASA

A SpaceX Dragon spacecraft full of cargo, experiments and equipment blazed into orbit Friday, April 18, on the strength of one of the company's Falcon 9 boosters. Two days later, the Dragon arrived at the International Space Station where it was grappled by the Canadarm2 and locked into place so astronauts could later retrieve almost 5,000 pounds of equipment, experiments and supplies.

Launching without a crew, cargo resupply flight such as SpaceX-3 are critical to the operation of the orbiting laboratory and the six people living and working there.

"SpaceX is delivering important research experiments and cargo to the space station," said William Gerstenmaier, NASA associate administrator for human exploration and operations. "The diversity and number of new experiments is phenomenal. The investigations aboard Dragon will help us improve our understanding of how humans adapt to living in space for long periods of time and help us develop technologies that will enable deep-space exploration."

The manifest for the flight included a spacewalking suit for astronauts plus related hardware and supplies for more than 150 science investigations to be conducted by the space station crews.

The Dragon spacecraft, making the company's third operational cargo mission to the station, separated from its Falcon 9 second stage as planned and deployed its twin solar arrays on time. An issue with one of the thruster sets was dealt with quickly soon after the spacecraft achieved orbit.

"Looks like everything's good on Dragon," SpaceX founder and CEO Elon Musk said during a news conference following the launch. "I'm feeling pretty excited, this is a happy day," Musk said.

The launch took place on a day that started with heavy clouds and occasional rain at the launch site at Cape Canaveral Air Force Station in Florida. The launch preparation teams from SpaceX and payload teams for NASA had to work inside tight schedules to safely set up for launch between the bouts of poor weather.

"They did a lot of good work," Gerstenmaier said.

The weather was on the front of everyone's mind throughout the morning, but cleared up enough about two and half hours before the 3:25 p.m. launch time to allow a liftoff.

"Weather was our primary concern," said Hans Koenigsmann, vice president of Mission Assurance for SpaceX. "It's a really good day."

Musk also reported success in SpaceX's test to have the first stage of the Falcon 9 reignite its engines and slow the stage to a soft landing on the ocean's surface a few minutes after liftoff. All data is not in yet, he said, but the slowdown seemed to go well. He did not expect to be able to pick the first stage out of the water, however, because the ocean waves were substantial having been roiled up by days of rough weather. He said the flight encourages him to continue its pursuit of recovering a first stage intact.

"I think we have a decent chance of bringing a stage back this year, which would be wonderful," Musk said.

"It looked great, it looked like it was doing what it was supposed to do," Koenigsmann said.

The science-related equipment includes the VEGGIE system that is designed to grow leafy vegetables in orbit. A system called OPALS will test whether lasers can be used to carry data from space to Earth. The T-cell Activation in Aging unit will seek the cause of the depression of the human immune system in astronauts in microgravity.

The Dragon also carries four commercially available high-definition video cameras that will be mounted to the outside of the station to

This snapshot of the SpaceX Dragon spacecraft docked to the International Space Station was photographed by one of two spacewalking astronauts on April 22, 2014. NASA astronauts Rick Mastracchio and Steve Swanson, Expediton 39 flight engineers, replaced a failed backup computer relay box in the S0 truss on the orbital outpost. Photo credit: NASA

see how they handle the conditions of space. Although they will be inside temperature-controlled enclosures, the cameras will experience the radiation of orbit. Online viewers will be able to watch the footage from the cameras.

A pair of legs for Robonaut 2 are now on the station as well, thanks to the supply flight. The humanoid robot has been going through testing inside the space station since 2011.

The robot is designed to perform repetitive tasks and free up astronauts' time for science experiments and other research. Its head and torso now are supported on a moveable post in the station's pressurized module. The legs and their special fittings would allow the robot to move around inside the station. Later additions to the robot would allow it also to work on the outside of the station as an assistant to spacewalkers.

The Dragon will remain docked to the station about a month before it is released and guides itself back through the atmosphere to a parachute landing off the coast of California. It will return more than 3,000 pounds of completed experiments from the station along with other equipment and unneeded materials.

ORION Vibe

Image Credit: NASA/Daniel Casper

Inside the Operations and Checkout Building high bay at NASA's Kennedy Space Center in Florida, the Orion crew module is positioned on a special portable test chamber and prepared for a multi-point random vibration test. --LINDA HERRIDGE

http://go.nasa.gov/1rFHcRF

a look online

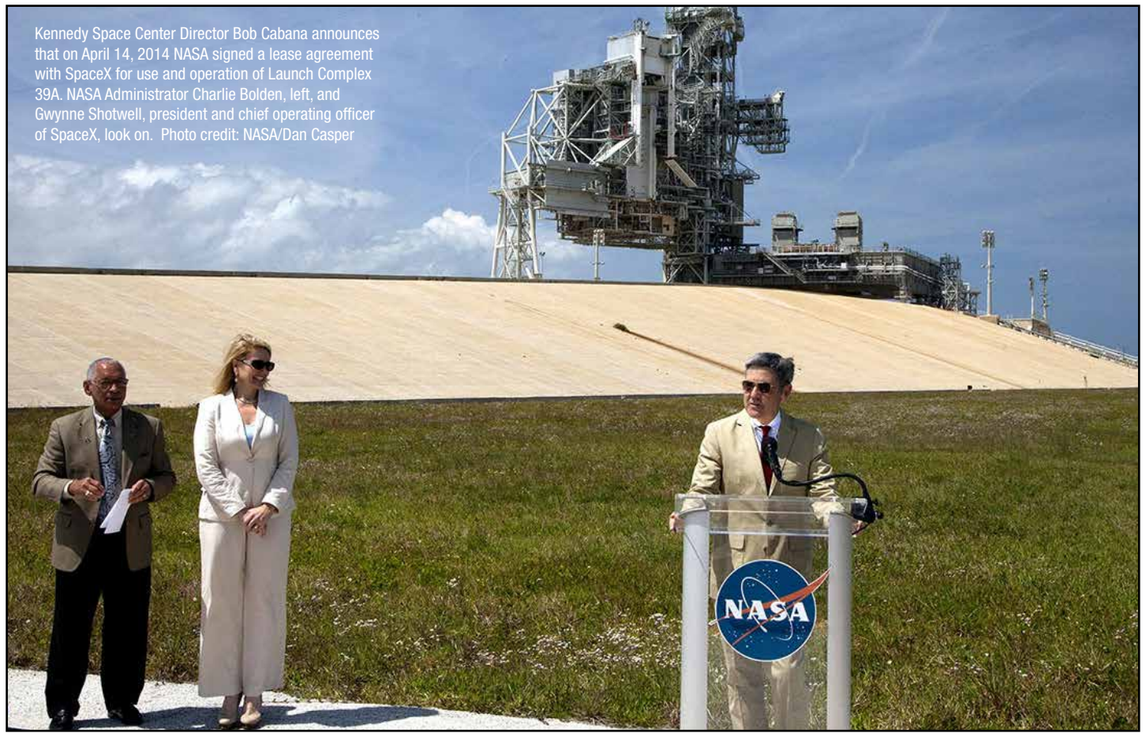
more online

HISTORIC HANDOFF

NASA, SpaceX sign lease agreement for Launch Pad 39A

BY BOB GRANATH

In this photograph taken March 11, 2014, Launch Pad 39A looks much like it did after the liftoff of STS-135, the final space shuttle mission which lifted off July 8, 2011. This view shows the flame trench where smoke and flame from the shuttle's twin solid rocket boosters were deflected away from the pad. Photo credit: NASA/Dan Casper



Kennedy Space Center Director Bob Cabana announces that on April 14, 2014 NASA signed a lease agreement with SpaceX for use and operation of Launch Complex 39A. NASA Administrator Charlie Bolden, left, and Gwynne Shotwell, president and chief operating officer of SpaceX, look on. Photo credit: NASA/Dan Casper

The historic site where American astronauts first launched to the moon was the location of a recent landmark agreement, part of NASA's continuing process to transform the Kennedy Space Center in Florida into a 21st century spaceport. During ceremonies on April 14, agency officials announced they signed a property agreement with SpaceX of Hawthorne, Calif., for use and operation of Launch Complex (LC) 39A for the next 20 years.

NASA Administrator Charlie Bolden stated that pad A is beginning a new mission as a commercial launch site, part of an ongoing effort to collaborate with industry in meeting the agency's objectives.

"NASA today signed a property agreement with SpaceX, which allows them to develop Launch Complex 39A to serve as a platform for the company's future commercial launch activities," he said during a news briefing at the pad. "SpaceX and our other commercial partners are a critical part of our exploration strategy. This includes the (International Space Station), proving technologies in deep space, the asteroid initiative that brings an asteroid closer to Earth so astronauts can visit it and a mission to Mars in the 2030s."

Bob Cabana, Kennedy's director, noted that permitting the pad's use and operation by a commercial space partner will ensure its continued viability and allow for its ongoing use in support of the nation's space activities.

"This agreement will preserve this national asset and will enable commercial operations at Kennedy," he said. "We continue to enable commercial operations from the Cape, allowing them to use national assets that would otherwise sit empty and decay."

Gwynne Shotwell, president and chief

operating officer of SpaceX, noted that her company places a high value on the significance of the launch site.

"We're honored to sign the lease a few minutes ago." she said. "Pad 39A is a historic pad. I'm so excited that NASA has selected us to be one of their partners and also to be one of

On July 16, 1969, Apollo/Saturn V left Earth from Launch Complex 39A. Photo credit: NASA

their partners in developing pad 39A "

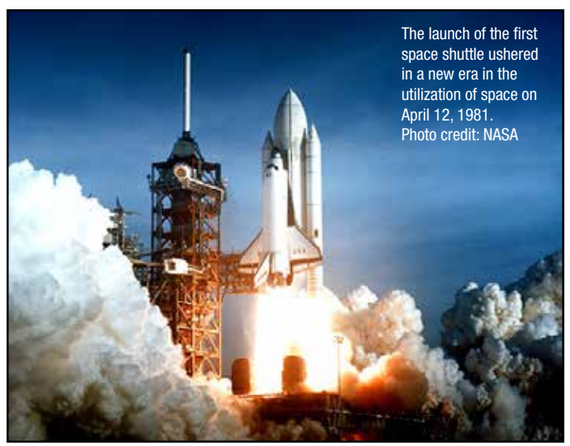
Founded in 2002, SpaceX designs, manufactures and launches advanced rockets and spacecraft such as the Falcon 9 and Dragon respectively. The Dragon capsule first delivered supplies to the space station in May 2012. The company also is the only private enterprise to return a spacecraft from the station.

The new agreement is another step in transitioning from a historically government-only launch facility of the Apollo and space shuttle eras into a multi-user spaceport for both federal and commercial customers. Partnerships between NASA and other organizations are a key element in that effort.

"I want to commend Kennedy Space Center Director Bob Cabana for his ongoing tireless work to transform the center into a 21st century launch complex," Bolden said. "He's turned the retirement of the space shuttle into an opportunity to expand and strengthen America's leadership in space. He and his Kennedy team are focused on the ways this national asset can help us reach higher and send our astronauts even farther. This work creates jobs and stability for the future as it keeps our nation a leader in space exploration."

Originally built in the 1960s, LC-39A and B have served as backdrops for some of America's most significant human spaceflight endeavors. Both were designed for the huge Saturn V rockets that launched American astronauts on their Apollo journeys to the moon and back. Pad 39A is the site where Apollo 11 lifted off on July 16, 1969, on the first expedition to land on the moon.

Both pads were designed to support the concept of mobile launch operations, in which space vehicles are checked out and assembled in the protected environment of the Vehicle Assembly Building. The rockets then were transported to the pad atop a mobile launcher platform by large, tracked crawler-transporters



The launch of the first space shuttle ushered in a new era in the utilization of space on April 12, 1981. Photo credit: NASA

for final processing and launch.

Following Skylab and the joint U.S.-Soviet Apollo-Soyuz Test Project mission in the mid-1970s, the pads were modified to support space shuttle operations. For the shuttle, two

An aerial view of Launch Complex 39A taken Sept. 12, 2000, basks in the early morning sun where the space shuttle Discovery awaits launch on STS-92. Photo credit: NASA

permanent service towers were installed at each pad -- the fixed service structure and the rotating service structure. LC-39A again made history launching the first space shuttle mission on April 12, 1981.

In the three decades that followed, pads 39A and B supported all 135 space shuttle missions, the last lifting off from pad 39A on July 8, 2011.

Shotwell said SpaceX will use LC-39A for rockets such as the Falcon Heavy, currently under development. While using some of the existing systems, new construction is planned.

"We will launch the Falcon Heavys from this pad early next year," she said during the briefing. "We'll be building a hangar not far from here on the path for rolling the vehicle to the pad. There will be some modifications, but the historic elements, obviously, we're leaving (in place)."

While partnering with industry for launching to low-Earth orbit, NASA is also at work assembling its Orion spacecraft and preparing Kennedy's infrastructure to support the Space Launch System rocket. Bolden explained that Orion is a key part of the agency's plans to explore beyond Earth.

"Just a few miles south of here is SLC-37, or Space launch Complex 37, the (United Launch Alliance) Delta IV complex from which Orion will take to space later this year on Exploration Flight Test-1," he said. "Orion will travel farther and faster than any spacecraft built for humans in more than 40 years. And that test will be a major milestone in our work to send humans to an asteroid and later to Mars."

Bolden noted that work at these launch pads demonstrates NASA's strategy for human space exploration.

"While we make advances in commercial access to low-Earth orbit, we're on a parallel path to develop the new technologies to send humans farther into space," he said. "Part of NASA's charge since the beginning of President Obama's administration has been to serve as a catalyst for a vibrant commercial space industry. What we're seeing here today demonstrates one of the many ways that strategy is paying off."

NEEDED MORE SPACE

Firing Room 4 to feature multi-user concept layout

BY LINDA HERRIDGE

A metamorphosis is taking place inside Firing Room 4 (FR4) in the Launch Control Center at NASA's Kennedy Space Center. The Ground Systems Development and Operations (GSDO) Program is overseeing the work to create a new firing room as part of NASA's effort to transform Kennedy into a multi-user spaceport.

Unlike previous work at Kennedy focusing on a single kind of launch system, such as the Saturn V rocket or space shuttle, engineers are preparing the spaceport's infrastructure to support several different spacecraft and rockets in development for human exploration.

The new concept for FR4 will feature four separate firing room areas to serve NASA and potential commercial or private users' needs. Eight-foot-high walls will divide the rooms, with each room measuring 30 by 32 feet. Each room will have a door and large window with privacy blinds. Interconnecting doors will allow users access to more space if needed.

"The idea is that if a customer needed more space, they could open the window shades and doors and combine the space to make larger work areas," said Greg Gaddis, NASA test director. "In the end, a customer could utilize a single area all the way up to the entire room."

In November 2013, work began to reconfigure the room that supported shuttle launches for its future purpose. All of the main floor launch consoles and some upper-level consoles were removed, along with all of the shuttle-era cables and wiring beneath the floor. Completely new wiring and subflooring has been installed. High above, the ceiling tiles have been removed, exposing conduits and wiring.

The only elements that remain are the three rows of consoles for managers and the two glass-enclosed observation rooms on the upper level, as well as the space shuttle launch plaques that cover a soffit from one side of the room to the other. In this room, a team of NASA and contractor test directors and engineers launched 21 space shuttle missions, from STS-115 to the final mission, STS-135.

"The new construction shows life and we're moving forward," said Steve Cox, the GSDO element operations manager for the Launch Control Center.

GSDO is responsible for management of the firing rooms and ensuring that NASA and customers' requirements will be met.

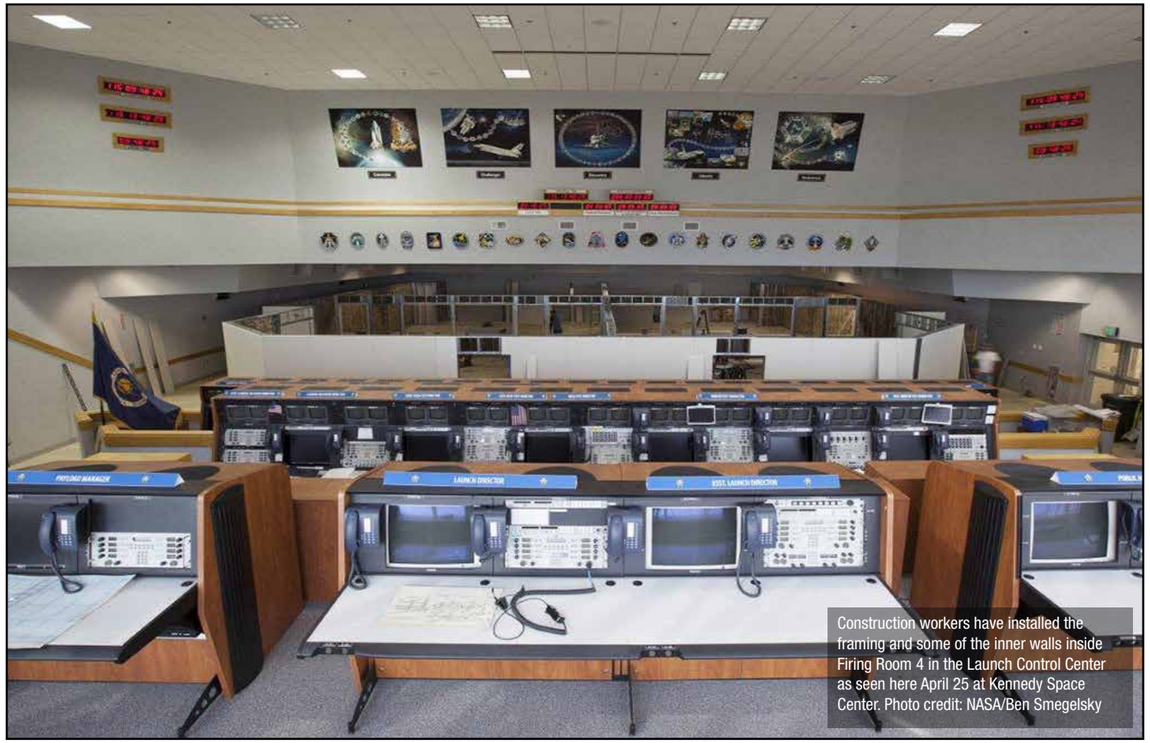
Cox said the goal is to be flexible, to be able to provide space for several users on a daily, weekly, monthly or yearly basis. The ideal scenario is that each room would be equipped as needed to meet a user's particular requirements. Customers would bring in their own systems and equipment.

Construction workers are busy installing the supports so that the walls can be added. The room has been measured off and steel beams dot the floor in an orderly fashion.

After the walls go up and windows have been added, new energy-efficient LED lighting will be added throughout the firing room. New sound-absorbing ceiling tiles will be installed to provide privacy and reduce noise levels. The walls will be painted and new carpeting will be laid over the subflooring. Then the window blinds

A portion of the crawlerway, the Vehicle Assembly Building and the Launch Control Center.

opposite:
Inside Firing Room 4 in the Launch Control Center at NASA's Kennedy Space Center in Florida, construction workers make adjustments to conduit in the ceiling.



Construction workers have installed the framing and some of the inner walls inside Firing Room 4 in the Launch Control Center as seen here April 25 at Kennedy Space Center. Photo credit: NASA/Ben Smegelsky

will be added so that individual work areas can be further isolated.

"We have a plan. We have a purpose and a focus," Cox said. "We're providing the tools that will allow others to do their job more efficiently."

While work continues in FR4, much has been accomplished in the other three firing rooms.

Firing Room 1, also called the Young-Crippen Firing Room, has been completely renovated and will serve as NASA's firing room for launches of the Space Launch System and Orion spacecraft on exploration missions beginning in 2017. FR1 has been configured for software validation and flight following for Exploration Flight Test-1 (EFT-1), which is scheduled to launch later this year on a United Launch Alliance Delta IV Heavy rocket from Cape Canaveral Air Force Station. In this room, engineers are developing the systems to follow EFT-1 from ground processing through flight.

Firing Room 3 has been configured as a development area for Launch Control System software development applications, and models and simulations. FR3 also contains the Customer Avionics Development and Analysis (CAIDA) emulator of Orion's flight software and hardware. CAIDA will be used to support GSDO Orion testing and development.

A study is in progress to see how FR2 could be configured to offer customers flexibility for checkout, training, launch and post-launch evaluation needs. Some of the consoles in FR2 may be returned to FR4 for reuse.

"Kennedy has only four firing rooms, so we want to make sure they will be used in the most efficient way possible," Cox said. "We launch rockets. That's what we're preparing to do here."

I am GSDO

Yves Lamothe
Lead Systems Engineer

National Aeronautics and Space Administration

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SP-2014-03-073-KSC

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A small-scale model of Sierra Nevada Corporation's Dream Chaser spacecraft was put to the test recently in one of the historic wind tunnels at NASA's Langley Research Center in Virginia.
Engineers carefully glued 250 individual grains of sand in place on the 22-inch-long model to simulate turbulence.
Mounted on an arm that does not interfere with airflow, the Dream Chaser model was subjected to high speed wind flow that simulates the conditions the spacecraft will encounter during its return from space and glide to a runway on Earth.
Engineers outfitted the Dream Chaser with hundreds of sensors to gather the smallest detail about airflow around the lifting body. Designers will use the results to confirm their expectations, make modifications to the spacecraft and adjust computer models.
The six-week-long testing is the latest in the development of the spacecraft as the company refines its design in partnership with NASA's Commercial Crew Program. Photo Credit: David C. Bowman

http://www.nasa.gov/commercialcrew

WIND-TUNNEL TESTED

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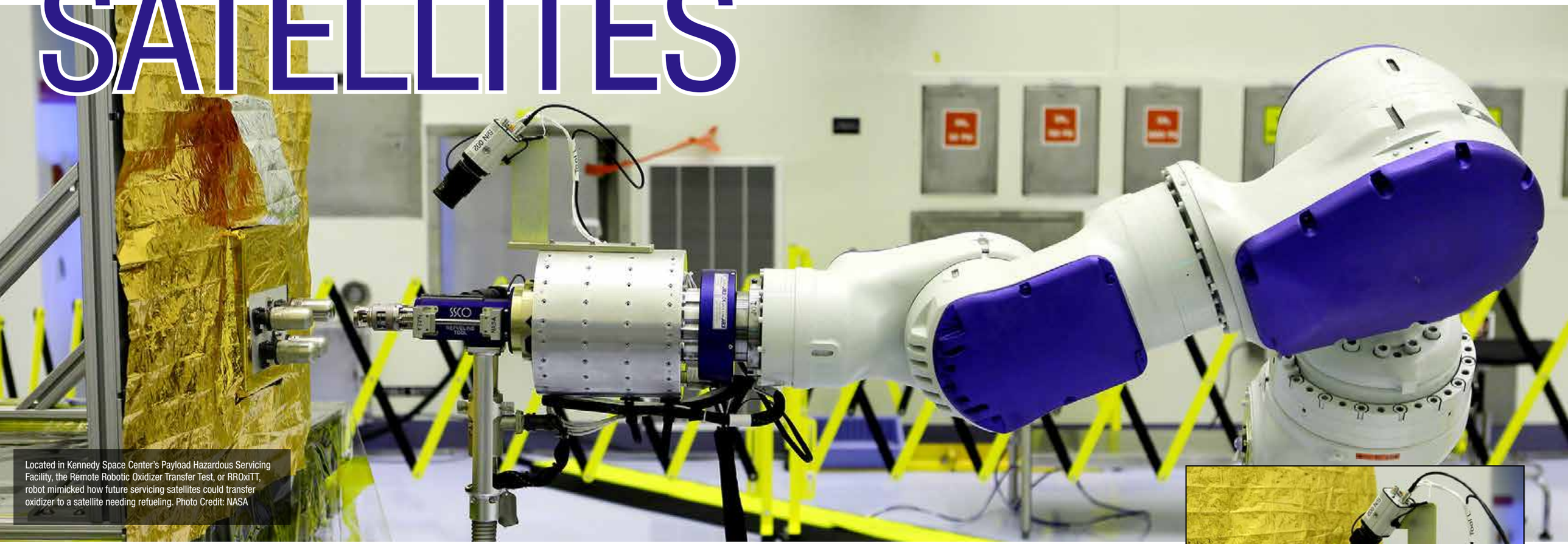
SERVICING SATELLITES



Located in Kennedy Space Center's Payload Hazardous Servicing Facility, the Remote Robotic Oxidizer Transfer Test, or RROxiTT, robot mimicked how future servicing satellites could transfer oxidizer to a satellite needing refueling. Photo Credit: NASA

Satellites play vital roles in everyday life

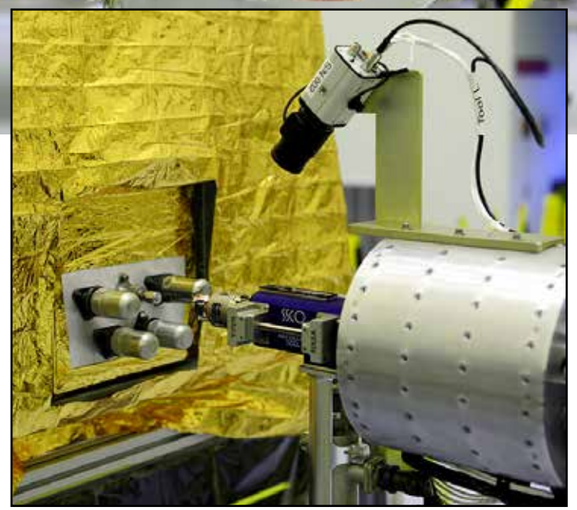
BY BOB GRANATH

From weather observations to navigation to communications, Earth-orbiting spacecraft are now so prevalent they could easily be taken for granted. A team at NASA's Kennedy Space Center, collaborating with counterparts at the agency's Goddard Space Flight Center in Greenbelt, Md., recently demonstrated ground breaking technology that could add additional years of service to satellites.

Engineers at Kennedy are performing the design, development and qualification testing of the critical hypergolic propellant transfer system for a simulated servicing satellite under the leadership of Tom Aranyos, technical integration manager in the spaceport's Fluids and Propulsion Division, and Gary Snyder, project manager for the satellite servicing project at the space center.

"Kennedy's role is to develop a propulsion transfer assembly in collaboration with Goddard," Aranyos said. "We are actually involved in designing, developing and testing satellite hardware that could be used in the future to refuel a satellite."

Benjamin Reed, deputy project manager of Goddard's Satellite Servicing Capabilities Office



(SSCO) expressed appreciation for resourceful efforts of the group at the Florida spaceport in support of the project.

"The Kennedy contingent was extraordinarily creative and innovative in the ways that they repurposed shuttle hardware, miraculously negotiated facilities in extraordinarily tight scheduling pockets and designed new technologies to match an immensely challenging problem set," he said.

Since April 2011, engineers at Kennedy have partnered with the SSCO at Goddard to develop robotic satellite servicing technologies necessary to bring in-orbit inspection, repair, refueling, component replacement and assembly capabilities to spacecraft needing aid. The project could also lead to life extension or re-purposing in Earth orbit or applications beyond.

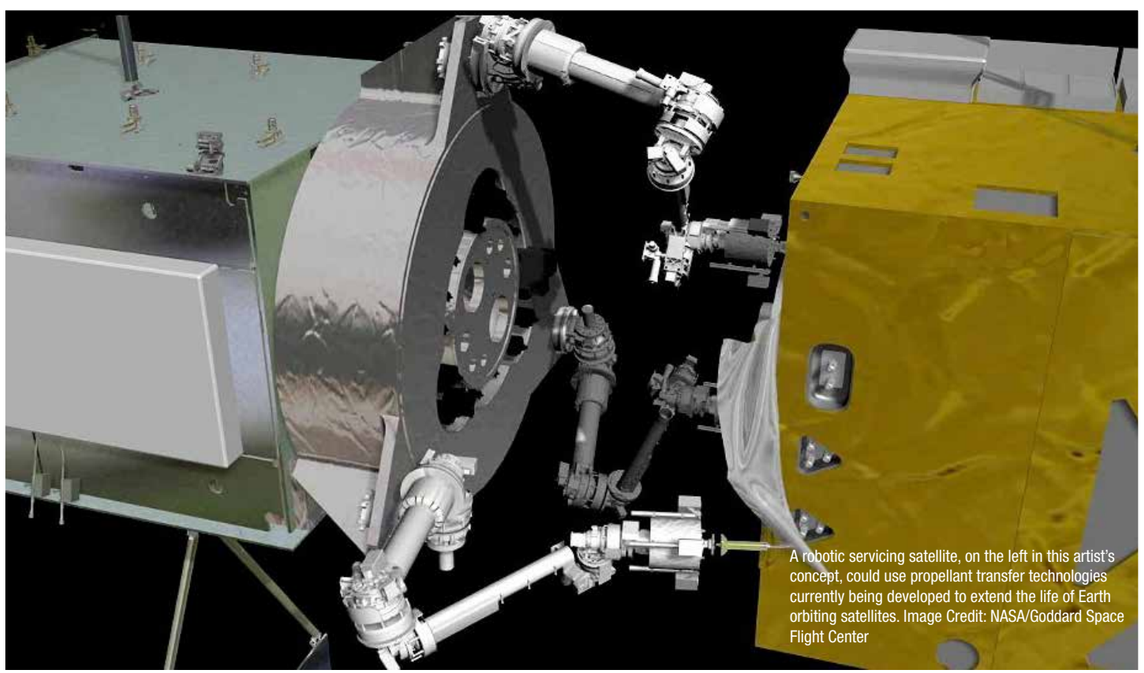
According to Pepper Phillips, NASA's director of Engineering and Technology at Kennedy, the Florida spaceport's skills in preparing vehicles for launch now are leading to its employees being asked to support development of in-orbit satellite servicing capabilities.

"Kennedy has a long and storied history of employees processing launch vehicles and spacecraft," he said. "Now other centers are looking to apply that expertise in designing satellites."

Brian Nufer, a fluids engineer in the Fluids Engineering Branch of NASA Engineering and Technology, noted that SSCO wanted to take advantage of those years of experience in loading propellants and apply them to designing related components for a simulated robotic servicing satellite.

By choosing Kennedy, project participants also were able to use existing equipment, facilities and excess Space Shuttle Program hardware saving several million dollars in development costs.

"Goddard came to Kennedy near the end of the Space Shuttle Program to leverage our expertise in hypergolic propellants," Nufer said. "They wanted to use our know-how to help design an in-orbit satellite propellant servicing system."



A robotic servicing satellite, on the left in this artist's concept, could use propellant transfer technologies currently being developed to extend the life of Earth orbiting satellites. Image Credit: NASA/Goddard Space Flight Center

A combined test team from both the Kennedy Space Center and Goddard Space Flight Center perform a flow test of nitrogen tetroxide using a robot simulating refueling of a satellite in Earth orbit. Photo Credit: NASA

Hypergolic propellants such as hydrazine and nitrogen tetroxide are the most frequently used fuel and oxidizers for maneuvering satellites in Earth orbit.

Kennedy leverages expertise from processing and launching spacecraft developed at other centers and has branched out to become a part of the designing process of a flight propellant transfer system for the in-orbit satellite servicing project.

"We've primarily been processing spacecraft and vehicles using our ground systems and doing some spacecraft repair," Phillips said. "Now, we're actually designing flight hardware."

Aranyos explained that the effort included analysis to reduce risk for several low-technology readiness level (TRL) items and involves multiple patents by the Kennedy team. TRL is a type of measurement system used to assess the maturity of a particular technology.

The most recent testing at Kennedy took place in the Payload Hazardous Servicing Facility (PHSF) and has focused on moving from a proof-of-concept phase to building the first engineering development unit. During February 2014, SSCO demonstrated that a remotely operated robot – with supporting technologies – could transfer oxidizer into the tank of another orbiting spacecraft not originally designed to be refueled. Kennedy's propellant transfer system was an essential part of this Remote Robotic Oxidizer Transfer Test, or RROxiTT.

"This is a unique test that's never been done, as far as we know, anywhere in the world," Nufer said. "The Kennedy folks developed the propellant transfer assembly, what we call the PTA," said Matt Sammons, a robotics tools engineer with Stinger Ghaffarian Technologies Inc. at the SSCO. "We have been working heavily with the robotics and the fueling tools that will

receive the propellant from the Kennedy-provided PTA and deliver it to the simulated client satellite."

The team at Goddard shipped an industrial robotic arm to Kennedy for the test. From 800 miles away in Maryland, the team remotely controlled the robotic arm with its attached SSCO oxidizer nozzle tool to connect with a propellant fill and drain valve on the simulated satellite's servicing panel. Downstream, the Kennedy-provided propellant transfer system and hose delivery assembly flowed oxidizer through the tool into the client fill-drain valve, with all hardware located in the PHSF in Florida.

"This project has not only been a challenge, but it's been a lot of fun for the entire team. I've never had to ask for a volunteer for this project. People just raised their hands and worked nights, weekends, whatever it took to get this job done."

— Tom Aranyos
technical integration manager of
Kennedy's Fluids and Propulsion Division

"We directed the hypergolic propellant to flow at the various flight and client pressures and flow rates to prove the PTA concept worked," Aranyos said.

The latest test involved about 45 different Kennedy players who contributed to make it all happen. While the robotic arm was being operated from Goddard, Kennedy personnel monitored operations in the PHSF from an adjacent control room.

"In addition to the individuals working directly on the test, several outside organizations and companies were called upon to provide services such as inert gasses, precision cleaning, component fabrication and other services needed to successfully perform the integrated test," Snyder said.

Following the mechanical robotic interconnects and leak checks, the Kennedy team performed the transfer of nitrogen tetroxide using flight-like concept of operations parameters. Because of the highly corrosive and toxic nature of the hypergolic propellant, those technicians and engineers required for standby emergency operations in the PHSF high bay, and performing manual portions of the procedures for test setup and post-disconnect operations, wore protective Self-Contained Atmospheric Protective Ensembles, or SCAPE suits.

"The focus of the work was not only in the Fluids Division, but included mechanical involvement, the Safety Department, the Ground Operations Directorate, the electrical and controls that were involved, all the wiring and interconnects to Goddard," Aranyos said.

More testing is planned in the near future.

"We have over a thousand different tests we've run to date with Freon, with water and with the hypergolics," Aranyos said. "We now have to get through that series of test data, and we're taking that and putting it with lessons learned into the actual flight development specifications which we will use to build and qualify the flight hardware, hopefully starting with the fiscal year 2015 budget." Aranyos says that finding people willing to continue participating in the project has been easy.

"This project has not only been a challenge, but it's been a lot of fun for the entire team," he said. "I've never had to ask for a volunteer for this project. People just raised their hands and worked nights, weekends, whatever it took to get this job done."

Snyder noted that the effort included individuals from different NASA and contractor

Kyle Norman from the Goddard Space Flight Center, foreground, adjusts a typical client satellite fill drain valve on a mockup interface for the Remote Robotic Oxidizer Transfer Test, or RROxiTT, in February 2014. Assisting, from the left, are Greg Coll of Goddard, Erik Tormoen from the Kennedy Space Center, and Mark Behnke of Goddard. Photo Credit: NASA

organizations working together seamlessly. "The unified 'one team' spirit was obvious," he said. "Kennedy has continued to meet all the challenges with our people finding innovative solutions and efficiently using available resources to get the job done." Sammons echoed that sentiment.

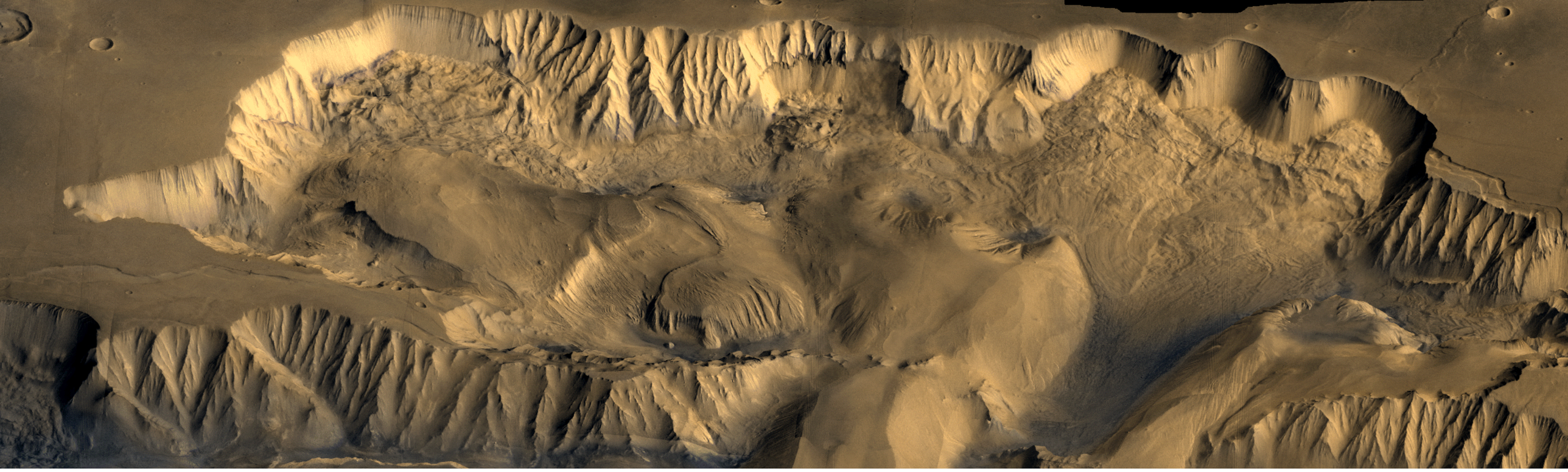
"The project is very dynamic, diverse and exciting," he said. "It's really wonderful to have fun being on the cutting edge of technology. I think what we're doing here in trying to develop and mature technology that has applications in orbit and in the future of the space industry."

The success of the recent testing holds many possibilities. On Earth, RROxiTT technologies could one day be used to robotically fuel satellites before they launch, keeping humans at a safe distance during an extremely hazardous operation.

The full contingent of operating spacecraft is right around 1,000, with more than 400 in the geosynchronous Earth orbit (GEO) belt some 22,000 miles above Earth. A geosynchronous equatorial orbit is a circular orbit 22,236 miles above the Earth and thus appears motionless, at a fixed position in the sky, to ground observers.

By developing robotic capabilities to repair and refuel these spacecraft in GEO, NASA hopes to add precious years of functional life to satellites and expand options for operators who face unexpected emergencies, tougher economic demands and aging fleets. Phillips believes this also is the beginning of new capabilities for Kennedy, particularly for the center's engineering and design capability.

"We have largely focused on ground processing and ground operations, and we've earned our expertise in that area," Sammons said. "In this realm, it's literally spacecraft development work and it's venturing out beyond our traditional work. It's challenging our people to be better engineers and better scientists."



NASA'S HUMAN PATH TO MARS

NASA is developing the capabilities needed to send humans to an asteroid by 2025 and Mars in the 2030s – goals outlined in the bipartisan NASA Authorization Act of 2010 and in the U.S. National Space Policy, also issued in 2010.

Mars is a rich destination for scientific discovery and robotic and human exploration as we expand our presence into the solar system. Its formation and evolution are comparable to Earth, helping us learn more about our own planet's history and future. Mars had conditions suitable for life in its past. Future exploration could uncover evidence of life, answering one of the fundamental mysteries of the cosmos: Does life exist beyond Earth?

Kennedy Space Center is expected to play a large role in this exploration program as NASA's primary launch site and the only place in the world where people have lifted off to visit other worlds. The center's extensive experience of successfully readying launchers and spacecraft for groundbreaking flights sets the stage for further successes with missions that will be as challenging as anything attempted before.

While robotic explorers have studied Mars for more than 40 years, NASA's path for the human exploration of Mars begins in low-Earth orbit aboard the International Space Station. Astronauts on the orbiting laboratory are helping us prove many of the technologies and communications systems needed for human missions to deep space, including Mars. The space station also advances our understanding of how the body changes in space and how to protect astronaut health.

Our next step is deep space, where NASA will send a robotic mission to capture and redirect an asteroid to orbit the moon. Astronauts aboard the Orion spacecraft will explore the asteroid in the 2020s, returning to Earth with samples. This experience in human spaceflight beyond low-Earth orbit will help NASA test new systems and capabilities, such as Solar Electric Propulsion, which we'll need to send cargo as part of human missions to Mars. Beginning in FY 2018, NASA's powerful Space Launch System rocket will enable these "proving ground" missions to test new capabilities. Human missions to Mars will rely on Orion and an evolved version of SLS that will be the most powerful launch vehicle ever flown.

A fleet of robotic spacecraft and rovers already are on and around Mars, dramatically increasing our knowledge about the Red Planet and paving the way for future human explorers. The Mars Science Laboratory Curiosity rover measured radiation on the way to Mars and is sending back radiation data from the surface. This data will help us plan how to protect the astronauts who will explore Mars. Future missions like the Mars 2020 rover, seeking signs of past life, also will demonstrate new technologies that could help astronauts survive on Mars.

Engineers and scientists around the country are working hard to develop the technologies astronauts will use to one day live and work on Mars, and safely return home from the next giant leap for humanity. NASA also is a leader in a Global Exploration Roadmap, working with international partners and the U.S. commercial space industry on a coordinated expansion of human presence into the solar system, with human missions to the surface of Mars as the driving goal.

Follow our progress at www.nasa.gov/exploration and www.nasa.gov/mars.

HUMAN EXPLORATION

NASA's Path to Mars

EARTH RELIANT

MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS

PROVING GROUND

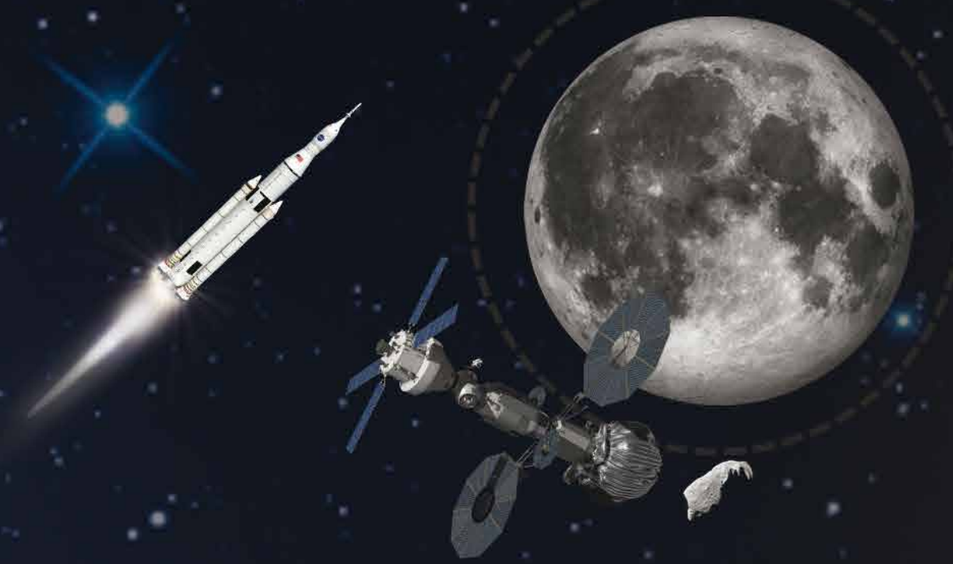
MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS

MARS READY

MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS

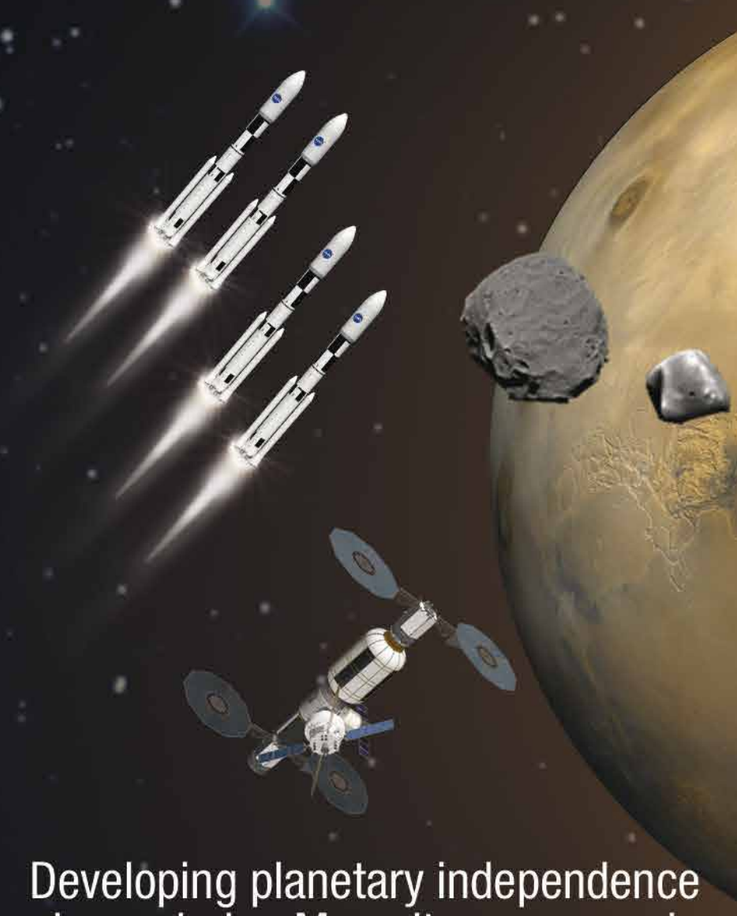
Mastering fundamentals aboard the International Space Station

U.S. companies provide access to low-Earth orbit



Expanding capabilities by visiting an asteroid redirected to a lunar distant retrograde orbit

The next step: traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft



Developing planetary independence by exploring Mars, its moons and other deep space destinations

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Partner UP

This aerial view shows the Vehicle Assembly Building (VAB) and other buildings in the Launch Complex 39 area at NASA's Kennedy Space Center on May 6, 2013.
Photo credit: NASA/Kim Shiflett

Forum's focus on NASA partnerships for launch multi-user spaceport

BY BOB GRANATH

Teamed with its industry partners, NASA at the Kennedy Space Center is well on its way to establishing a multi-user spaceport to help meet America's spacefaring needs for the 21st century. Counterparts from companies who are now operating several space center facilities recently met with agency officials to discuss ongoing partnerships and plans for the center's future.

Hosted by Kennedy's Center Planning and Development Directorate, the first Partnership Landscape Forum was held on April 10, 2014. The gathering is designed to be a quarterly meeting between Kennedy leaders and current partners. The first get-together focused on how the center has changed since the end of the Space Shuttle Program and plans for the road ahead.

Center Director Bob Cabana opened the forum, noting the progress that has been made in transitioning Kennedy from a historically government-only launch facility to a multi-user spaceport.

"If you look at what we're putting in place here at Kennedy, it's pretty amazing when you consider that three years ago there was one program here that paid for everything," he said. "Now we've got multiple commercial customers, we've got a new government

program, and we're utilizing these assets to become a spaceport with government and commercial operations to and from low-Earth orbit and beyond for both crew and cargo."

Center Planning and Development is the "front door" for partnerships with NASA's Kennedy Space Center. The Partnership Landscape Forum took place to promote awareness of center activities, programs and policies which may impact partnerships and existing capabilities, and allow input from industry leaders.

Tom Engler, Kennedy's deputy director of Center Planning and Development, explained that as the shuttle program was winding down, NASA saw that it would be left with many key facilities that would not be needed in the immediate future.

"We invested 30 years in the shuttle program, 50 years overall at the center, and billions of dollars in capabilities that we really didn't want to lose," he said. "We've taken center facilities that we didn't need and we've found outstanding partners to be able to take advantage of those capabilities."

One example of a key partnership is Bay 3 of the shuttle era's Orbiter Processing Facility. It now is being modernized by The Boeing Company as the Commercial Crew and Cargo Processing Facility (C3PF). There, Boeing plans to prepare its CST-100 spacecraft, currently under development with the agency's Commercial Crew Program to ferry astronauts to and from low-Earth orbit.

NASA recently established a partnership with PaR Systems, Inc., for operation of Hangar N at Cape Canaveral Air Force Station and its nondestructive testing equipment.

The agency also signed a partnership agreement with Craig Technologies to maintain unique processing and manufacturing equipment in Cape Canaveral, Fla., for future mission support at the space center. Formerly known as the NASA Shuttle Logistics Depot in its new role, the facility is now the Aerospace and Defense Manufacturing Center.

In additional to Boeing, Craig Technologies and PaR Systems, other partners participating in the forum were Energy Florida, Sierra Nevada Corporation, Space Florida, SpaceX and United Paradyne.

Paul Vona, a Non-Destructive Test Services operations engineer with PaR Systems Inc., demonstrates an automated X-ray system in the robotic inspection cell in Cape Canaveral Air Force Station's Hangar N on April 2.
Photo credit: NASA/Cory Huston

The 15,000-foot-long Shuttle Landing Facility at the Kennedy Space Center was photographed in this aerial view July 19, 2012. Photo credit: NASA/Kim Shiflett

Looking ahead, Cabana described his vision for space center operations in the near future.

"In five years, I want to see the Space Launch System and the Orion launching at least once a year on a mission to explore beyond planet Earth," he said. "I want to see commercial launches off of Pad 39A and maybe even another (pad) just north of Pad 39B. I want to see crew and cargo flights. I want to see operations out at the Shuttle Landing Facility with sub-orbital flights and a horizontal launch capability. I want to see all the partnerships we've put in place being productive. I want to capitalize on everything we are doing."

Trey Carlson, NASA's master planner for Kennedy, looked further into the future and described what will guide space center activities during the next two decades.

"We have a future development concept that is fully defined for our master plan," he said. "We were the first center to go down that route and that was approved a couple of years ago. We have a master plan of how were going to develop over the next 20 years."

That plan includes adopting new business practices allowing companies and outside organizations to make investments in the center to operate their enterprises. Operation of facilities not being used by NASA will be transferred to partners and the agency will dispose of those not needed. Where needed, new facilities will be built that are economically and environmentally sustainable and can be used by a variety of people, organizations and programs.

Engler pointed out that the effort to involve industry in operating the Kennedy Space Center is ahead of schedule.

"As we started the planning for where we were going in developing an emerging multi-user spaceport, we thought we'd get there in the 2020 to 2025 timeframe," he said. "We're basically there now. We have a multi-user spaceport and we are looking for more customers."

This artist's concept shows an astronaut preparing to use a special tool to take samples from the captured asteroid after it has been relocated to a stable orbit in the Earth-moon system. Image Credit: NASA

Engineering's four lines of business focus on problem-solving

BY BOB GRANATH

Engineering is about making dreams a reality. At NASA's Kennedy Space Center, the team in the Engineering and Technology Directorate not only puts those visions on paper, they work to see the designs all the way through from development to reality.

This key organization recently aligned its structure around four new lines of business. This fresh approach is designed to bring its functions in line with the spaceport's efforts to transition from a historically government-only launch facility to an affordable, sustainable, multi-user spaceport for both government and commercial customers. It's also about meeting the complex challenges facing an increasingly technological world.

"It's all about being proactive in our current environment," said Jack Fox, technical assistant for Engineering and Technology's Lines of Business. "We have many areas of expertise here at Kennedy. We want to engage the emerging multi-users and apply our capabilities to help them accomplish their missions."

The four new lines of business focus are Exploration Surface Systems, Spaceport and Space Systems Development, Technical Mission Success, and Tom Aranyos, Technical Integration manager in NASA's Fluids and Propulsion Division and leader of the Spaceport and Space System Development line of business, explains that NASA Engineering and Technology is looking for ways to assist other NASA centers, as well as commercial industries.

"We need to listen to what is keeping them up at night and offer assistance and advice on how we can help make them successful," he said. "Our strategy is to respond to others' needs by raising our hands and offering to help."

Fox says that being a multi-user spaceport means Kennedy is transitioning from supporting two or three large programs for long periods of time to supporting multiple customers with numerous, short-term efforts.

"In the past, the bulk of our work focused on supporting programs such as the space shuttle and International Space Station," he said. "We now are approaching other Kennedy directorates, other NASA centers, industry and academia to establish partnerships for proposing and winning engineering and technology development work."

In addition to oversight of the lines of business, Fox is responsible for the Exploration Surface Systems line.

"Surface Systems can be either here on Earth or on another planet," Fox said. "It's applied technology that, for example, could help upgrade systems on a former shuttle launch pad or be applied to robotically construct a landing site on Mars for a future human expedition."

Today NASA experts are transforming Launch Pad 39B to support the agency's new Space Launch System rocket that will take astronauts beyond low-Earth orbit.

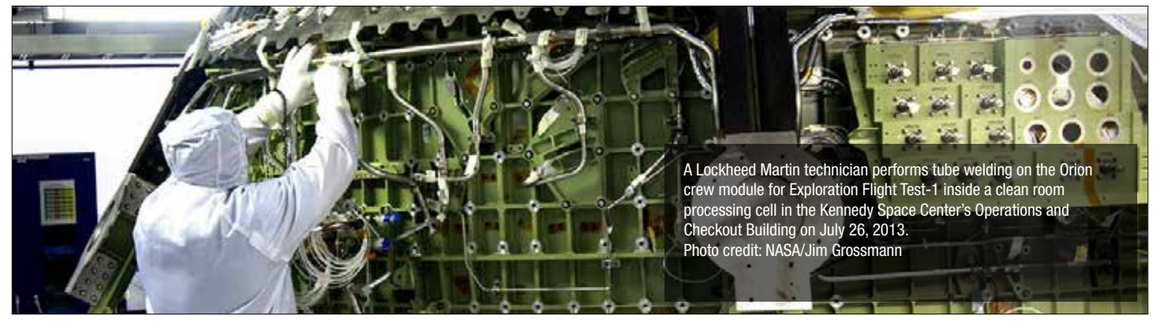
At the same time, NASA scientists and engineers are using the lessons of how technology was developed during the Apollo era and robotic missions to Mars to develop technologies for future extraterrestrial landings.

"Collecting surface samples or mining for resources on another planet fits into Kennedy's assigned areas of responsibility," Fox said. "That would include developing tools for astronauts retrieving rocks and other samples from an asteroid or, later, developing the equipment to mine for resources on Mars."

The Technical Mission Success line of business is being led by George Hamilton, deputy of Kennedy's Chief Engineer's Office. His group is assigned the task to provide expertise that will ensure the success of projects within NASA's Ground Systems Development and Operations Program, Launch Services Program, Commercial Crew Program and the International Space Station Program.

"We try to match up the right expertise with those needing solutions to any particular problem," Hamilton said. "Our goal is to also deliver on commitments being made to both government and commercial projects."

Fox pointed out that the agency's Space Technology Mission Directorate (STMD) and Human Exploration Operations Mission Directorate (HEOMD) would be primary customers for the four lines of business. The Game Changing Division in STMD is working to rapidly develop, demonstrate and introduce revolutionary, high-payoff technologies through collaborative partnerships.



A Lockheed Martin technician performs tube welding on the Orion crew module for Exploration Flight Test-1 inside a clean room processing cell in the Kennedy Space Center's Operations and Checkout Building on July 26, 2013.
Photo credit: NASA/Jim Grossmann

"Advanced Exploration Systems is now HEOMD's primary program for the development of technology to support human space exploration," he said.

AES is developing prototype systems, demonstrating key capabilities and validating operational concepts for future human and robotic missions beyond Earth orbit such as the Asteroid Redirect Mission.

Spaceport and Space Systems Development covers all typical ground and flight processing support requiring engineering efforts, Aranyos explains. That includes designing and building new hardware, as well as providing the needed controls, software, special testing and technical reviews.

"Space Systems Development also focuses on new expanded territory that Kennedy has just recently started," he said. "It includes development, qualification and acceptance testing of critical spaceflight hardware and subsystems in collaboration with other NASA centers and commercial aerospace industries."

An example of such a collaborative effort is a team at Kennedy working with counterparts at the agency's Goddard Space Flight Center to demonstrate groundbreaking technology to develop satellites that could service and refuel orbiting spacecraft. Engineers in Florida are developing a hypergolic propellant transfer system for a simulated servicing satellite.

Greg Clements, chief of Kennedy's Control and Data Systems Division, explains that the SPLITS line of business is designed to support three different classes of small payloads.

"We have had previous experience with microsatellites in support of the Launch Services Program and for the International Space Station," he said. "Recently we have been engaged in launches of small payloads called 'CubeSats' to support education and external partnerships. It is an emerging market with a lot of interest, and we believe that Kennedy can provide support to a growing set of customers both inside and outside of NASA."

SPLITS is an affordable method of research focusing on three classes of small satellites. Pico-Satellites, or Pico-Sats, are less than 1 kilogram (about 2.2 pounds) in mass. The class called Nano-Sats is between one and 10 kilograms (about 22 pounds) in mass and Micro-Sats, are between 10 and 100 kilograms (about 220 pounds) in weight.

A specialized class of Nano-Sats, called CubeSats, is especially popular in academia. These small spacecraft use a standardized cube-shaped form 10 centimeters (about four inches) in size and one kilogram in weight. One to six of these building block-like packages can be integrated into a CubeSat. Additionally, CubeSat standardization allows for sharing of expertise, simplicity in developing avionics and they are easily deployed. Components also can be re-used for other missions.

The goals of Engineering and Technology's new four lines of business represent the kind of challenge Aranyos likes.

"I enjoy taking concept ideas and developing implementation plans and guiding efforts to meet our customer expectations," he said. "If we continue to meet and exceed expectations of our customers, more valuable and rewarding work will continue to flow our way here at Kennedy."

It is also about making dreams a reality.

"We're trying to shape the future, but we don't do that by just creating drawings and throwing it over the fence," Aranyos said. "We build and fabricate too. A dream doesn't become a reality until it goes from paper to actual development."

A set of Nano CubeSats are deployed by the Expedition 38 crew onboard the International Space Station on Feb. 11, 2014. The CubeSat program contains a variety of experiments such as Earth observations and advanced electronics testing. Photo credit: NASA

OUTSTANDING ENGINEER

GSDO engineer realizes dream of working at Kennedy Space Center

BY LINDA HERRIDGE

GSDO engineer Jessica Parsons stands near space shuttle Discovery on June 15, 2005, as it rolled out to Launch Pad 39B at Kennedy Space Center in Florida for return to flight mission STS-114.

Growing up in Cali, Colombia, Jessica (Rodriguez) Parsons knew at a very young age that she wanted someday to work for NASA. Fast forward to 2014, and Parsons now is an engineer in the Ground Systems Development and Operations (GSDO) Program at Kennedy Space Center.

She also is the recipient of the Space Coast Outstanding Woman Engineer of the Year Award for 2014 from the Society of Women Engineers-Space Coast "for outstanding contributions to the next generation of human space exploration systems, leading systems integration for the Exploration Systems Development enterprise."

"I was totally surprised," Parsons said. "It's good to be recognized outside of NASA for the work we do here."

The Space Coast Section, founded in 1989, recognizes women who have made a positive impact in their community and in the engineering field. Its mission is to inform the community of opportunities open to women in engineering and to encourage women to enter and grow in engineering and the sciences.

Tim Honeycutt, the GSDO technical management branch chief at Kennedy, nominated Parsons for the award.

Jessica Parsons stands in front of the cupola in 2005 inside the Space Station Processing Facility at Kennedy Space Center in Florida.

"She is an extremely competent and professional engineer who exudes the characteristics that others should follow within this industry," Honeycutt said. "It is through the efforts and expertise of engineers like Parsons that NASA will continue to reach for the stars and achieve its goals."

"I first became interested in space when I was young," Parsons said. "I don't remember how old I was. I just remember looking up at the stars and thinking, 'Wow, there's a whole universe out there, outside of our planet Earth.'"

After moving with her family to Miami when she was 15, Parsons settled into a new high school and asked her guidance counselor what courses she needed to achieve her goal of working at the space center.

"She told me engineering, so I made sure at that point I took all the classes and everything that was needed to pursue an aerospace engineering degree," Parsons said.

A Bachelor of Science in aerospace engineering from Embry Riddle Aeronautical University in Daytona Beach, master's degrees in space systems and systems management from Florida Technological University in Melbourne, Fla., and a background in fluid systems have helped Parsons in her role as the Cross-Program Systems Integration lead in GSDO.

She is responsible for managing a group of cross-discipline and cross-program technical teams and the different, integrated products they develop. These include interfaces to integrated test and checkout products, operation maintenance requirements, avionics and software, and plans and processes.

Parsons began her career at Kennedy in 2001 in the co-op program. She worked in the International Space Station Processing Directorate and supported payload processing for various experiments bound for the space station.

What led her to want to work for the GSDO Program was the fact that this was the direction that NASA was heading for the future.

"The coolest part of my job now is that I get to work in something new and something that is different," Parsons said. "This is the first time that we're building a rocket of the huge magnitude that the Space Launch System is. We're building and modifying hardware that's been here for 40 years or more, and we're modifying the infrastructure."

At the same time, Parsons says GSDO is utilizing a different process for systems engineering and integration. It's the first time the group will use a virtual approach involving teams from the different programs—Space Launch System, Orion and GSDO—spread across several NASA centers. They will be responsible for the integration itself, which is unlike anything done before.

Parsons is excited about the future at Kennedy and the work involved in preparing for the new heavy launch vehicle.

"I want to be part of the new vision. To know that I would be able to contribute to this program is exciting. Hopefully, in a few years from now, we'll be seeing that rocket launch from our backyards," Parsons said.

Cater 2 GATORS

Alligators thrive amid rockets, space-age facilities

BY ANNA HEINEY

Ancient creatures are prowling the complex network of waterways at NASA's Kennedy Space Center.

Sometimes they're barely visible, their positions given away only by the telltale pattern of their eyes and noses breaking the surface of a pond or canal. They'll also lounge on riverbanks, basking in the sun, wearing a wide, toothy, menacing "grin."

The American alligator (Alligator mississippiensis) is a longtime resident at the coastal spaceport, which shares boundaries with the Merritt Island National Wildlife Refuge on Florida's east coast. Generation after generation of the enormous reptiles has called the area home.

This is a unique population that spends a large amount of time in an estuarine environment.

"These alligators don't leave this area. This is a great habitat for them," said Russell Lowers, a wildlife biologist with InoMedic Health Applications at Kennedy.

"Hardly anyone has fished out here for 50 years, so they have some of the best food resources available. They also need freshwater sources, because unlike a saltwater crocodile, which has a salt-secreting gland, an alligator must have access to fresh water to survive."

Although they typically choose to stay in or near the water, alligators still are a common sight to employees and visitors. They're often spotted crossing roads, sunning themselves on runways, venturing into parking lots or wandering a little too close to buildings. For example, a large alligator briefly stopped afternoon traffic in 2011 as it crossed a busy intersection in the Launch Complex 39 area.

Despite their frequent appearances, the beasts are surprisingly mysterious. Lowers and

several colleagues around the world have been working since 2006 to learn more about their reproductive and feeding habits, how changes in the climate and environment affect them, and how they impact the other animals in their ecosystem.

Through hormone analysis, they've learned that the estuarine alligators living at the refuge nest once about every three years, while the inland or freshwater populations typically nest every other year. These animals typically build nests in the same general area where they've nested in the past, producing, on average, about three dozen eggs per clutch.

The babies' genders depend on the temperature of the eggs during a critical time in their incubation period. Temperatures below 31.5 degrees Celsius, or nearly 89 degrees Fahrenheit, produce more females as the temperature drops; temperatures above that point result in more males. As average temperatures rise, alligator populations may become increasingly male.

Once the young hatch out, their mother will supervise and care for them for a year or two to help protect against larger, cannibalistic males.

The American alligator sits at the top of its food chain -- an "apex predator." That's part of the appeal in studying them, Lowers explained.

"They'll eat anything in the environment. Small mammals, fish, turtles -- you name it, they eat it," he said. "They're like a little chemistry set."

In fact, Lowers said, that is what they currently are studying. About once a week, he and his colleagues will make the rounds, visiting different watering holes around the space center to capture alligators larger than five or six feet in order to obtain blood, urine and tissue samples. Once they locate an animal, Lowers pulls it onto the bank using an animal snare, secures its mouth with tape, and quickly works to gather the necessary samples. This whole process is done while the animal lays calmly on the bank with a towel covering its eyes.

"You'll see people catching alligators on TV, but this is nothing like that," Lowers said. "You catch a gator, you pull him on the bank, and he sits there while you take a blood sample, urine sample and tissue sample. In 15 minutes, he's done. There's no wrangling and jumping around."

The shorter the process, the easier it is on everyone involved -- the alligator most of all. On hot, sunny days especially, it's important to let the animal get back to the water where it can cool off.

Lowers believes if the process looks easy, he's done his job right.

"It's like taking someone to the doctor's office," he explained. "You want to take them in, get their blood drawn, let them pee in a cup, step on the scale, and let them walk out the door."

Russell Lowers, a wildlife biologist with InoMedic Health Applications at Kennedy captures an alligator to obtain blood, urine and tissue samples. Photo Credit: Dan Casper

Blood samples will reveal long-term environmental contaminants, while pesticides and herbicides are found in urine. Radioactive isotope analysis on the tissues will help determine specifically what the animals are eating.

One of the biggest mysteries remaining among Kennedy's alligators is seemingly one of the simplest: How many alligators live here? That answer is determined more by statistics than by catching, tagging or biological specimen-sampling.

"It's the number-one question people ask," Lowers said. "But nobody really knows."

The refuge encompasses 140,000 acres, which are evenly divided between land and water, according to Lowers.

Since many areas are inaccessible to humans but could potentially contain large numbers of alligators, there is no surefire way to estimate the population.

This mystery may puzzle the biologists and ecologists studying the animals but for the alligators, it's just one of the many benefits of living here. Since they generally stay away from humans, those remote areas offer a lot of space for the animals to be themselves -- wild and undisturbed.

Lowers, a scientist in the KSC Ecological Program, works among a group of colleagues at organizations and universities within the U.S. and around the world who are focused on learning more about alligators and crocodiles with the goal of understanding the way ecosystem health reflects human health.

"This is a cooperative project," Lowers said. "We have probably a multimillion-dollar study being done with a very limited budget; people around the world are matching their time and instruments."

In addition to KSC, crocodilian samples for the study are being collected in South Carolina, Belize, and South Africa. Samples are processed by a variety of laboratories including the Medical University of South Carolina, Centers for Disease Control, National Institute of Standards and Technology, and the Center for Marine Environmental Studies laboratory in Japan, and the University of Florida in Gainesville. Researchers at the different laboratories are focusing on topics related to their expertise, including the effect of emerging contaminants such as flame retardants and plasticisers on the endocrine and reproductive system, response of the thyroid gland to organ-metals and more. Much of this information is directly related to human health and wellbeing.

As launch vehicles, components, facilities and chemicals change, the alligator is like the canary in the coal mine -- a sentinel species giving us indications of environmental changes at the spaceport as they happen.

"If the alligators are healthy, the other animals should be healthy," Lowers said. "And that means it's a safe place for animals to live, and for people to work."

Tackling Terrain

The Morpheus lander ignites its methane- and oxygen-powered engine and lifts off
Photo Credit: NASA/Frankie Martin

Equipped with new sensors, Morpheus preps to handle landing on its own

BY STEVEN SICELOFF

A set of sensors met its latest challenge April 24 to map out a 65-yard square of boulder-sized hazards and pick out a safe place to land. The successful test sets the stage for more flight tests that will progressively increase the workload and expectations on the experimental devices.

Mounted to an uncrewed prototype lander called Morpheus that flies autonomously several hundred feet above the ground, the sensor system will have 10 seconds to do its work: six seconds really, as it will take four seconds to map the area before choosing a landing site.

The sensor system is a 400-pound set of computers and three instruments called ALHAT, short for Autonomous Landing and Hazard Avoidance Technology.

Jon Olansen, Morpheus project manager at Johnson Space Center in Houston, and Greg Gaddis, the Kennedy Morpheus and ALHAT site manager, discuss the lander and its unique systems. Image Credit: NASA/Kim Shiflett

If it works in a pair of later flights, the sensor package and a host of technologies introduced by the lander may find themselves instrumental in the success of future missions to other worlds – perhaps propelling a descent stage on a spacecraft landing people on Mars.

That's a big dream for the two small projects. Morpheus is the lander -- a 10-foot-diameter, 2,400-pound four-legged metal frame holding four spheres of propellant that feed into a single, 5,300-pound-thrust engine. They were developed in the Advanced Exploration Systems Division of the agency's Human Exploration and Operations Mission Directorate. The branch pioneers new approaches for rapidly developing prototype systems, demonstrating key capabilities and validating operational concepts for future human missions beyond Earth's orbit.

The good news for the team of about 45 engineers who have been working on the combined projects for years is that the sensor set did just what it was supposed to during an earlier free flight, so it should do just as well as upcoming flights over a landing field at the Shuttle Landing Facility at NASA's Kennedy Space Center.

"I generally don't sleep much the night before a flight," said Jon Olansen, project manager for Morpheus, which is based at NASA's Johnson Space Center in Houston. "But the team has really done a fantastic job of trying to tease out potential issues and mitigate them. I have tremendous faith in the team."

Just as during a spaceflight, the lander controls itself once it's launched.

"The only thing we do in the control center is push the go button and watch the data," Olansen said.

Morpheus is filled with innovations, including an engine that burns methane mixed with oxygen, which has also, for the first time, been coupled with smaller roll-control jets using the same propellants. Methane is considered an earth-friendly fuel, and its importance in spaceflight is that it can be stored in space without boiling off like hydrogen. It's also a chemical that has been seen by robot scouts surveying the moon and Mars.

"We know these technologies have a place in the future of spaceflight," Olansen said.

Bolted to different parts of the lander, the suite of sensors surveys the target landing area, identifies safe landing sites, and then uses three methods to tell the lander where it needs to go to avoid rocks or slopes or other hazards.

"We've been working a long time, eight years, to prove we can do autonomous, precision landing and hazard avoidance and guidance," said Chirold Epp, project manager for ALHAT. "We really need to show the world that everything we've been advertising for eight years works."

MORPHEUS

"We know these technologies have a place in the future of spaceflight"

Engineers and technicians prep the Morpheus lander and its ALHAT guidance and navigation system before a free-flight test. Image Credit: NASA/Kim Shiflett

The technological advancements have come with the work of a team that comprises people from seven NASA field centers.

"The opportunity to take people from seven different centers and get them to work together on what is a relatively small project really is phenomenal," Olansen said.

Thursday's free flight is an open-loop test, which means Morpheus' own flight computer will fly the lander above 800 feet before heading several hundred feet away to the landing field and landing softly on a predetermined pad. While this is happening, the ALHAT system will employ its flash Lidar system, a laser altimeter and a Doppler velocimeter – think of it as a super-accurate speedometer for spacecraft – to scan the field and pick out the best place to land.

The benefit of the hazard avoidance system is that it gives spacecraft far more flexibility to land accurately and to land on worlds that are not as well-studied as Mars and the moon. The ALHAT team is shooting for a system that can land within 10 feet of a given spot, a big improvement on the current best of about 270 feet.

The precision isn't academic – it could be the difference between setting down on a stable plateau or tipping over into a ravine.

The successful flight April 24 was followed by another successful open-loop test April 30 to clear the way for the next important step in this development: closed-loop flights that turn over control of the lander to the ALHAT system, letting it tell the lander where it needs to park.

"We've done airplane tests, helicopter tests, but this is the first time we've been in this environment," Epp said. "Free flight 10 gave us tremendous information. Some things didn't work quite right and other things worked quite well. Everything worked to some degree. So we go back and we fix it and we test it again."

"We've already achieved an awful lot with this project," Olansen said. "We just need to wrap up well and get the closed-loop flights accomplished."

The second set of two Ogive panels for the Orion Launch Abort System have arrived at the Launch Abort System Facility, or LASF, at NASA's Kennedy Space Center in Florida. One of the Ogive panels has been uncrated and is being moved by crane for placement on a work stand. The launch abort system is positioned on a work stand.
Photo Credit: Kim Shiflett

OGIVE PANELS ARRIVE

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Magellan Mapping

Mission to map Venus began 25 years ago with STS-30

BY LINDA HERRIDGE

Though NASA's Magellan radar mapper was not the first mission to Venus, it was unique in that it was the first interplanetary spacecraft deployed from a space shuttle. It also was the first spacecraft sent to complete a radar map of the entire surface of the planet and study the geology and surface geophysics.

The STS-30 mission on space shuttle Atlantis lifted off from Launch Pad 39B at NASA's Kennedy Space Center 25 years ago on May 4, 1989. Aboard the space shuttle were Commander David M. Walker, Pilot Ronald J. Grabe, and Mission Specialists Norman E. Thagard, Mary L. Cleave and Mark C. Lee, and more than 260,000 pounds of cargo, including the primary payload, the 7,604-pound Magellan spacecraft.

Six hours and 14 minutes into Atlantis' flight, the Magellan/Venus radar mapper and its attached inertial upper stage (IUS) were deployed into flight from the payload bay. After the IUS fired its first and second stages, Magellan was sent on its 15-month journey to Venus.

Magellan arrived at Venus on Aug.10, 1990, and started mapping the planet continuously for 243 days, the time necessary for the planet to rotate once under the spacecraft's orbit, and continued for two more 243-day cycles. It sent back radar images every three hours. Magellan continued for three more 243-day cycles to complete the mapping.

The Magellan spacecraft is mated to the inertial upper stage March 15, 1989, inside the Vertical Processing Facility at NASA's Kennedy Space Center, as preparations begin for installation into the payload canister and transport to Launch Pad 39B.
Photo credit: NASA/Klaus Wilkins

Unlike visible light, Magellan's radar waves were able to penetrate Venus' thick clouds and reflect off the solid planet back to Earth. Aided by computer processing, the radar reflections were turned into pictures of the planet's surface. For the first time, scientists had a complete global map of Venus. Magellan's radar mapping revealed the existence of continent-like highlands, hilly plains, large volcano-like mountains and flat lowlands.

With its mission completed, Magellan intentionally was crashed into Venus on Oct. 12, 1994, having used up almost all of its propellant.

The Magellan spacecraft began its journey in Denver, Colo., and visited the Jet Propulsion Laboratory (JPL) in Pasadena, Calif., before it was shipped to Kennedy for additional processing prior to its launch.

Julie Webster was a systems engineer with Martin Marietta (now Lockheed Martin) in Denver during Magellan's assembly, test and launch operations phase. Webster said there were close to 450 people from Martin Marietta, JPL and Hughes Aircraft Company in El Segundo, Calif., working on Magellan. About 100 people worked on Magellan at Kennedy prior to launch. Hughes built the spacecraft's radar sensor.

"I was the Magellan test conductor at launch," Webster said. "From October 1988 to January 1989, we were processing the spacecraft itself, testing sequences and new software in the Spacecraft Assembly and Encapsulation Facility-2 (SAEF-2) at Kennedy."

She jokingly called Magellan the "spare parts" program. The spacecraft used a spare antenna, electronics box and several space thrusters from Voyager. The team shared computer and tape recorder parts with the Galileo program.

"We were always scrambling to make things work," Webster said.

At Kennedy, John Conway was the NASA Payload Operations director when Magellan arrived at SAEF-2. Kennedy hosted the spacecraft and processing team for final assembly and checkout, and he worked closely with the JPL and Martin Marietta team.

He recalls a battery fire on the spacecraft that threatened to delay the launch of STS-30. The team worked through the Thanksgiving and

Processing activities continue on the Magellan spacecraft in the Spacecraft Assembly and Encapsulation Facility-2 (SAEF-2) high bay at NASA's Kennedy Space Center in Florida on Dec. 9, 1988.
Photo credit: NASA/George Neven

Processing activities continue on the Magellan spacecraft in the Spacecraft Assembly and Encapsulation Facility-2 (SAEF-2) high bay at NASA's Kennedy Space Center in Florida on Dec. 9, 1988. Photo credit: NASA/George Neven

Christmas holidays to recover and stay on track.

"They did a very good job working through the problem and getting Magellan ready for its mission," Conway said. "It was great teamwork."

Also aboard Atlantis were three mid-deck experiments. All had flown before. Mission Specialist Cleave used a portable laptop computer to operate and monitor the Fluids Experiment Apparatus (FEA). An eight-millimeter video camcorder, flown for the first time on the shuttle, provided the opportunity for the crew to record and downlink in-orbit activities such as the FEA, which was a joint endeavor between Rockwell International and NASA.

Payload bay video cameras were used to record storm systems on Earth as part of the Mesoscale Lightning Experiment. Atlantis also was used as a calibration target for a third experiment involving ground-based electro-optical sensors at the U.S. Air Force Maui Optical Station in Hawaii.

Atlantis touched down at Edwards Air Force Base, Calif., on May 8, 1989. The mission lasted a total of 4 days and 56 min.

Magellan synthetic aperture radar mosaics from the first cycle of mapping are compiled onto a computer-simulated globe to create this image of the surface of Venus in 1991.
Image Credit: NASA/JPL

a look online

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BRIC system

Big Science in Small Canisters
Four tiny canisters, carrying science specimens in petri dishes, arrived to the International Space Station April 20 aboard the SpaceX-3 Dragon spacecraft. The Biological Research in Canisters (BRIC) experiments, BRIC-18-1 and BRIC-18-2, will be activated in the U.S. Laboratory module to study better prevention and treatment of antibiotic-resistant bacterial infections, and make it easier to grow plants in space. Bacteria that have mutated while in space will be studied, giving scientists an opportunity to better understand how these mutations occur. --ANNA HEINEY

http://go.nasa.gov/1rFEbRf

Original 7

Pioneering Mercury astronauts eager to launch 55 years ago

BY BOB GRANATH

These seven men composed the first group of astronauts selected by NASA in April of 1959. Photo credit: NASA

From ancient astronomers to fantasy authors to modern-day scientists, visionaries dreamed for centuries about travel beyond Earth into outer space. On a spring day in 1959, America's fledgling space agency introduced seven military test pilots who would turn the stuff of science fiction into the "right stuff," launching the nation into the future.

Over the coming years these new astronauts would make frequent trips to Florida's Space Coast and Cape Canaveral Air Force Station training for flights into the "new frontier." All would go on to become early heroes in space exploration and in the Cold War competition with the Soviet Union.

In a Washington D.C. news conference on April 9, 1959, 55 years ago, Dr. Keith Glennan, NASA's first administrator, announced the names of the long-awaited first group of astronauts. Now known as the "Original Seven," they included three Naval aviators, M. Scott Carpenter, Walter M. Schirra Jr., and Alan B. Shepard Jr.; three Air Force pilots, L. Gordon Cooper Jr., Virgil I. (Gus) Grissom, and Donald K. (Deke) Slayton; along with Marine Corps aviator John H. Glenn Jr.

"Today we are introducing to you and to the world these seven men who have been selected to begin training for orbital spaceflight," Glennan said. "These men, the nation's Project Mercury astronauts, are here after a long, and perhaps unprecedented, series of evaluations which told our medical consultants and scientists of their superb adaptability to their coming flight."

On Oct. 7, 1958, the space agency announced plans to launch humans into space. Project Mercury became NASA's first major undertaking. The objectives of the program were simple by today's standards, but required a major undertaking to place a human-rated spacecraft into orbit around Earth, observe the astronaut's performance in such conditions and safely recover the astronaut and the spacecraft.

President Dwight D. Eisenhower's decision that the military services could provide the pilots simplified the astronaut selection process. From a total of 508 service records screened in January 1959, 110 men were found to meet the minimum standards. This list of names included five Marines, 47 Naval aviators and 58 Air Force pilots.

NASA officials were pleased so many agreed to participate in the man-in-space project. At the introductory news conference, Shepard said that he was eager to participate as soon as he learned NASA was seeking pilots for spaceflight.

"I think that I was enthusiastic about the program from the start and I enthusiastically volunteered," he said.

Carpenter pointed out that his eagerness extended to his wife.

"When I was notified that I was being considered during the second and third days of the competitive program, I was on duty at sea," he said, "so my wife called (NASA Headquarters in) Washington and volunteered for me."

When the group was asked why they wanted to travel into space, Slayton explained

President John F. Kennedy honors astronaut John Glenn at Cape Canaveral on Feb. 23, 1962, just three days after his historic first piloted orbital flight by an American. Photo Credit: NASA

his belief that aviation had extended around the globe and it was now time to start looking up.

"I feel that this is the future of not only this country but for the world," he said. "It is an extension of flight and we have to go somewhere and that is all that is left. This is an excellent opportunity to be in on something new."

The initial battery of written tests, technical surveys and medical history reviews were administered to 56 pilots during February 1959. Those who declined or were eliminated reduced the total at the beginning of March to 36. They then were invited to undergo extraordinary physical examinations at the Lovelace Clinic in Albuquerque, N.M., and extreme mental and physical environmental tests at the Wright Air Development Center in Dayton, Ohio.

When asked to name the toughest test during the extensive evaluations, Glenn pointed to the physical examinations.

"We had some pretty good tests," he said. "It is difficult to pick one because if you figure how many openings there are on a human body and how far you can go into any one of them, you answer which one would be the toughest for you."

During the introductory news conference, Schirra noted that his father was a pioneer in the early days of flight. The elder Schirra went to Canada during World War I and earned his pilot rating, later becoming a barnstormer.

"My father was one of the very early aviators," he said, "so I feel going into space is an expansion in another dimension, much as aviation was an expansion from the surface of the Earth."

Grissom saw volunteering to be an astronaut as another way to help America as an Air Force officer.

"My career has been serving the nation, serving the country and here is another opportunity where they need my talents," he said. "I am just grateful for an opportunity to serve in this capacity."

Cooper was quick to express faith in the thousands of people who would be designing, building and preparing the launch vehicles and spacecraft for flight.

"I have faith in the people that I am working with in this program," he said, "and I know it will be a success."

Glenn compared Project Mercury to the Wright Brothers' first powered aircraft flight in North Carolina in 1903.

"My feelings are that this whole project with regard to space is like the Wright Brothers standing at Kitty Hawk about fifty years ago, with Orville and Wilbur pitching a coin to see who was going to shove the other one off the hill," he said. "I think we stand on the verge of something as big and as expansive as that."

During the April 9, 1959, news conference that introduced the Mercury astronauts, they were asked, "Who wants to be the first man launched into space?" All seven raised their hands.
Photo Credit: NASA

THE ORIGINAL SEVEN ASTRONAUTS

Alan B. Shepard Jr.
(1923–1998)

Mercury Redstone-3 (Freedom 7) – May 5, 1961 – First piloted Mercury flight in which Shepard became the first American in space.

Apollo 14 – Jan. 31-Feb. 9, 1971 – Commanded the third lunar landing and became the fifth person to walk on the moon.

Virgil I. (Gus) Grissom
(1926–1967)

Mercury Redstone-4 (Liberty Bell 7) -- July 21, 1961– Second suborbital Mercury flight; Liberty Bell 7 sank after splashdown and was retrieved July 20, 1999.

Gemini 3 (Molly Brown) – March 23, 1965 – Command pilot for the first piloted Gemini mission. It was the first spaceflight to change its orbital plane. Grissom also became the first person launched into space twice.

Apollo 1 – Jan. 27, 1967 – Commander for the first piloted Apollo mission. He and his crew were killed in a fire during a launch pad test one month before the planned launch.

John H. Glenn Jr.
(Born 1921)

Mercury Atlas-6 (Friendship 7) – Feb, 20, 1962 – Glenn became the first American in orbit, circling the Earth three times. Elected to the U.S. Senate, representing Ohio from 1974 to 1999.

STS-95 Discovery – Oct. 29-Nov. 7, 1998 -- Payload Specialist aboard the space shuttle. At the age of 77, Glenn became the oldest person to fly in space.

M. Scott Carpenter
(1925–2013)

Mercury Atlas-7 (Aurora 7) – May 24, 1962 – Second three-orbit Mercury mission

Walter M. (Wally) Schirra Jr.
(1923–2007)

Mercury Atlas-8 (Sigma 7) – October 3, 1962 – Six-orbit Mercury flight

Gemini 6 - Dec. 15-16, 1965 – Command pilot on the first rendezvous in space. Gemini 6 flew within one foot of the already orbiting Gemini 7.

Apollo 7 - Oct. 11-22, 1968 – Commander of the first piloted Apollo mission. Schirra became the first person to be launched into space three times and the only person to fly Mercury, Gemini and Apollo missions.

L. Gordon (Gordo) Cooper Jr.
(1927–2004)

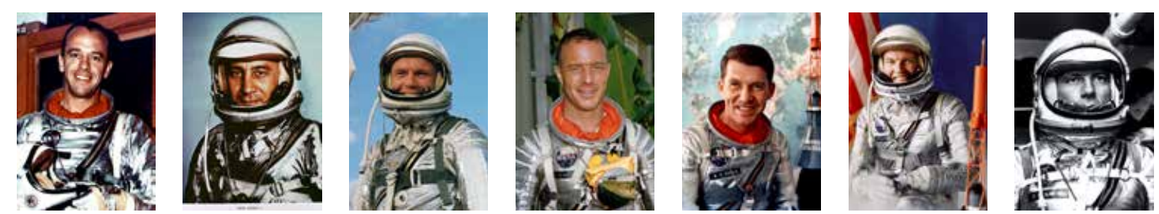
Mercury Atlas-9 (Faith 7) – May 15-16, 1963 – Final Mercury mission which became the first American spaceflight to last more than a day, totaling 22 orbits.

Gemini 5 - August 21-29, 1965 – Command pilot of the first eight-day space mission which also was the first to use fuel cells.

Donald K. (Deke) Slayton
(1924–1993)

While training for the second orbital Mercury mission, he was grounded due to cardiac idiopathic atrial fibrillation, an erratic heart rate.
Served as NASA's director of Flight Crew Operations and was later returned to full flight status.

Apollo-Soyuz Test Project – July 15-24, 1975 – Docking module pilot on the first joint American–Soviet space mission, the first docking of an American and Russian spacecraft in space.



Shepard Grissom Glenn Carpenter Schirra Cooper Slayton

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International Space Station Expedition 39 began March 11. The crew members are, ascending from left, Russian cosmonaut Mikhail Tyurin and NASA astronaut Rick Mastracchio, flight engineers; Japan Aerospace Exploration Agency (JAXA) astronaut Koichi Wakata, commander; Russian cosmonauts Alexander Skvortsov, Oleg Artemyev and NASA astronaut Steve Swanson, flight engineers. High-definition camera equipment, growing plants in space, and a variety of physical science, biology and biotechnical experiments define the research of Expedition 39.

Image credit: NASA