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This has been an awesome year for the team here at NASA's Kennedy Space Center. We truly are a premier, multi-user spaceport supporting government and commercial space operations with an ever-increasing number of launches.

It is also a great time for America’s space program. Soon, we will once again be launching astronauts from U.S. soil. Today, three commercial companies are building spacecraft to take humans to orbit: Lockheed Martin, Boeing and SpaceX.

Our Commercial Crew partners are completing preparations to fly the Boeing Starliner and SpaceX Crew Dragon to the International Space Station. Based primarily at Kennedy, these two companies are developing safe, reliable and cost-effective access to and from low-Earth orbit with American-built spacecraft systems. That’s our number one priority for 2019.

As we prepare to send crews to the space station, we continue the important work of processing and launching equipment and supplies to the orbiting outpost on Commercial Resupply Services missions.

Lockheed Martin is building the Orion spacecraft in the Neil Armstrong Operations and Checkout Building. We’re getting Orion ready to fly on the Space Launch System rocket. It will travel beyond the Moon, farther out than any human-rated spacecraft on Artemis 1. Ultimately, Orion will help us put boots on Mars.

This past summer, Kennedy’s Exploration Ground Systems team moved the mobile launcher to Launch Complex 39B for a fit test and then into the Vehicle Assembly Building for verification and validation checks.

The Launch Services Program celebrated its 20th anniversary by supporting six missions, including one to fly into the Sun’s atmosphere and another to Mars. The Parker Solar Probe is performing the closest-ever observations of a star. The InSight lander is designed to study the Martian crust, mantle and core.

One launch that resulted in a great deal of attention took place in February. SpaceX had a spectacular liftoff of the first Falcon Heavy rocket. It gives our nation a greater capability to boost payloads to Earth orbit and beyond. Here at Kennedy, NASA is proud to play a role in supporting our partners’ achievements, providing services needed to process and launch their vehicles as part of our ever-growing, multi-user spaceport.

Vice President Mike Pence hosted a meeting of the National Space Council here at Kennedy earlier this year. In simple, yet profound words, he described our role here on Florida’s Space Coast.

“Much more than the bridge to space,” he said, “Kennedy Space Center is the bridge to the future.”
Vision, Mission and Core Competencies

KSC Vision

KSC is the world’s preeminent launch complex for government and commercial space access, enabling the world to explore and work in space.

KSC Mission

KSC safely manages, develops, integrates and sustains space systems through partnerships that enable innovative, diverse access to space and inspire the nation’s future explorers.

KSC Core Competencies

Acquisition and management of launch services and commercial crew development

Launch vehicle and spacecraft processing, launch, landing, recovery, operations and sustaining

Payload and flight science experiment processing, integration and testing

Designing, developing, operating and sustaining flight and ground systems and supporting infrastructure

Development, test and demonstration of advanced flight systems and transformational technologies to advance exploration and space systems
NOVEMBER 2017

JPSS-1 Launched Aboard Delta II

NOAA’s Joint Polar Satellite System-1 (JPSS-1) and a host of small satellites known as CubeSats lifted off aboard a United Launch Alliance Delta II rocket from Space Launch Complex 2 at California’s Vandenberg Air Force Base. JPSS-1 is the first in NOAA’s series of four, next-generation operational environmental satellites designed to advance observations used for severe weather prediction and environmental monitoring.

DECEMBER 2017

SpaceX Launched 13th Commercial Resupply Mission

SpaceX launched a Falcon 9 rocket and Dragon cargo spacecraft on the company’s 13th commercial resupply services mission for NASA from Cape Canaveral Air Force Station’s Space Launch Complex 40. The Dragon carried science, research, crew supplies and hardware to the International Space Station.

JANUARY 2018

Underway Recovery Test 6

NASA’s Exploration Ground Systems and the U.S. Navy conducted the weeklong Underway Recovery Test 6 in the Pacific Ocean, testing and improving their processes and ground support hardware to recover astronauts in the Orion capsule once they splash down in the Pacific Ocean. Aboard the USS Anchorage, the combined team rehearsed through a variety of sea conditions, time of day and equipment scenarios.

JANUARY 2018

NASA Initiates First Grow-out in APH on Station

The Advanced Plant Habitat, a fully automated plant growth facility aboard the International Space Station, initiated its first grow-out with the help of Expedition 54 astronaut Joe Acaba and researchers at Kennedy Space Center. Investigation data from the small crop of Arabidopsis and dwarf wheat seeds will help the agency prepare crews to grow their own food in space during deep space missions.
FEBRUARY 2018
Falcon Heavy Launch a Multi-User Spaceport Success Story

SpaceX launched a Falcon Heavy rocket on its demonstration flight from Kennedy’s Launch Complex 39A. The successful liftoff of the new vehicle signaled that the center is continuing to grow as the nation’s premier, multi-user spaceport. NASA has partnerships with more than 90 companies that enable commercial space manufacturing, processing and launch operations along Florida’s Space Coast.

MARCH 2018
GOES-S Launched Aboard Atlas V

NOAA’s Geostationary Operational Environmental Satellite-S (GOES-S) lifted off aboard a United Launch Alliance Atlas V rocket from Cape Canaveral Air Force Station’s Space Launch Complex 41. GOES-S was the second in a series of next-generation GOES weather satellites.

FEBRUARY 2018
Vice President Pence Hosts National Space Council at Kennedy

Vice President Mike Pence returned to Kennedy to chair a meeting of the National Space Council. Pence also visited facilities at Kennedy and Cape Canaveral Air Force Station. Re-established in 2017 by President Donald Trump, the National Space Council’s role is to advise the president on America’s space policy and strategy, and review the nation’s long-range goals for space activities.

FEBRUARY 2018
Orion Crew Access Arm Installed on Mobile Launcher

NASA reached an important milestone on the path to Artemis 1 with the installation of the crew access arm at about the 274-foot level on the 380-foot-tall mobile launcher tower. Astronauts will step across the crew access arm to board the Orion spacecraft when it is in place atop the Space Launch System (SLS) rocket.
**MARCH 2018**

**Parachute Testing Lands Partners Closer to Crewed Flight Tests**

Crew safety is paramount in the return of human spaceflight launches from Florida’s Space Coast, and a round of parachute testing provided valuable data to help industry partners Boeing and SpaceX meet NASA’s requirements for certification. Boeing conducted the first in a series of parachute reliability tests for its Starliner flight drogue and main parachute system in February 2018. SpaceX performed its 14th overall parachute test supporting Crew Dragon development in March 2018.

**APRIL 2018**

**SpaceX Launched 14th Commercial Resupply Mission**

SpaceX launched a Falcon 9 rocket and Dragon cargo spacecraft on the company’s 14th commercial resupply services mission for NASA from Cape Canaveral Air Force Station’s Space Launch Complex 40. The Dragon carried science, research, crew supplies and hardware to the International Space Station.

**APRIL 2018**

**TESS Launched Aboard Falcon 9**

NASA’s Transiting Exoplanet Survey Satellite (TESS) spacecraft launched from Space Launch Complex 40 at Cape Canaveral Air Force Station aboard a SpaceX Falcon 9 rocket. TESS is the first space-based, all-sky surveyor to search for Earth-like planets that are outside our solar system but close enough for further study.

**APRIL 2018**

**Launch Pad 39B LOX Tank Test**

Exploration Ground Systems conducted a six-hour pressurization test of the liquid oxygen (LOX) tank at Launch Pad 39B, which has been upgraded for the agency’s SLS rocket. The SLS will use both liquid oxygen and liquid hydrogen propellants. Results of the test confirmed that the tank was functioning as needed to achieve proper pressurization.
MAY 2018
InSight Launched Aboard Atlas V

NASA’s Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) spacecraft launched from Space Launch Complex 3 at California’s Vandenberg Air Force Base aboard a United Launch Alliance Atlas V rocket. InSight is the first interplanetary mission to launch from the West Coast and will be the first mission to look deep beneath the surface of Mars. It will measure the Red Planet’s heat output and listen for marsquakes to develop a map of its deep interior.

JUNE 2018
SpaceX Launched 15th Commercial Resupply Mission

SpaceX launched a Falcon 9 rocket and Dragon cargo spacecraft on the company’s 15th commercial resupply services mission for NASA from Cape Canaveral Air Force Station’s Space Launch Complex 40. The Dragon carried science, research, crew supplies and hardware to the International Space Station.

JULY 2018
Tail Service Mast Umbilicals Installed on Mobile Launcher

Two 35-foot-tall tail service mast umbilicals were installed on the zero-level deck of the mobile launcher. When the Space Launch System rocket stands atop the mobile launcher, these umbilicals will connect to the aft section of the vehicle’s core stage, providing liquid hydrogen fuel as well as electricity prior to launch.

AUGUST 2018
Crews Assigned to First Flights on Commercial Spacecraft

NASA announced the first U.S. astronauts who will fly on American-made, commercial spacecraft to and from the International Space Station – an endeavor that will return astronaut launches to U.S. soil. The agency assigned astronauts to crew the first test flight and mission of both Boeing’s CST-100 Starliner and SpaceX’s Crew Dragon. In January 2019, astronaut Michael Fincke replaced Eric Boe for Boeing’s Crew Flight Test.
**AUGUST 2018**

**Parker Solar Probe Launched Aboard Delta IV Heavy**

NASA’s Parker Solar Probe launched from Space Launch Complex 37 on Cape Canaveral Air Force Station aboard a United Launch Alliance Delta IV Heavy rocket. During its mission to “touch” the Sun, Parker Solar Probe will use gravity assists from Venus seven times over nearly seven years to gradually bring its orbit closer to the Sun. It will fly directly through the Sun’s atmosphere, as close as 3.8 million miles from the star’s surface.

**AUGUST 2018**

**Ascent Abort-2 Data Recorders Drop Test**

NASA successfully tested the approach to collect and retrieve valuable data in support of an upcoming test of the abort system for the agency’s Orion spacecraft. Ejectable data recorders were released from a helicopter 5,000 feet in the air and splashed into the Atlantic Ocean off the spaceport’s coast. The floating devices were then located through beacons transmitting GPS coordinates and scooped up with fishing nets by NASA personnel operating boats.

**AUGUST 2018**

**Mobile Launcher Moves to Launch Complex 39B, VAB**

The mobile launcher to be used in support of the Space Launch System rocket and Orion spacecraft made milestone moves during 2018. Carried atop the crawler-transporter, the mobile launcher moved from its construction site near the Vehicle Assembly Building (VAB) out to Launch Pad 39B, where it remained for several days of testing. Next, it traveled into the VAB to continue preparations for Artemis 1.

**SEPTEMBER 2018**

**ICESat-2 Launched Aboard Delta II**

NASA’s Ice, Cloud and land Elevation Satellite-2 (ICESat-2) spacecraft launched from Space Launch Complex-2 at California’s Vandenberg Air Force Base aboard a United Launch Alliance Delta II rocket. It was the final flight of the Delta II after 29 years in service. ICESat-2 will make high-resolution data measurements documenting changes in the Earth’s polar ice caps and improving forecasts of sea level rise bolstered by ice sheet melt in Greenland and Antarctica.
Vice President Mike Pence addresses a meeting of the National Space Council in the high bay of Kennedy’s Space Station Processing Facility on Feb. 21, 2018.
Launch Capabilities Increase from Launch Pad 39A

Bangabandhu-1

KoreaSat-5A

Falcon Heavy Maiden Voyage

SES-11
Center Planning and Development’s (CPD) work on developing partnership agreements has supported a 17 percent increase of non-NASA jobs from fiscal years 2010-2018 in support of Kennedy’s transformation to America’s premier, multi-user spaceport.

2018’s New Partnerships

These companies signed agreements for the use of Kennedy Space Center capabilities.

Growing Non-NASA Workforce

<table>
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<tr>
<th>Year</th>
<th>Total Workforce</th>
<th>Civil Servants</th>
<th>Contractors</th>
<th>Non-NASA jobs</th>
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</thead>
<tbody>
<tr>
<td>2010 Govt-only Launch Complex</td>
<td>13,386</td>
<td>17%</td>
<td>73%</td>
<td>10%</td>
</tr>
<tr>
<td>2012 Post Space Shuttle Program</td>
<td>8,605</td>
<td>25%</td>
<td>65%</td>
<td>10%</td>
</tr>
<tr>
<td>2018 Multi-user Spaceport</td>
<td>10,194</td>
<td>19%</td>
<td>54%</td>
<td>27%</td>
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Leveraged $1.01 Billion in KSC Assets

Since 2011, CPD has divested NASA facilities and infrastructure used for the Space Shuttle Program that the agency no longer needs, including the 15,000-foot-long Shuttle Landing Facility, the three bays of the Orbiter Processing Facility, historic Launch Complex 39A and others.
Kennedy Space Center released a Notice of Availability (NOA) https://go.nasa.gov/2LJIeO2 for undeveloped land to support activities in launch operations, assembly, testing and processing, renewable energy, research and development, support services, and vertical launch and landing. The announcement is part of Kennedy’s multi-user spaceport objectives and is based on effectively utilizing land assets identified in the center’s 20-year Master Plan. This NOA has a two-year window of opportunity beginning June 2, 2018, and expiring June 1, 2020. Interested parties can respond to the NOA anytime during the open period.
Kennedy approved a Master Plan Amendment, converting an undeveloped 67-acre site from “renewable energy” to “launch operations and support,” in June 2018 to allow for SpaceX’s proposed launch control center and processing facility. The land use change was passed to more effectively accommodate SpaceX’s requirements without impacting NASA operations.

SpaceX signed a Reimbursable Space Act Agreement for the use of space inside Launch Control Center Firing Room 4.

The Master Plan Implementation Strategy (MPIS) is a crucial piece for the continued evolution of Kennedy as a multi-user spaceport. The MPIS aims to further support the center’s continual growth as an environment where government, commercial and academia are able to be successful and will ensure that Kennedy will continue to be humankind’s starting point into the universe.
NASA’s Commercial Crew Program (CCP) and commercial partners, Boeing and SpaceX, made significant strides in Fiscal Year 2018 to return human spaceflight launch capabilities to the United States. Each company continued to develop, test and integrate unique space systems to fly astronauts for the agency to and from the International Space Station.

CCP assigned the first crews to fly on Boeing and SpaceX’s flight tests and first operational missions. The crews include a total of eight NASA astronauts and one Boeing astronaut. Boeing plans to fly its uncrewed flight test, known as the Orbital Test Flight, and its Crew Flight Test in late 2019. SpaceX’s uncrewed flight test, known as Demo-1, launched March 2 from Launch Complex 39A at Kennedy Space Center. NASA and SpaceX are reevaluating target test dates for Demo-2, the company’s flight test with crew. Operational missions will begin following NASA certification.

The International Space Station continued to prepare for the new commercial spacecraft to arrive, installing high-definition cameras that will provide enhanced views during the final phase of approach and docking of the Boeing Starliner and SpaceX Crew Dragon. The nine astronauts training to fly the test flights and first operational missions on each spacecraft participated in simulations to rehearse each phase of CCP flights. The astronauts continued to lend their unique expertise, participating in spacesuit checkouts and practicing interfacing with the provider systems.

Parachute and landing system tests continued for Boeing’s Starliner and the SpaceX Crew Dragon through a series of choreographed trials in the Western U.S. Plans call for completion of parachute testing in 2019.

At Space Launch Complex 41 on Cape Canaveral Air Force Station, United Launch Alliance upgraded the white room, which astronauts will walk through just before boarding Starliner. Astronauts and launch support personnel also participated in an emergency escape system test, zip lining from the Crew Access Tower to the ground and driving armored vehicles to a triage site where they received medical treatment. The escape system will be available to anyone at the launch pad to use in the unlikely event of an emergency prior to liftoff. In this fiscal year, United Launch Alliance also completed and prepared to ship the dual engine Centaur, as well as other major structures for its Atlas V rocket that will launch Starliner on the uncrewed Orbital Flight Test.

Boeing continues to manufacture the Starliner spacecraft inside the Commercial Crew and Cargo Processing Facility at Kennedy Space Center.

Victor Glover and Nicole Mann are two of the nine U.S. astronauts selected for commercial crew flight assignments. On Aug. 21, 2018, they learned about the tools and hardware they will use in spacewalk training at NASA’s Space Vehicle Mockup Facility in Houston. Mann is assigned to launch to the International Space Station on the first crewed flight of Boeing’s CST-100 Starliner. Glover will fly to the station on the second crewed flight of SpaceX’s Crew Dragon.
Multiple service modules and three crew modules are in various phases of production – one that will perform a Pad Abort Test and two that will be used for flight tests and follow-on missions to the space station. Throughout the year, the Boeing team tested critical hardware in simulated space environments around the country. Boeing, NASA and U.S. Army teams also rehearsed safely bringing the Starliner home to Earth at White Sands Missile Range in New Mexico. This proved the team can safely and efficiently get crew and cargo out of the spacecraft post-landing.

CCP updated its Commercial Crew Transportation Capability, or CCtCap, contract with Boeing to provide flexibility in its commercial flight tests to the space station. Boeing approached NASA and proposed extending the duration of the Crew Flight Test, if necessary, and adding a third crew member to the flight. These modifications could offer NASA additional flexibility to ensure continued U.S. access to the orbital laboratory. The modification also identifies cargo capabilities for the company’s uncrewed and crewed test flights. Exact details of how to best take advantage of the contract modification are under evaluation but could allow for additional microgravity research, maintenance, and other activities while Starliner is docked to station.

SpaceX continued manufacturing the Crew Dragon spacecraft inside the company’s headquarters and manufacturing facility in Hawthorne, California. In total, SpaceX has six Crew Dragon modules in various stages of production and testing, including a qualification module, a life support system testing module, the two spacecraft for flight tests and the two for fully operational missions. This year, SpaceX completed environmental testing on the Crew Dragon capsule for Demo-1, the uncrewed flight test,
and shipped it to Cape Canaveral, Florida for final flight preparation. Further qualification testing and work on mechanical integration for Demo-2, the crewed flight test, is ongoing.

CCP is moving forward with SpaceX’s plan to fuel the Falcon 9 rocket after the astronauts are in place in the Crew Dragon spacecraft on launch day. While this plan is the baseline for operations, it is contingent upon NASA’s final certification of the operation.

SpaceX, NASA and U.S. Air Force personnel completed another full-scale joint recovery exercise to prepare for and ensure crew safety in the unlikely event of a rescue scenario. A full-size model of the spacecraft was used during rescue training, and Air Force pararescue specialists practiced extracting crew from the capsule in the water and transporting them to lifeboats.

Boeing and SpaceX continued spacesuit testing to ensure the suits perform as designed.

At Launch Complex 39A, SpaceX installed its Crew Access Arm and white room along with additional structural upgrades at the site. The company also completed a launch day simulation of crew transport from Crew Quarters to the launch pad and ascent of the Crew Access Tower to the white room.

Vice President Mike Pence and members of the National Space Council surveyed progress at Boeing and SpaceX facilities at Kennedy following their National Space Council meeting in February 2018.

CCP continued work with Blue Origin and Sierra Nevada Corporation in FY 18 to develop and refine their respective spacecraft and launch systems. Under these agreements, NASA provides expertise and insight into their spaceflight designs. Sierra Nevada Corp. completed a free flight test of its Dream Chaser spacecraft in November 2017 under the Commercial Crew Integrated Capability Space Act Agreement, or CCiCap.
The Sun rises over a waterway near the Apollo/Saturn V Center, part of the Kennedy Space Center Visitor Complex.
October 2018 marked the 20th anniversary for NASA’s Launch Services Program, or LSP, which connects entities with payloads to launch vehicle providers. The LSP team at the agency’s Kennedy Space Center works to provide reliable, competitive and user-friendly launch services in the commercial arena to satisfy agency-wide space transportation requirements and maximize the opportunities for mission success.

LSP had an ambitious schedule for Fiscal Year 2018, working with teams from rocket and satellite providers, including Ball Aerospace, the Johns Hopkins Applied Physics Laboratory, Lockheed Martin, the National Oceanic and Atmospheric Administration (NOAA), Northrop Grumman, SpaceX, United Launch Alliance (ULA), the University of California, Berkeley, and more. LSP managed the launch service for six NASA science missions that launched on two coasts, from Cape Canaveral Air Force Station in Florida and Vandenberg Air Force Base in California.

LSP certified two rockets for NASA missions that flew this year: the SpaceX Falcon 9 Full Thrust for NASA’s Transiting Exoplanet Survey Satellite mission, or TESS, and the United Launch Alliance Delta IV Heavy for the agency’s Parker Solar Probe mission.

In addition to NASA’s science missions, LSP manages Educational Launch of Nanosatellites (ELaNa) missions, which launch complements of small satellites, known as CubeSats, selected for flight by the agency’s CubeSat Launch Initiative (CSLI). During four missions in FY 2018, 18 CubeSats were launched: ELaNa XIII and XIV in November 2017, ELaNa XXIII in May 2018 and ELaNa XVIII in September 2018.

The Joint Polar Satellite System-1, or JPSS-1, is the first in a new series of four highly advanced NOAA polar-orbiting satellites to increase weather forecast accuracy. NASA, NOAA and ULA launched JPSS-1 in November 2017 on a Delta II rocket from Vandenberg Air Force Base.

The Geostationary Operational Environmental Satellite-S, or GOES-S, now called GOES-17, will occupy NOAA’s GOES-West position and provide faster, more accurate data for tracking wildfires, tropical cyclones, fog and other storm systems and hazards. NASA, NOAA and ULA launched GOES-17 in March 2018 on an Atlas V rocket from Cape Canaveral Air Force Station.

TESS is the next step in the search for planets outside of our solar system. The spacecraft will survey the nearest and brightest stars for two years. NASA and SpaceX launched TESS in April 2018 on a Falcon 9 rocket from Cape Canaveral Air Force Station.

NASA’s latest mission to Mars – the Interior Exploration using Seismic Investigations, Geodesy and Heat Transport spacecraft, or InSight, is the
The final United Launch Alliance Delta II rocket is revealed following rollback of the Space Launch Complex 2 mobile service tower at Vandenberg Air Force Base, California, on Sept. 15, 2018. The rocket launched hours later carrying NASA’s Ice, Cloud and land Elevation Satellite-2 (ICESat-2).
first mission to peer deep beneath the Martian surface, studying the planet’s interior by measuring its heat output and listening for marsquakes. NASA and ULA launched InSight in May 2018 on an Atlas V rocket from Vandenberg Air Force Base. Also aboard the rocket were two CubeSats known as Mars Cube One (MarCO), the first test of miniaturized CubeSat technology in deep space.

Parker Solar Probe will provide unprecedented information about our Sun and how changing conditions can spread into the solar system affecting Earth and other worlds. NASA and ULA launched Parker Solar Probe in August 2018 on a Delta IV Heavy from Cape Canaveral Air Force Station.

NASA’s Ice, Cloud and land Elevation Satellite-2, or ICESat-2, will measure the changing height of Earth’s ice, carrying a single instrument, the Advanced Topographic Laser Altimeter System (ATLAS). NASA and ULA launched ICESat-2 in September 2018 from Vandenberg Air Force Base on the final Delta II mission.

The Ionospheric Connection Explorer, ICON, will study the layer of charged particles high in our atmosphere where Earth’s weather meets space weather. Knowledge gleaned from ICON will aid in mitigating effects of the processes that can distort signals from satellites and communications technology worldwide. During the fiscal year, NASA and Northrop Grumman prepared for the launch of ICON on a Pegasus XL rocket.

LSP also hosted its third annual customer forum bringing together spacecraft customers and rocket providers.

A total of 39 CubeSats are being prepared to launch on seven different ELaNa missions in FY 2019. Ten of these CSLI selected CubeSats will fly on LSP’s first Venture Class Launch Services (VCLS) mission. These small satellites will be carried aboard a Rocket Lab Electron rocket from the company’s launch pad, Launch Complex 1, located on the southern tip of the Mahia Peninsula in New Zealand.

NASA also awarded two missions, Sentinel-6A, targeted to launch in 2020 aboard a SpaceX Falcon 9 Full Thrust rocket; and Landsat 9, targeted to launch in 2021 aboard a United Launch Alliance Atlas V 401 rocket. LSP will manage the launch service for both missions, which will launch from Vandenberg Air Force Base.

Inside the Payload Hazardous Servicing Facility at Kennedy Space Center on Feb. 21, 2018, the first of two solar panels is being deployed on the agency’s Transiting Exoplanet Survey Satellite (TESS).
NASA’s Interior Exploration using Seismic Investigations, Geodesy and Heat Transport spacecraft (InSight) is lifted for placement on a spin table during preflight processing inside the Astrotech processing facility at California’s Vandenberg Air Force Base.

A United Launch Alliance Delta II rocket lifts off from Space Launch Complex 2 at Vandenberg Air Force Base on Nov. 18, 2017 carrying the Joint Polar Satellite System-1 (JPSS-1) spacecraft.
Fiscal Year 2018 was a busy year for Exploration Ground Systems (EGS). While other Exploration Systems Development programs are hard at work building the Orion spacecraft and Space Launch System (SLS) rocket, EGS is putting the finishing touches on Kennedy Space Center’s infrastructure to support not only SLS and Orion, but a myriad of other spacecraft and rockets that are in development. A key aspect of the program’s approach is long-term sustainability and affordability. EGS’s flexible engineering designs makes Kennedy’s processing and launch infrastructure available to commercial and other government customers, thereby distributing the cost among multiple users and reducing the cost of access to space.

Artemis 1 (A1) really came into focus in early December as EGS took ownership of the SLS rocket’s Interim Cryogenic Propulsion Stage — the first integrated piece of flight hardware to arrive in preparation for the uncrewed mission.

A month later, the new year came in with a splash for EGS’s Landing and Recovery Team as the integrated NASA and U.S. Navy team aboard the USS Anchorage tested out new ground support equipment and practiced procedures needed to recover the Orion capsule and crew when they return from deep space in the Pacific Ocean off the coast of California.

An important step in preparation for A1 took place March 29, 2018, with a demonstration of a portion of the launch countdown focused on fueling the new SLS. For A1, the countdown is expected to take about 45 hours and 40 minutes beginning two days prior to liftoff. The launch team already has started writing the launch countdown procedures for SLS, and having an opportunity to run through those operations is extremely beneficial so the team can take what they learn from the demonstrations and roll them into the launch countdown processes and procedures.

A month later, the new year came in with a splash for EGS’s Landing and Recovery Team as the integrated NASA and U.S. Navy team aboard the USS Anchorage tested out new ground support equipment and practiced procedures needed to recover the Orion capsule and crew when they return from deep space in the Pacific Ocean off the coast of California.

Packed inside its canister, the Interim Cryogenic Propulsion Stage (ICPS) stands inside the high bay of Kennedy Space Center’s Space Station Processing Facility. The ICPS is the first integrated piece of flight hardware to arrive in preparation for the uncrewed Artemis 1. With the Orion attached, the ICPS sits atop the SLS rocket and will provide the spacecraft with the additional thrust needed to travel tens of thousands of miles beyond the Moon.
In addition to the mobile launcher testing at the pad, Launch Pad 39B saw a lot of action this year, starting with an initial wet flow test in December where thousands of gallons of water flowed into the flame trench and through upgraded systems at the pad. In the spring, about 450,000 gallons of water flowed at high speed from a holding tank through new and modified piping and valves, the flame trench, flame deflector nozzles and mobile launcher interface risers during a second wet flow test. The test was performed to confirm the performance of the Ignition Overpressure/Sound Suppression system. During launch of the SLS and Orion spacecraft, the high-speed water flow will help protect the vehicle from the extreme acoustic and temperature environment during ignition and liftoff. The major construction on the flame deflector in the pad’s flame trench that began in July 2017 also was completed this year. The new main flame deflector is critical to safely deflecting the plume exhaust from the massive SLS rocket during launch.

Drawing on more than five decades of excellence, EGS continues to make strides toward the first launch of SLS and Orion while unlocking deep space access for others from the world’s premier multi-user spaceport.
Teams from the U.S. Navy’s Explosive Ordnance Disposal Mobile Unit 3, the Special Boat Unit, the USS Anchorage and the USS New Orleans work together to connect tending lines to the Orion test article off the coast of San Diego during Underway Recovery Test-6 on Jan. 21, 2018. Kennedy Space Center’s NASA Recovery Team works with the U.S. Navy to improve recovery procedures and hardware ahead of Orion’s next flight, Artemis 1, when it splashes down in the Pacific Ocean.

About 450,000 gallons of water flowed at high speed from a holding tank through new and modified piping and valves, the flame trench, flame deflector nozzles and mobile launcher interface risers during a wet flow test Dec. 20, 2017, at Launch Pad 39B. At peak flow, the water reached about 100 feet in the air above the pad surface. The test was a milestone to confirm and baseline the performance of the Ignition Overpressure/Sound Suppression system. During launch of NASA’s Space Launch System rocket and Orion spacecraft, the high-speed water flow will help protect the vehicle from the extreme acoustic and temperature environment during ignition and liftoff.
A sliver of the Moon is visible through one of the steel structures of the mobile launcher.
In fiscal year 2018, employees from NASA’s Kennedy Space Center Exploration Research and Technology Programs (ER&T) carried out a number of firsts and advanced the state of the art in their fields through execution of research and development projects that support Space Technology, Human Exploration and Operations and Science mission directorates. Additionally, ER&T partnered with small businesses and academia through the Small Business Innovation Research and Small Business Technology Transfer initiatives, sponsored innovation events and competitions at Kennedy, and led the agency in the total number of new patent license agreements executed, with 18 licenses.

In October 2017 on the International Space Station, astronauts installed the Advanced Plant Habitat (APH), which features 180 sensors and the ability to tightly control biological growth conditions. Simultaneously, the astronauts harvested three plant varieties from the Veggie growth chamber, a first for Veggie.

In January, APH started testing by growing with Arabidopsis and dwarf wheat. Plant growth experiments in microgravity occurred continuously throughout the year on the space station in Veggie and APH. Veggie also provided edible fresh greens for the crew, adding to Thanksgiving and many other meals. Principal investigators from institutions across the country used the center’s growth chambers for research, advancing progress for NASA’s exploration goals.

More than 100 schools contributed data through a multiyear partnership with the Fairchild Tropical Botanic Garden in Miami and identified two species of plants suitable for growing in space that went to the station in June 2018. The successful testing of new crop species and the testing of new plant watering systems resulted in new scientific knowledge in closed environmental systems.

Among the significant ER&T accomplishments during fiscal year 2018 was a demonstration of excavation, autonomy and resource collection for in-situ resource utilization operations featuring RASSOR 2.0. During the fall of 2017, ER&T hosted the center’s annual Innovation Expo, which demonstrated technologies developed by Kennedy’s researchers, and the center held a KickStart Competition to foster creative thinking.
Above: NASA scientists with advanced degrees aren’t the only ones deciding what crops should be grown in space. Students, including a special group from Columbus, Ohio, are also taking a bite out of this tasty cause. Tessa Hanna, at right, an AmeriCorps Vista volunteer, helps students from schools in Columbus, Ohio, collect and record data on plants they are growing as part of The Fairchild Challenge.

Below: Two cryogenic propellant system technologies developed by ER&T were incorporated in the construction of the new 1.4-million-gallon liquid hydrogen storage tank at Launch Pad 39B. These technologies enable future zero boil-off and densification of the hydrogen.
Dr. Howard Levine, a research scientist at Kennedy Space Center, reviews the growth of several tomato plants in a laboratory in the Space Station Processing Facility. The tomato plants are growing in the Veggie Passive Orbital Nutrient Delivery System (PONDS), a direct follow-on to the Veg-01 and Veg-03 hardware and plant growth validation tests. PONDS is planned for use during Veg-04 and Veg-05 on the International Space Station after the Veggie PONDS Validation flights on SpaceX-14 and OA-9.

In the Swarmathon competition at the Kennedy Space Center Visitor Complex on April 28, 2018, students were asked to develop computer code for the small robots, programming them to look for “resources” in the form of AprilTag cubes, similar to barcodes. Teams developed search algorithms for the Swarmies to operate autonomously, communicating and interacting as a collective swarm similar to ants foraging for food.

Team members from New York University work on their robot miner in the RobotPits on the fourth day of NASA’s 9th Robotic Mining Competition, May 17, 2018, at Kennedy Space Center Visitor Complex. More than 40 student teams from colleges and universities around the U.S. used their mining robots to dig in a supersized sandbox filled with simulated lunar soil, gravel and rocks, and participate in other competition requirements. The Robotic Mining Competition is a NASA Human Exploration and Operations Mission Directorate project designed to encourage students in science, technology, engineering and math, or STEM fields. The project provides a competitive environment to foster innovative ideas and solutions that could be used on NASA’s deep space missions.
efforts for NASA's role in developing and transferring the Autonomous Flight Termination Unit (AFTU) to more than 26 commercial space companies and other government agencies, earning Kennedy the FLC’s U.S. Southeast Region’s 2018 Interagency Partnership Award.

As a significant example of technology infusion into our spaceflight programs, the Exploration Ground Systems Program approved incorporation of two ER&T-developed technologies for cryogenic propellant systems in the construction of the new 1.4 million gallon liquid hydrogen storage tank for Launch Complex 39B to enable future zero boil off and densification of the hydrogen. The center also loaned the Universal Propellant Servicing System (UPSS) to a commercial partner to support critical systems level testing. The UPSS, a versatile capability for transferring cryogenic propellants, provides an option for servicing small-class launch vehicles and broadens Kennedy’s ability to support commercial launch operations.

Space station resupply and utilization work remains a key focus, and the ER&T ground processing crews prepared payloads for SpaceX CRS-13, which launched in December 2017, and similar activity occurred for science payloads including the Transitioning Exoplanet Survey Satellite, the InSight Mars Lander, Parker Solar Probe, and other station resupply missions.

The Orbital Replacement Units team traveled to Tanegashima Space Center in Japan in April 2018 and spent four weeks completing the final processing and integration of the Life Science Glovebox facility and two basic express racks into the Japanese Pressurized Logistics Carrier. The team also demonstrated mixing nitrogen and oxygen to make breathable air on the space station as a contingency for emergency situations by repurposing existing support.

Establishing deeper working relationships with the Science Mission Directorate, ER&T has been given the opportunity to develop two scientific instruments. The Water Analysis and Volatile Extraction (WAVE) instrument, intended for use in a future lunar rover, would accept and heat regolith samples to quantify water and other volatiles extracted from below the surface. Mass Spectrometer observing lunar operations instrument, or MSolo, is a component of WAVE that could be used as a stand-alone instrument for one of the first Commercial Lunar Payload Services missions.

Branching out to work with new partners also occurred when ER&T performed the first optical quality testing on a window for NASA’s Orion spacecraft. Meanwhile, other projects met development milestones, including efforts to turn waste on spacecraft into usable gases in a reactor, the ability to control dust buildup on surfaces using electrostatic fields, using algae in a bioreactor for waste processing, and printing a polymer concrete mix using regolith and plastic wastes.

ER&T had a full year of supporting the center’s academic engagement activities such as the annual Swarmathon and Robotic Mining Competition, participation in “NASA Days” recruiting events, providing technical guidance to students interested in space biology through the “Fairchild Gardens” initiative, and the mentoring of student interns engaged in a variety of life science, ground technology and advanced systems development.

Inside the Spectrum prototype unit on Oct. 16, 2017, organisms in a Petri plate are exposed to blue excitation lighting. The device works by exposing organisms to different colors of fluorescent light while a camera records what’s happening with time-lapse photography. Results from the Spectrum project will shed light on which living things are best suited for long-duration flights into deep space.
ORION PRODUCTION OPERATIONS AT KENNEDY

The Orion production team of engineers and technicians and their Lockheed Martin counterparts achieved several major processing milestones in fiscal year 2018—helping the agency get closer to sending humans farther into space than ever before.

FINAL PREPARATIONS FOR ARTEMIS 1 ORION CREW MODULE

In the beginning of the year, the Orion processing team successfully completed thermal cycle testing of both the heat shield and the Orion crew module. The test, in a specially constructed thermal cycle chamber in the airlock of the Neil Armstrong Operations and Checkout Building’s (O&C) high bay, exposed the spacecraft to the stress of harsh environmental elements and monitored how they performed. All systems performed well and will ship out along with the service module in Fall 2019 for integrated thermal cycle testing at NASA Glenn’s Plum Brook Station in Sandusky, Ohio. This final thermal testing will be one of the validations needed for flight readiness.

In addition to environmental testing, the team worked to pre-fit Orion’s heatshield and back shells—the outer skin of the spacecraft. The heatshield was secured on the vehicle for the final time to the bottom of the crew module. The heat shield is the largest of its kind designed for missions to carry astronauts. The installation of this mighty shield that will withstand temperatures of nearly 5,000 degrees Fahrenheit marks the beginning of closing out the crew module assembly, a huge milestone in the progress toward Artemis 1. The back shells were pre-fitted and will be installed for the final time early next year.

PROCESSING HUMANITY’S RIDE BACK TO DEEP SPACE

While the team is working hard on Artemis 1 processing and launch, they also have started processing for the next launch, Artemis 2 or A2. This mission will take humankind back into deep space for the first time since Apollo 17 in 1972. The production of the A2 pressure vessel, which is the primary structure that maintains the atmosphere astronauts will breathe and work in while in the vacuum of deep space, began with the first weld on Dec. 18, 2017, at Michoud Assembly Facility in New Orleans. The final weld to the vehicle was performed on July 24, 2018, before it was packed in a Crew Module Transportation Fixture and driven to Kennedy in a super-wide transport truck where it arrived on Aug. 24, 2018. The pressure vessel is now residing in the O&C high bay where it is undergoing structural build for flight.

TESTING FOR ASTRONAUT SAFETY

The production team also played a crucial part in preparing for the Ascent Abort-2, or AA-2, flight test. Targeted for 2019, AA-2 will be a full-stress test of the launch abort system (LAS) and will launch on a booster provided by Northrop Grumman from Space Launch Complex 46 (SLC-46) on Florida’s Cape Canaveral Air Force Station.
To prepare, this year all three aeroshells, or outer-coverings for the booster, arrived for processing inside the Vehicle Assembly Building, where they were stacked and rolled to SLC-46 for pathfinding exercises. Two of the three motors that make up the LAS, the jettison abort motor and the launch abort motor, have arrived for processing in the Launch Abort System Facility at Kennedy. The team also did a drop test of the electronic data recorders, or black boxes that will jettison off the mock Orion crew module during AA-2 to verify and validate recovery operations. The test was smooth and recovery time exceeded expectations. AA-2 will be the final validation test needed for the LAS to be verified for humans, making it a monumental milestone for A2 processing.

Lockheed Martin engineers and technicians install the heat shield to the Orion crew module July 25, 2018, inside the Neil Armstrong Operations and Checkout Building high bay at NASA’s Kennedy Space Center in Florida. Orion is being prepared for Artemis 1, the first uncrewed integrated flight test atop NASA’s Space Launch System rocket. The heat shield will need to withstand temperatures of up to 5,000 degrees Fahrenheit during Orion’s descent and re-entry through the Earth’s atmosphere before it splashes down in the Pacific Ocean.
This year was a banner year for the Engineering Directorate at NASA’s Kennedy Space Center. The team accomplished an unprecedented number of achievements while supporting all of the agency’s spaceflight programs. The team persisted with advancements in engineering and technology developments that have firmly established the center as a premier, multi-user spaceport, enabling research, processing and launch site operations for government and commercial customers.

The Engineering team supported the Commercial Crew Program’s (CCP) significant progress toward certifying both CCP partners, SpaceX and Boeing, for their first flight tests. These flights, while uncrewed, will be the first time the United States has launched a human-rated spacecraft in more than seven years. While focused on the test flights, the team continues to work on all SpaceX Crew Dragon modules and Boeing Starliners, including the vehicles that will carry the astronaut crews that were named this year.

The Space Launch System, Orion and Exploration Ground Systems Programs realized significant progress as the Kennedy Engineering team delivered, prepared and installed ground system equipment that will enable the fulfillment of NASA’s goals and objectives of deep space exploration.

This year marked the completion of umbilical testing at the Launch Equipment Test Facility, with subsequent installation of all 21 required umbilicals and vehicle support posts on the Mobile Launcher (ML). Activity progressed as the ML made a successful trek to Launch Complex 39B and to the Vehicle Assembly Building, where Multi-Element Verification and Validation testing began.

In 2018, the Engineering Directorate provided critical engineering expertise to the Launch Services Program (LSP) to help them successfully launch a historic portfolio of six launches, including launches from two different coasts. This includes the launch of the Parker Solar Probe, which will travel through the Sun’s atmosphere and closer to the surface than any spacecraft before.

This increased launch pace and launch vehicle diversity created challenges and complexities throughout the year, but all were conquered by the LSP team. The directorate also worked throughout 2018 to provide engineering excellence during the ground processing and flight readiness of three commercial resupply missions that launched over 19,000 pounds of science, crew supplies, and hardware to the International Space Station and is on target to launch two more missions prior to the end of the year.

The Engineering Construction of Facilities (CoF) team had another successful year, providing superior leadership and technical prowess in the design and construction of both institutional and programmatic facilities. The CoF team is in the process of completing the first of two phases of the Kennedy Coastal Shoreline Restoration project in support of Hurricane Matthew recovery efforts. The successful implementation of this project will mitigate a center-wide risk as breach of the 4.5-mile shoreline would result in a significant disruption of Kennedy’s critical center-wide services and operational support.

Kennedy continues to serve as the archetype of innovation, paving the way for a dynamic future in space exploration. The Engineering Directorate’s significant contributions to all center programs help the agency be better positioned for overcoming future challenges. The combined expertise and diligent engineering provided by Kennedy’s workforce this past year will transform a rich record of successes into tomorrow’s victories.
Employees of Kennedy’s Engineering Directorate gather in the conference room of Operations Support Building II for a presentation by NASA Administrator Jim Bridenstine. He made his first official visit to the Florida spaceport on Aug. 6 and 7, 2018.

The team that tested the umbilical lines and accessories that will connect from the mobile launcher to NASA’s Space Launch System rocket and Orion spacecraft for Artemis 1 pause for a group photo during a banner signing event July 24, 2018, marking the completion of testing at the Launch Equipment Test Facility.

The team that tested the umbilical lines and accessories that will connect from the mobile launcher to NASA’s Space Launch System rocket and Orion spacecraft for Artemis 1 hold a banner signing event July 24, 2018, to mark completion of testing at Kennedy’s Launch Equipment Test Facility. A total of 21 umbilicals and launch accessories were tested on various simulators at the facility before they were transferred to the mobile launcher for installation.
The Spaceport Management and Integration Division is an integral part of Kennedy’s evolution to a multi-user spaceport. The division leads the processes that enable NASA’s commercial space partners to operate as independently as possible, efficiently obtain essential services, and successfully conduct Federal Aviation Administration-licensed launches from America’s spaceport. A total of 20 launches were supported in 2018, including three NASA Launch Services Program missions and 14 commercial launches licensed by the Federal Aviation Administration, including the first launch of the SpaceX Heavy rocket from historic Launch Complex 39A.

FACILITY UPGRADES
Spaceport Integration refurbished the Astronaut Crew Quarters inside the center’s Neil Armstrong Operations and Checkout Building; renovated the Beach House, a historic conference facility damaged during 2016’s Hurricane Matthew; and revitalized the Central Industry Assistance Office Facility.

28,000+ Pieces of Inventory
Spaceport Integration Improves Inventory Tracking by reducing the center’s loss rate to .08 percent, well below the agency benchmark of .5 percent.

Key Facility Systems Pass the Test
The Facility Systems Branch created and tested Kennedy Complex Control System Human Machine Interface screens in support of numerous Construction of Facilities and Program projects. This included screens for the C5 emergency power plant, Central Campus power distribution, Central Campus Solar Farm, Pad B Uninterruptible Power Supply, Mobile Launcher power, fire suppression and facility pneumatic panels. The Facility Systems Branch engineering personnel were also the project managers and lead engineers for the Pad B UPS replacement project, which was completed mid-summer.

KENNEDY IS ENVIRONMENTALLY ‘GREEN’
Environmental stewardship and sustainability are essential to managing resources and protecting the unique landscape the spaceport calls home. The center scored almost all “green” on its annual Sustainability Scorecard, by meeting or surpassing the center’s goals in the reduction of greenhouse gas emissions, energy and potable water usage, use of renewable energy and alternative fuels, pollution prevention and waste management, and sustainable acquisition. The FY2018 Energy and Water Program goals were met and contributed to substantial cost savings for the center and agency.

60 Million Pounds
Tons of waste were diverted from the center’s landfill including soil dredged from roadside ditches, steel from Launch Complex 39A, compost, office paper, recycled glass, aluminum, plastic and steel cans/bottles.
Facilities Ready to Support MULTI-USER SPACEPORT

Facility Systems Branch engineering personnel supported successful completion of Launch Pad 39B flame deflector installation; supported solid rocket booster throat plug resolution team efforts and supported Blue Origin regarding their Ignition Overpressure and Sound Suppression system. In May, the team successfully led the Pad B Standalone Wet Flow 2.0 Verification and in September, the Validation Test and mobile launcher fit check test at Launch Complex 39B.

REVOLUTIONARY AIR TECHNOLOGY DEVELOPED

The Biomedical Engineering and Research Laboratory (BERL) has been involved in improving the state-of-the-art of liquid air-based life support technology. Under a partnership with the National Institute for Occupational Safety and Health (NIOSH), the BERL has developed new techniques for long term storage of liquid air, new breathing devices capable of working in various orientations, and sensors to detect cryogenic liquid levels in a moving dewar (a liquid air storage device). During this past year, BERL personnel have developed a revolutionary technology for a liquid air self-contained breathing apparatus (SCBA) that utilizes the user’s body heat to vaporize and warm the liquid air and make it breathable.

BERL has also prepared for a new era in human spaceflight by developing specialized equipment for crew rescue and medevac capabilities. This includes new, dual patient capacity for Kennedy’s helicopters, maximizing space available for patient treatment. BERL is developing specialized equipment for Air Force helicopters, improving paramedics’ ability to effectively treat patients. Additionally, they worked on converting the Mine Resistant Ambush Protected (MRAP) vehicles from their original design for military use to meet the center’s needs as an emergency crew egress vehicle.

12,000+ Tons of Soil

In a Launch Site Clean-up, the Remediation Program conducted the excavation and proper disposal of 8,771 tons of contaminated soil from three sites and is currently removing 2,380 tons from a fourth site.

3.5 Miles of Shoreline

Kennedy’s Hurricane Matthew Shoreline Repair Project is underway to restore its natural state by fortifying 3.5 miles of Kennedy’s shoreline. This project is designed to not only restore habitat, but protect Kennedy’s crucial launch infrastructure.

10,700+ POUNDS RECYCLED

During Kennedy’s America Recycles Day event, a total of 10,736 pounds of employees’ personal material was collected and donated to charitable organizations.
Ready for Emergencies

The Protective Services Office Emergency Management Team activated the Emergency Operation Center 37 times to support Kennedy and 45th Space Wing launches and a visit to the spaceport by Vice President Mike Pence.

Full-Scale Aircraft Training Exercise

Kennedy’s Fire Department conducted a full-scale aircraft training exercise which required firefighters to perform aircraft firefighting extinguishment and search-and-rescue operations. The training was conducted in extreme smoke and live fire conditions.

Lights Out for Sea Turtles runs from March through October contributing to a successful nesting season on the beaches of the Canaveral National Seashore and Merritt Island National Wildlife Refuge.

$2.2 Million Excessed
$308,000 Sales of Surplus

The logistics branch also supplemented Kennedy’s budget for new procurements by coordinating the reutilization of $2.2 million in excess property, and generating $308,000 in proceeds from surplus sales.
Preparing for Orion Ascent Abort-2

Kennedy’s Flight Operations team worked with members from the Orion Ascent Abort-2 program at NASA’s Johnson Space Center in Houston for testing of electronic data recorders five miles offshore of the Florida spaceport. The recorders were dropped from one of Kennedy’s UH-1H II helicopters flying 5,000 feet above the ocean surface to simulate deployment during an ascent abort scenario. Flight Operations personnel led the team through the Airworthiness and Flight Safety Review Board process. The test was a key requirement in preparing for a FY2019 flight test from Cape Canaveral Air Force Station’s Space Launch Complex 46.

World-Class Competitors

Kennedy’s Emergency Response Team placed fifth overall while participating in the 2017 annual SWAT Roundup International Competition. There were 54 teams from around the world.

Fast Rope

Kennedy’s Flight Operations and the Emergency Response Team conduct fast rope training on space center property. Security works frequently with Flight Operations to conduct realistic training to ensure both groups are prepared.

Active Shooter Exercise

More than 150 Kennedy first responders, volunteers, controllers, evaluators and observers participated in a full-scale, realistic active-shooter exercise testing all aspects of the space center’s emergency first-response capabilities. The exercise was captured for a video to be used as a training and awareness tool.
Communication and Public Engagement

Journalists came to Kennedy Space Center during FY 2018 to participate in the 52 media projects that took place throughout the year. Six launches and five media day events brought in about 865 media members. Kennedy also hosted individual media requests on projects for the Discovery Channel, BBC, Travel Channel and Science Channel, as well as 150 crew members for movie production of “First Man.”

Through a variety of social media channels, Kennedy engaged and informed millions of people online about the exciting missions and science taking place.

Priority social media platforms include Facebook, Twitter, Instagram, YouTube, Flickr and USTREAM.

Through hundreds of posts and Tweets, the center reached 38.1 million Twitter users and 3.8 million Facebook users. On YouTube, Kennedy has 75K subscribers and had more than 1.3 million views and 2.5 million minutes watched in FY 2018.

NASA Social events brought more than 350 participants to the Florida spaceport to cover six launches: three commercial resupply missions to the International Space Station, the Geostationary Operational Environmental Satellite-S, Transiting Exoplanet Survey Satellite and Parker Solar Probe. In addition to launches, two NASA Socials were held in conjunction with major agency events at Kennedy: the State of NASA and a meeting of the National Space Council, chaired by Vice President Mike Pence.

The Kennedy Academic Engagement Team reached 38,493 students and educators through workshops and programs led by professional educators at the Public Engagement Center and Educator Professional Development Cohort. Kennedy hosted two educator and 133 undergraduate and graduate interns.

NASA Established Program to Stimulate Competitive Research (EPSCoR) awarded 14 new Research Cooperative Agreements and augmented 28 Research Infrastructure Development projects with an additional year of funding. The program released four solicitations, including Research, International Space Station Flight Opportunity, Rapid Response Research and Research Infrastructure Development. EPSCoR partnered with Minority University Research Education Program (MUREP) to form a new collaboration, EPSCoR/MIRO (MUREP Institution Research Opportunities). Three International Space Station Flight Opportunity projects successfully flew in their third year.

The Academic Engagement Team hosted two university-level competitions at Kennedy, impacting approximately 3,000 students. Swarmathon is a software competition utilizing NASA’s “Swarmies” technology. The Robotic Mining Competition has teams design and build robots to mine regolith simulant and return it for processing. They also wrote and presented outreach project reports and system engineering papers. NASA’s First Nations Launch Competition, hosted in partnership with Wisconsin’s Space, reached more than 102 Native American students.

NASA Days at Minority Serving Institutions provides college students the opportunity for one-on-one interaction with NASA managers, information sessions on NASA internship programs, networking meetings with faculty members and NASA managers, and insight for the science and technology research community on conducting research business with NASA. Visits in 2018 included two campuses of Polytechnic University of PR, three...
campuses of Inter-American University in Puerto Rico, Southern University, Florida International University and Bethune Cookman University.

Educator programs hosted at Kennedy included two NASA MUREP Educator Institute (MEI) and a NASA Community College Aerospace Scholars (NCAS) workshop. MEI hosts pre-service teaching students and faculty from minority serving institutions for an immersive experience with NASA facility tours, presentations by subject-matter experts, and “train the trainer”-style workshop sessions. It requires pre-requisite online coursework and post-requisite professional development. The NCAS workshop is a four-day, on-center workshop for community college students who have successfully completed a five week online course. Student teams mentored by Kennedy engineers compete in two Lego rover challenges to win a fictional NASA contract.

Members of the media attend a briefing in the NASA News Center auditorium on June 28, 2018. The briefing focused on research planned for launch to the International Space Station on SpaceX CRS-15.

Above: Television reporters begin setting up at the NASA News Center to await lift-off of the SpaceX Falcon Heavy rocket from Kennedy’s Launch Complex 39A at Kennedy Space Center in Florida. The iconic Vehicle Assembly Building and Launch Control Center are visible in the background. The Falcon Heavy demonstration flight was a significant milestone for the world’s premier multi-user spaceport.

Below: Students from Montgomery College in Rockville, Maryland, follow the progress of their Swarmie robots during the spaceport’s third annual Swarmathon competition at the Kennedy Space Center Visitor Complex on April 17, 2018. Twenty-three teams representing 24 minority serving universities and community colleges were invited to develop software code to operate these innovative robots known as “Swarmies” to help find resources when astronauts explore distant locations, such as the Moon or Mars.
The Kennedy Space Center Fiscal Year 2018 budget was $2.57 billion. The center also performed $179.1 million in reimbursable work with other government and commercial entities.

During Fiscal Year 2018, the Commercial Crew Program (CCP), along with industry partners Boeing and SpaceX, made significant strides to return human spaceflight capabilities to the United States through its Commercial Crew Transportation Capability (CCtCap) contracts. Both partners continued to develop, test and integrate their unique space systems, completing key milestones and making significant progress toward NASA certification.

CCP assigned flight crews to Boeing and SpaceX’s test flights and first operational missions. The crews include a total of eight NASA astronauts and one Boeing astronaut.

The program updated its CCtCap contract with Boeing to provide flexibility in its flight tests to the space station. Boeing proposed extending the duration of the Crew Flight Test, if necessary, and adding a third crew member to the flight. These modifications could offer NASA additional flexibility to ensure continued U.S. access to the orbiting laboratory. The modification also identifies cargo capabilities for the company’s uncrewed and crewed test flights. Exact details of how to take advantage of the contract modification are currently under evaluation.

Boeing continues to manufacture its CST-100 Starliner spacecraft inside the Commercial Crew and Cargo Processing Facility at Kennedy. Multiple service modules and three crew modules are in various phases of production.

At Launch Complex 39A, SpaceX installed its Crew Access Arm and white room, along with additional structural upgrades to the site. The company also completed a launch day simulation, which involved crew transport from Crew Quarters to the launch pad and ascent of the Crew Access Tower to the white room.

SpaceX, NASA and U.S. Air Force personnel also completed a joint recovery exercise to prepare for and ensure crew safety in the unlikely event of a rescue at sea. As part of this exercise, a full-scale model of the spacecraft was used for Air Force pararescue specialists to practice extracting crew from the capsule and transporting them to lifeboats.

CCP also is working with Blue Origin and Sierra Nevada to develop and refine their respective spacecraft and launch systems. Under these Commercial Crew Development Program Round 2 (CCDev2) and Commercial Crew Integrated Capability (CCiCap) agreements, NASA provides expertise and insight into their spaceflight designs.

All of these activities demonstrate how the CCP continues to contribute toward making the Florida Spaceport a premier launch complex for human spaceflight.

During the fiscal year, the Launch Services Program supported five successful mission launches: Geostationary Operational Environmental Satellite (GOES-S), Transiting Exoplanet Survey Satellite (TESS), Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight), Parker Solar Probe, and Ice, Cloud and land Elevation Satellite-2 (ICESat-2) launched from Cape Canaveral Air Force Station in Florida and Vandenberg Air Force Base in California. LSP achieved its 90th mission with the recent launch of ICESat-2 on the final Delta II rocket. The program also procured launch vehicle services and other support for several manifested missions scheduled to launch in FY 2019 and beyond.

The Exploration Ground Systems Program budget included both Exploration Ground Systems and the 21st Century Space Launch Complex funding. Key modernization and compatibility efforts for the launch of the Space Launch System rocket and the Orion spacecraft on Artemis 1 (A1) include the move of the mobile launcher into the Vehicle Assembly Building (VAB), which signifies the center’s readiness for A1. In addition, support began for mobile launcher and VAB multi-element validation and verification, Pad B modernization (including the Liquid Hydrogen Sphere Upgrades) and development of the Spaceport Command and Control System. Furthermore, enhancements for the Kennedy Space Center multi-user spaceport continued for the development of ground operations infrastructure to facilitate the activities of future customers and stakeholders, including government agencies, commercial industry, and current and future NASA programs.

The International Space Station Program allowed for continued success toward achieving and maintaining the space station program mission of fully utilizing a permanent human outpost in space. Kennedy’s Exploration Research and Technology Programs efforts afforded provisions for ground processing support for experiments hardware, as well as orbital replacement units needed to maintain the space station. The budget also provided for ongoing development of hardware intended to promote full utilization of the space station through the establishment of fundamental biological research capabilities.

Kennedy’s Center Management and Operations maintained the center’s essential infrastructure and its core technical capabilities, and sustained necessary safety and engineering technical authorities to support NASA’s mission and enable multi-user spaceport readiness.

Kennedy’s Hurricane Irma emergency supplemental budget funded windstorm damage assessments, facility stabilizations and subsequent ongoing repairs to ensure all underlying center capabilities and critical infrastructure are ready and able to help fulfill NASA mission objectives and Spaceport partner requirements.
## KENNEDY SPACE CENTER
### FY 2018 BUDGET AUTHORITY ($ IN MILLIONS)

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<th>Element</th>
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<td>Launch Services/Science</td>
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## NASA/KSC BUDGET AUTHORITY SUMMARY
### FY 2016 THROUGH FY 2018 ($ IN MILLIONS)

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## FY 2018 KSC BUDGET BY ELEMENT ($ IN MILLIONS)

- **Procurement**: $2,277M (88.3%)
- **Personnel Costs**: $294M (11.4%)
- **Travel**: $7M (0.3%)

Total: $2,578M
Kennedy Space Center is the nation’s premier, multi-user spaceport. It is an integral part of the local economy, providing nearly 10,000 jobs for civil servants, contractors, tenants and construction crews.

The workforce includes people with many skills who are dedicated to supporting the nation’s space program and NASA’s future exploration to destinations including the Moon and Mars. To accomplish the agency’s various missions, these individuals fulfill a multitude of tasks.

At the end of each year, the center takes a snapshot of its workforce. This picture includes all federal and contractor employees chartered to work for Kennedy. Other organizations, such as the European Space Agency and Patrick Air Force Base, have roles here but are not reflected in these numbers.

The civil servant skill mix includes those in science, technology, engineering and mathematics positions and those in professional administrative and clerical positions.

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**KENNEDY SPACE CENTER WORKFORCE PROFILE**

*(through 9/30/18)*

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<table>
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<td>1,909*</td>
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<td>NASA Pathways Interns</td>
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<td><strong>Total Civil Servants</strong></td>
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<td>*includes 8 part-time permanent and 1 full-time temporary employees</td>
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**Civil Servants Skill Mix**

- Scientific, Technology, Engineering and Mathematics: 33%
- Clerical and Professional Administrative: 67%

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<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Total Construction Workers</td>
<td>445</td>
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<tbody>
<tr>
<td>Total Tenants</td>
<td>2,146</td>
</tr>
<tr>
<td><strong>TOTAL KSC POPULATION</strong></td>
<td><strong>9,224</strong></td>
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</table>
INDUSTRY PARTNERS AT A GLANCE

The companies listed below were some of Kennedy Space Center’s top support or launch services contractors in terms of dollars obligated in Fiscal Year 2018. Following is a brief description of their work for the agency:

THE BOEING COMPANY

The Boeing Company participated in NASA’s goal of developing orbital commercial Crew Transportation Systems. Under the Commercial Crew Transportation Capability (CCtCap) contract for NASA’s Launch America initiative, Boeing was tasked with developing safe, reliable and cost-effective crew transportation to and from the International Space Station on American spacecraft launched from the United States.

UNITED LAUNCH SERVICES LLC

United Launch Services, or ULS, is a subsidiary of United Launch Alliance, a joint venture between The Boeing Company and Lockheed Martin Commercial Launch Services. ULS provided commercial launch services to NASA using the Delta and Atlas launch vehicles under the NASA Launch Services (NLS) II multiple-award, indefinite delivery, indefinite quantity task order contract. Principal location for the Delta and Atlas vehicle assembly is Decatur, Alabama. Both vehicles launch from Cape Canaveral Air Force Station in Florida and Vandenberg Air Force Base in California.

JACOBS TECHNOLOGY INC.

Jacobs Technology Inc., prime contractor for the Test and Operations Support Contract (TOSC), is responsible for the overall management and implementation of ground systems capabilities, flight hardware processing and launch operations at Kennedy Space Center. Specific services provided by Jacobs Technology under TOSC include launch vehicle, spacecraft and payload integration and processing; operations and development of associated processes for ground systems to support integration, processing and launch; servicing and testing of flight hardware; and launch of development and operational flights at Kennedy.

SPACE EXPLORATION TECHNOLOGIES CORP.

Space Exploration Technologies Corporation (SpaceX) participated in NASA’s goal of developing orbital commercial Crew Transportation Systems. Under the Commercial Crew Transportation Capability (CCtCap) contract for NASA’s Launch America initiative, SpaceX was tasked with developing safe, reliable and cost-effective crew transportation to and from the International Space Station on American spacecraft launched from the United States. SpaceX also participated via a Space Act agreement supporting the agency’s Commercial Crew Integrated Capability (CCiCap) initiative.

URS FEDERAL TECHNICAL SERVICES INC.

URS Federal Technical Services provided base operations support for Kennedy Space Center. URS Federal Technical Services was responsible for operations, maintenance and engineering for specific Kennedy facilities, systems, equipment and utilities. URS Federal Technical Services also was responsible for calibration and propellants handling at the center.

PRECISION MECHANICAL INC.

Precision Mechanical Technical Services provided for the fabrication, construction and integration of a new 1.25 million gallon LH2 storage sphere, associated vaporizers, flare stack and propane system, and other equipment into the liquid hydrogen (LH2) system at the center’s Launch Complex 39B.

J.P. DONOVAN CONSTRUCTION INC.

J.P. Donovan Construction Inc., provided general contracting management and construction services for Exploration Ground Systems’ mobile launcher ground support equipment installation effort. The mobile launcher modifications are necessary to meet NASA’s beyond Earth orbit mission. J.P. Donovan Construction also was the prime contractor for the Pad 39B flame trench deflector and refurbishment, and the center’s shoreline restoration effort.

AFDS FEDERAL DATA SOLUTIONS LLC

AFDS Federal Data Solutions provided communication and information technology services under the Kennedy Infrastructure Applications & Communications, or KIAC, contract. Products and services AFDS provides include: application operations and software development; data center operations; voice, imaging and data communications; multimedia services support; documentation and reproduction; and research and library management.
**YOUR PROCUREMENT DOLLARS AT WORK**

**GEOGRAPHICAL DISTRIBUTION BY STATE**

(Fiscal Year 2018 Obligations)

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<thead>
<tr>
<th>STATE</th>
<th>TOTAL DOLLARS</th>
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<tr>
<td>ALABAMA</td>
<td>10,941,844</td>
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<tr>
<td>ARIZONA</td>
<td>8,723,000</td>
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<tr>
<td>CALIFORNIA</td>
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<td>COLORADO</td>
<td>456,006,224</td>
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<tr>
<td>CONNECTICUT</td>
<td>4,223,245</td>
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<tr>
<td>FLORIDA</td>
<td>199,613,403</td>
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<tr>
<td>GEORGIA</td>
<td>8,711,900</td>
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<td>ILLINOIS</td>
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<tr>
<td>INDIANA</td>
<td>2,193,282</td>
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<td>LOUISIANA</td>
<td>8,133,520</td>
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<td>MARYLAND</td>
<td>237,532,822</td>
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<tr>
<td>MICHIGAN</td>
<td>1,531,344</td>
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<td>MISSOURI</td>
<td>2,083,018</td>
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<tr>
<td>MONTANA</td>
<td>816,947</td>
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<tr>
<td>NEVADA</td>
<td>228,260</td>
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<tr>
<td>NEW JERSEY</td>
<td>19,321</td>
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<tr>
<td>NEW MEXICO</td>
<td>11,708,296</td>
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<tr>
<td>NEW YORK</td>
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<tr>
<td>OHIO</td>
<td>4,371,418</td>
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<tr>
<td>PENNSYLVANIA</td>
<td>20,945,475</td>
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<tr>
<td>SOUTH DAKOTA</td>
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<tr>
<td>TENNESSEE</td>
<td>312,847,868</td>
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<tr>
<td>TEXAS</td>
<td>660,419,656</td>
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<td>VIRGINIA</td>
<td>78,392,660</td>
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<td>WASHINGTON</td>
<td>614,325</td>
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<tr>
<td>TOTAL</td>
<td>$2,307,026,733</td>
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46
# TOP 25 KSC BUSINESS CONTRACTORS FOR FY 2018

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Dollars</th>
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<tbody>
<tr>
<td>THE BOEING COMPANY</td>
<td>650,286,847</td>
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<tr>
<td>UNITED LAUNCH SERVICES LLC</td>
<td>455,470,330</td>
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<tr>
<td>JACOBS TECHNOLOGY INC.</td>
<td>293,217,559</td>
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<tr>
<td>SPACE EXPLORATION TECHNOLOGIES CORP.</td>
<td>260,521,115</td>
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<tr>
<td>URS FEDERAL SERVICES INC.</td>
<td>148,869,119</td>
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<tr>
<td>PRECISION MECHANICAL INC.</td>
<td>60,683,436</td>
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<tr>
<td>J.P. DONOVAN CONSTRUCTION INC.</td>
<td>51,119,483</td>
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<tr>
<td>ASRC FEDERAL DATA SOLUTIONS INC.</td>
<td>40,435,809</td>
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<tr>
<td>AI SOLUTIONS INC.</td>
<td>35,963,687</td>
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<tr>
<td>CHENEGA INFINITY INC.</td>
<td>32,664,256</td>
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<tr>
<td>MILLENNIUM ENGINEERING AND INTEGRATION CO.</td>
<td>22,815,199</td>
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<tr>
<td>INTEGRATED MISSIONS SUPPORT SERVICES LLC</td>
<td>16,753,837</td>
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<tr>
<td>AIR PRODUCTS AND CHEMICALS INC.</td>
<td>15,463,970</td>
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<tr>
<td>FLORIDA POWER AND LIGHT COMPANY INC.</td>
<td>14,157,975</td>
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<tr>
<td>APACHE-LOGICAL JV</td>
<td>11,730,866</td>
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<tr>
<td>PAE-SGT PARTNERS LLC</td>
<td>10,982,415</td>
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<tr>
<td>SWORD &amp; SHIELD ENTERPRISE SECURITY INC.</td>
<td>10,969,613</td>
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<tr>
<td>AIR LIQUIDE LARGE INDUSTRIES U.S. LP</td>
<td>9,918,243</td>
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<tr>
<td>NEW DIRECTIONS TECHNOLOGY CORP.</td>
<td>9,651,221</td>
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<tr>
<td>ABACUS TECHNOLOGY CORP.</td>
<td>9,578,880</td>
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<tr>
<td>ODYSSEY INTERNATIONAL INC.</td>
<td>8,723,000</td>
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<tr>
<td>A-P-T RESEARCH INC.</td>
<td>8,679,541</td>
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<tr>
<td>SES CIVIL CONTRACTORS LLC</td>
<td>7,928,034</td>
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<tr>
<td>BREVARD ACHIEVEMENT CENTER INC.</td>
<td>6,986,856</td>
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<tr>
<td>SAUER INC.</td>
<td>6,552,428</td>
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<tr>
<td>TOTAL</td>
<td><strong>2,200,123,719</strong></td>
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