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National Aeronautics and Space Administration

KENNEDY SPACE CENTER'S

SPACEPORT magazine

Celebrating Apollo 11 50th Anniversary
Preparing for our Return to the Moon

KENNEDY SPACE CENTER'S

SPACEPORT MAGAZINE

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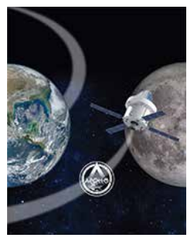

The cover design celebrates NASA's 50th anniversary of the Apollo 11 launch and Moon landing, and the agency's plans to send the first woman and next man back to the Moon. Design credit: NASA/Amy Lombardo

Kennedy Space Center has its own monthly podcast. Welcome to the "Rocket Ranch." **Listen to Episode 11: The Place that Sends Stuff to Space**. We're looking back at the Space Station Processing Facility, or SSPF, as it turns 25 years old. Check out Episode 11, read the full transcript and catch up on missed episodes at https://www.nasa.gov/kennedy/rocketranch.

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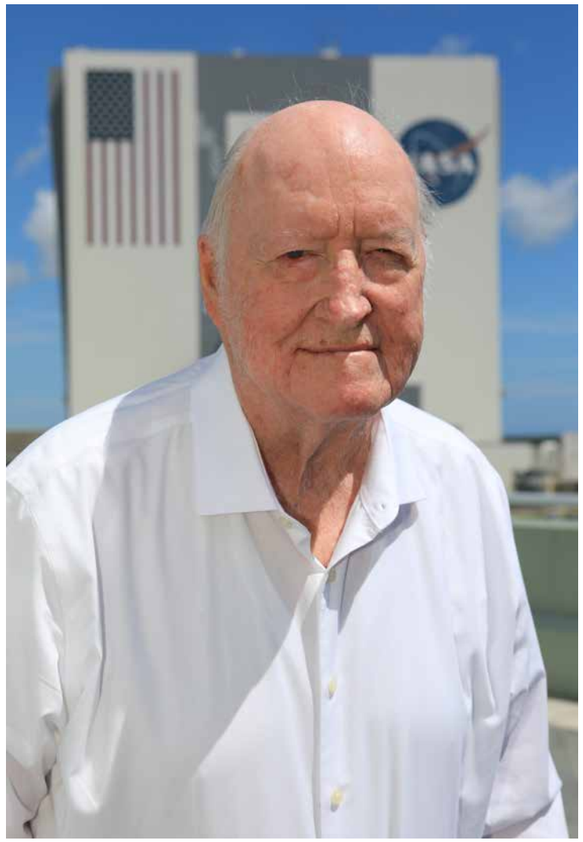


GRADY B. MCCORQUODALE

I am an engineer and subject matter expert with KBR/SGT on the Test and Operations Support Contract at Kennedy Space Center. My main responsibilities are design and test engineering in space launch systems.

I have been at Kennedy since 1965, and in my current job for seven years. I work on the design and test hydraulic systems for the thrust vector control that will steer NASA's Space Launch System rocket. I also design and test the air revitalization system which will separate carbon dioxide from oxygen on future space systems.

I began my aerospace career at Marshall Space Flight Center in Huntsville, Alabama, in 1963. I was an engineer and worked on the Saturn V/Apollo. I followed the equipment I designed to Kennedy to participate in that equipment's integration into the Apollo Program. Since that time, I have worked for many companies at Kennedy in design and test engineering.

The biggest challenge is trying to fit this job with my personal life and taking care of my wife of 67 years. I depend on the Lord's guidance every day to help me through the challenges. I also have an interest in helping the younger generations in our space program.

One of my favorite memories was watching the first Apollo Saturn V launch, Apollo 7. I had equipment supporting this launch which had been running for two weeks continuously. I watched Apollo 11 from home with my family. It was truly a wonderful experience and I strongly believed all along that we were going to succeed. History had its greatest opportunity binding the country together and demonstrating to the world we had taken a giant leap for mankind. I'm looking forward to the development of a supersonic nozzle which will separate carbon dioxide from oxygen for future space flight. This is important because carbon dioxide is our common enemy in microgravity and we are trying to solve this very bothersome problem with a more robust system.

I'm getting close to 90 years old and still find this job exciting.

Honoring NASA's Heritage

Pence praises agency's bright future on anniversary of historic Apollo launch

BY JIM CAWLEY

NASA's past and present came together during Vice President Mike Pence's visit to **Kennedy Space Center** on July 20, 2019 — 50 years from the day the first two humans walked on the Moon.

Attending with his wife, second lady Karen Pence, and NASA Administrator Jim Bridenstine, the vice president honored the heroes of the **Apollo 11 mission** during his stop at the Florida spaceport, which included visits to the Shuttle Landing Facility and **Launch Complex 39A**, the site of the historic Apollo 11 launch on July 16, 1969. He then addressed National Space Council members, elected officials, invited guests and NASA and Lockheed Martin employees at Kennedy's Neil Armstrong Operations and Checkout (O&C) Building.

"On this historic occasion, I'm told that we've also achieved a critical milestone in our effort to go to the Moon and beyond," said Pence, who serves as chairman of the National Space Council. "Today, thanks to the hard work of the men and women of NASA and of American industry, the **Orion crew vehicle** for the **Artemis 1 mission** is complete and ready to begin preparations for its historic first flight."

Apollo 11 astronaut Buzz Aldrin, who followed Neil Armstrong in walking on the lunar surface while Michael Collins piloted the command and service module, stood and saluted the crowd as Pence praised the three men as heroes.

"True to their creed, astronauts have never liked the idea of being called heroes," Pence said. "Yet, for all they did and for all the risks they took… if Neil Armstrong, Buzz Aldrin and Mike Collins are not heroes, then there are no heroes. We honor these men today, and America will always honor our Apollo astronauts."

Pence also thanked **Apollo 17** astronaut Harrison Schmitt, who attended the celebration, for his "courageous service." Schmitt was a part of the final trip to the Moon, almost 47 years ago. During that mission, Gene Cernan uttered these final words as he stepped off the Moon on Dec. 17, 1972: "We leave the Moon as we came, and God willing, we shall soon return — with peace and hope for all mankind." That quote rings true today, Pence said, as NASA follows President Donald Trump's Space Policy Directive 1.

Vice President Mike Pence addresses National Space Council members, elected officials, invited guests and NASA and Lockheed Martin employees at Kennedy's Neil Armstrong Operations and Checkout Building on Saturday, July 20, 2019. Photo credit: NASA/Kim Shiflett

Apollo astronaut Buzz Aldrin, right, shakes hands with Vice President Mike Pence as NASA Administrator Jim Bridenstine applauds at Kennedy Space Center's Neil Armstrong Operations and Checkout Building on Saturday, July 20, 2019. Photo credits: NASA/Kim Shiflett

"This challenges NASA to lead the return of Americans to the Moon, send the first Americans to Mars, and enable Americans to expand and deepen our reach across the solar system," Pence said. "It is our mission."

Florida Governor Ron DeSantis was the opening speaker at the event, which included brief speeches from Bridenstine, Kennedy Director Bob Cabana and Lockheed Martin Chairwoman, President and CEO Marillyn Hewson. Members of Neil Armstrong's family also were in attendance.

"I am excited to look back on that 50 years and what a great achievement it is," DeSantis said of the Apollo 11 mission. "But I think the story of that is still being written because I think the things that are going to happen in the relatively near future are going to be ones for the record book."

Bridenstine called the day a celebration not only for NASA and the country, but also the world. The NASA administrator sees stark similarities between present day and that historic moment 50 years ago.

"Similar to the 1960s, we, too, have an opportunity to take a giant leap forward for all of humanity," Bridenstine said. "President Trump and Vice President Pence have given us a bold direction as an agency to return to the Moon within five years and go forward to Mars."

The NASA administrator also commended Cabana for his efforts in transforming Kennedy into a multi-user spaceport capable of carrying out President Trump's directive.

"Now we have great news that, in fact, the American space program is coming back," Bridenstine said. "And it's coming back with a vengeance."

“The Eagle Has Landed”

50 years ago: Apollo 11 astronauts land, take first U.S. steps on Moon

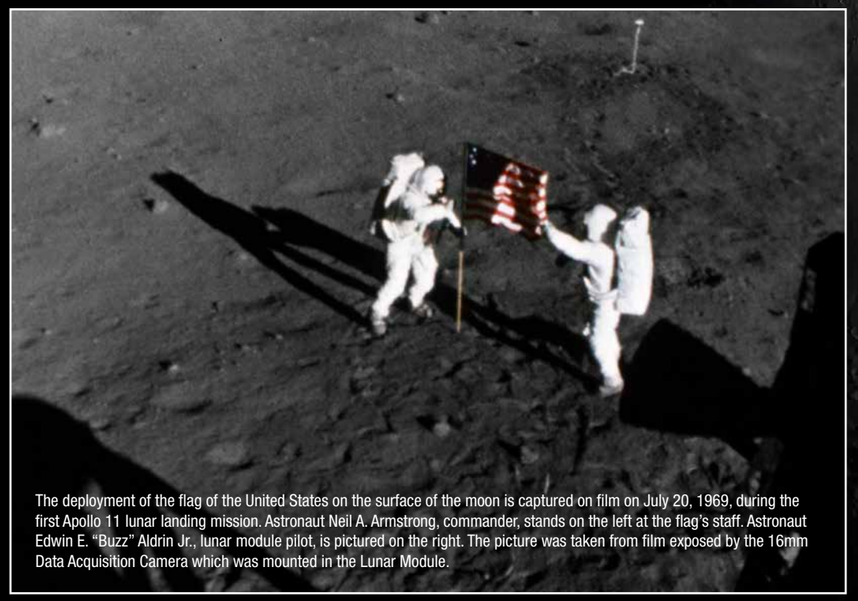
BY LINDA HERRIDGE
(with NASA archival mission information)

“Tranquility base here. The Eagle has landed.” Most everyone knows these iconic words spoken by Apollo 11 Commander **Neil A. Armstrong** after he and fellow crewmate, Lunar Module Pilot **Edwin “Buzz” Aldrin**, set the **lunar module**, called Eagle, on the surface of the Moon 50 years ago, on July 20, 1969. Command Module Pilot **Michael Collins** remained in the command and service module (CSM), called Columbia, orbiting above.

Collins revisited Launch Complex 39A, the site of the Apollo 11 launch, and Firing Room 1 in the Launch Control Center at Kennedy Space Center on July 16, 2019, and reminisced about the mission with Center Director Bob Cabana.

“The Apollo 11 mission to the Moon had many important milestones along the way,” Collins said. “More than anything else, it was the attention to detail our workers and administrator gave to putting the equipment together on the ground, and then testing it in as close to flight conditions as they could.”

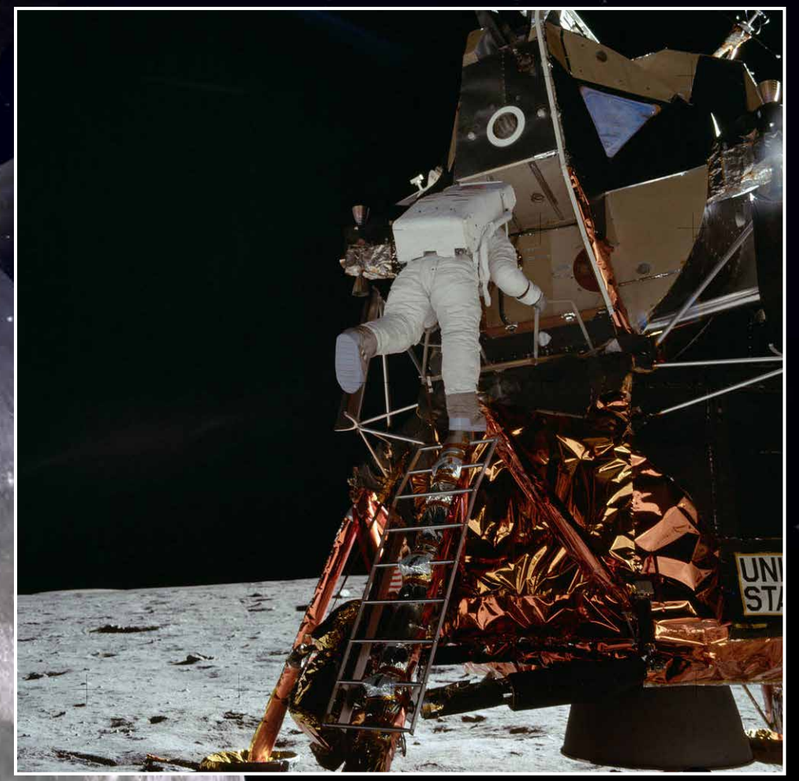
Those efforts paid off as an estimated 650 million people watched Armstrong’s image and heard his voice describe the event as he took “….one small step for (a) man, one giant leap for mankind.” The second astronaut to step foot on the Moon, Aldrin, is the image we see in many photographs. Armstrong and Aldrin planted an American flag on the Moon. Although it was a significant first for the American space program, all three Apollo 11 astronauts journeyed to the Moon for all mankind.



The deployment of the flag of the United States on the surface of the moon is captured on film on July 20, 1969, during the first Apollo 11 lunar landing mission. Astronaut Neil A. Armstrong, commander, stands on the left at the flag’s staff. Astronaut Edwin E. “Buzz” Aldrin Jr., lunar module pilot, is pictured on the right. The picture was taken from film exposed by the 16mm Data Acquisition Camera which was mounted in the Lunar Module.

The **Apollo 11** mission began when the three crewmembers launched in their **Apollo command/ service module** atop the powerful **Saturn V rocket** on July 16, 1969, at 9:32 a.m. from Pad 39A.

The first stage’s five F1 engines ignited, creating 7.5 million pounds of thrust to propel the rocket upward.



Astronaut Edwin E. “Buzz” Aldrin Jr., lunar module pilot, descends the steps of the Lunar Module (LM) ladder as he prepares to walk on the Moon on July 20, 1969. He had just egressed the LM. This photograph was taken by astronaut Neil A. Armstrong, commander, with a 70mm lunar surface camera during the Apollo 11 extravehicular activity (EVA). While Armstrong and Aldrin descended in the LM “Eagle” to explore the Moon, astronaut Michael Collins, command module pilot, remained with the Command and Service Modules in lunar orbit. Photo credit: NASA/Neil Armstrong

After burning out, the first stage separated and the second stage’s five J-2 engines ignited to further propel Apollo into an initial Earth-orbit. The second stage separated and fell away as the third stage’s single J-2 engine ignited to push Apollo out of Earth orbit. It reignited for a second burn of about five minutes, which placed Apollo 11 into a translunar orbit. The CSM separated from the third stage, which included the spacecraft-lunar module adapter (SLA), containing the lunar module (LM). The SLA panels jettisoned on the third stage, and Collins maneuvered the CSM back and around to dock with the LM.

The world viewed the first color television transmission to Earth from Apollo 11 during the translunar coast of the CSM and LM. On July 18, Armstrong and Aldrin climbed through the docking tunnel from Columbia to Eagle to check out the lunar module and make the second television transmission.

The first lunar orbit insertion maneuver occurred on July 19, after Apollo 11 flew behind the Moon and out of contact with Earth. Nearly 76 hours into the flight, a retrograde firing of the propulsion system placed the spacecraft into an initial, elliptical lunar orbit. A second burn of the propulsion system placed the docked vehicles into lunar orbit about 70 miles above the surface.

The Apollo 11 astronauts, from left, Neil A. Armstrong, commander; Michael Collins, command module pilot; and Edwin E. "Buzz" Aldrin Jr., lunar module pilot. Photo credit: NASA

On July 20, Armstrong and Aldrin entered the LM and made a final check. At about 100 hours into the flight, the astronauts undocked the "Eagle" and separated from "Columbia" for visual inspection. About an hour later, the LM descent engine fired for 30 seconds to provide retrograde thrust and commence descent orbit insertion. The flight trajectory was nearly identical to that flown by Apollo 10. Another firing of the LM descent engine occurred for several minutes until the LM was about 26,000 feet above the lunar surface.

As mission controllers were holding their breath, along with the rest of the world, Armstrong manually piloted the lunar module past a very rocky crater and landed in the **Sea of Tranquility**, about four miles downrange from the predicted touchdown point, and almost 1.5 minutes earlier than predicted. At about 109 hours, 42 minutes after launch, Armstrong stepped on the Moon. About 20 minutes later, Aldrin followed him.

During an interview on Sept. 19, 2001, Armstrong said: "I was certainly aware that this was a culmination of the work of 300,000 or 400,000 people over a decade and that the nation's hopes and outward appearance largely rested on how the results came out. It seemed the most important thing to do was focus on our job as best we were able to and try to allow nothing to distract us from doing the very best job we could."

The Apollo 11 moonwalkers spent 21 hours and 36 minutes on the Moon. They explored the surface, took extensive photographs of the lunar terrain and each other, and collected lunar surface samples. They deployed a television camera to transmit signals to Earth, a solar wind composition experiment, a seismic experiment package and a Laser Ranging Retroreflector.

"We learned a lot from Armstrong's surface samples; it's a gift that keeps on giving," said Harrison Schmitt, **Apollo 17** astronaut and first geologist to walk on the Moon. He joined Apollo-era launch team members JoAnn Morgan and Bob Sieck for an "Apollo Heroes" panel discussion July 16, 2019, at the Kennedy Space Center Visitor Complex.

Often referred to as a trailblazer, Morgan was the only female engineer in the firing room during Apollo 11 launch countdown activities. Sieck was a test team project engineer for Apollo and former space shuttle launch director.

The two moonwalkers left behind commemorative medallions bearing the names of the three Apollo 1 astronauts who lost their lives in a launch pad fire, and two cosmonauts who also died in accidents, on the lunar surface. A one-and-a-half inch silicon disk, containing micro miniaturized goodwill messages from 73 countries, and the names of congressional and NASA leaders, also were left on the Moon's surface. Attached to the descent stage was a commemorative plaque signed by President Richard M. Nixon and the three astronauts.

After resting for about seven hours, Armstrong and Aldrin fired the LM ascent stage to reach an initial orbit of 55 miles above the Moon on July 21, 13 miles below and slightly behind the CSM. Subsequent firings of the reaction control system helped the LM to reach an orbit of 72 miles above the Moon. The LM docked with the CSM on the CSM's 27th revolution. Armstrong and Aldrin

Astronaut Neil A. Armstrong, Apollo 11 commander, participates in simulation training June 19, 1969, in preparation for the scheduled lunar landing mission. In this photo, Armstrong is in the Apollo Lunar Module Mission Simulator in the Kennedy Space Center Flight Crew Training Building in Florida. Photo credit: NASA

returned to the CSM with Collins for the trip back to Earth. The LM was jettisoned four hours later and remained in lunar orbit, until it crashed on the Moon.

The Apollo 11 crew initiated re-entry procedures on July 24, 44 hours after leaving lunar orbit. The service module separated from the crew module. Collins re-oriented the crew module to a heat-shield-forward position for the descent to Earth. Apollo 11 splashed down in the Pacific Ocean, 13 miles from the recovery ship USS Hornet, and was retrieved. Apollo 11 was NASA's first mission to send astronauts to step on the Moon and return them safely to Earth. Five more Moon landings would follow before the Apollo Program ended in 1972.

Now, NASA is planning to establish a foundation for sustainable human presence on and around the Moon with commercial and international partners. Through the **Artemis** program, the agency will land American astronauts, including the first woman and the next man, on the Moon by 2024. Then the agency will use what it learns on the Moon and take the next giant leap – sending astronauts to Mars.

"I think it's a noble goal. It's much more extensive than Apollo. It's part of a bigger picture," Sieck said.

SATURN V FACTOIDS

Height: 363 feet tall, or 60 feet taller than the Statue of Liberty

Weight: 6.2 million pounds, fully fueled, or about the weight of 400 elephants

Thrust at launch: 7.6 million pounds, creating more power than 85 Hoover Dams

Payload weight to Earth orbit: 130 tons, or about the weight of 10 school buses

Payload weight to the Moon: 50 tons, or about the weight of four school buses

A car that gets 30 miles to the gallon could drive around the world about 800 times with the amount of fuel the Saturn V used for a lunar landing mission.

Rocket Fuel in Her Blood:

The Story of JoAnn Morgan

BY THALIA PATRINOS
NASA HEADQUARTERS

As the **Apollo 11 mission lifted off** on the **Saturn V rocket**, propelling humanity to the surface of the Moon for the very first time, members of the launch firing team inside Launch Control Center watched through a window.

The room was crowded with men in white shirts and dark ties, watching attentively as the rocket thrust into the sky. But among them sat one woman, seated to the left of center in the third row in the image below. In fact, this was the only woman working on console in the launch firing room for the Apollo 11 liftoff.

This is JoAnn Morgan, the instrumentation controller for Apollo 11.

Today, this is what Morgan is most known for. But her career at NASA **spanned over 45 years**, and she continued to break ceiling after ceiling for women involved with the space program. In addition to being the first woman at NASA to win a Sloan Fellowship, she was the first woman division chief, the first woman senior executive at Kennedy Space Center, the first woman associate director for the center, the first woman director of Safety and Mission Assurance…and the list goes on, as this feature will show.

So, let's begin to answer a question that has become crucial to understanding women's contributions to the Moon landing and NASA at large: Who *IS* JoAnn Morgan?

Members of the Kennedy Space Center government-industry team listen to a post-launch talk by Vice President Spiro T. Agnew after the Apollo 11 liftoff. JoAnn Morgan is seated to the left of center in the third row. Photo credit: NASA

JoAnn Morgan works in the Computer Systems Division at Kennedy Space Center. Photo credit: NASA

"A PRECOCIOUS LITTLE KID"

As a child, Morgan was a self-described "precocious little kid." She loved math, science and especially music — so much so, that she was convinced she would grow up to become a piano teacher. But that trajectory quickly changed after her father uprooted the entire family from their close-knit community in Alabama, and moved everybody to Titusville, Florida.

The move was jarring for the whole family. Morgan, a high school junior, was plucked out of a school she had been attending since the third grade and felt as if she had been "plopped down" somewhere completely new.

Morgan noticed many differences between her new Florida home and where she had come from. The main one? Rockets.

Rockets blasted off just across the river from her high school so often that watching them with her friends felt just like "watching fireworks on the beach." But to say they were the main inspiration for Morgan's eventual career at NASA? That would be way off the mark. If anything, the rocket launches were just background noise. They were little more than flashes of light in the peripheral.

"THE OPPORTUNITY FOR NEW KNOWLEDGE"

Those rockets began to mean something much more to Morgan on Jan. 31, 1958, **the day Explorer 1 was launched into space** — the first satellite to do so from the United States. Satellites were not as ubiquitous as they are today. At this point in history, the Soviet Union's Sputnik and Sputnik 2 were the only two satellites successfully launched into orbit.

Explorer 1 was instrumental in discovering what has become known as the Van Allen radiation belt. The Explorer 1 instrumentation reacted to what appeared to be radiation, and thus Dr. James Van Allen theorized that charged particles were trapped in space by Earth's magnetic field.

This was the discovery that inspired Morgan to be a part of the space program. The roaring of the nearby rocket launches was nothing compared to this.

"I thought to myself, this is profound knowledge that concerns everyone on our planet," she says. "This is an important discovery, and I want to be a part of this team. I was compelled to do it because of the new knowledge, the opportunity for new knowledge."

The opportunity came when Morgan spotted an advertisement for two open positions with the Army Ballistic Missile Agency. The ad listed two Engineer's Aide positions available for two students over the summer.

(Right) Saturn 500F begins its rollout to Launch Complex 39A, with its chief designer Wernher Von Braun, left, and Kennedy Space Center Director Kurt Debus in attendance. Photo credit: NASA

In the blockhouse of Launch Pad 34 at Cape Canaveral Air Force Station, Deputy Director of Launch Operations Walter Kapryan, left, confers with Director of Launch Operations Rocco Petrone during the Flight Readiness Test for the countdown of Apollo 7 in October 1968. Photo credit: NASA

"Thank God it said 'students' and not 'boys'" says Morgan, "otherwise I wouldn't have applied."

"I'VE GOT ROCKET FUEL IN MY BLOOD"

With Morgan's strengths in math and science, it was no wonder when she got the internship. From there, things moved pretty quickly: "Graduation from high school was on the weekend, and I went to work for the Army on Monday. I worked on my first launch on Friday night."

At age 17, Morgan began work during the summers as a University of Florida trainee for the Army at Cape Canaveral Air Force Station. This program was quickly rolled into a brand-new space exploration agency that had just been forged in response to early Soviet achievements: **a little agency called the National Aeronautics and Space Administration, also known as NASA**.

As Morgan worked in the summers for the new NASA, and during the school year chipped away at a Bachelor of Arts in mathematics from Jacksonville State University, her potential did not go unnoticed. **Dr. Wernher von Braun**, chief architect of the Saturn V rocket that propelled Apollo spacecraft to the Moon, and members of his team recognized the level at which Morgan could contribute to the human spaceflight program.

"All of my mentors were men," says Morgan. "That's just a plain fact and that needs to be acknowledged."

Dr. Kurt Debus, the first director of KSC, looked at Morgan's coursework and saw that she had experience writing technical papers, working with data systems and building computer components (which were also not as ubiquitous as they are today.) He provided Morgan with a pathway to certification, and a couple of courses later, she was certified as a Measurement and Instrumentation Engineer and a Data Systems Engineer, and was employed as a Junior Engineer on their team.

"It was just meant to be for me to be in the launching business," she says. "I've got rocket fuel in my blood."

And from all appearances, that was the perfect summation. Morgan was a talented mathematician, a fantastic communicator and a bona fide engineer — but that didn't stop prejudice, especially in the sixties.

"YOU DON'T ASK AN ENGINEER TO MAKE COFFEE"

Morgan heard later from colleagues that when she was hired to join the team, her immediate supervisor, Jim White, called everyone for a meeting — except her. As the room filled with men, White explained to the crew:

"This is a young lady who wants to be an engineer. You're to treat her like an engineer. But she's not your buddy. You call her Ms. Hardin. You're not to be familiar."

"Well, can we ask her to make coffee?" someone asked.

"No," White said. "You don't ask an engineer to make coffee."

White wanted to make it perfectly clear to the team: Morgan was a serious engineer, and her being a woman did nothing to affect that. By speaking candidly with the team, White intended to establish an environment of respect for Morgan. However, this was not always how it played out.

"JOANN, YOU ARE WELCOME HERE"

There was a seemingly infinite amount of obstacles that Morgan was forced to overcome — everything from obscene phone calls at her station to needing a security guard to clear out the men's only restroom.

"You have to realize that everywhere I went — if I went to a procedure review, if I went to a post-test critique, almost every single part of my daily work — I'd be the only woman in the room," reflects Morgan. "I had a sense of loneliness in a way, but on the other side of that coin, I wanted to do the best job I could."

"A startling moment" for Morgan came when a test supervisor saw her sitting down at Blockhouse 34 to plug in her headset to acquire test results.

"The supervisor came and just whacked me over the back — actually hit me in the back! He said 'we don't have women in here!' He had this ugly look on his face and I thought, uh-oh."

Morgan called **Karl Sendler**, the man who developed the launch processing systems for the Apollo program and had ordered the test results, and said, "Uh…this test supervisor said women aren't allowed here."

He replied: "Oh, don't listen to him! Plug in your headset and get those test results to me as soon as you can."

In response to the test supervisor's treatment of Morgan, others came forward to make it known that she was accepted. **Rocco Petrone**, who presided over the development of the Saturn 5 lunar launch vehicle and operation, later tapped Morgan on the shoulder.

"JoAnn, you *ARE* welcome here," he said.

"YOU ARE OUR BEST COMMUNICATOR"

In spite of working for all of the Mercury, Gemini and Apollo programs, and being promoted to a senior engineer, Morgan was still not permitted in the firing room at liftoff — until Apollo 11, when "Karl Sendler went to bat for me."

Without her realizing, Sendler had had to go all the way to the top to ask permission from Debus. When Sendler called Morgan into his office to share the good news, he was "practically gleeful":

"You are our best communicator," he said. "You're going to be on the console for Apollo 11!"

The added bonus was the fact that Morgan wouldn't have to work the night shift, 3 p.m. to 3 a.m. For the first time, she would get off work at 3 in the afternoon and spend time with her husband who, as a schoolteacher and bandmaster, she rarely got to see. As soon as the launch was over, he would whisk her off to Captiva Island on a boat trip to celebrate.

"I was just thrilled," she says. "My life was coming together. I would get to be there for the launch, feel the shockwave hit, and then — I got to go on vacation!"

"IT ABSOLUTELY MADE MY CAREER"

To be the instrumentation controller in the launch room for the Apollo 11 liftoff was as huge as a deal as it sounds. The launch is the beginning of the mission, and after the first couple of critical events the launch team is devoted to — including launch and translunar injection — Mission Control team in Texas would take over and the launch team would have zero control.

For Morgan, to be there at that pivotal point in history was ground-breaking: "It was very validating. It absolutely made my career."

Perhaps the best part was finally being able to feel the vibrations of the shockwave. Up until then, Morgan had always been at a telemetry station or a display room or an upper antennae site for launch, and would have to hear from other people about what the vibrations felt like. Now, Morgan finally had the chance to experience them for herself.

"There's a whole wealth of knowledge NASA can achieve"

Much like the Saturn V rocket, Morgan's career took off. She was the first NASA woman to win a Sloan Fellowship, which she used to earn a Master of Science degree in management from Stanford University in California.

When she returned to NASA, she became a division chief of the Computer Systems division. This was in the seventies, when the agency was transitioning from using old, giant computers to many smaller computers. The change was supplemented with the fact that she was the first woman to have that role: "So, people were having to change and adapt to me *AND* the new technology. So that was a lot to choke on for some people! A double whammy!"

It was difficult, but Morgan once again proved she was capable.

The United States' first satellite, Explorer 1, is launched into orbit by a Jupiter C rocket on Jan. 31, 1958. Explorer 1 confirmed existence of high-radiation bands above the Earth's atmosphere. Photo credit: NASA

She was "the manager with the velvet glove." She combined her Southerner, gentlewoman personality with her training at Stanford to inspire change and move people down the road.

From there, Morgan excelled in many other roles, including deputy of Expendable Launch Vehicles, director of Payload Projects Management and director of Safety and Mission Assurance. She was one of the last two people who verified the space shuttle was ready to launch and the first woman at KSC to serve in an executive position, associate director of the center.

But what excited Morgan the most about her contributions was the same thing that inspired her to join the space program in the first place: the scientific discoveries.

"My last mission was those two little plucky Mars rovers, [**Spirit and Opportunity**]. That was a lot of fun — getting people to understand there's a whole future out there, there's a whole wealth of knowledge NASA can achieve."

To this day, Morgan is still one of the most decorated women at Kennedy. Her numerous awards and recognitions include an achievement award for her work during the activation of Apollo Launch Complex 39, four exceptional service medals and two outstanding leadership medals. She also received the Kurt H. Debus Award, as well as two meritorious executive awards from President Bill Clinton. In 1995, she was inducted into the Florida Women's Hall of Fame.

After serving as the director of External Relations and Business Development, she retired from NASA in August 2003.

JoAnn Morgan was the only woman working on console in the launch firing room during the launch of Apollo 11. Photo credit: NASA

"I HOPE THAT PHOTOS LIKE THE ONES I'M IN DON'T EXIST ANYMORE."

Florida Governor Jeb Bush appointed Morgan to be a state university trustee. She had already worked on boards at the University of Florida's Aerospace Engineering, University of Central Florida's College of Engineering and the University of West Florida's Institute for Human and Machine Cognition (IHMC).

While serving as a trustee, Morgan realized how important it was to encourage more women to pursue careers and college programs in STEM. Today, she sponsors endowments and scholarships at seven universities and provides internships at IHMC.

"Even though I'm almost 80 years old, I'm not giving up," she says.

Morgan encourages young people to stick with STEM careers even when they are hard work, because the rewards will be worth it in the end. "There is such a great variety of work to do within the NASA family: government, contractors, university partnerships — there will be a place for you to fit in," says Morgan. "I had fun. I had wonderful people to work with. You're just not going to have a dull day."

Morgan is especially excited about seeing more women involved with the upcoming **Artemis missions to return humans to the Moon and eventually make it to Mars**. She remembers clearly when Dr. von Braun described to her in person about the goal to go to Mars — although, he had calculated that we would have already made it there by now.

"So, we're behind, by JoAnn Morgan time."

People today are reflecting on the 50th anniversary of Apollo 11, looking back on photos of the only woman in the launch firing room and remembering Morgan as an emblem of inspiration for women in STEM. However, Morgan's takeaway message is to not look at those photos in admiration, but in determination to see those photos "depart from our culture."

"I look at that picture of the firing room where I'm the only woman. And I hope all the pictures now that show people working on the missions to the Moon and onto Mars, in rooms like Mission Control or Launch Control or wherever — that there will always be several women. I hope that photos like the ones I'm in don't exist anymore."

The Saturn V rocket with the Apollo 11 spacecraft, atop the mobile launcher, traverses the crawlerway to Launch Complex 39A on May 20, 1969. The crawler-transporter carried the mobile launcher and rocket from High Bay 1 in the Vehicle Assembly Building to the pad at NASA's Kennedy Space Center in Florida. Photo credit: NASA

On a Roll!

NASA's mobile launcher treks to Launch Complex 39B – final trip before Artemis 1

BY DANIELLE SEMPSROTT

On June 27, 2019, NASA's **mobile launcher** made its last solo trek to Kennedy Space Center's Launch Pad 39B for final testing before its next roll to the pad with the Space Launch System (SLS) rocket and Orion for the launch of **Artemis 1**. As part of NASA's Moon to Mars exploration approach, the **Artemis** program at the Moon will pave the way for sending humans to Mars.

The mobile launcher, carried atop the **crawler-transporter 2**, made the 10-hour trip to the pad from the Florida spaceport's Vehicle Assembly Building (VAB), where it has been for testing since last fall. At 380 feet tall, the mobile launcher contains all of the connection lines – known as **umbilicals** – and ground support equipment that will provide SLS and Orion with the necessary power, communications, fuel and coolant for launch.

"The mobile launcher has gone through a series of critical tests in the VAB," said Dan Florez, NASA test director with **Exploration Ground Systems** at Kennedy. "We've conducted umbilical arm swing tests, environmental control system tests, hydraulic testing, nitrogen and helium testing and electrical tests to verify commands from the Launch Control Center are properly communicating with the ground support equipment and umbilicals."

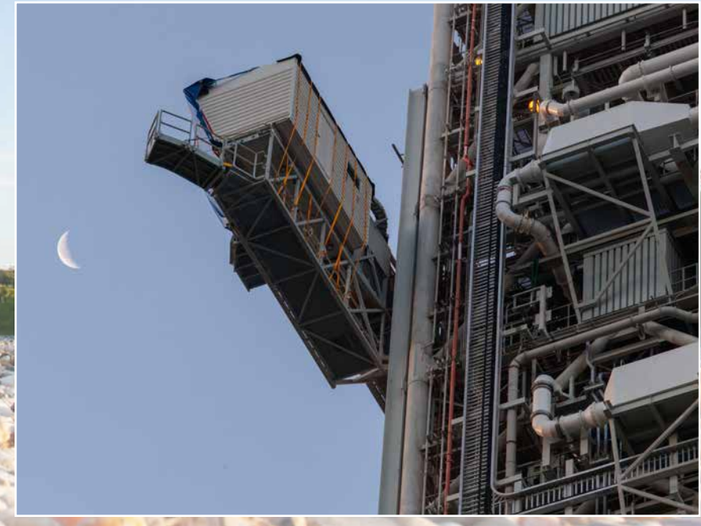
Prior to the roll, the mobile launcher also underwent shake, or modal, testing to characterize the bending modes of the mobile launcher structure during Artemis 1.

With the mobile launcher now at the pad, some of the final testing that will take place includes water flow testing of the **ignition overpressure and sound suppression systems** that will help protect the SLS, Orion, the mobile launcher and launch pad from the extreme acoustic and temperature environment of launch. Testing also will evaluate cryogenic flows for the ultra-cold propellant and additional checkout of electrical and umbilical systems.

"One important test coming up involves swinging three umbilical arms on the mobile launcher simultaneously, which is the first time all three arms will move together, just as they would during launch," said Cliff Lanham, NASA's senior project manager for the mobile launcher at Kennedy.

The three arms being tested are the core stage intertank umbilical, the core stage forward skirt umbilical and the interim cryogenic propulsion stage (ICPS) umbilical. The umbilicals for the intertank and forward skirt will provide power and air to purge the lines for the SLS rocket. The umbilical for the ICPS will provide cryogenic propellants – or super-cooled liquid hydrogen and liquid oxygen – in addition to power and purge air to the **ICPS**, which provides the power and propulsion needed to send Orion to the Moon and back.

"The arms, built offsite, were first sent to the Launch Equipment Test Facility where each one was tested individually before installation on the mobile launcher," said Florez. "Now it's time for the integrated test to validate that all three arms can retract at the same time so that when the countdown clock hits zero, each arm swings away at the right time for that historic launch moment."



In this view, Exploration Ground Systems' mobile launcher's crew access arm (CAA) can be seen. The CAA will interface with the agency's Space Launch System (SLS) rocket at the Orion crew hatch, providing entry and exit from the Orion crew module. The first crewed flight aboard Orion will be Artemis 2, after the uncrewed Artemis 1 launch verifies SLS and Orion as an integrated system. Photo credit: NASA/Ben Smegelsky

Exploration Ground Systems' mobile launcher makes its last solo trek along the crawlerway atop crawler-transporter 2 to Kennedy Space Center's Launch Complex 39B on June 27, 2019. The mobile launcher departed from the Vehicle Assembly Building at midnight on June 27 for the 10-hour journey to the pad and will remain there for the summer, undergoing final testing and checkouts. Its next roll to the pad will be with the agency's Space Launch System rocket and Orion spacecraft in preparation for the launch of Artemis 1. Photo credit: NASA/Ben Smegelsky

After successfully arriving at Kennedy Space Center's Launch Complex 39B, Exploration Ground Systems' mobile launcher is photographed at the pad surface atop crawler-transporter 2 on June 28, 2019. The mobile launcher began its final solo trek to the pad at midnight on June 27, departing from NASA's Vehicle Assembly Building. The mobile launcher will remain at the pad over the summer, undergoing final testing and checkouts. Its next roll to the pad will be with the agency's Space Launch System rocket and Orion in preparation for the launch of Artemis 1. Photo credit: NASA/Glenn Benson

After final testing at the pad is complete, which is slated for the end of September, the mobile launcher will roll back to the VAB for minor testing before SLS and Orion stacking.

"Once the vehicle is stacked on the mobile launcher, it will roll to the pad one final time for a rehearsal prior to launch," said Lanham. "It's exciting to see it all falling into place."

Artemis 1 is the first in a series of missions that will test SLS and Orion as an integrated system before the agency returns astronauts to the lunar vicinity. After the first launch and in preparation for **Artemis 2**, an emergency egress system for the crew will be added to the mobile launcher.

With Artemis, we will see the first woman and next man set foot on and explore the Moon by 2024, and a new class of American Moon walkers will inspire the next generation. With our goal of sending humans to Mars, Artemis is the first step to begin this next era of exploration.

NASA Update

Agency awards contract for second mobile launcher at Kennedy Space Center

NASA has selected Bechtel National, Inc., of Reston, Virginia, to design and build a second mobile launcher, known as Mobile Launcher 2 or ML2, for **Exploration Ground Systems** at the agency's **Kennedy Space Center** in Florida.

The cost-plus-award-fee end item contract has a total value of approximately $383 million. Bechtel National will complete the design, build, test, and commissioning of the mobile launcher within a 44-month period beginning July 1.

ML2 is the ground structure that will be used to assemble, process, and launch NASA's **Space Launch System** (SLS) Block 1B rocket and **Orion** spacecraft from **Launch Pad 39B** at Kennedy for missions under NASA's **Moon to Mars** exploration approach.

It will consist of a base structure, the platform for SLS, and a tower equipped with a number of connection lines called umbilicals, as well as launch accessories that will provide SLS and Orion with power, communications, coolant, fuel, and stabilization prior to launch.

Kennedy Space Center Celebrates 50th Anniversary of Apollo 11 Launch and Moon Landing

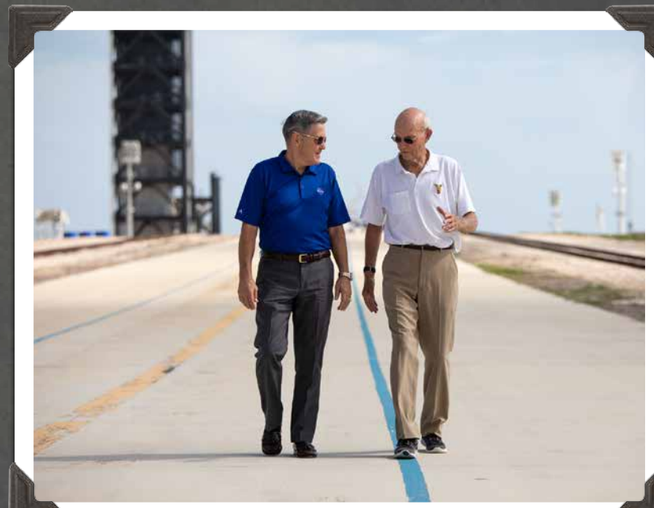
A new addition, the statue of the three Apollo 11 astronauts, Michael Collins, Neil Armstrong and Edwin "Buzz" Aldrin, is unveiled in the "Moon Tree" garden near the entrance to the Apollo/Saturn V facility at the Kennedy Space Center Visitor Complex in Florida. The three astronauts are facing toward Launch Complex 39A at Kennedy Space Center, the site of the Apollo 11 launch 50 years ago on July 16, 1969. Photo credit: KSCVC

NASA Kennedy Space Center Director Bob Cabana, far right, serves as moderator for the "Apollo Heroes Panel Discussion" in the IMAX Theater at the Kennedy Space Center Visitor Complex in Florida on July 16, 2019. Panelists were, from left, JoAnn Morgan, the only woman on console in the Launch Control Center for Apollo 11 launch countdown activities; Bob Sieck, Apollo-era launch team member and former space shuttle launch director; and Harrison Schmitt, Apollo 17 astronaut and moonwalker. The panel discussion was one of several events at the visitor complex to honor the 50th anniversary of NASA's Saturn V/Apollo 11 launch and landing on the Moon. Photo credit: Kim Shiflett

Apollo astronaut Al Worden rides in a classic Corvette during the "Man on the Moon" astronaut parade in Cocoa Beach, Florida, on July 13, 2019. The parade was held to honor the 50th anniversary of NASA's Saturn V/Apollo 11 launch and landing on the Moon. Photo credit: NASA/Ben Smegelsky

Astronaut Stan Love speaks at Kennedy Space Center's Apollo/Saturn V Center on Friday, July 19, 2019. Love addressed a crowd at the Florida Spaceport during a 50th Anniversary celebration of the Apollo 11 mission. The U.S. Postal Service issued two forever stamps to honor the historic moment. The event marked the first day of issue for the special stamps. Photo credit: NASA/Frank Michaux

On July 16, 2019, the 50th anniversary of the Apollo 11 launch, astronaut Michael Collins, right, speaks to Kennedy Space Center Director Bob Cabana at Launch Complex 39A. During his visit to the Florida spaceport, Collins discussed the moments leading up to launch at 9:32 a.m. on July 16, 1969, and what it was like to be part of the first crew to land on the Moon. Photo credit: NASA/Frank Michaux



On July 16, 2019, the 50th anniversary of the Apollo 11 launch to the Moon, astronaut Michael Collins speaks to launch team members from Apollo 11 and the current launch team for Artemis 1 in Firing Room 1 in the Launch Control Center at NASA's Kennedy Space Center in Florida. Photo credit: Kim Shiflett

On July 16, 2019, the 50th anniversary of the Apollo 11 launch, Apollo-era and Artemis 1 workers gathered together in Launch Control Center Firing Room 1 at NASA's Kennedy Space Center in Florida. From left, are Artemis 1 Launch Director Charlie Blackwell-Thompson, Apollo-era launch team member Carl Green, and Tiffany Lindsley Wardlow, Strategic communications specialist in Exploration Ground Systems. Photo credit: Kim Shiflett

A reception was held July 14, 2019, to celebrate the 50th anniversary of Apollo 11 and the updates to the Saturn V/Apollo facility at the Kennedy Space Center Visitor Complex in Florida. Photo credit: KSCVC

NASA and contractor employees who were working at NASA's Kennedy Space Center in Florida during the Apollo 11 launch gathered for a group photo on the observation deck of Operations and Support Building II on July 11, 2019. From left, along with their titles from 50 years ago, are Richard Sharum, NASA civil servant; Edward Wilson, security officer for Wackenhut Corporation; Sue Gross, secretary to the deputy procurement officer; Emery Lamar, co-op student in the Apollo Spacecraft Electrical Division; James Scotti, material clerk with Bendix Corporation; Suzanne Stuckey, secretary for telemetry; Andrew Pritchard, contractor with McGregor-Warner; Ken Poimboeuf, Design Engineering Directorate; and Grady McCorquodale, Launch Control Center engineer with Boeing.

Not pictured: Richard Cota, civil servant in the Engineering Directorate; and Victor Kurjack, data courier. Photo credit: NASA/Ben Smegelsky

EGS Team Completes Drop Test of Tail Service Mast Umbilicals

A drop test of the Tail Service Mast Umbilicals (TSMU) for NASA's Space Launch System (SLS) rocket is underway on the mobile launcher in High Bay 3 of the Vehicle Assembly Building at NASA's Kennedy Space Center on June 19, 2019. The 35-foot-tall TSMUs will connect to the SLS core stage aft section and provide liquid oxygen and liquid hydrogen fluid lines and electrical cable connections to the core stage engine section to support propellant handling during prelaunch operations. The drop test was performed to ensure that the umbilicals will disconnect before launch of the SLS carrying Orion on its first uncrewed mission, Artemis 1, from Launch Complex 39B. Exploration Ground Systems and Engineering completed the tests. Photo credit: NASA/Ben Smegelsky

EXCEPTIONAL EXECUTION

Ascent Abort-2 hailed as ‘spectacular’ flight test

BY JIM CAWLEY

NASA officials were all smiles following the **Ascent Abort-2** flight test of the launch abort system (LAS) for NASA’s **Orion** spacecraft on Tuesday, July 2.

“That was a spectacular test we all witnessed this morning. It was really special for the program; a really big step forward to us,” Orion Program Manager Mark Kirasich said during a post-launch briefing about two hours after the launch from Cape Canaveral Air Force Station in Florida. “It was a really great day all around — weather and the vehicle.”

Don Reed, who heads Orion’s test flight office and served as the flight test launch director, enthusiastically echoed that sentiment.

“We couldn’t ask for a better flight, better mission, a better performance,” Reed said. “That sums it up.”

NASA successfully demonstrated the Orion spacecraft’s LAS can outrun a speeding rocket and pull astronauts to safety in case of an emergency during launch. During the 3-minute, 13-second event, a test version of the Orion crew module launched at 7 a.m. EDT from Space Launch Complex 46 on a modified Peacekeeper missile procured through the U.S. Air Force and built by Northrop Grumman.

The Orion test spacecraft traveled to an altitude of about six miles, at which point it experienced high-stress aerodynamic conditions expected during ascent. The abort sequence triggered and, within milliseconds, the abort motor fired to pull the crew module away from the rocket.

Its attitude control motor flipped the capsule end-over-end to properly orient it, and then the jettison motor fired, releasing the crew module for splashdown in the Atlantic Ocean. All 12 ejectable data recorders that were ejected during the test capsule’s descent were recovered by 8:10 a.m. Abort was initiated with the test spacecraft traveling at about 760 mph. Maximum speed was about 1,000 mph, and peak altitude was hit at just under 44,000 feet.

“One of the most important parts of the test was to see how the attitude control motor performed,” Kirasich said. “The internal motor pressure was rock solid, straight line and it had excellent control characteristics. Everything we’ve seen so far looks great.”

The test is another milestone in the agency’s preparation for **Artemis** missions to the Moon that will lead to astronaut missions to Mars.

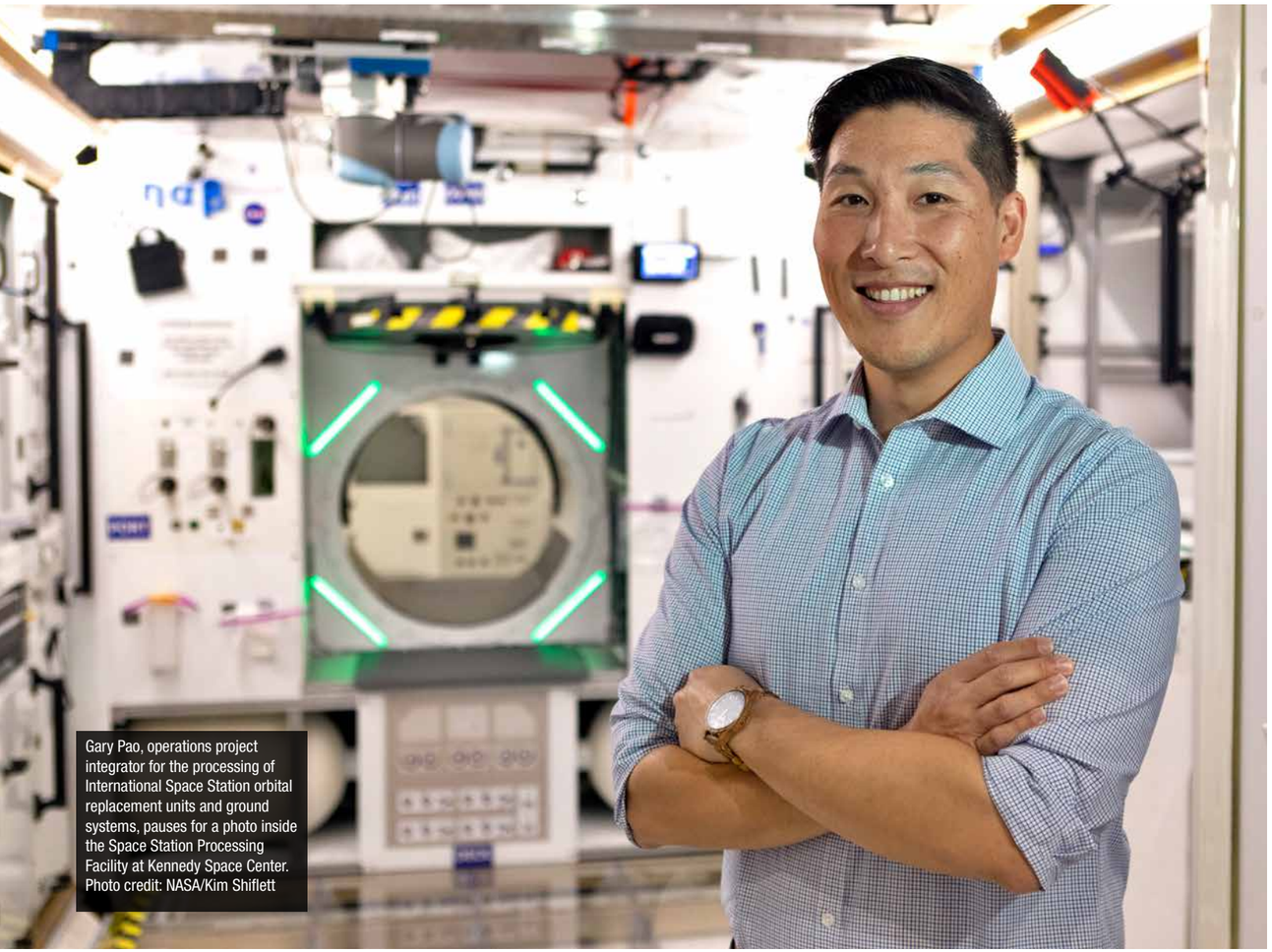
“The next big check mark is the Moon — it’s our Artemis 1 mission,” Kirasich said. “A little over a year from now we’ll be sending Orion on a Space Launch System rocket and the destination of that vehicle is the Moon.”

Crowds of spectators watch from Jetty Park in Cape Canaveral, Florida, on July 2, 2019, as a Northrop Grumman provided booster launches from Space Launch Complex 46, carrying a fully functional Launch Abort System with a test version of Orion attached for NASA’s Ascent Abort-2 flight test. Launch time was 7 a.m. EDT. Photo credit: NASA/Ben Smegelsky

A fully functional Launch Abort System (LAS) with a test version of Orion attached, launches on NASA’s Ascent Abort-2 (AA-2) atop a Northrop Grumman provided booster on July 2, 2019, at 7 a.m. EDT, from Launch Pad 46 at Cape Canaveral Air Force Station in Florida. Photo credit: NASA/Tony Gray and Kevin O’Connell

NASA's Kennedy Space Center Innovators' Launchpad:

Gary Pao



Gary Pao, operations project integrator for the processing of International Space Station orbital replacement units and ground systems, pauses for a photo inside the Space Station Processing Facility at Kennedy Space Center. Photo credit: NASA/Kim Shiflett

Please explain your job in a single sentence.

I am an operations project integrator for the processing of orbital replacement units, which are the spare parts and hardware for the **International Space Station**, as well as the various ground systems that interface with flight hardware in support of the station.

What do you find most exciting about your job?

I'm blessed to be able to support a variety of projects for the space station and I really enjoy working in this dynamic environment with such great people. Plus, the fact that I get to touch things that are now on-orbit is super exciting!

What is a typical day like for you?

The space station's flight manifest determines the servicing activities we perform each day. So whether it's hazardous operations like high pressure tank fills or lifting operations, to ground systems requirements development or chemical sampling, I interface with our NASA teammates and commercial partners to verify flight requirements are met within the scope of the project's budget and schedule.

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

When I started my career at Kennedy, I had the opportunity to work on solid rocket booster avionics during the **Space Shuttle Program**. That experience was similar to my current work in terms of processing flight hardware and supporting crewed missions.

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

I have a degree in electrical engineering from the University of Central Florida. I actually made the switch from computer science/programming when my math professor advised me to consider electrical engineering as a diverse field that allows me to work with hardware in addition to software.

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

I was born and raised in Miami, Florida, but my parents are Chinese immigrants who overcame cultural and language barriers to go on to own a few successful businesses. My parents have always stressed the importance of hard work, and I have the opportunity to do what I do today as a result of their commitment and sacrifices.

What motivated you to want to work for NASA?

For my senior engineering design project, I participated in the University Nanosatellite Program competition and interfaced with engineers from NASA and the United States Air Force. My class even got to take a summer course at **Kennedy Space Center**, and teams were assigned NASA engineers as mentors. It was during this time that I gained a tangible appreciation for space-related research and technology.

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

In my opinion, the development of technology matters because it improves life on Earth through the way we manage our resources, the advancements in medicine, the creation of household goods, and the expansion of jobs.

How do you think your NASA research or the agency as a whole benefits people on Earth?

The space station is a one-of-a-kind human spaceflight program that is developing new technology that will **benefit those on Earth** while at the same time paving the way for further exploration of the **Moon, Mars and beyond**. It's humbling to know that the supplies and experiments we process support the crew who are tasked with that mission.

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

Don't be afraid to fail. Ideas don't always work the first time. When that happens, figure out why, develop your ideas, and try again. In my experience, failure has proven to be a far more effective teacher than success.

Left: From left, Oscar Monje, Ph.D., a plant physiologist with AECOM Management Services; and Alora Mazarakis, an electrical engineer with Techshot, prepare to harvest radish plants from the base of the Advanced Plant Habitat ground unit inside a laboratory in the Space Station Processing Facility at NASA's Kennedy Space Center on June 13, 2019. The radishes were harvested as part of a science verification test. The APH is currently the largest plant chamber built for the agency in use on the International Space Station. It is an autonomous plant growth facility that is being used to conduct bioscience research on the space station with the goal of enabling astronauts to be sustainable on long duration missions to the Moon, Mars and beyond. Photo credit: NASA/Kim Shiflett

Above: A radish plant is weighed inside a laboratory in the Space Station Processing Facility at NASA's Kennedy Space Center on June 13, 2019. The radishes were harvested from the base of the Advanced Plant Habitat (APH) ground unit as part of a science verification test. Photo credit: NASA/Kim Shiflett

Merritt Island High students are photographed at Kennedy Space Center with StangSat – a cube satellite (CubeSat) that was built and developed by the students at the school. StangSat launched on a SpaceX Falcon Heavy rocket as part of the Department of Defense Space Test Program-2 mission, managed by the U.S. Air Force Space and Missile Systems Center. The Falcon Heavy launched from Launch Complex 39A at Kennedy on June 25, 2019, at 2:30 a.m. EDT. Photo credit: NASA/Shaun Daly

Local Florida high school shoots for stars with student-developed CubeSat

BY DANIELLE SEMPSROTT

It took eight years and nearly 80 high school students participating in the project along the way, but the Merritt Island High School's "StangSat" cube satellite – more commonly known as a CubeSat – was finally ready to launch. It was among several CubeSats that launched on a SpaceX Falcon Heavy rocket on June 24, 2019.

Named for the high school's mascot – the mustang – StangSat will measure the shock and vibration of a launch to determine just how durable CubeSats must be built.

StangSat has a sister satellite, Launch Environment Observer (LEO), from California Polytechnic State University that required students to take two trips to California for testing to ensure the two satellites were compatible.

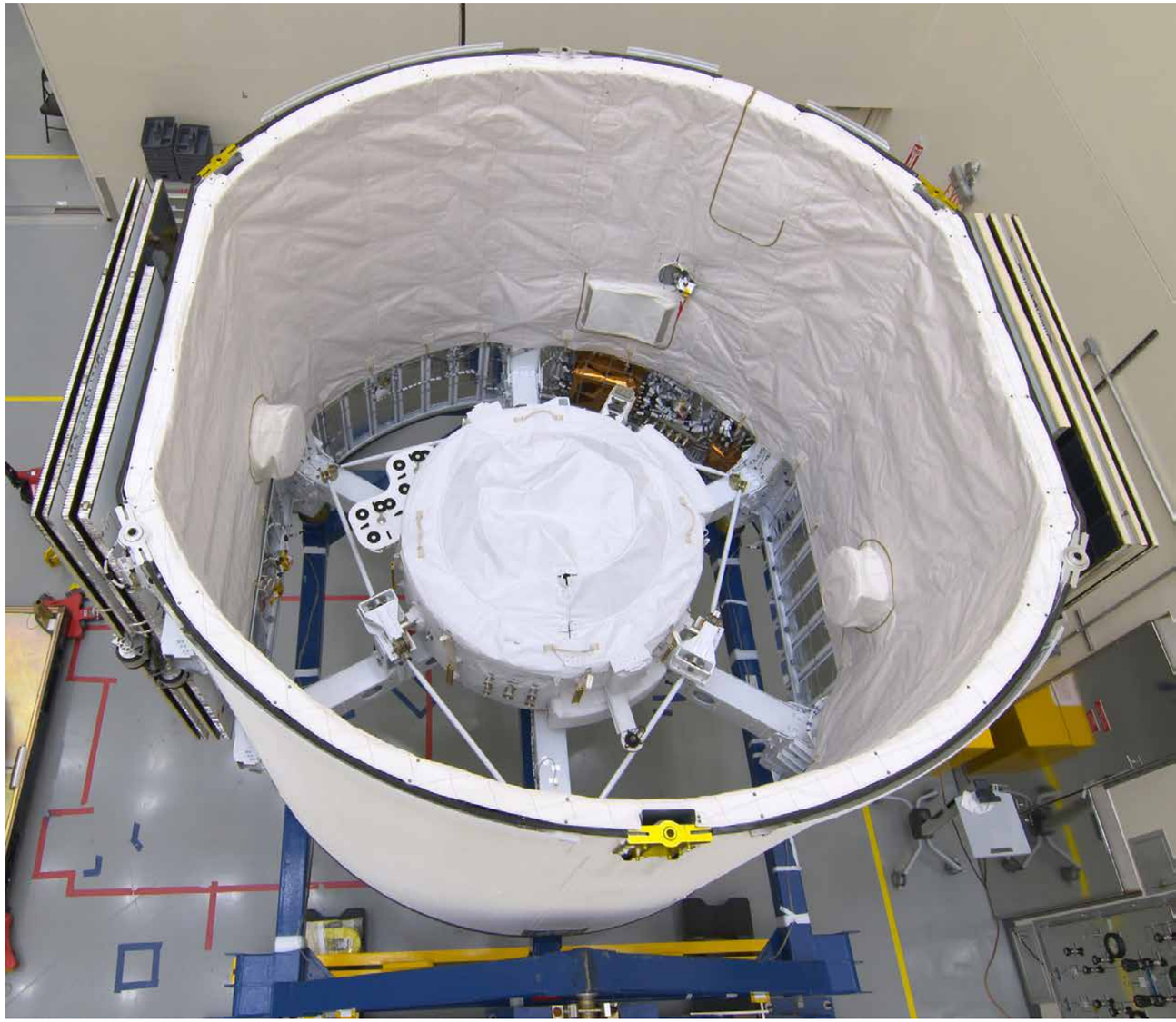
While StangSat is made of more malleable and cost-effective materials, LEO is a more rigid satellite and, thus, more expensive to build. The goal is to collect data from both satellites to see how strong a CubeSat really has to be to withstand a launch and if there's an opportunity to build them in a more cost-effective manner.

"If you build it too strong, you've wasted money. And if you build it too weak, it will break and you've wasted money," said Tracey Beatovich, a math teacher at the high school and the lead of this project. "We're really trying to optimize the sweet spot of testing and building."

In addition to traveling to California, the project required students to devote many weekends, holidays and nights to its development.

StangSat has been in development since 2011, as part of a Space Act Agreement between NASA's Kennedy Space Center in Florida and Brevard County schools. As part of the agreement, NASA provided mentors, hardware and knowledge, while the students actually built the CubeSat. Merritt Island High School was chosen by the school system as the ideal candidate due to its close proximity to Kennedy, where many meetings between students and mentors were held.

Read the full story at **https://go.nasa.gov/2WTgR9g**.



The International Docking Adapter 3, a critical component for future crewed missions to the International Space Station, is carefully packed away in the unpressurized "trunk" section of the SpaceX Dragon spacecraft at the SpaceX facility on Cape Canaveral Air Force Station in Florida on June 19. It will launch to the orbiting laboratory on the company's 18th commercial resupply mission. The adapter will support future U.S. crewed vehicles visiting the station. Photo credit: NASA/Cory Huston

Boeing Completes Parachute System Testing

In this view looking up, Boeing's CST-100 Starliner's parachutes deploy above the U.S. Army's White Sands Missile Range in New Mexico during parachute system testing on June 24, 2019. Boeing conducted the test using a full-scale Starliner test article, known as a boiler plate, designed to simulate the actual spacecraft. The test involved intentionally disabling one of the parachute system's two drogue parachutes and one of the three main parachutes to evaluate how the remaining parachutes handled the additional loads during deployment and descent. This was one of a series of important parachute tests to validate the system is safe to carry astronauts to and from the International Space Station as part of NASA's Commercial Crew Program. Starliner will launch atop a United Launch Alliance Atlas V rocket from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida. Photo credit: Boeing

Boeing's CST-100 Starliner's parachute system is tested above the U.S. Army's Yuma Proving Ground in Arizona on June 26, 2019. This "high Q" test involved dropping a dart-shaped device – functioning as a Starliner weight simulant – from a C-17 aircraft and intentionally inflating the parachutes at higher pressures than expected during missions. Photo credit: U.S. Army

The huge, 363-foot-tall Apollo 11 (Spacecraft 107/ Lunar Module S/Saturn 506) space vehicle is launched from Pad A, Launch Complex 39, at Kennedy Space Center in Florida, at 9:32 a.m. EDT, July 16, 1969. Onboard the Apollo 11 spacecraft are astronauts Neil A. Armstrong, commander; Michael Collins, command module pilot; and Edwin E. "Buzz" Aldrin Jr., lunar module pilot. Photo credit: NASA

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