NEWS &NOTES

National Aeronautics and Space Administration

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FROM THE CHIEF HISTORIAN

Congratulations to our very own Steve Garber and Glen Asner, authors of *Origins of 21st-Century Space Travel: A History of NASA's Decadal Planning Team and the Vision for Space Exploration, 1999–2004*—again! You may recall that the last edition of *News and Notes* started with a very similar line because Steve and Glen were about to be presented the American Institute for Aeronautics and Astronautics (AIAA) 2020 History Manuscript Award. In early January, they went to the award ceremony at the AIAA Science and Technology Forum and Exposition (SciTech 2020) in Orlando, Florida. Just a month later, we got advance notification from the Society for History in the Federal Government (SHFG) that Steve and Glen's book was the winner of the prestigious SHFG Henry Adams Prize. The Henry Adams Prize is presented annually to the outstanding major publication in federal history as judged by fellow government historians. Steve and Glen will be presented the Adams Prize at the SHFG annual meeting, which will be held at the Robert C. Byrd Center for Congressional History and Education in Shepherdstown, West Virginia, March 13–14, 2020. As you can see in the image on page 2, the cover of *Origins…* is now getting pretty crowded with awards. While quite a number of the 214 NASA history publications have been recognized with a variety

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A LIFE OF NUMBERS: REMEMBERING THE REMARKABLE LEGACY OF KATHERINE JOHNSON

By Catherine Baldwin

"I counted everything. I counted the steps to the road, the steps up to church, the number of dishes and silverware I washed… anything that could be counted, I did."

Katherine Johnson's life was defined by her love of numbers. Born on 26 August 1918 in West Virginia, Katherine was a precocious child. Her love of math propelled her through school, allowing her to graduate early from high school and enter West Virginia State College at the age of 15. Recognizing her bright mind and aptitude for learning, mathematician W. W. Schieffelin Claytor mentored her throughout her college experience and encouraged her to become a research mathematician, an ideal job which would plant itself in the back of her mind. After graduating in 1937, Katherine Johnson went on to teach in her local community. She returned to school to pursue a graduate degree in mathematics but ultimately left after one semester to raise her family. After her three daughters were older, she

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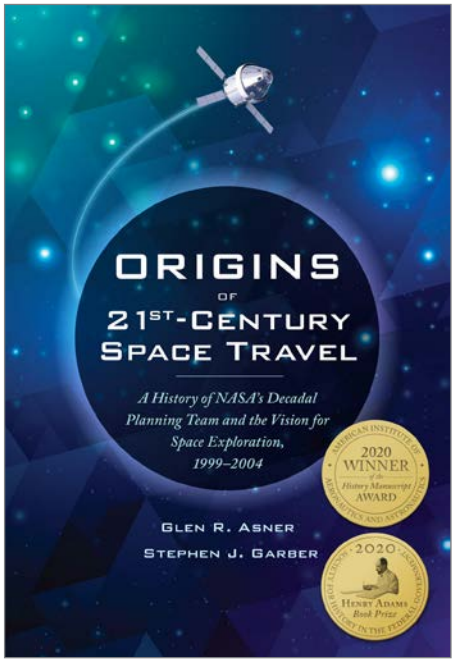
OFFICE OF COMMUNICATIONS

From the Chief Historian (continued)

of awards, multiple award-winning books are very rare. We are thrilled by the success of this book, thankful for outstanding work by Steve, Glen, and the team that produced the book, and appreciative of the SHFG recognition.



Origins of 21st-Century Space Travel. (Credit: NASA)

I'm also thrilled that there will be more recognition of NASA history at the SHFG award ceremony on March 14. One of that organization's newer awards is the annual Excellence in New Media Award, presented to a digital born or based historical exhibit or project that contributes to a broader understanding of the federal government created by any agency or unit of the federal government. The award can also recognize nongovernmental organizations, including federal contractors, who created something on behalf of a unit of the federal government. The Excellence in New Media Award for 2020 will be presented to Ben Feist of the ARES Division at Johnson Space Center. If you are thinking, "Hmm…that name sounds familiar…," you may recall mentions of Ben and his work in our summer and winter 2019 issues, or on the NASA website. But, most probably, you know Ben from his phenomenal work on ***https://Apollo17.org*** and Apollo 11 in Real Time. Ben and an amazing team of volunteers are being recognized by SHFG for the Apollo 11 in Real Time site. I wish the history program could claim a bit of the credit for this amazing digital extravaganza, but our contribution was limited to cheering from the sidelines. Nonetheless, I will be bursting with pride at the SHFG award ceremony as Ben, Steve, and Glen collect a pair of well-deserved prizes for their works on NASA history. (PS: Wait until SHFG and all the rest of us see what Ben and his team have in store for Apollo 13 in Real Time.)

NASA history is not just a story about awards; it is also a story of change. In the last couple of months, we've experienced that in bittersweet ways with the departure of two of our archivists. Long-serving archivist Colin Fries decided to retire in mid-December 2019. For over 20 years, Colin has been the constant face of the Headquarters Historical Reference Collection to a generation of researchers. His name appears in the acknowledgments section in a phenomenal number of books about NASA history; for example, his is the first name mentioned in the acknowledgments in Margot Lee Shetterly's path-breaking *Hidden Figures*. Colin has certainly earned a long, healthy, and happy retirement, but we are going to miss him. You can read more about Colin and his retirement send-off inside this issue. In February, Craig Haibon also left the archive. Craig had been brought on for a special project funded by NASA's Science Mission Directorate about a year ago. He did great work on that project and was also an important addition to our archival team. With the Science Mission Directorate (SMD) project wrapped up on schedule, Craig is moving on to a full-time civil service job, and we wish him the best. But, we'll miss his dedication, diligence, and especially, his gentle humor.

Until next time, Godspeed,

Bill

William P. Barry
Chief Historian

returned to teaching but continued to hope that she would one day become a research mathematician.

In 1953, Katherine Johnson began her career with National Advisory Committee for Aeronautics (NACA) as a human computer at the West Area Computing section of NACA's Langley Laboratory. Under the management of Dorothy Vaughan, Katherine was assigned to the Maneuver Loads Branch of the Flight Research Division. What was originally a temporary position soon became permanent, and she spent the next four years analyzing data from flight tests. When NACA transitioned into NASA, Katherine transitioned into a new role.

> "We wrote our own textbook, because there was no other text about space. We just started from what we knew. We had to go back to geometry and figure all of this stuff out. Inasmuch as I was in at the beginning, I was one of those lucky people."

In 1960, she and engineer Ted Skopinski coauthored a report called *Determination of Azimuth Angle at Burnout for Placing a Satellite Over a Selected Earth Position*.[1] The report presented the equations necessary for an orbital spaceflight with a specified landing position. This was the first time any woman in the Flight Research Division had received credit as an author of a research report. Being the only woman was nothing new to Katherine. She was known for her inquisitive nature. The details of the program mattered to her, and she was determined to get the answers she sought, attending briefings and meetings that originally were only open to men. Despite the obstacles she experienced due to her race and gender, Katherine became an extremely valuable member of the team and went on to perform important calculations for the start of the human spaceflight program, including the trajectory analysis for Alan Shepard's inaugural flight in Freedom 7.

Katherine Johnson working at her desk in 1966. (Credit: NASA)

In 1962, NASA was preparing for the mission that would become Katherine Johnson's most famous: MA-6, also known as Friendship 7. John Glenn would take the United States' first human orbital flight, a feat that had not been attempted by NASA. The math necessary to successfully complete an orbital flight is enormously complex. NASA had to construct a worldwide communications network which linked tracking stations to IBM computers in Washington, DC, Cape Canaveral, and Bermuda. The IBM computers were programmed with the equations that would control Glenn's trajectory. However, the astronauts were rightfully leery of the numbers calculated by the

1 *https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19980227091.pdf*

Katherine Johnson at NASA Langley facility opening in 2017. (Credit: NASA)

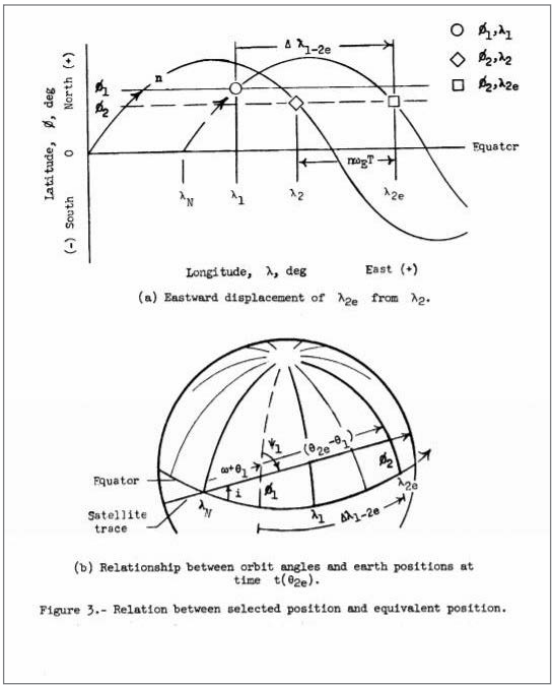
IBM computers, as the machines were notoriously unreliable. As recounted in Margot Lee Shetterly's book, *Hidden Figures*, during preflight, John Glenn decided that the numbers from electronic calculating machines needed a second check and said, "Go get the girl." He requested that Katherine Johnson run the numbers again to check against the computer. "If she says they're good," Glenn purportedly said, "I'm ready to go." Katherine reported that the computer's math was correct and John Glenn's flight was a success.

Katherine Johnson continued to work at NASA Langley Research Center, coauthoring over 20 research reports and doing critical calculations for a number of NASA missions, including Project Apollo, the Lunar Orbiter Spacecraft, the Space Shuttle, and the Earth Resources Technology Satellite (later known as Landsat). She retired in 1986, after 33 years of working for NASA. She loved her work. "I found what I was looking for at Langley," she said. "This was what a research mathematician did. I went to work every day for 33 years happy. Never did I get up and say, 'I don't want to go to work.'"

Later in life, in large part due to her depiction in Margot Lee Shetterly's book, *Hidden Figures,* and subsequently the movie of the same name, Katherine Johnson was honored for her contributions. She was awarded an honorary doctorate from The College of William and Mary, had a Barbie doll designed after her likeness, and had two separate NASA facilities named after her. In 2015, she was presented the Presidential Medal of Freedom, one of our nation's highest honors.

Katherine Johnson passed away on 24 February 2020, at the age of 101. The loss of Katherine Johnson is one that is felt deeply by NASA. Her mathematical contributions to the early Space Program helped propel NASA to the Moon and beyond. A trailblazer, she has left a legacy that continues to inspire people from all around the world. As President Obama said, "Katherine G. Johnson refused to be limited by society's expectations of her gender and race while expanding the boundaries of humanity's reach."

Read more about Katherine Johnson's incredible life here: ***https://www.nasa.gov/langley/katherine-johnson***.



A diagram from *Determination of Azimuth Angle at Burnout for Placing a Satellite Over a Selected Earth Position.*

NEWS FROM HEADQUARTERS AND THE CENTERS

NASA HEADQUARTERS

Washington, DC

By Bill Barry

The winter of 2019–2020 has been full of highs and lows in terms of personnel. In mid-December, we said "happy retirement" to archival icon Colin Fries. You can read more about his career and his send-off elsewhere in this issue. The next day, we also said farewell to our amazing fall interns Andrew Parco and David Skogerboe. Going into the holidays, we hoped that Craig Haibon would shift from his special project for Science Mission Directorate over to the contract archival position vacated by Colin Fries. But it didn't work out that way for long, and we wish Craig the best as he moves onward. Nonetheless, we were fortunate to get our spring semester interns in early this year. Stacy Bishop, a former teacher back in school herself working on her master's degree at the University of Maryland, and Alisa Greenhalgh, a junior at Brigham Young University who is here on a semester in Washington, DC, program, arrived here along with many other folks just coming back from the holiday break on 6 January. Their quick adjustment has gone a long way toward smoothing out the personnel turbulence at the start of the year. Stacy and Alisa will be with us until April. While it seems like we are just getting to know them, in February we were already interviewing applicants for our summer intern positions.

Along with the usual focus on Black History Month (February) and Women's History Month (March), we're also preparing for some other significant anniversaries this spring. First up is the 50th anniversary of Apollo 13. That story may be well known, but thanks to some incredible work by Ben Feist and his team of volunteers, this year we'll be able to gain insights into the flight from Mission Control. For the first time in five decades, we'll be able to hear the taped audio of the "loops" at Mission Control for the entire mission. While most of the recorded audio was available in Houston, there hasn't been a way to play it back. Moreover, many of the tapes that covered the time immediately after the explosion of the oxygen tank on Apollo 13 had been sent to Langley Research Center to be used in the investigation of the accident. After the investigation was completed, those tapes wound up in the hands of the National Archives. Thanks to some great detective work, those tapes were tracked down and digitized. While there will be a number of Apollo 13 anniversary events and publications, the most exciting new development will be a chance to listen to the unfolding drama in real time at: ***https://apolloinrealtime.org/***. The other significant anniversary this spring will be 22 April 2020, Earth Day. That will mark the 50th anniversary of Earth Day, and NASA history will be helping the Agency to celebrate the importance of our favorite (and, so far, only) planet. While we don't have 30-track audio from the first Earth Day, we will be helping to mark this important milestone in a number of ways.

You may be wondering how things are going with the Mission Support Future Architecture Program (MAP) History Working Group. In December, the Working Group made a good start on coming up with MAP options for the history and archival programs at NASA. Yet it quickly became apparent that things were more complex than we imagined. As this is being written, the team has concluded data-gathering and is coming up with proposals for implementing MAP in the history and archival programs. We expect to brief the initial proposals to the MAP program managers and various leaders here at Headquarters in March. It is much too early at this point to know how this process will turn out. The range of potential answers swings from hardly any noticeable change at all, to a major overhaul of our history and archival program. Regardless of the specific MAP plans, I believe that this is the best chance we have had in decades to address some of the challenges that have faced our Agency's history efforts in recent decades. Keep your fingers crossed.

From the Archives:

By Robyn Rodgers

NASA Headquarters Archives would like to thank Craig Haibon for his year of hard work, hard decisions, and good nature. The Regional Planetary Information Facilities (RPIF) have undergone a review, and Craig was the archivist working to help determine which of their images were historic in nature. As he moves on to his next adventure, we wish him and his family well.

NASA History Publications:

By Steve Garber

We're pleased to have recently submitted two manuscripts for production (copyediting, layout, and then printing) with our esteemed colleagues in the Communications Support Services Center (CSSC). First, Linda Billings has graciously edited a collection of essays stemming from a symposium we had several years ago on the 50th anniversary of robotic solar system exploration. This volume includes a number of thoughtful, interesting chapters. Second, Chris Gainor has written a fine operational history of the Hubble Space Telescope (HST). Designed as a complement to Robert Smith's well-known development history of HST, this book expertly covers a number of important themes and will be heavily illustrated. Both of these volumes should appear later this year.

The third volume of *Wind and Beyond*, an aerodynamics documentary history, is currently in layout. Edited by Jeremy Kinney and Jim Hansen, this comprehensive volume will cover airships, flying boats, and rotorcraft and should also go to print later this year.

Emily Cook recently completed writing a manuscript on the history of NASA's Stennis Space Center (SSC). This carefully researched and well-written manuscript should serve as an excellent follow-up to Mack Herring's *Way Station to Space*, with a focus on both the technical details of rocket propulsion testing and the social and economic impact that SSC has had on the local area. Her manuscript should go out for peer review shortly.

AMES RESEARCH CENTER

Moffett Field, California

By James Anderson

On 14 November 2019, Ames had the honor of hosting Vice President Mike Pence for a visit to the Center. This was just the third visit of a sitting Vice President to Ames, the others being Lyndon Johnson in 1961 and George H.W. Bush in 1988. While it's not uncommon for Air Force One to land at Moffett Field, Ames has never hosted a sitting President. The hours of history-sleuthing to elucidate those little facts for the occasion were made possible from the years of work that have gone into the archives and the coverage afforded by the *Astrogram* newsletter. In orchestrating the actual visit, the team in the Office of Communications did a tremendous job in making the event a success.

The following month, Ames celebrated the 80th anniversary of its ground-breaking as the NACA's second laboratory on 20 December. Center Director Eugene Tu spoke to Ames staff during a cake-cutting ceremony in the cafeteria, and historian James Anderson introduced a letter collection box to complement the existing Ames time capsule. That time capsule was created in 1989, when Ames celebrated its 50th anniversary. The capsule is sealed at the intersection of King Road and DeFrance Avenue, on a patch of ground where a wooden shack was constructed that served as an office for planning the construction of the first facilities at Ames. The capsule awaits opening at the centennial celebration in 20 years. In the meantime, letters submitted to the collection box from the Ames community will be archived and shared in the future. The plan is to continue and build upon the submission campaign annually as we look toward the centennial.

The last few months have remained quite busy. A short publication covering Ames' history is currently under review and being edited in the office. An update of the Center-at-a-Glance is also underway. At the end of February, James will present a talk about Ames history to the NASA Community College Aerospace Scholars, who will be at Ames for a workshop.

ARMSTRONG FLIGHT RESEARCH CENTER (AFRC)

Edwards Air Force Base, California

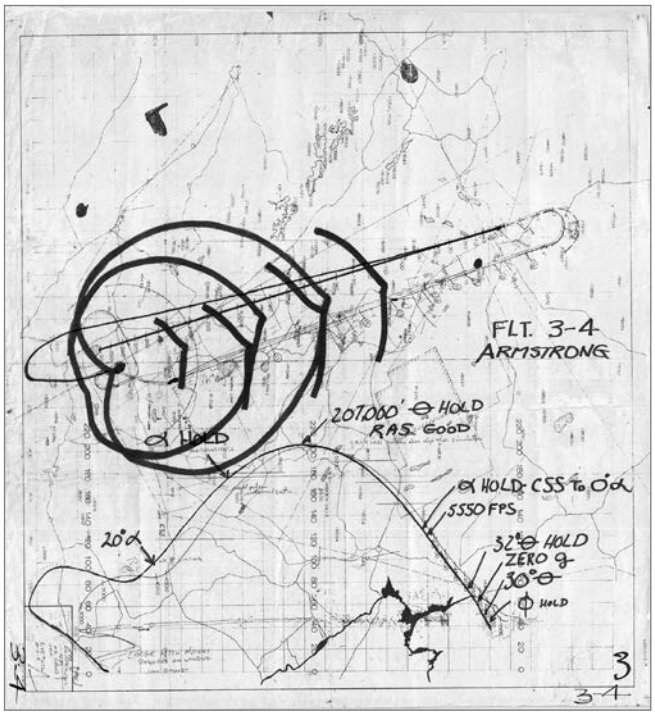
By Christian Gelzer

Work on the reference collection has begun again following the return of two pallets of boxes—scanned—and a hard drive with the first batch of data. Karl Bender (research librarian) and Christian Gelzer are starting the quality control process with the data files.

Gelzer's article, "The Longest Flight in the X-15 Reconsidered" was accepted by the International Test and Evaluation Journal and will appear in March 2020. On 20 April 1962, Neil Armstrong made his second-to-last flight in the X-15. Trying to trigger an experiment while on the way back to Edwards, he bounced off the atmosphere and found himself headed toward Los Angeles. He thought about landing at LAX but turned the aircraft around; he was, by then, over one of the metropolis' suburbs. Armstrong is considered the culprit in the usual telling of the story, but evidence drawn from flight transcripts, post-flight debriefings, and other primary sources, offers nuance to the story. High on the list of issues endemic to the X-15 were spotty radio communication, poor visibility downward, and regular calls of smoke in the cockpit during flights. This particular flight lasted 12 minutes 38 seconds, 11 minutes 07 seconds of which were spent mostly without radio contact with NASA. This mattered because the pilots depended on ground control to get themselves home safely. Following a flight, Joe Walker admitted that, on his way home, he could see the tops of the mountain chain near the base, but could not see the base itself because of visibility issues in the X-15—the Antelope Valley is big and was visible to shuttle pilots coming across the Pacific. Perhaps what drew the most attention was Center management's comments in a post-flight report, which stated, "smoke was observed emanating from above the instrument panel at 90,000 feet during the entry." Three factors conspired to limit Armstrong's situational awareness on his flight, and it is my contention that he was not the primary cause of the "excursion," as Milt Thompson called it.

"PERHAPS WHAT DREW THE MOST ATTENTION WAS… COMMENTS IN A POST-FLIGHT REPORT, WHICH STATED, 'SMOKE WAS OBSERVED EMANATING FROM ABOVE THE INSTRUMENT PANEL AT 90,000 FEET DURING THE ENTRY.'"

This image is the flight trace from the control room plotting board for Neil's long flight. The top trace shows the X-15's horizontal displacement (latitude-longitude), and the bottom trace shows its vertical displacement (altitude) during the flight. The traces run from right to left, the horizontal trace ending in a fishhook. Burnout is marked (5550 fps on the



Flight path for Neil Armstrong's X-15 long flight in 1962. (Credit: NASA)

altitude trace); thereafter, the X-15 flew on its recently imparted kinetic energy while acquiring potential energy (altitude) all the way to apogee. As kinetic energy declined thereafter, the pilot drew on potential energy to reach home. The bounce is plotted. There are four shorthand and two longhand cardioids—the thick, hand-drawn lines superimposed on the flight trace. These heart shapes are indicators of the X-15's diversion range at that point in the flight based on its total remaining energies. The cardioids diminish in area as the aircraft descends and slows.

GLENN RESEARCH CENTER (GRC)

Cleveland, Ohio

By Anne Mills

Glenn Contributions to the Apollo 13 Mission

"Cleveland, Ohio, June 12—The unique capabilities of a facility to produce weightlessness here on earth at NASA's Lewis Research Center are being used to help pinpoint the cause of the oxygen failure tank which crippled the Apollo 13 spacecraft on its way to the moon last April 13."

This year marks 50 years since NASA's most "successful failure." The above quote opened a 1970 press release from Lewis Research Center (now Glenn) detailing how the relatively new Zero Gravity Facility contributed to the accident investigation. The Zero Gravity Facility came online in 1966. The tower dropped 460 feet and provided researchers 5.2 seconds of microgravity to better understand its effects on liquid hydrogen. In 1985, the facility was designated as a National Historic Landmark and today continues to provide valuable information on fluid physics and combustion in near weightless conditions.

During the Apollo 13 accident investigation, the "Zero G" was tasked with testing a theory that burning Teflon insulation around a shorted wire in the oxygen tank caused the explosion. It was previously believed that Teflon would not burn in space conditions, but testing at Lewis proved otherwise. This information was part of the investigation board's final report and was utilized in improving the safety of future missions. Lewis employee Irv Pinkel, who could arguably be considered the "father" of the NASA safety program, served as an official observer to the Apollo 13 accident investigation after his key contributions to the Apollo 1 investigation.

Apollo 13 Lunar Module Pilot Fred Haise (like fellow Apollo astronaut Neil Armstrong) began his NASA career at Lewis Research Center as a research pilot. Haise flew at Lewis from 1959 to 1963 and published several papers on research he supported. Most notably, he piloted the Center's AJ-2 Savage in microgravity, inducing parabolic flights over Lake Erie for early microgravity studies.

JOHNSON SPACE CENTER (JSC)

Houston, Texas

By John Uri

Early in the new year, Jennifer Ross-Nazzal conducted a joint interview with Harry Larson and David Myers, two members of the group known as the Gallaudet 11. The Gallaudet 11, a misnomer since the group included more than 11 members, participated in studies of the vestibular system led by noted neuroscientist Dr. Ashton Graybiel from 1961 to 1968. Scientists selected Larson and Myers, then students at Gallaudet University for the deaf, for a number of reasons, including their ability to communicate. The childhood meningitis that led to their deafness also rendered their vestibular systems resistant to all forms of motion sickness. As subjects in a variety of experiments, they provided significant help to NASA in understanding the causes and the prevention of motion sickness early in the human spaceflight era. The oral history with Larson and Myers was videotaped using sign language interpreters, and the final product will be used in promoting the contributions of the Gallaudet 11 to aerospace medicine. The two men, along with Dr. John Allen, Program Executive for Crew Health and Safety at NASA Headquarters, described the program and their contributions during a panel session at the annual Human Research

Program Investigators Workshop in Galveston, Texas, and during a special program at Space Center Houston. Dr. Allen publicly recognized Jennifer and Sandra's efforts, as well as the overall JSC oral history project, during both sessions as well as in an e-mail to their management. In his e-mail, Dr. Allen expressed his gratitude and admiration for the oral history and complimented them on their leadership.

David Myers and Harry Larson, members of the Gallaudet 11, during their presentation at the Human Research Program Investigators Workshop. (Credit: NASA)

In January, the JSC History Office helped to acquire some of the personal records of Apollo geologist Bill Muehlberger. This came about because of some of the research we provided to the Human Exploration and Operations Mission Directorate. Geoscientist Pat Dickerson, who searched Muehlberger's records on our behalf, decided that his papers at the University of Texas at Austin needed to be in a publicly accessible archive with climate control. The JSC History Archives at the University of Houston—Clear Lake (UHCL) was suggested, and the papers were shipped at the end of January. Arrangements have been made with JSC Archivist Mark Scroggins to house the items until UHCL takes ownership. Additional conversations are ongoing about other Muehlberger materials at the Walter Geology Library.

The JSC History Office has been actively participating in an effort led by the JSC External Relations Office (ERO) to celebrate key moments leading up to the 20th anniversary of permanent occupancy of the International Space Station (ISS) on 2 November 2020. Feature articles to date highlighted the history[1] and assembly[2] of ISS, the announcement of the naming of the Expedition 1 crew[3], the first to occupy ISS, and how astronauts celebrate their birthdays aboard the orbiting laboratory.[4]

We continue to work with the JSC ERO on a series of articles commemorating other significant historical milestones, in particular the 50th anniversary of Apollo 13, the 45th anniversary of the Apollo-Soyuz Test Project, and further afield the 40th anniversary STS-1. The content is posted on the ***www.nasa.gov*** website and JSC's Facebook and Twitter accounts. Select articles are posted on JSC's *Roundup Reads* and abstracts of the articles appear online in JSC's Roundup Today. The features often highlight the anniversaries of less-celebrated events and people that were nevertheless important to the Apollo Program and other spaceflight endeavors. We would like to thank history and archive personnel at other NASA Centers for their valued help and contributions to many of these products.

1 *https://www.nasa.gov/feature/space-station-20th-historical-origins-of-iss*

2 *https://www.nasa.gov/feature/iss20th-high-flying-construction*

3 *https://www.nasa.gov/feature/space-station-20th-expedition-1-crew-named*

4 *https://www.nasa.gov/feature/space-station-20th-celebrating-birthdays-on-iss*

MARSHALL SPACE FLIGHT CENTER

Huntsville, Alabama

By Brian Odom

Over the past few months, the Marshall History Office and Archives have been busy with the usual research, writing, and reference requests. One of the more interesting projects was the development of a public history course, taught at the University of Alabama Huntsville. Through a series of guest lectures, this course explores both the history and current state of NASA in the region, spanning impacts on everything from religion to architecture. This series features guest talks from contributors to the forthcoming work, *NASA and the American South.*

The Marshall History Office also continued planning for a March 2021 symposium—NASA and the Rise of Commercial Space. This symposium will examine the evolution of commercial space activities in Low-Earth orbit and beyond—tackling the evolving legal framework for commercial space and a philosophy of New Space, and sorting through the varying definitions of commercial. The Call for Papers for this symposium is forthcoming.

Research continues into the long history of Gravity Probe B—the Stanford mission designed to test two important aspects of Albert Einstein's theory of general relativity. Key components of the experiment were two pairs of spherical, electrostatically suspended, spinning rotors. Made from Homosil-grade fused silica and roughly 1.5 inches (3.81centimeters) across in size, these rotors hold the Guinness World Record by being the "Most Spherical Manmade Object." In fact, the rotors were so round that if enlarged to the size of the Earth, the tallest mountain and the deepest ocean trench would measure only 8 feet. Last month, Brian interviewed precision machinist Joe Hayden. Now retired from the Speedring company, Hayden was responsible for the initial machining of the rotors (and gyroscope housings) before shipping to Stanford for final polishing.

Hayden's work for the space program did not begin with Gravity Probe B. During the Apollo program,

Joe Hayden displays a mock-up of the rotor and gyroscope housing developed for the Gravity Probe B experiment. (Credit: Brian Odom)

Hayden and the Speedring company where he was employed provided precision machining for many aspects of the Apollo 11 mission, including mirrors for both the optical unity assembly for the Apollo guidance system and the retroreflectors that were part of the Lunar Laser Ranging experiment.

Yet, while showing me around his shop in Cullman, Alabama, Hayden noted he was most proud of his work developing those all-too-critical rotors for Gravity Probe B. Preserving the stories of the scientists, engineers, and technicians like Hayden is certainly one of the most important and fulfilling functions of the NASA History Program.

More information on Gravity Probe B is located here: ***https://einstein.stanford.edu/***

STENNIS SPACE CENTER

Hancock County, Mississipi

By C. Lacy Thompson

NASA Artemis Program and Stennis Space Center Set the Stage for Testing in 2020

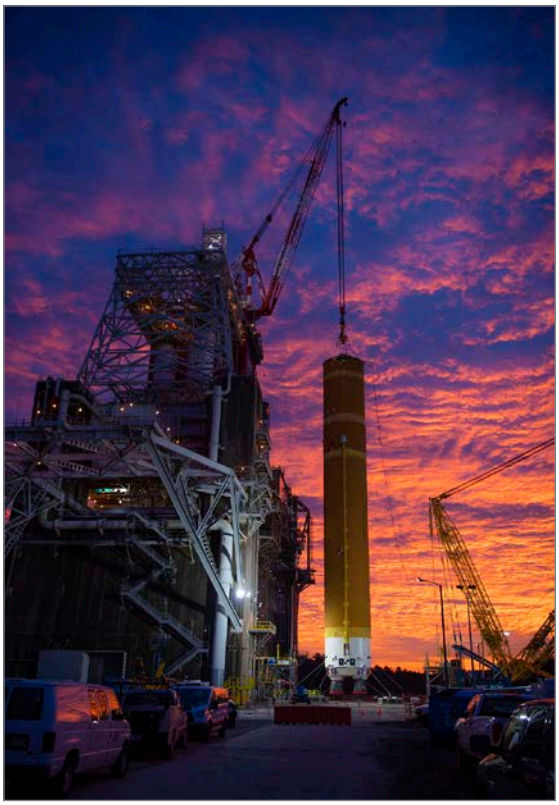
All eyes were on south Mississippi with last month's delivery and installation of NASA's Space Launch System (SLS) rocket's first core stage to Stennis Space Center for a milestone Green Run test series prior to its Artemis I[1] flight.

The Green Run[2] testing will be the first top-to-bottom integrated testing of the stage's systems prior to its maiden flight. The testing will be conducted on the B-2 Test Stand at Stennis, located near Bay St. Louis, Mississippi, and the nation's largest rocket propulsion test site. Green Run testing will take place over several months and culminates with an 8-minute, full-duration hot fire of the stage's four RS-25 engines to generate 2 million pounds of thrust, as during an actual launch.

"This critical test series will demonstrate the rocket's core stage propulsion system is ready for launch on missions to deep space," Stennis Director Rick Gilbrech said. "The countdown to this nation's next great era of space exploration is moving ahead."

NASA is building SLS as the world's most-powerful rocket to return humans to deep space, to such destinations as the Moon and Mars. Through the Artemis program, NASA will send the first woman and next man to the Moon by 2024. Artemis I will be a test flight without crew of the rocket and its Orion spacecraft. Artemis II[3] will carry astronauts into lunar orbit. Artemis III will send astronauts to the surface of the Moon.

The SLS core stage, the largest rocket stage ever built by NASA, stands 212 feet tall and measures 27.6 feet in diameter. It is equipped with state-of-the-art avionics,



SLS at sunset. (Credit: NASA)

miles of cables, propulsion systems, and propellant tanks that hold a total of 733,000 gallons of liquid oxygen and liquid hydrogen to fuel the four RS-25 engines during launch. The core stage was designed by NASA and Boeing in Huntsville, Alabama, then manufactured at NASA's Michoud Assembly Facility in New Orleans by lead contractor Boeing, with input and contributions from more than 1,100 large and small businesses in 44 states.

"Delivering the Space Launch System rocket core stage to Stennis for testing is an epic historical milestone," said Julie Bassler, the SLS stages manager. "My team looks forward to bringing this flight hardware to life and conducting this vital test that will demonstrate the ability to provide 2 million pounds of thrust to send the Artemis I mission to space."

1 *https://www.nasa.gov/feature/around-the-moon-with-nasa-s-first-launch-of-sls-with-orion*

2 *https://www.nasa.gov/exploration/systems/sls/green-run-test-paves-way-for-nasa-moon-missions.html*

3 *https://www.nasa.gov/feature/nasa-s-first-flight-with-crew-important-step-on-long-term-return-to-the-moon-missions-to*

The stage was transported from Michoud to Stennis aboard the specially outfitted Pegasus barge. It arrived at the B-2 dock on 12 January and was rolled out onto the test stand tarmac that night. Crews then began installing ground equipment needed for lifting the stage into a vertical position and onto the stand.

The lift was performed on 21–22 January during optimal weather and wind conditions. Crews then worked to fully secure the stage in place and to stand systems.

NASA completed extensive modifications[4] to prepare the B-2 stand for the test series. The stand has a notable history, having been used to test Saturn V stages that helped launch astronauts to the Moon as part of the Apollo Program and the three-engine propulsion system of the space shuttle prior to its first flight.

Preparing the stand for SLS core stage testing required upgrades of every major system on the stand, as well as the high pressure system that provides hundreds of thousands of gallons of water needed during a test. It also involved adding 1 million pounds of fabricated steel to the Main Propulsion Test Article framework that will hold the mounted core stage and extending the large derrick crane atop the stand that will be used to lift the SLS stage into place.

With the core stage installed on the stand, operators began the Green Run series with an initial end-of-the-month modal test. In coming months, they will power up avionics;[5] conduct main propulsion system and engine leak checks; and check out the hydraulics system and the thrust vector control unit that allows for rotating the engines to direct thrust and "steer" the rocket's trajectory.

They also will conduct a simulated countdown as well as a "wet dress rehearsal" in which propellants are loaded and flow throughout the stage system. The rehearsal exercise will end just prior to engine ignition, with the full four-engine hot fire to come in subsequent days.

After the hot fire test, crews plan to perform refurbishment work on the stage and inspect and configure it for shipment to Kennedy Space Center. The stage will be removed from the stand, lowered to its horizontal position on the tarmac, and reloaded into Pegasus for the trip to Florida.

At Kennedy, the stage will be joined with other SLS elements and prepared for launch. The next time its four RS-25 engines fire, Artemis I will be taking flight.

4 *https://www.nasa.gov/centers/stennis/news/Stennis-Reaches-Readiness-Milestone-in-Preparation-for-Space-Launch-System-Testing*

5 *https://www.nasa.gov/exploration/systems/sls/avionics.html*

UPCOMING MEETINGS

The annual meeting of the Organization of American Historians was scheduled for **2–5 April 2020** in Washington, DC, but is cancelled due to Covid-19. Visit *https://www.oah.org* for more details.

The semiannual Mid-Atlantic Regional Archives Conference was scheduled for **16–18 April 2020** in Harrisonburg, Virginia, but is cancelled due to Covid-19. Visit *https://www.marac.info* for more details.

The annual meeting of the Society of American Archivists will be held **2–8 August 2020** in Chicago, Illinois. Visit: *https://www2.archivists.org/conference* for more details.

The annual meeting of the Society for the History of Technology will be held **7–11 October 2020** in New Orleans, Louisiana. Visit *https://www.historyoftechnology.org/annual-meeting* for more details.

NOT CHILD'S PLAY: TOYS THAT INSPIRED NASA INNOVATIONS

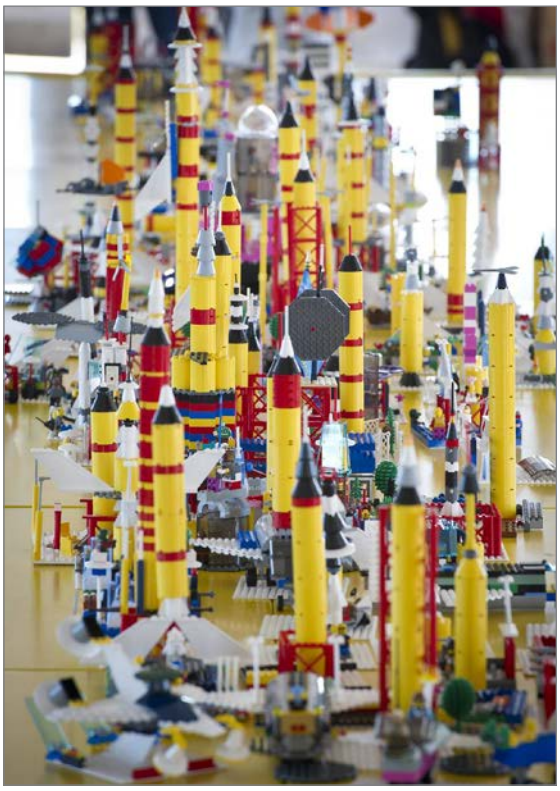
By Stacy Bishop, NASA History Division Intern

"Scientists go through their toy bins all the time for inspiration." —Phil West, NASA spokesman, 2000[1]

Baby toys and Martian landers may not be connected thoughts for most people, but toys have served as sources of inspiration for several NASA projects. The concept of using toys to inspire science dates back, at least, to the time Galileo considered a toy spy glass, eventually turning it into his famous telescope.[2] Many toys have "played" a part in space science.

NASA's influence on the toy market is commonplace. Model rockets, LEGO sets, and even an American Girl Doll all draw inspiration from the space agency. As part of the Space Act of 1958, section 203, NASA must "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."[3] Toys present a unique opportunity to increase awareness of NASA's strategic themes and NASA missions. NASA has a fairly straightforward merchandise approval process for toys and products that seek to carry the NASA logo or other NASA references. Many of these NASA-inspired toys also aim to encourage children to be interested in science and engineering. However, the toys have returned the favor, with children's playthings inspiring NASA scientists and engineers.

As NASA looks towards the Moon and Mars, the development of new technology will be essential. As scientists and engineers at NASA's Langley Research Center toyed with ideas for how to land future spacecraft, a toy was exactly what they needed. The plastic stacking rings, found in most playrooms, stirred the ideas of those designing an inflatable heat shield.[4] These stacking ring toys, meant for babies,



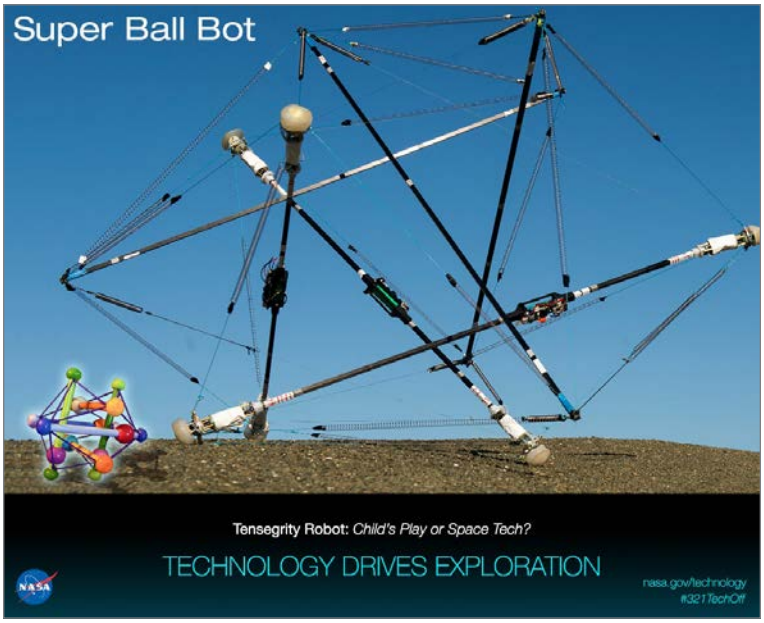
LEGO bricks at "Build the Future" at NASA's Kennedy Space Center in Cape Canaveral, Florida. (Credit: NASA)

1 Peabody, Zanto, "Car Designer to the Stars George Barris Has NASA Toying With One of His Early Ideas," *Los Angeles Times*, (22 April 2000), Valley Edition.

2 David Zax, "Galileo's Revolutionary Vision Helped Usher in Modern Astronomy," *Smithsonian Magazine* (August 2009). *https://www.smithsonianmag.com/science-nature/Galileos-Revolutionary-Vision-Helped-Usher-In-Modern-Astronomy-34545274/*.

3 *National Aeronautics and Space Act of 1958*, Public Law #85-568, 72 Stat., 426. Signed by the President on 29 July 1958, Record Group 255, National Archives and Records Administration, Washington, DC; available in NASA Historical Reference Collection, History Office, NASA Headquarters, Washington, DC (hereafter "HRC").

4 News Direct, "NASA's Inflatable Heat Shield: Aeroshell Inspired by a Toy Could One Day Help Humans Land on Mars," YouTube Video, 0:56 (3 February 2015). *https://www.youtube.com/watch?v=_jq7pPvcBLk*



Super Ball Bot is an all-in-one landing and mobility platform based on tensegrity structures, allowing for lower-cost and more reliable planetary missions. (Credit: NASA)

are often made of wood or plastic with the rings of increasing size in different colors or textures. The heat shield, named The Low-Earth Orbit Flight Test of an Inflatable Decelerator (LOFTID), also has a set of inflatable rings of increasing size. The stackable rings will be packed for the journey and inflate with gas when they reach the Martian surface. Using inflatable, stackable rings allows the spacecraft to have more room for experiments, equipment, or even people. LOFTID is set to launch in 2022.[5]

In 2013, a robotics researcher at NASA Ames Research Center stood in front of a crowd with a small springy toy designed for babies. He said, "So the initial inspiration was, we took one of these toys and we'd say, what can we use this for?"[6] The rattle and teether is made of wooden dowels, wooden balls, and elastic. The toy hardly resembles a spacecraft, but Vytas SunSpiral saw a landing robot saying, "Well they make them as baby toys because they're really safe; it's hard to break them, and hard to hurt yourself with it, hard for a baby to hurt themselves with it, and you can throw it on the ground really hard and you're not going to break it. Okay, that's a landing robot!" The Super Ball Bot is designed for planetary landing and exploration. This experimental robot concept would bounce, bend, fold, and stretch to explore unknown terrains.

In the archives of NASA Headquarters, there are articles that exist about a car designer named George Barris.[7] His famous works include the TV Batmobile, K.I.T.T. from Nightrider, and the Munster's unique automobile. Barris also designed model cars intended for children to build. It was in the year 2000 that a model car concept caught the attention of Robert Yowell, a NASA engineer based in Houston. Yowell was working on a design for a rover that could navigate Mars. He became intrigued by the wheel design and suspension of an old model car kit for a fantasy lunar rover named Moonscope.[8] Moonscope was a model car kit designed by George Barris in 1971 and manufactured by Model Products Corporation. Yowell wrote to George Barris asking if he would share his design for the rover. "I was intrigued by the wheel and suspension design and how far ahead of its time it was," said Yowell. Barris was flattered, agreed to share any designs and notes he had for the model car kit, and told NASA to use whatever they could.[9] Toy designers, particularly those designing fantasy space

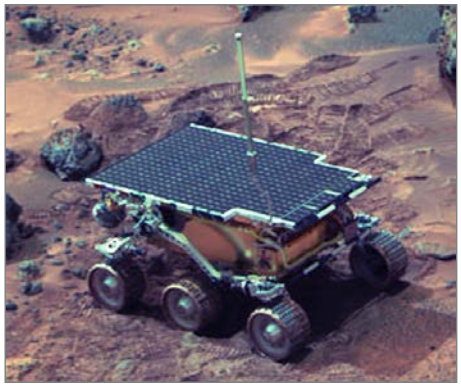
5 *LOFTID Fact Sheet. 2020. www.nasa.gov.* ***https://www.nasa.gov/sites/default/files/atoms/files/loftid_fact_sheet_june2019.pdf.***

6 NASAeClips,"NASA 360 Talks - Super Ball Bot," YouTube video, 2:20 19 February 2015. ***https://www.youtube.com/watch?v=0eC4A2PXM-U***

7 Zanto Peabody, "Car Designer to the Stars George Barris Has NASA Toying with One of His Early Ideas," *Los Angeles Times* (22 April 2000), Valley Edition.

8 Edward Lozzi, "Holy Martian Batmobile! NASA Mars Mission Engineers Consult with George Barris, Hollywood Car Designer and Creator of the Batmobile," Toys, Impact Box 120, HRC, Washington, DC; Los Angeles, California, 16 March 2000.

9 Zanto Peabody, "Car Designer to the Stars George Barris Has NASA Toying With One of His Early Ideas." *Los Angeles Times*, (22 April 2000), Valley Edition.



George Barris's Moonscope toy (Credit: scalemates) and Sojourner Rover. (Credit: NASA)

vehicles, are not bound by the physics of actual space travel. This freedom allows for creative design.

In 2003, when the U.S. Air Force Research Laboratory's Space Vehicles Directorate was tasked with bringing electronic components to spacecraft, they again looked toward toys, particularly the interchangeability of LEGO bricks.[10] According to the Manager of Strategic Alliances at NASA, "NASA and LEGO have a history of collaboration aimed at inspiring the next generation of space explorers and builders. LEGO wishes to further this partnership with NASA to bring to life even more of the stories, careers, technology, and science behind the various endeavors surrounding missions into space." In fact, some of the latest LEGO sets have "Inspired by NASA" right on the box. As LEGO has been inspired by NASA, the engineers at AFRL became inspired by aspects of LEGO bricks. By designing interchangeable parts with standardized ports that fit together, similar to LEGO bricks, they are able to move and manipulate parts without completely redesigning a whole instrument. Another advantage of building a modular system like LEGO bricks is, if there was a problem with a component, only that part could be replaced instead of having to rebuild the whole instrument. While designed for monetary savings as well as ease of use, this idea had the added benefit of being able to be transported in pieces and assembled in space.

Developing technology for space and exploration requires hardware that has never been made before. Beyond being technically knowledgeable, scientists and engineers need to be creative and able to look at everyday objects, even toys, in a new way. While NASA-inspired toys grace the shelves of retailers, toys have helped NASA scientists find original solutions to unique problems. Space science and engineering demand creativity and ingenuity, the same ideals that toys seek to nurture. It makes perfect sense that toys would serve as inspiration for the people solving some out-of-this-world challenges. NASA will continue to partner with toys that aim to share the excitement of space science with future generations. NASA scientists and engineers will always continue to look at the world around them as inspiration for innovations.

"BEYOND BEING TECHNICALLY KNOWLEDGEABLE, SCIENTISTS AND ENGINEERS NEED TO BE CREATIVE AND ABLE TO LOOK AT EVERYDAY OBJECTS, EVEN TOYS, IN A NEW WAY."

10 Rich Tuttle, "USAF Eyes Lego Concept for Space Structures," *Aerospace Daily*, (13 August 2003).

MAKING EVERY DAY EARTH DAY

By Alisa Greenhalgh, NASA History Division Intern

This year, the world is celebrating the 50th anniversary of Earth Day. Earth Day was started in 1970 to raise awareness of and further environmental movements to save our planet from the carelessness of humans. Wisconsin Senator Gaylord Nelson recognized the need for action and reached out to college-aged activists already involved in anti-war, civil rights, and other movements. To accommodate the younger audience, Earth Day was scheduled for 22 April, a date between spring break and finals. The original Earth Day was widely successful in America with approximately 20 million people participating in rallies across the country. Earth Day became a global movement in 1990 with 141 countries participating in rallies as well as increasing awareness about recycling.[1] From grassroots to global, Earth Day has raised awareness of how people can be better stewards of this planet that has given us life.

When you hear "Earth Day," you probably think about "going green" or planting trees. What might not come to mind is the National Aeronautics and Space Administration. However, the famous "Earthrise" photo taken by Apollo 8 astronauts in 1968 has been credited, in part, for inspiring the environmental movement. Photographing Earth is not the only way that NASA has been contributing to protecting the planet. In fact, NASA's Earth Science Division works every day to collect and study data that will help humans better understand planet Earth. This process has been ongoing for many decades now.

Since NASA's beginning, scientists looked to the stars to learn about the vast unknown of outer space, but the further they got into space, the more they realized they still knew very little about the planet we live on.

Iconic Apollo 8 "Earthrise" at its original orientation. (Credit: NASA)

The first satellite sent to orbit Earth was Explorer 1 in 1958. The mission of Explorer 1 was to measure the radiation element in Earth's atmosphere.[2] Explorer learned a lot about the atmosphere it was orbiting in. However, it did little to learn more about the planet itself. As NASA entered the 1960s, satellites collecting data on weather patterns were sent up, which was a huge step to humans' understanding weather patterns. According to the former director of NASA's Earth Science Division, Dr. Michael Freilich, before those satellites went up, "the human race had never had an image of a complete hurricane's cloud patterns."[3]

As wonderful as these findings were, NASA did not start looking at Earth as "one huge life supporting

1 Earth Day, "The History of Earth Day," Accessed 28 January 2020. *https://www.earthday.org/history/*.

2 NASA, "Explorer 1," Accessed 26 January 2020. *https://www.jpl.nasa.gov/missions/explorer-1/*.

3 Edward S. Goldstein and Tabatha Thompson, "Earth Science: NASA's Mission to Our Home Planet," NASA. Last Modified 6 August 2008. *https://www.nasa.gov/50th/50th_magazine/earthSciences.html.*

Earth Day 2017 poster featuring the total solar eclipse. (Credit: NASA)

system made up of discrete parts working together" until the 1970s and early 1980s.[4] This desire to study Earth as a huge singular system from space brought in a new generation of scientists ready to discover the unknown that was still here at home. In 1973, NASA Administrator James C. Fletcher told a Senate committee, "NASA is called the space Agency, but in a broader sense, we could be called an environmental Agency…Perhaps that is our essential task, to study and understand Earth and its environment."

These ideals stated by Fletcher were considered as NASA's Earth Science Division started looking at how to study the long-term changes of Earth and whether or not human activity was affecting the planet. In the early 1980s, NASA published a technical memorandum titled, "Land-Related Global Habitability Issues." This report outlined a vision of studying Earth as a single system. The plan was to have a satellite capable of studying global energy, water cycles, land surface, biological productivity on land, and the atmosphere. As this idea was further researched, NASA organized the Earth Observatory System (EOS) in 1990.

The planning went well through the decade, and on 18 December 1999, the first of many EOS satellites was launched. The Terra satellite fulfilled the hopes of the 1983 memorandum with five sensors that are able to "explore the connections between Earth's atmosphere, land, snow and ice, ocean, and energy balance to understand Earth's climate and climate change and to map the impact of human activity and natural disasters on communities and ecosystems."[5] Since then, there have been nine other satellites that

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>
> **—James C. Fletcher, Former NASA Administrator**

4 Land-Related Global Habitability Science Issues Working Group, "Land-Related Global Habitability Science Issues," NASA. July 1983. Accessed online at *https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19830021473.pdf*.

5 Kurtis Thome, "Terra," NASA. Accessed 28 January 2020. *https://terra.nasa.gov/*.

As of 10 October 2019, these were all the active Earth Observing satellites NASA associates with. (Credit: NASA)

have been used specifically for EOS missions. The Terra satellite, though only meant to function for five to six years, has been in operation for more than 20 years now. According to Steve Running, the former Chair of NASA's Earth Science Subcommittee, "Many of the Terra platform datasets, now more than 20 years long, are unique worldwide; no other country has developed, deployed, maintained, and distributed this type of critical Earth system datastream. Many Earth scientists worldwide use Terra datasets regularly, even though their country launches satellites of their own."[6] The data collected by Terra and the other EOS missions have allowed NASA to better understand the relationships among Earth, water, and the atmosphere, the changes the world is going through, and how the human race is affecting the planet.

Outside of the EOS missions, there are currently 36 satellites that are either orbiting or are being prepared to orbit Earth to continue these studies. Last year, NASA's administrator was quoted as saying, "At NASA, every day is Earth Day, as 20 missions continuously orbit the planet to study climate change, the behavior of oceans, precipitation worldwide, and many other Earth vital signs that help us become better stewards of our home."[7] Among many other benefits, these Earth-focused satellites have allowed scientists to track the quality of air, so that we may know if those conditions are no longer safe, and firefighters to safely navigate dangerous wildfires, to both extinguish them and evacuate affected areas.

As the 50th anniversary of Earth Day approaches, it is important to remember the beauty of Earth that we live on. Though NASA continues to push boundaries and go where no human has gone before, we cannot forget to look back and remember our responsibilities on planet Earth.

6 "Terra Research." *Terra Research*, 28 January 2020.

7 "Every Day Is Earth Day," NASA. Accessed 29 January 2020. *https://sservi.nasa.gov/articles/every-day-is-earth-day/*.

GROUNDBREAKING FOR THE MISSISSIPPI ARMY AMMUNITION PLANT (MSAAP)

By Jessica Herr

The Mississippi Army Ammunition Plant was completed in 1983 on the site of what is now known as Stennis Space Center. (Image source: NASA)

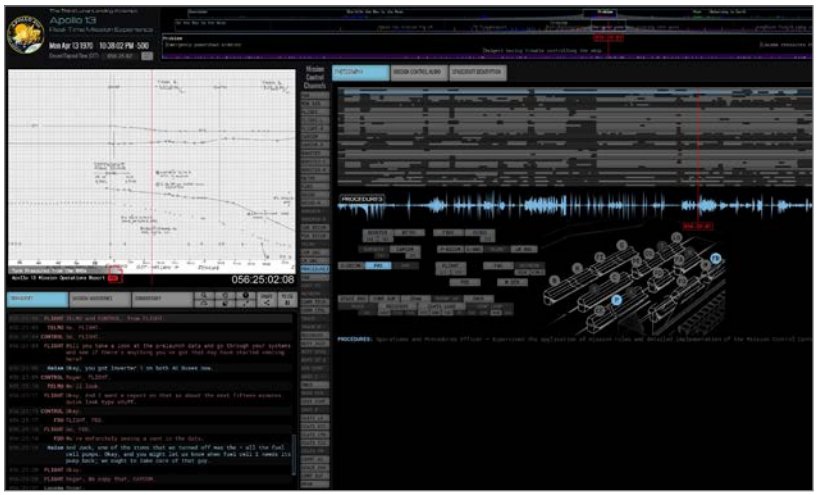
One thing Jackson Balch tried to do as Director of the Mississippi Test Facility (MTF), now known as Stennis Space Center, was bring agencies and organizations together so that their work and research would benefit each other. In 1971, the Army was looking for a place to build a plant for their ammunition modernization program. This was a classified program named "Steel City." At first, it was suggested that the Army look at Camp Shelby, just south of Hattiesburg, for their ammunition plant, but the Army had its sights set on the Mississippi Test Facility. The Army estimated that the plant was going to cost $500 million with about 1,200 employees. These were overwhelming numbers compared to the smaller installations on site at MTF. Balch also worried that the ammunition plant would overshadow the space and environmental work that was being done at MTF. However, Balch did not need to worry. The Army did initially suggest some changes at MTF, like moving engine testing to another site in Florida, but NASA and Senator Stennis maintained that engine testing would stay at MTF. The Army, MTF, and Senator Stennis all wanted to work together to make Steel City work. The Senate Armed Services Committee, chaired by Senator Stennis, gave the Army funding to begin construction of MSAAP. Despite all that was happening at MTF at that time, Jackson Balch was focusing on building up the agencies that would call MTF home. He convinced Dr. George Constan, a former manager of Michoud Assembly Facility, to serve as the liaison between NASA and the Army. The building of Steel City began with the groundbreaking ceremonies on 10 January 1978. There were 1,500 people from the surrounding areas that celebrated the building of this monumental facility. Senator Stennis was joined by Jerry Hlass as well as U.S. Representatives Trent Lott and Sonny Montgomery; Deputy Secretary of Defense Charles Duncan, Jr.; Secretary of the Navy W. Graham Clator, Jr.; Rear Admiral J. Edward Snyder, Jr.; and Deputy Administrator of NASA Alan Lovelace. In his address at the groundbreaking ceremony, Senator Stennis congratulated the arrangement of agencies at the site stating, "Today, this Facility exists as a national model of federal agency coordination and cooperation."

> **"…SENATOR STENNIS CONGRATULATED THE ARRANGEMENT OF AGENCIES AT THE SITE STATING, 'TODAY THIS FACILITY EXISTS AS A NATIONAL MODEL OF FEDERAL AGENCY COORDINATION AND COOPERATION.'"**

MISSING TAPES AND ACCEPTABLE RISK: APOLLO 13 IN REAL TIME

By Catherine Baldwin

Nearly 15 minutes pass between the arguably most famous statement in NASA history, "Houston, we've had a problem"[1] and "We are venting something out into space."



Apollo 13 in Real Time website. (Credit: Ben Feist)

Unlike any Hollywood reenactment, things in Mission Control unfold slowly. On Ben Feist's new website, Apollo 13 in Real Time, you can hear the polyphony of voices, slowly adding to the fray, as each member of Mission Control realizes the magnitude of the problem. In real time, you hear the team discuss the problem and offer solutions, one after the other. The stress is palpable, and the strain in their voices is audible. Then, suddenly, you hear the long, anxiety-filled silences before instructions are sent to the astronauts. Despite the days it takes, listening to the mission is as riveting as any movie.

Feist's new Apollo 13 website is now part of his growing collection of Apollo in Real Time, already populated with Apollo 11[2] and 17[3]. A much quicker process than its predecessors, the creation of Apollo 13 in Real Time will only take about eight months, as opposed to the two years taken for Apollo 11, and the six years needed for Apollo 17. This dramatic decrease in the time necessary to create this website is mostly due to the addition of a team! For Apollo 17 in Real Time, Ben Feist did 99 percent of the work, and for Apollo 11, he did about 90 percent; but for this mission, the site became much more of a group effort. Apollo 13 was created with a full team of passionate and skilled volunteers: Jeremy Cooper (software engineer), Stephen Slater (archive producer), David Charney (graphic designer), Johannes Kemppanen (historical researcher), Robin Wheeler (editor on the Apollo 10 flight journal), and Ernie Wright (science visualizer at NASA Goddard's Scientific Visualization studio). Just like Feist, all the people on this team are volunteers who, as Feist says, "do this work for the love of it."

The most exciting part of this already unbelievable website is the "discovery" of missing tapes. For years, there had been four tapes missing from the 21-tape collection of Mission Control audio. These tapes contained the audio surrounding the onboard explosion. Their whereabouts were not clear until Dan Rooney of the National Archives found them stored with the accident investigation material and e-mailed Feist saying, "I found them!" It is likely that these last

1 Found at *https://apolloinrealtime.org/13/?t=055:55:37.*

2 *https://apolloinrealtime.org/11/*

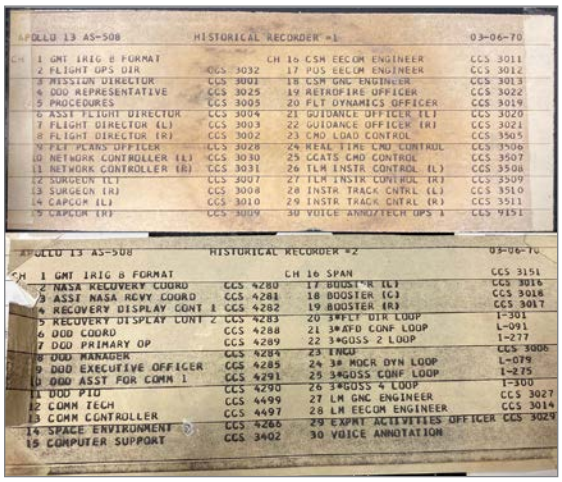
3 *https://apollo17.org/*

> **THE MOST EXCITING PART OF THIS ALREADY UNBELIEVABLE WEBSITE IS THE 'DISCOVERY' OF MISSING TAPES.**

four tapes were separated as evidence for the accident investigation that took place in 1972. With these four tapes, the Apollo 13 in Real Time team has digitized 50 channels of Mission Control audio, totaling 7,500 hours in length. As Feist makes clear, "Getting [the tapes] digitized has been a joint effort between NASA JSC and the National Archives."

Since this is the first time these tapes will be heard in 50 years, everything the public hears from them will be completely new! Like Apollo 11 in Real Time, there are moments and people to look out for. The tape recorders at the consoles were voice-activated, so every time someone spoke, the tape would record them. This, of course, led to the capture of some interesting moments. Some of them are large pieces of history, like Tom Stafford calling Vice President Spiro Agnew[4] to update him on the problem. Then, other moments are as simple and human as phone calls home to make sure their wives were not worried. One particularly interesting moment is captured when a young man, in the midst of all that is happening, decides he *must* take the time to ask a young lady out on a date.[5] Spoiler alert: It turned out that she had another date that night.

With the addition of Apollo 13, the collection has become a kind of a retrospective on the Apollo Program. Contrasting the three missions against each other, it is clear that, despite their inherent similarities, they each displayed a different facet of the space program. In the words of Fiest, "Apollo 11 was really a mission about engineering operations and survival, while Apollo 17 was the 'crown jewel.' There were so many firsts happening during the mission that it was more than possible that something serious could go wrong. Apollo 13 was unique because everyone had to work way outside of their normal jobs, in great coordination, and Apollo 17 was the science-focused 'crown jewel' of the Apollo program, with almost everything going perfectly and the successful return of a payload


APOLLO 13 AS-508 HISTORICAL RECORDER #1 03-06-70

CH					
1	GMT IRIG B FORMAT		16	CSM EECOM ENGINEER	CCS 3011
2	FLIGHT OPS DIR	CCS 3032	17	PDS EECOM ENGINEER	CCS 3012
3	MISSION DIRECTOR	CCS 3001	18	CSM GNC ENGINEER	CCS 3013
4	DOD REPRESENTATIVE	CCS 3025	19	RETROFIRE OFFICER	CCS 3022
5	PROCEDURES	CCS 3005	20	FLT DYNAMICS OFFICER	CCS 3019
6	ASST FLIGHT DIRECTOR	CCS 3004	21	GUIDANCE OFFICER (L)	CCS 3020
7	FLIGHT DIRECTOR (L)	CCS 3003	22	GUIDANCE OFFICER (R)	CCS 3021
8	FLIGHT DIRECTOR (R)	CCS 3002	23	CMD LOAD CONTROL	CCS 3505
9	FLT PLANS OFFICER	CCS 3028	24	REAL TIME CMD CONTROL	CCS 3506
10	NETWORK CONTROLLER (L)	CCS 3030	25	CCATS CMD CONTROL	CCS 3507
11	NETWORK CONTROLLER (R)	CCS 3031	26	TLM INSTR CONTROL (L)	CCS 3508
12	SURGEON (L)	CCS 3007	27	TLM INSTR CONTROL (R)	CCS 3509
13	SURGEON (R)	CCS 3008	28	INSTR TRACK CNTRL (L)	CCS 3510
14	CAPCOM (L)	CCS 3010	29	INSTR TRACK CNTRL (R)	CCS 3511
15	CAPCOM (R)	CCS 3009	30	VOICE ANNOT/TECH OPS 1	CCS 9151

APOLLO 13 AS-508 HISTORICAL RECORDER #2 03-06-70

CH					
1	GMT IRIG B FORMAT		16	SPAN	CCS 3151
2	NASA RECOVERY COORD	CCS 4280	17	BOOSTER (L)	CCS 3016
3	ASST NASA RCVY COORD	CCS 4281	18	BOOSTER (C)	CCS 3018
4	RECOVERY DISPLAY CONT 1	CCS 4282	19	BOOSTER (R)	CCS 3017
5	RECOVERY DISPLAY CONT 2	CCS 4283	20	3*FLT DIR LOOP	I-301
6	DOD COORD	CCS 4288	21	3*AFD CONF LOOP	L-091
7	DOD PRIMARY OP	CCS 4289	22	3*GOSS 2 LOOP	I-277
8	DOD MANAGER	CCS 4284	23	ENCU	CCS 3006
9	DOD EXECUTIVE OFFICER	CCS 4285	24	3* MOCR DYN LOOP	L-079
10	DOD ASST FOR COMM 1	CCS 4291	25	3*GOSS CONF LOOP	I-275
11	DOD PIO	CCS 4290	26	3*GOSS 4 LOOP	I-300
12	COMM TECH	CCS 4499	27	LM GNC ENGINEER	CCS 3027
13	COMM CONTROLLER	CCS 4497	28	LM EECOM ENGINEER	CCS 3014
14	SPACE ENVIRONMENT	CCS 4265	29	EXPRT ACTIVITIES OFFICER	CCS 3024
15	COMPUTER SUPPORT	CCS 3402	30	VOICE ANNOTATION	

Images of Historical Recorders 1 and 2. (Credit: Ben Feist)

Rediscovered tape reel. (Credit: Ben Feist)

4 Found at *https://apolloinrealtime.org/13/?t=058:01:38&ch=52.*

5 Found at *https://apolloinrealtime.org/13/?t=076:58:56&ch=46.*

of scientific data that continues to be studied now 48 years later."

Apollo 13 is rightfully hailed as one of NASA's greatest successes. Feist was struck most by the focus and professionalism of the entire mission, both onboard and in Mission Control. The teamwork that brought Lovell, Haise, and Swigert home safely is nothing short of remarkable. Consequently, the success of Apollo 13 is often framed as a miracle. However, this event didn't happen in a vacuum. Just like every mission before it, Apollo 13 was preceded by a prolonged and intense training period. As Feist puts it, "Planning, simulation, and training can make risk acceptable risk. The Apollo program had a contingency ready for problems like the one that occurred on Apollo 13. One contingency that was used allowed the use of the Lunar Module as a lifeboat to get the crew home in case the Command Module was disabled. This is exactly what needed to be done, and they had already thought of this 'what if' and were ready. It's an excellent example of what it takes to balance acceptable risk with the inherently dangerous prospect of exploring other planets. Apollo 13 is an example of how to do it right."

RECENT PUBLICATIONS

Disclaimer: *This list was adapted from the astronautics list compiled by Gideon Marcus for 2019. The NASA History Office thanks him for allowing us to use his list. Please note that the list of titles does not represent an endorsement by NASA.*

A Computer Called Katherine: How Katherine Johnson Helped Put America on the Moon, by Veronica Miller Jamison and Suzanne Slade (Little, Brown Books for Young Readers, 2019).

A History of Space Exploration in 100 Objects, by Sten Odenwald (Experiment, 2019).

A History of the Italian Space Adventure: Pioneers and Achievements from the XIVth Century to the Present, by Giovanni Caprara (Springer, 2019).

Apollo 11: 50th Anniversary of the First Man on the Moon, by David Baker (Mortons Media Group, 2019).

Apollo 11: The Moon Landing in Real Time, by Ian Passingham (Pen and Sword History, 2019).

Apollo Confidential: Memories of Men on the Moon, by Lukas Viglietti (Morgan James Publishing, 2019).

Apollo Mission Control: The Making of a National Historic Landmark, by Manfred "Dutch" von Ehrenfried (Springer International Publishing, 2019).

Chasing the Moon: The Story of the Space Race—from Arthur C. Clarke to the Apollo Landings and the Space Shuttle, by Alan Andres and Robert Stone (William Collins, 2019).

China's Space Station: Reaching for the Moon and Mars, by Brian Harvey (Springer, 2019).

Daring Dozen: The Twelve Who Walked on the Moon, by Alan Marks and Suzanne Slade (Charlesbridge, 2019).

Destination Moon: The Remarkable and Improbable Voyage of Apollo 11, by Richard Maurer (Roaring Brook Press, 2019).

Disaster Strikes!: The Most Dangerous Space Missions of All Time, by Jeffrey Kluger (Philomel Books, 2019).

DK Life Stories: Katherine Johnson, by Charlotte Ager and Ebony Joy Wilkins (DK Children, 2019).

DK Readers Level 3: Moon Landings, by DK and Shoshana Weider (DK Children, 2019).

Dr Space Junk vs The Universe: Archaeology and the Future, by Alice Gorman (The MIT Press, 2019).

From Cave Man to Cave Martian: Living in Caves on the Earth, Moon and Mars, by Manfred "Dutch" von Ehrenfried (Springer, 2019).

Geopolitics of the Outer Space: A European Perspective, by Bohumil Domos (Springer, 2019).

Handprints on Hubble: An Astronaut's Story of Invention, by Kathryn D. Sullivan (The MIT Press, 2019).

Heroes of Space: Who Changed the World (Graphic Greats), by Emily Sohn (B.E.S., 2019).

Ike: The Memoir of Isom "Ike" Rigell, by Ike Rigell (Koehler Books, 2019).

Interplanetary Robots: True Stories of Space Exploration, by Rod Pyle (Prometheus, 2019).

John F. Kennedy: From Florida to the Moon, by Raymond B. Sinibaldi (Arcadia Publishing, 2019).

Light from the Void: Chandra X-Ray Observatory, by Smithsonian Astrophysical Observatory (Smithsonian Books, 2019).

Manned Lunar Landing and Return, by Robert Godwin (CG Publishing, 2019).

Mars: A Journey of Discovery, by Rod Pyle (Andre Deutsch Ltd., 2019).

Moon Mission: The Epic 400-Year Journey to Apollo 11, by Sigmund Brouwer (Kids Can Press, 2019).

Moon Rush: The New Space Race, by Leonard David (National Geographic, 2019).

Moon: Architectural Guide, by Paul Meuser (DOM Publishers, 2019).

Moonshots: 50 Years of NASA Space Exploration through the Lens of Hasselblad, by Piers Bizony (Voyageur Press, 2019).

Moving to Mars: Design for the Red Planet, by Andrew Nahum (The Design Museum, 2019).

My Journey to the Stars (Step into Reading), by André Ceolin and Scott Kelly (Random House Books, 2019).

NASA and the Long Civil Rights Movement, by Brian Odom and Stephen Waring (University Press of Florida, 2019).

One Giant Leap: The Untold Story of How We Flew to the Moon, by Charles Fishman (Simon & Schuster, 2019).

Picturing Apollo 11: Rare Views and Undiscovered Moments, by John Bisney and J. L. Pickering (University Press of Florida, 2019).

Planetary Rovers: Mobile Robots in Extreme Environments, by Lutz Richter (Springer, 2019).

Project Apollo: The Moon Odyssey Explained, by Norman Ferguson (The History Press, 2019).

Reaching for the Moon: The Autobiography of NASA Mathematician Katherine Johnson, by Katherine Johnson (Atheneum Books for Young Readers, 2019).

Rocket to the Moon!, by Don Brownie (Harry N. Abrams, 2019).

Russia's Posture in Space: Prospects for Europe, by Marco Aliberti and Ksenia Lisitsyna (Springer, 2019).

Shoot for the Moon: Achieve the Impossible with the Apollo Mindset, by Richard Wiseman (Quercus, 2019).

The Apollo Missions: The Incredible Story of the Race to the Moon, by David Baker (Arcturus, 2019).

The Astronaut Who Painted the Moon: The Story of Alan Bean, by Dean Robbins and Sean Rubin (Orchard Books, 2019).

The Case for Space: How the Revolution in Spaceflight Opens Up a Future of Limitless Possibility, by Robert Zubrin (Prometheus Books, 2019).

The Consequential Frontier: Challenging the Privatization of Space, by Peter Ward (Melville House, 2019).

The Eagle Has Landed: 50 Years of Lunar Science Fiction, by Neil Clarke (Night Shade Books, 2019).

The History of the American Space Shuttle, by Dennis R. Jenkins (Schiffer, 2019).

The Mission of a Lifetime: Lessons from the Men Who Went to the Moon, by Basil Hero (Grand Central Publishing, 2019).

The View from Space: NASA's Evolving Struggle to Understand Our Home Planet, by Thor Hogan and Richard Leshner (University Press of Kansas, 2019).

Wally Funk's Race for Space: The Extraordinary Story of a Female Aviation Pioneer, by Sue Nelson (Chicago Review Press, 2019).

Where Once We Stood: Stories of the Apollo Astronauts Who Walked on the Moon, by Martin Impey and Christopher Riley (Harbour Moon Publishing, 2019).

OTHER AEROSPACE HISTORY NEWS

AMERICAN ASTRONAUTICAL SOCIETY (AAS) HISTORY COMMITTEE

By Michael Ciancone

2019 Emme Award for Astronautical Literature

The Emme Award Panel, chaired by Dr. Don Elder, is early in the process of soliciting and reviewing selected titles. *Ronald Reagan and the Space Frontier*, by Dr. John Logsdon, was the recipient of the 2018 Emme Award. Other members of the Panel are Dr. Rick Sturdevant, Dr. Jennifer Levasseur, and Dr. De Witt Kilgore.

2019 Astronautics Booklist

Marcus Gideon is in the process of assembling the annual booklist. We will circulate the list for comment before posting for wider dissemination.

Dr. Rick Sturdevant also reports that the FY20 NDAA redesignated the Air Force Space Command (AFSPC) as the United States Space Force (USSF). The change became effective on 20 December 2019. His title changed from Deputy Director of History, HQ AFSPC, to Deputy Director of History for HQ USSF (USSF/HO). In addition, since the establishment of United States Space Command (USSPACECOM) on 29 August 2019, his office has been dual-hatted as the USSPACECOM history office (USSPACECOM/J012).

Bernard S. Finn IEEE History Prize

The Bernard S. Finn IEEE History Prize is awarded annually to the best paper in the history of electrotechnology—power, electronics, telecommunications, and computer science—published during the preceding year. Any article published in a learned periodical or collection of essays is eligible if it treats the art or engineering aspects of electrotechnology and its practitioners. The article must be written in English, although the journal or periodical in which it appears may be a foreign language publication. The prize consists of a cash award of $1,000 and a certificate. In addition, IEEE will provide a travel subsidy ($750 domestic, $1,000 international) to allow the winner to attend SHOT's annual meeting, and SHOT will waive the basic registration and awards-banquet fees for the winner.

The deadline for submissions is 15 April 2020. Please e-mail a copy of the paper to Paul Israel at *pisrael@taep.rutgers.edu*.

The website for the award is located at *https://www.historyoftechnology.org/about-us/awards-prizes-and-grants/the-bernard-s-finn-ieee-history-prize/*.

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RETIREMENT OF COLIN FRIES

Senior Archivist at Headquarters Colin Fries retired in December after over 20 years with the History Division. Acknowledged in an unbelievable number of books, aerospace history and otherwise, Colin has been a staple of the Historical Research Collection. When collecting well-wishes for Colin's retirement party, we received countless notes from people who have been touched by Colin and his expertise. His dedication has truly left a mark on the aerospace community. Filled with gratitude and admiration, these notes were read aloud at Colin's retirement party.

Here are some excerpts:

> "Thank you for your help with my research, but more importantly, for your years of dedication to preserving the history of one of humanity's greatest achievements."
>
> —Margot Lee Shetterly

> "I do think it will take the history of what has preceded to inspire future generations to strive to achieve even greater feats of exploration. You are owed a debt of gratitude for your role in preserving this history—thank you!"
>
> —Richard Faust

> "As someone who has relied on the resources of the NASA Headquarters Archives for most of my books, I want to express my thanks to Colin Fries for his important but rarely acknowledged contributions to the work we historians do."
>
> —Chris Gainor

> "Colin's helpfulness and knowledge, as well as patience and humility, are a rare combination, and he made the process of mining the NASA archives for golden nuggets of details and historic facts that much easier and enjoyable."
>
> —Richard Jurek

> "Many thanks for all those folders pulled out, all those questions answered and all those e-mails taken care of. Every single time I have come to the NASA History Office over the past decade I have been looking forward to seeing and chatting with you, and every single time it has been such a pleasure."
>
> —Alexander Geppert

Colin Fries at his retirement party in December. (Credit: Aubrey Gemignani/NASA)

> "While we wish you a most pleasant, healthy, and long retirement, we will miss the expertise, dogged determination, and good fellowship that you brought to the NASA History Division. I can't tell you how many times in conversations someone would say, 'Well, we better check with Colin,'and all of us knew who exactly that was. Your contributions have been many, varied, and lasting, and I know I speak for many when I say that you will be greatly missed."
>
> —Dick Hallion

The History Division will miss Colin, but we will always be grateful for the impact he has made on this office. We wish him a happy and healthy retirement!

IN MEMORIAM

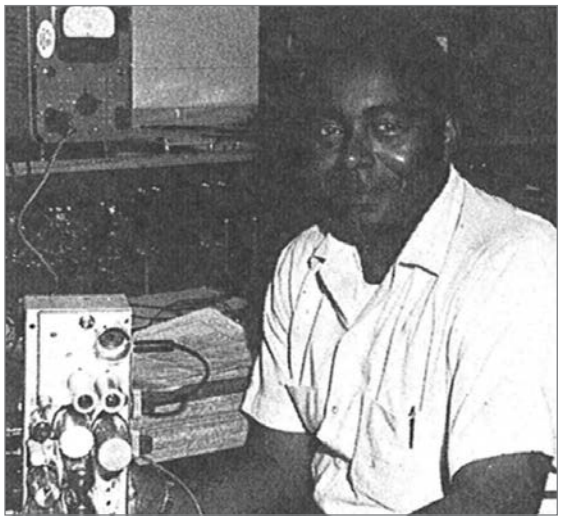
REMEMBERING JULIUS MONTGOMERY: SPACE PROGRAM PIONEER

By Richard Paul

This article originally appeared on the Smithsonian website. We are so grateful that the Air and Space Museum allowed us to reprint it and continue to share this beautiful story.

Julius Montgomery, a pioneering African American in the space program, died on 22 January 2020, in Florida. He was the first African American ever hired at the Cape Canaveral space facility to work as a technical professional. Additionally, he integrated the Florida Institute of Technology and was the first black member of the Melbourne, Florida, City Council.

When Julius Montgomery came to the Cape from Alabama in 1956, the Ku Klux Klan controlled east central Florida. The Orange County Sheriff was a Klansmen, as were city commissioners, Alderman, and county commissioners. One historian has said, "Local businessmen joined the Klan almost like joining the Rotary club." In the Klan's wake, of course, came lynching. In the Southern states where the space program was based, Florida had the highest lynching rate per capita, so the racial animus was palpable on Montgomery's first day.



Julius Montgomery at work as a "Range Rat." The Range Rats repaired the electronics in malfunctioning ballistic missiles. (Photo by USAF/AMR Cape Canaveral. Courtesy Jack Tolman and Vic Craft)

As he remembered it, "I was a strange person coming into an all-white building. All white." As he entered his new workplace, the RCA Development Lab, "Nobody would shake my hand," he recalled. One by one, each of his coworkers turned away. "I got to the last fellow," he said, "and I said, 'Hello, I'm Julius Montgomery.' He said, 'Look boy, that's no way to talk to a white man!'" In a story indicative of who Julius Montgomery was—one he told many times during his life, "I said, 'Ah, forgive me, oh great, white bastard. What should I call you?' And I laughed, and he laughed, and he shook my hand."

Montgomery began his career as a member of the "Range Rats," technicians who repaired malfunctioning ballistic missiles. Their work mostly involved developing circuits, as there was no "over-the-counter equipment to do the jobs" at the time, Montgomery said. The team also traveled out to the ships that, he said, "searched the skies for anything the Russians were doing," to perform maintenance on the satellite equipment.

At the end of the 1950s, a senior member of Montgomery's team went to his bosses at RCA and told them he wanted to open a school to keep workers up to date on the state-of-the-art in engineering. The school, originally called Brevard Engineering College (BEC), began with three rented classrooms at a public junior high school. Montgomery signed up to attend the new school and, on the sign-up sheet, listed that he had earned his undergraduate degree at Tuskegee Institute. Within days, the county superintendent of schools was on the phone to BEC, telling them that the school system was canceling their contract to rent the classrooms. The all-white

Julius Montgomery (in sunglasses), the first African American hired as a professional at Cape Canaveral, spoke on a panel at the National Air and Space Museum with Morgan Watson, NASA's first African American engineer, and astronauts Leland Melvin and Mae Jemison. This event was held in February 2010. (Image courtesy of Smithsonian Institution)

Florida public schools could not allow a black man through its doors.

BEC's founder summoned Montgomery to his office, told him his dilemma, and begged him to drop out and spare the school. Montgomery did, only enrolling after the school had its own building. Today, Florida Tech (which BEC became) acknowledges that it would not exist without Montgomery's sacrifice and, in his honor, presents the Julius Montgomery Pioneer Award annually. Days before Montgomery's death, the school also awarded him an honorary doctorate in humane letters.

Montgomery was also a pioneer in Florida politics. Standing for elections beginning in 1956 (when fewer than 50 African Americans held elected office in the former Confederate states) and finally prevailing in 1969, he became the first African American ever to win a seat on the Melbourne City Council.

Julius Montgomery's story is one of many stories of the space program's African American pioneers that does not comport with what we read about civil rights achievement in the standard high school textbook. Not everyone reached the ends of the Civil Rights Movement by marching, picketing, and saying "no." Many did, of course, but others, like Julius Montgomery, applied the principles of self-help and—often—accommodation to reach the same ends.

On 20 February 2010, Julius Montgomery appeared on a panel at the National Air and Space Museum with NASA's first black engineer, Morgan Watson, and astronauts Leland Melvin and Mae Jemison. Montgomery told the story of his first day at the Cape. After the talk, as people snapped pictures of Mae Jemison with the Tuskegee Airmen, also at the event that day (it was tough to tell who was more honored to meet whom), Julius Montgomery sidled over to Leland Melvin and looked up (the astronaut, a former wide receiver who had briefly been drafted by the Detroit Lions, towered over the older man) with wide-eyed awe. "I'll tell you," Montgomery said, "You astronauts, you're the bravest people I ever met." Leland Melvin returned the look, and his grin broke into a wide, beaming smile. "No, sir," he said. "I heard your story out there. You are the bravest person I ever met." And Julius laughed, and Leland laughed, and they shook hands.

In January 2020, Julius Montgomery received an honorary doctorate of humane letters from Florida Institute of Technology. Pictured are Florida Tech President Dwayne McCay and Julius Montgomery's daughters, Gaye and Lisa, with their dad. (Image courtesy of Florida Tech)

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