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↗ Astronaut Jerry Ross assembles a portion of a truss structure in NASA's neutral buoyancy simulator at Marshall Space Flight Center in 1992. (Credit: NASA)

NASA HISTORY OFFICE

OFFICE OF COMMUNICATIONS

From the Chief Historian

TWENTY TWENTY-FOUR was a busy year. NASA saw increased activity in low Earth orbit, preparations for Artemis II, the launch of Europa Clipper, expansion of the Artemis Accords, and much more. Activity in the NASA History Office certainly reflected that hectic pace. The areas of archives, engagement, research, and publications formed the backbone of the work we collectively undertook in our efforts to support agency goals and decision-making.

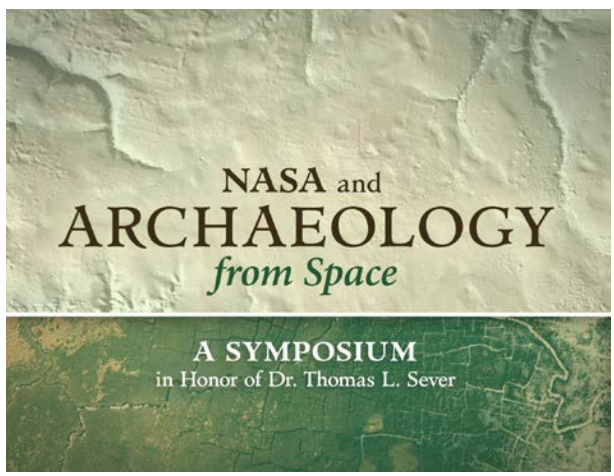
The core of all historical work begins with sources. In the History Office, that work begins with archives. Over the past year, our incredible team of archivists working across the agency continued their work in archival appraisal, accessioning, processing, preserving, and providing access to our important documents. While a NASA Archives Catalog became available to NASA internal users in April 2024, the archivists are working diligently on a public-facing version of the catalog that will provide broad access to collections at repositories across the agency.

Several key outreach events in 2024 reflected both our approach to engagement and a bit of experimenting with bridging the gap between art and science. In June at the National Academy of Sciences in Washington, DC, the Discovery@30, New Frontiers@20 Symposium brought historians and scientists together in an exploration of past challenges and celebration of the accomplishments of these two solar system exploration programs. Future plans include a continuation of this conversation with a daylong event in 2025 that will include principal investigators for missions in development, early career science researchers, and students.

In September in Huntsville, Alabama, the History Office teamed with the University of Alabama in Huntsville for the NASA and Archaeology from Space Symposium. This event included several speakers who worked on projects initiated several decades ago, presenting findings from several campaigns, highlighting the evolution of the field of remote sensing for archaeology and historical ecology, and advocating next steps for the field. An edited volume from the symposium is in the works.

Finally in October, NASA Headquarters hosted a workshop dedicated to the DC-8 Airborne Science Laboratory as that program ended. Much like the other events, this one included historians in conversation with practitioners seeking contextualization of the agency's experiences with that platform. The success of this program, and others like it, stems from the integration of history with scientific and engineering practice as well as buy-in from NASA leadership that historical context is important to future successes. Our experience working with NASA Associate Director for Research Jack Kaye and his team provides an excellent model for future applied history efforts.

The History Office continues to engage with numerous audiences across several platforms, including our website and social media channels. Our *News & Notes* issues are an important way to engage with audiences interested in NASA history. We are continuously evaluating new engagement strategies, and our newsletter is a reflection of that effort. The four issues from this year addressed several important historical topics while highlighting the diversity of work undertaken by office historians and archivists. The fall issue provided a special focus on archives. If



↑ In September, the NASA History Office hosted a symposium about the agency's history with using space-based Earth observations for archaeology. (Credit: NASA)

From the Chief Historian (continued)

you are interested in archives, give that one a look!

Another noteworthy effort has been our NASA History Speaker Series. This past year's lineup was stellar indeed. From Joshua Winn's discussion of "TESS and Exoplanets" to Jeffrey Nesbit's look at "Architecture and the Space Complex," this diverse lineup reflected the extraordinary diversity and health of the space history field. These talks will continue in 2025. We will also launch a yearlong seminar series on the topic of Aerospace Latin America. The goal of this series is to offer insight into the long history of Latin American involvement in aerospace—knowledge of which will help NASA leadership understand how this regional history shapes current attitudes as we move toward increased cooperation.

Oral histories were a major focus in 2024 as well. Projects designed to capture perspectives on NASA history included efforts related to planetary science missions of Discovery and New Frontiers, Artemis Science, NASA's tenure under Administrator Bill Nelson, DC-8, Stratospheric Observatory For Infrared Astronomy (SOFIA), and much more. These sources offer a rich body of narratives that will be a benefit to future historians.

On the publications front, 2024 saw continued research and writing with several major works, long in process, finally published. For NASA History Special Publications, *NASA's Discovery Program: The First Twenty Years of Competitive Planetary Exploration* was published in January as David Brown completed an important work started by Susan Niebur, who sadly passed away before her manuscript could be completed. The *Aeronautics and Space Report of the President: Fiscal Year 2023 Activities* highlighting the aerospace activities of 14 federal departments and agencies was published in May. *A Wartime Necessity: The National Advisory Committee for Aeronautics (NACA) and Other National Aeronautical Research Organizations' Efforts at Innovation During World War II*, edited by Alex M Spencer, explores the early historical context of fundamental research—something that has always been and continues to be important to NASA. Our latest publication from John Logsdon, *Going Beyond: The Space Exploration Initiative and the Challenge of Organizational Change at NASA*, provides numerous insights to NASA leadership about the formulation of space policy and the challenges that sometimes come with that process.

Beyond our in-house publications was the publication, with academic partners, of two edited volumes stemming from earlier scholarly engagement—*NASA and the American South* (published in January) and *The Rise of the Commercial Space Industry* (released in September). These volumes provide an examination of NASA's early development in the southern United States and an interdisciplinary investigation of the evolution of commercial aerospace efforts respectively. Both are also examples of how applied history is being utilized by the office in support of NASA's leadership and workforce.

While there is certainly much more to be said about the work of our historians and archivists over 2024, I believe this overview gives the reader a sense of what you can expect from the office in the year to come. As of this writing, the nation and the agency are moving toward a transition in leadership. As always, changes in leadership come with potential new directions and priorities. Regardless, the NASA History Office will continue to look to the past with a critical eye to find vital lessons, pose new questions that expand interpretive frameworks, and deliver sources and engagement opportunities for the space history field as a whole. Here's looking forward to 2025. ■

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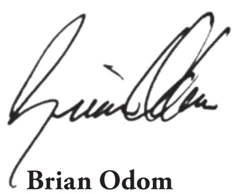


Brian Odom
Chief Historian

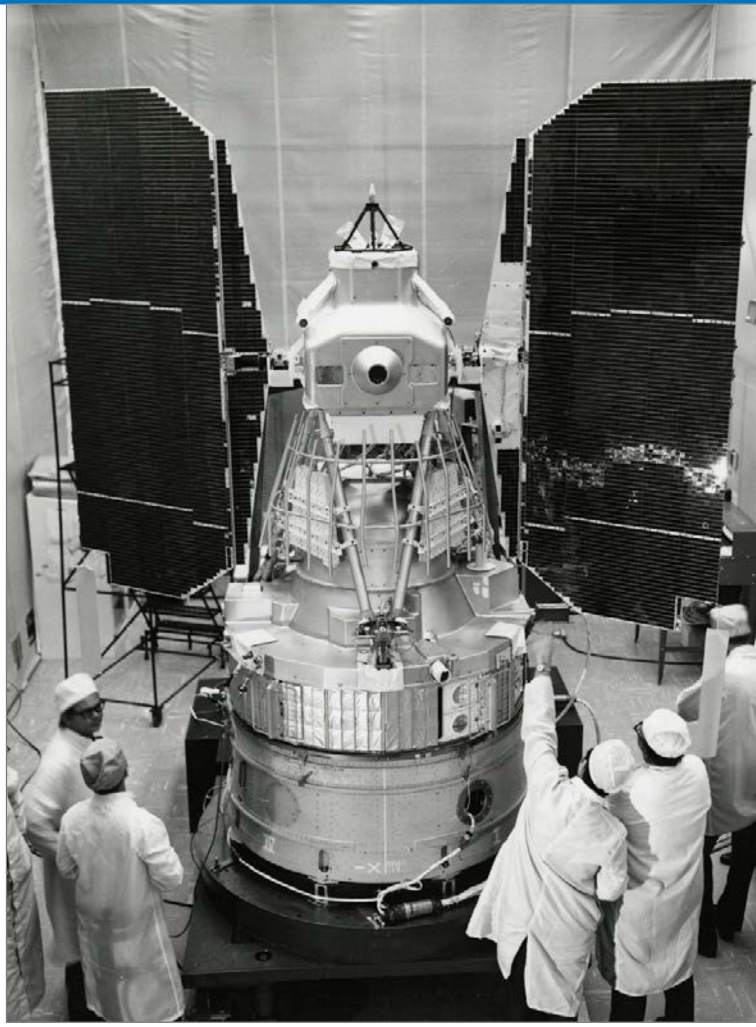
Landsat and the Green Revolution

» By **Brad Massey**, NASA Historian

HYBRID CROPS, industrial fertilizers, and global supply chains commoditized foodstuffs, increased harvest yields, and dramatically transformed many agricultural systems after World War II. This was especially the case in developing countries. Agricultural production soared in Mexico, India, and other nations with growing populations. All told, global harvest levels increased threefold between 1950 and 1990.[1]

This agricultural transformation, which was sponsored and exported by the U.S. government, special interest groups, and corporations, is known as the Green Revolution. American politicians, agribusinesses, and scientists who supported the revolution believed increasing harvest yields worldwide reaped diplomatic and economic rewards in the mid- and late 20th century. Helping developing countries become food self-sufficient, these disciples of the Green Revolution theorized, could stabilize the global food market, feed those in need, and, in the process, undercut the appeal of communist political ideology during the Cold War.

The transnational connections the Green Revolution spawned, however, created a new set of global problems, some of which required new technologies to remedy. To flourish, new high-yield hybrid crops required massive amounts of synthetic fertilizers, pesticides, and fresh water, which led to increasing pollution levels and the disruption of natural ecosystems. The sowing of hybridized varieties of seed also decreased the genetic diversity of crops, which made them susceptible to disease. Furthermore, because the revolution created a global food network that commodified grain, rice, seed, synthetic fertilizer, and more, an interconnected corporate- and government-sponsored food system was born that required accurate crop yield predictions to ensure stable prices and accessibility.



Workers examine and prepare the first Landsat satellite for launch. (Credit: NASA)

This last fact became painfully clear in the early 1970s when world food prices spiked. This inflation sent shock waves through the global food system and motivated U.S. policymakers to search for new tools to predict harvest yields. One such tool was NASA's Landsat satellite program.

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The Green Revolution Buds

The pioneers of the Green Revolution used U.S. farms as their primary laboratories. Motivated by the financial and environmental pressures of the early 20th century, American scientists and farmers created a new hybrid corn by crossbreeding different existing corn stocks. These new seeds created ears of corn that had larger kernels and more rows. However, they needed extensive fertilizing and pesticide application to flourish. For U.S. farmers, the costs and trouble of applying fertilizers and pesticides proved economically worthwhile, especially during the farm labor shortages of World War II.[2]

After their successful implementation in the United States, American government officials, scientists, and anti-communist organizations decided to spread the tools and know-how of the Green Revolution to developing countries. One influential revolutionary supporter was Henry Wallace, an Iowa farmer and politician who established the Hi-Bred corn seed company and served as the U.S. Secretary of Agriculture (1933–40) and U.S. Vice President (1941–45). Wallace preached that introducing hybrid high-yield crops and fertilizers to the developing world would eliminate food scarcity. In a 1942 speech, he argued that modern science "has made it technologically possible to see that all of the people of the world get enough to eat."

Wallace was not alone in his thinking. The Rockefeller Foundation, one of the revolution's most influential sponsors, and other U.S.-based institutions also reasoned that working to solve food-scarcity issues in Mexico, India, and other developing countries would stave off hunger. They also believed that the revolution's bounty could be used to thwart the spread of communist political ideology to the developing world. For these groups, and many U.S. politicians, exporting the tools of the revolution served both humanitarian and political ends.

The Rockefeller Foundation and Norman Borlaug, who created a new semi-dwarf wheat that thrived in Mexican fields, first brought the tools of the revolution to Mexico. Successful harvests there and the creation of an attendant corporate-government coalition motivated the revolution's supporters to venture to India, the Philippines, Turkey, Iran, Iraq, Brazil, Indonesia, Kenya, and Egypt in the 1960s. Once there, agricultural scientists created new varieties of high-yielding rice and other crops, all of which required heavy fertilization and pesticide application, while supportive government officials created the necessary bureaucratic support structures. With that, a U.S.-sponsored corporate global food and commodities market was spread.

Landsat Data and Predicting Harvest Yields

The Green Revolution reduced worldwide hunger, but the system had weaknesses that were exposed in the early 1970s. Monsoons in India reduced

Left: U.S. Vice President Henry Wallace working in his Victory Garden in 1942. This same year, he argued that technology had made it possible to ensure food stability for all the world's people. (Credit: Farm Security Administration/John Vachon. Courtesy Library of Congress) **Right:** Norman Borlaug, fourth from left, in Mexico during a training initiative. (Credit: International Maize and Wheat Improvement Center [CIMMYT])

wheat harvest yields, and climatic forces in China slashed the country's grain production. Chinese farmers harvested a reported 10 million tons of grain *less* in 1972 than they did in 1971. Southeast Asian rice-producing countries also reported smaller harvests. To make matters worse, drought enveloped West Africa and also drastically reduced the Soviet Union's wheat and potato harvest.[3] This motivated the Soviet Union to import large amounts of foodstuffs, including roughly a quarter of the 1972 U.S. wheat harvest.

This trade deal, a devalued U.S. dollar, food inflation, and production shortfalls led to a spike in prices that challenged the food gains of the revolution's transnational food network. In a 12-month span, the price of a bushel of wheat rose from $2.16 to $5.17. Inflation struck other agricultural commodities as well. The price of turkey in the United States rose from 39 to 90 cents a pound from 1972 to 1973. U.S. policy-makers did not comprehend the scale and ramifications of the trade deal, the global harvest failures, and food inflationary pressures until it was too late. With American consumers fuming and food instability rising around the globe, the victories of the Green Revolution were imperiled.[4]

U.S. congressional leaders looked for answers, and solutions, in disparate places, and in 1973 they asked NASA officials what could be done. Could satellite data, including Landsat 1, help improve harvest forecasts?

NASA officials believed it could, but Landsat (launched July 23, 1972) was not specifically designed to monitor the products of the Green Revolution. Unlike for early weather and communications satellites, Landsat engineers did not have a single user or application in mind when researching and developing the remote sensing satellite. Still, when queried, NASA officials asserted that Landsat's cameras and Multispectral Scanner (MSS) could be used by agricultural officials, along with traditional forecasting tools, to monitor crop health and predict harvest yields.

Before the 1972 food crisis, the U.S. Department of Agriculture (USDA) was not convinced of Landsat's utility.

Before the 1972 food crisis, the U.S. Department of Agriculture (USDA) was not convinced of Landsat's utility. In 1971, USDA official Theodore Byerly argued that the cost-benefit ratio of future Landsat data "was not high enough to make the earth resources program a high priority activity within Agriculture." Byerly was not alone. Other agricultural officials believed traditional means of predicting harvests, which included ground surveys and aerial photographs, to be more cost efficient and accurate. Ultimately, the food price spikes and political pressures of 1972 and 1973 made USDA policy-makers reconsider their position on the usefulness of Landsat's remote sensing capabilities.[5]

To test the agricultural value of Landsat, NASA, the National Oceanic and Atmospheric Administration (NOAA), and the USDA teamed up to use Landsat data, along with meteorological information and field studies, to try and predict harvest yields more accurately. In October 1973, the Large Area Crop Inventory Project (LACIE), which focused on measuring wheat production levels, was launched. Although the USDA and NASA butted heads regarding procedures, expenses, and how to use remote sensing data most effectively during the experiment, LACIE achieved important results. For example, the project scored a victory when it accurately predicted a diminished Soviet wheat harvest in 1977.

Despite its imperfections and interagency conflicts, LACIE highlighted that satellite sensing data could, and would, be used in tandem with traditional datasets to predict global harvest yields. This laid the foundation for the Agricultural Resources Inventory Surveys through Aerospace Remote Sensing (AgRISTARS) Program, which began in 1978, and other future programs, like today's NASA Harvest.[6]

Logo for the LACIE experiment, a collaboration between NASA, NOAA, and the USDA. Note the wheat, corn, and satellite. (Credit: NASA)

2025 NASA HISTORY SEMINAR SERIES

Aerospace Latin America

Over the course of 2025, the NASA History Office will present a seminar series on the topic of Aerospace Latin America. This series will explore the origins, evolution, and historical context of aerospace in the region since the dawn of the Space Age, canvasing a broad range of topics including aerospace infrastructure development, space policy and law, Earth science applications, and much more.

These talks will be held on Thursdays at 1 p.m. CST via Microsoft Teams. To receive details on how to attend, join our mailing list by sending a blank email to *history-join@lists.hq.nasa.gov* or request a meeting link by emailing Brian Odom at *brian.c.odom@nasa.gov*.

FEBRUARY 6
Stephen Buono
(University of Chicago)
"Governing the Moon: A History"

FEBRUARY 20
Pete Soland
(University of Houston—Downtown)
"A God's Eye View: Aviators and the Re-Conquest of Latin America"

MARCH 6
Anne W. Johnson
(Universidad Iberoamericana—Mexico City)
"So Far from God, So Close to NASA"

Landsat and the Green Revolution (continued)

Conclusion

Landsat data was a useful tool in the arsenal of the Green Revolution's disciples, as well as those dedicated to stabilizing the global food market of the late 20th century. But why should we care? As historians of the French Revolution, Germany's Weimar Republic, and other periods of high food inflation can attest, runaway food prices can quickly lead to food scarcity; political upheaval; and radical, sometimes violent, change. With this historical fact in mind, it is important for policy-makers to understand the tools experts have leveraged in the past to create food-stable societies.

The story of the Green Revolution and Landsat data is also a tale of how technologies not created for a particular application can effectively be reconsidered and repurposed for a specific scientific end. Landsat was not specifically designed to help predict harvest yields, yet its data were ultimately processed and reconsidered in ways that helped researchers do just that. ■

Endnotes

1 For a concise summary of the Green Revolution, see Ted Steinberg, *Down to Earth: Nature's Role in American History*," 3rd ed. (Oxford University Press, Oxford: 2018), pp. 274–277. Famines and food shortages did not disappear, but many potential famines were stymied by the Green Revolution. The world's human population increased from roughly 2.5 to 5.3 billion between 1950 and 1990, whereas crop production increased threefold.

2 For a look at the history of creating hybrid corn, see Ruth Schwartz Cowan, *A Social History of American Technology*, 2nd ed. (Oxford: Oxford University Press, 2018), pp. 301–306.

3 For a contemporary take on low harvests of the early 1970s see John A. Schnittker, "The 1972–73 Food Price Spiral," Brookings Institute website, https://www.brookings.edu/wp-content/uploads/1973/06/1973b_bpea_schnittker.pdf (accessed November 15, 2024).

4 Johnathan Derrick, "The Great West African Drought, 1972–1974," African Affairs, vol. 76:305 (October 1977): 537; Judith Stein, *Pivotal Decade: How the United States Traded Factories for Finance in the Seventies* (New Haven: Yale University Press, 2010), pp. 103, 105–106.

5 Byerly quote from Pamela E. Mack, *Viewing the Earth: The Social Construction of the Landsat Satellite System* (Cambridge: Massachusetts Institute of Technology, 1990), p. 150.

6 For a brief look at Landsat and agriculture see Landsat Legacy Project Team, *Landsat's Enduring Legacy: Pioneering Global Land Observations from Space* (Bethesda: The American Society for Photogrammetry and Remote Sensing, 2017), pp. 91–94.

The Administration Building, seen here in July 1945, served as the seat for the center's leaders and a focal point for visitors. (Credit: NACA)

Farewell to Glenn's Administration Building

» By **Robert Arrighi**, NASA Historian and Archivist

"**SIMPLY, AND QUIETLY,** without display or ceremony, the new Administration Building was opened Monday morning," is how the center's newsletter described the beginning of operations in the Administration Building on December 15, 1942, at what is today NASA's Glenn Research Center. The atmosphere was similarly subdued when the center staff permanently vacated the building in July 2024, bringing an end to its role as the center's management team's base for over 80 years.

The Administration Building, which is located just inside the front gate, was one of the original structures built at the NACA's Aircraft Engine Research Laboratory in the early 1940s. Its primary function was accommodating center leadership, including the director, deputy and associate directors, and directorate heads. Over the years, it also provided space for the fiscal, personnel, public affairs and other functions, as well as the mailroom, switchboard operations, and the center's library.

According to the NACA's construction manager, Raymond Sharp, the $625,000 Administration Building was designed by the Federal Works Agency's Public Buildings Administration. Architect Howard Lovewell Cheney, who designed a host of federal buildings, including the Ronald Reagan Washington National Airport, is listed on some blueprints as the architect.

The two-story, U-shaped building has a tan brick façade that matches the laboratory's other original buildings, giving the campus a unified appearance. In addition to its office space, the Administration Building included a reception area just inside the front entrance, a large auditorium, and several conference rooms.

The Cleveland-based Sam W. Emerson Company, which built most of the laboratory's original structures, constructed the Administration Building over a nine-month period in 1942. Its completion in December came as a relief for the staff that had been working for the past year in temporary offices built inside the hangar across the street.

Sharp, who became director of the laboratory in 1944, initially occupied a suite of rooms at the west corner of the first floor. From 1948 until his retirement in 1960, Sharp resided in the second-floor office above the front entrance. During much of this period, associate director Abe Silverstein worked in Sharp's original first floor office. When Silverstein became director in 1961, he returned the director's

> **The atmosphere was similarly subdued when the center staff permanently vacated the building in July 2024, bringing an end to its role as the center's management team's base for over 80 years.**

Farewell to Glenn's Administration Building (continued)

office to the first-floor location, where it has remained ever since.

For nearly 50 years, visitors funneled through the Administration Building, checking in with the receptionist in the lobby and often having a photograph taken with their host in the sitting area or on the front steps. Guests included prominent politicians and military leaders, researchers from across the globe, and tour groups. The lobby walls featured a large relief map of the campus and language from the 1915 Congressional act that established the National Advisory Committee for Aeronautics (NACA).

The auditorium occupies the building's entire eastern wing and included an adjacent kitchen and a projection booth. The room, which was the center's only indoor assembly area until 1964, was used for staff meetings, technical conferences, visitor receptions, and social gatherings up until 2024. Across the hall is a foyer that served as a conference room and, for many years, an overflow area for the auditorium.

The second floor included the technical library and two conference rooms (one adjacent to Sharp's office and another designed specifically to host NACA committee meetings). The center's telephone switchboard began with a single operator but expanded in the early 1960s to meet the increased needs of the new space agency. The switchboard was relocated to another building in the 1980s and replaced by a videoconference facility.

In December 1956, division chief John Collins advises new engineer John Gibb in the lobby underneath an excerpt from the 1915 congressional act. (Credit: NACA)

In response to the dramatic increase in the number of employees in the early 1960s, the interior of the Administration Building was reconfigured, with larger rooms being converted into multiple smaller offices, additional offices built in the basement, and the relocation of the library to another building. In the early 1970s, the building underwent substantial modifications that included bricking over the large auditorium windows, remodeling the lobby, and redesigning the front entrance. The director's suite and lobby have undergone multiple redesigns in the ensuing years.

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With the exception of a flagpole, the grassy area in front of the Administration Building remained vacant until trees were planted in 1958. The area was occasionally used for large gatherings such as celebrating VE Day in 1945, hosting a talk by Dwight Eisenhower in 1946, and hosting astronaut James McDivitt in July 1965. For the center's 50th anniversary in 1991, the landscaping of the area was improved and two additional flagpoles and a metal sculpture containing a time capsule were

Farewell to Glenn's Administration Building (continued)



Left: A May 1958 meeting of the NACA's Special Committee on Space Technology in the committee conference room. (Credit: NACA) **Center:** The library in its original location on the second floor in 1948. (Credit: NACA) **Right:** Operators at the center's switchboard in the Administration Building basement in 1975. (Credit: NASA)

added. In 2016, a Centaur G prime upper stage was put on display and an Ohio historical marker was installed.

In 2004, NASA began implementing an agencywide effort to reduce infrastructure and its physical footprint in an effort to minimize energy and maintenance costs. This endeavor led to the removal of older, sometimes historically significant, facilities across the agency and the construction of more affordable and sustainable buildings, including new administration buildings at eight NASA centers.

Left: General Dwight Eisenhower addresses NACA employees in April 1946. (Credit: NACA) **Right:** The Administration Building as it appeared in 2021 with the Ohio marker and time capsule in front. (Credit: NASA)


In response, Glenn developed a Facilities Master Plan that would transform the campus through a series of demolitions and new construction projects. The plan included the eventual removal of the Administration Building. The addition of the ultramodern Research Support Building in 2022 gave center management the opportunity to revisit the removal of the Administration Building. In the fall of 2023, Director Jimmy Kenyon announced that center leadership would be relocating. Several months later, the center began soliciting outside entities to lease several buildings, including the Administration Building. It became apparent, however, that repair costs would be prohibitive for any potential tenant, and that demolition was inevitable.

In July 2024, the center invited employees to an open house to say goodbye to the historic building. Shortly thereafter, leadership and the Office of Communications moved into the Research Support Building, bringing an end to the Administration Building's over 80 years of service to the center and agency.

The Administration Building is a contributing structure to Lewis Field Historic District, which is eligible for listing on the National Register of Historic Places. Despite various modifications over the years, the building maintains much of its original integrity and appearance. Matthew Rector, Glenn's Cultural Resources Manager, is currently undertaking National Historic Preservation Act compliance with the Ohio State Historic Preservation Office. The building is currently scheduled to be razed in fiscal year 2026.

The Neutral Buoyancy Simulator

A Preservation Case Study for Marshall Space Flight Center National Landmarks

» By **Jillian Rael**, NASA Historian

SINCE CONGRESS CODIFIED the preservation of historic buildings, structures, and sites in the 1930s, the National Park Service (NPS) continuously pursues the protection of such resources for the benefit of the American populace.[1] Over the course of the 1960s and 1970s, additional congressional legislation sought to clarify or expand prior statutes. One such elucidating measure, a 1980 amendment to the Historic Site's Act, codified NPS's responsibility to report upon identified themes significant to the nation's history.[2] Consequently, by 1984 NPS had identified humanity's presence in outer space as a critical exploratory theme.

In that year, NPS sponsored a nationwide survey entitled "Man in Space: A National Historic Landmark Theme Study," which collated the most

← Astronauts Russell Schweickart and Ed Gibson test an emergency procedure to free the jammed solar array panels on the Skylab workshop not long after the May 14, 1973, launch anomaly where it lost a micrometeoroid shield and one of its two solar array wings. This photograph shows Schweickart and Gibson in the Neutral Buoyancy Simulator (NBS) using various cutting tools and methods developed to free the remaining jammed solar array. Extensive testing and many hours of practice in simulators such as the NBS tank helped prepare Skylab 2's Charles "Pete" Conrad and Joseph Kerwin to make the mission-saving repairs during an extravehicular activity. (Credit: NASA)

The Neutral Buoyancy Simulator (continued)

important intact and tangible expressions of America's space triumphs. This study sought to evaluate resources related to the identified theme, assess the historical significance and integrity of each, and, ultimately, recommend those qualifying resources as National Historic Landmarks (NHLs)—a designation reserved for the nation's most celebrated treasures.[3] Each approved NHL simultaneously entered into the National Register of Historic Places.

To facilitate the report's completion, surveyors visited NASA and U.S. Air Force centers across the country to evaluate potential significance under four general subthemes: Technical Foundations before 1958, The Effort to Land a Man on the Moon, The Exploration of the Planets and Solar System, and The Role of Scientific and Communications Satellites. The final report recommended 24 total resources for potential NHL status; however, two were ultimately discounted. Of the 22 deemed eligible, 21 belonged to NASA.[4]

NASA leadership, however, objected to NHL designation for its historic properties on dual fronts. First, the agency argued that some of the recommended resources failed to meet the established eligibility criteria. Second, NASA viewed NHL designations as inhibitory to its operations.[5] As NHL properties require high levels of preservation to maintain structural and historical integrity, NASA expressed warranted concerns. After all, with limited real estate combined with the ever-advancing nature of its work, agency leadership foresaw the possibility of facility alterations, or even demolitions, as NASA operations inevitably evolved. Although private ownership of potential NHL properties may prevent their formal inclusion in the program, governmental agencies lack such power. Thus, NPS effectively ignored NASA's objections, labeling the agency's concerns as "unwarranted," and the 21 properties were designated as NHLs in 1985. Ultimately, NASA capitulated to the designations and committed to preserving, to the best of its abilities, its NHL properties.[6]

As NHL properties require high levels of preservation to maintain structural and historical integrity, NASA expressed warranted concerns.

Among the designated NASA NHLs was the Neutral Buoyancy Simulator

In April 1984, the STS-41C mission became the first to retrieve and repair a satellite in space, the Solar Maximum Mission Spacecraft, or SolarMax. Mission Specialist Dr. George D. Nelson performs a replacement task on the SolarMax mock-up in the NBS in January 1983. (Credit: NASA)

(NBS) located at Marshall Space Flight Center (MSFC).[7] Recommended under The Effort to Land a Man on the Moon subtheme, the NBS was identified by the NPS study as significant through its association with Apollo Training Facilities. According to the documentation, it played an important role within NASA training programs centered on the preparation of America's crewed missions to the Moon. In a brief description of NBS significance, the report states, "The Neutral Buoyancy Space Simulator was used to familiarize Apollo astronauts with the dynamics of zero gravity while operating outside of the Apollo Spacecraft."[8]

However, the subtheme utilized to provide the NBS's historical significance in the Apollo program is inaccurate. First among the factual errors is that astronaut training for Apollo extravehicular activities (EVAs) took place at the Manned Spacecraft Center (MSC), now Johnson Space Center, in Houston, Texas. In 1967, the MSC opened its Water Immersion Facility, a 25-foot-diameter, 16-foot-deep water tank, for the purpose of training Apollo astronauts for their work in the weightless environment of space. Secondly, primary source documents show that the NBS was built in 1968 for its support of NASA's Apollo Applications Program (AAP), which aimed to find new purposes for hardware developed for the nation's manned Moon program, including the Apollo Telescope Mount and Orbital Workshop in development at MSFC. Thus, the tank's 75-foot diameter and 40-foot depth intentionally provided adequate space to insert full-scale mockups of hardware for use in tool design and testing. In 1970, the AAP officially evolved into Skylab, America's first manned orbital laboratory, which launched its inaugural mission in 1973. With its initial launch, Skylab encountered severe damage to its solar panel arrays and micrometeoroid shield, which inhibited its ability to provide needed power and a safe working environment for astronauts. Skylab, it seemed, was doomed to failure.

However, because the NBS was designed around Skylab, its full-scale mockups allowed engineers and astronauts to quickly find solutions to the laboratory's problems. New tools were developed and designed "on the fly," and NBS's size allowed personnel to not only assess tool feasibility but also quickly develop and test EVA maneuvers to safely perform the necessary repairs. Although the NBS proved a useful tool in the development of the Skylab program, it was the salvage of that initial mission that marked its reputation within NASA's portfolio and its necessity in future missions. The NBS continued to provide the needed support for missions such as the Space Shuttle Program, repairs to the Hubble Space Telescope and SolarMax, and the International Space Station. By providing a uniquely spacious environment to house mockups, as well as advanced technology and equipment, the NBS continued to serve NASA until its closure in 1997.

As NASA considers its future mission needs, it must also consider the treatment of its historic landmarks. With facilities such as the NBS, historically significant though they are, unable to serve those mission needs, the agency must weigh options of preservation and practicality. Preservation

Two of the 21 photos that are part of the HAER survey of the NBS site at Marshall Space Flight Center. **Left:** Exterior view of the NBS Facility. **Right:** The suit systems engineer uses the console in the NBS's top side control room to monitor air flow and water flow to the underwater spacesuit during a test. (Source: Library of Congress Historic American Engineering Record HAER AL-129-B)

documentation of the NBS has occurred twice thus far: first with its NHL listing and second with its inclusion within the Historic American Engineering Record (HAER) in 2006. Administered through a partnership between NPS, the Library of Congress, and the private sector, the HAER serves as part of the nation's Heritage Documentation Program and records historically significant buildings, structures, and sites, as well as mechanical and engineering treasures. Standard HAER documentation includes large-format photography, measured drawings, generalized descriptions, and histories of each resource.[9]

This standardized procedure was utilized in documenting the NBS through the HAER program (HAER AL-129-B), as well as a historical narrative compiled through various sources, including oral interviews with the NBS creator, Charles Cooper, and former test and facilities directors. A total of 21 photographs accompanies the written packet, as well as 10 drawings that provide details on three building elevations, four interior levels, building cross-sections, and details of the control room.[10] The Library of Congress houses the NBS documentation records, and their digitized formats remain accessible to the public online. Thus, despite what the future may hold for the NBS, its significance in both the NASA program and engineering technology remains within America's record of built environments crucial to its history.

NBS preservation efforts continue with the NASA History Office's forthcoming monograph on its history, which will be made publicly available free of charge. An update to the NHL and HAER records, providing more accurate historical information concerning the NBS's significance, would also serve an important role in preservation documentation. Moreover, the use of new technologies, such as laser and photogrammetry scanning, is one possible consideration. Data gleaned from such technologies would provide the global public with unprecedented access to the inner workings of the NBS through products like 3D models, online and virtual reality tours, and enhanced exhibits. These exciting preservation tools offer the world new ways of experiencing historic places like never before, and the NBS is an ideal place to introduce the public to NASA's many uniquely historic places. ■

With facilities such as the NBS, historically significant though they are, unable to serve those mission needs, the agency must weigh options of preservation and practicality.

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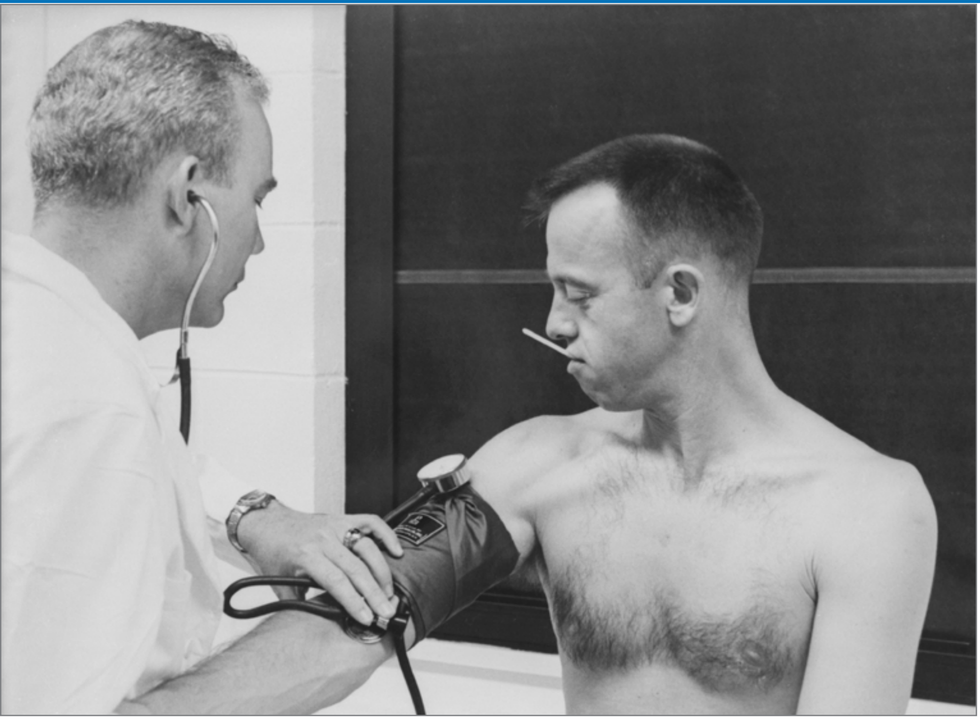

Astronaut Alan B. Shepard Jr. has his blood pressure and temperature checked on May 5, 1961, prior to his Mercury-Redstone 3 (MR-3) mission, the first American crewed spaceflight. The attending physician is Dr. William K. Douglas. (Credit: NASA)

Matters of the Heart

Confronting Questions About Blood Pressure Physiology Ahead of America's First Human Spaceflight

» By **Jennifer Ross-Nazzal**, NASA Historian

Only weeks before astronaut Alan B. Shepard Jr. was scheduled to fly in space, the historic Mercury-Redstone (MR)-3 mission was suddenly in jeopardy. Physicians on the President's Science Advisory Committee (PSAC) were "about to blow the whistle on the first manned flight, because there was no way to measure blood pressure of the astronauts."[1] This "vote of no confidence" by the PSAC medical team caught the director of Project Mercury, Robert R. Gilruth, by surprise. "We thought we had satisfied all their questions," he later recalled. But physicians on the panel feared that the human heart would fail to function in space and insisted on more testing involving chimpanzees, to which Gilruth wryly suggested that NASA move Project Mercury to Africa, where there was "an adequate supply" of primates.[2]

The crisis started in March 1961, when the Ad Hoc Mercury Panel of the PSAC reviewed the preparations undertaken by the Space Task Group (STG) to send a man into space. They visited the McDonnell Aircraft factory in St. Louis, Missouri; Cape Canaveral in Florida; and NASA's Langley Field in Virginia, where they received briefings from employees of the STG, NASA's Marshall Space Flight Center, and other NASA personnel. The Atlas rocket program director and James S. "Mac" McDonnell, head of the aircraft company building the Mercury spacecraft, also shared updates on the program. Newly elected President John F. Kennedy had grown increasingly concerned about the health of the astronauts in space and requested that Jerome Wiesner, chair of PSAC and special assistant for Science and Technology, look into the matter.[3] A smaller group, focused on biomedicine, spent two additional days at Langley and another day at NASA Headquarters, and they later met with representatives from the Central Intelligence Agency, the United States Air Force, and United States Army.[4]

Engineering, design, operations, and procedures received high marks from the larger panel, which concluded that the group had done "almost everything possible to assure the pilot's survival." But the committee determined that the STG had not taken seriously the very real medical uncertainties of sending a man into space. Nearly two and a half years had passed since the creation of Project Mercury, and the Mercury medical program had not conducted any serious or penetrating experiments to understand the impact of stress on the human body in space. No one yet knew what "normal" physiological values looked like. The panel called the efforts thus far inadequate. "Too little emphasis," the panel believed,

Matters of the Heart (continued)

← Astronauts James McDivitt (top) and L. Gordon Cooper Jr. (bottom), command pilots for the Gemini IV and Gemini V missions respectively, have their blood pressure checked by Dr. Charles A. Berry, chief, Center Medical Programs, Manned Spacecraft Center, during their preflight physical examinations in 1965. (Credits: NASA)

"was given by NASA to the degree of biomedical uncertainties which should have been solved before MERCURY [*sic*] flights were this far advanced." The NASA Special Committee on Life Sciences, the NASA Life Science Advisory Committee, and the Armed Forces–National Research Council Committee on Bio-Astronautics reached similar conclusions. The STG had conducted too few tests and medical experiments, leading the panel to raise concerns about sending a man into Earth orbit. "We are not as sure as we would like to be that a man will continue to function properly in orbital missions."[5]

Particularly worrisome was the fact that NASA flew two test flights with rhesus monkeys, in preparation for human spaceflight, but important physiological information such as blood pressure measurements had not been gathered on the animals during flight simulations or during their missions. The limited physiological data gathered on a chimpanzee called Ham, the only animal to fly a trajectory like Shepard's, provided little physiological information on the safety of spaceflight. Electrodes measured his heart and respiration rates and body temperature, but not blood pressure. Unfortunately, NASA lost telemetry for a short time just as Ham's heart rate, measured by an electrocardiogram, started to rise significantly to over 180 beats per minute and even higher—more than 200 beats per minute—as his capsule returned to Earth.[6] But with no spacecraft blood pressure recordings, the panel was uncertain if the chimp was okay or "whether he was on the edge or over the edge of circulatory collapse."[7]

…with no spacecraft blood pressure recordings, the panel was uncertain if the chimp was okay or "whether he was on the edge or over the edge of circulatory collapse."

Similarly, NASA had no significant physiological data on the Mercury Seven. No one had thought to take the astronauts' blood pressure before, during, or after simulations in the centrifuge, in the gimbal rig trainer, or during tests of the spacecraft environmental control systems.[8] No physician could say if an astronaut's blood pressure was too low or too high during these runs. They were missing other important physiological data as well.

Before the United States committed to flying a man in orbit, the panel concluded that the STG medical team needed to start gathering blood pressure data on astronauts and primates during spaceflight simulations and ensuring the inclusion of a spacecraft blood pressure sensor and recorder on all missions. "If the United States is serious about engaging in space research," the committee asserted, "preparations must be made so that man can invade space not on a marginal physiological basis but on the basis of unequivocally full physiological tolerance and competence." They also proposed that the STG fly a chimpanzee on the Mercury-Atlas (MA)-3 flight scheduled to fly before Shepard's MR-3 mission, to capture physiological data that would demonstrate the safety of flying a human in

← **Top:** In support of the Blood Pressure Regulation Experiment, Expedition 35 Commander Chris Hadfield is pictured in April 2013 after having set up the Human Research Facility Pulmonary Function System and the European Physiology Module Cardiolab Leg/Arm Cuff System. The experiment demonstrated the feasibility of obtaining a set of indicators of overall cardiovascular regulation from the non-invasive measurement of continuous blood pressure. **Bottom:** Cosmonaut Gennady I. Padalka, Expedition 9 commander, works with the Cardiocog experiment on board the International Space Station in July 2004. Originally part of Pedro Duque's VC5 "Cervantes" science program, Cardiocog studied changes in the human cardiovascular system in microgravity, expressed in the peripheral arteries, and the vegetative regulation of arterial blood pressure and heart rate. (Credits: NASA)

space. Documenting and reviewing the chimp's physiological values would give the panel the confidence to send an astronaut on board the MR-3 flight. If that was not possible, they advised the group to substitute an astronaut with a chimpanzee for MR-3.[9] Doing so might give the Soviets an edge, and Gilruth was unhappy with the committee's conclusion.

As a result of PSAC's concern, the STG accelerated the development of their automatic blood pressure measuring system (BPMS).[10] When Project Mercury began, STG employees tried their best to use existing technology wherever possible, but there was no off-the-shelf technique for measuring blood pressure during spaceflight or the test flight of an X-plane. Instead, flight surgeons relied on the pilot and his performance "to tell how close the man was to collapse." Remote measuring of a pilot's blood pressure was an entirely new concept, and AiResearch was in the process of developing an automatic BPMS, but it was not yet ready.[11]

Physicians warned Dr. Charles A. Berry, Aeromedical Monitor for Project Mercury Flight Operations, of the risks. "Al Shepard is going to go into cardiac failure," they warned. His heart rate might go too high, and NASA would be unable to save him.[12]

Ironically, the flight of cosmonaut Yuri Gagarin on April 12, 1961 (also oddly enough the date of the PSAC report) demonstrated that humans could safely fly in space, and his successful mission more than justified the continued preparations for America's first suborbital flight despite the findings in the report. On May 5, 1961, Shepard became the first American to fly in space. Contrary to the fears of medical professionals, neither he nor Virgil I. "Gus" Grissom, the second American in space, suffered any ill effects of spaceflight, even though their blood pressure was not monitored during the mission. On February 20, 1962, John H. Glenn Jr. became the first American to orbit Earth, and during that flight he became the first astronaut to use the manual BPMS and measured his blood pressure 10 times. After reviewing the flight data, the flight surgeons concluded that his "physiological responses" were "consistent with…normal body function."[13] Excellent blood pressure data came from Mercury's final two flights: MA-8 and MA-9. MA-9 astronaut L. Gordon Cooper's inflight blood pressure measurements did not vary greatly from those taken prior to flight.[14]

While Project Mercury demonstrated that humans could work safely in space for up to 34 hours, the controversy over a human's ability to fly safely in space beyond little more than a day continued to be an issue for NASA's medical team overseeing the safety of the astronaut corps. Some of America's leading scientists continued to insist it was not safe to fly humans in space for longer periods because NASA did not have the physiological data to prove the astronauts could safely stay in space more than 34 hours. Before the crew of Gemini IV flew their four-day mission in June 1965, physiologists from across the country called Berry, then chief of the Center Medical Operations Office, to tell him he was sending the two-man

Before the crew of Gemini IV flew their four-day mission in June 1965, physiologists from across the country called Berry… to tell him he was sending the two-man crew "to their death."

crew "to their death."[15] These concerns continued for many more years.

Today, more than 60 years after Shepard's historic flight, NASA knows much more about the human body and its response to spaceflight. Even so, there remain questions about the response of the cardiovascular system in space, and America's space agency and its international and commercial partners continue to gather blood pressure data and study the impact of weightlessness on the human body. In 2023, the four-member crew of Ax-2 (Axiom mission-2) took blood pressure measurements to learn more about the effects of weightlessness on the human body.[16] The Polaris Dawn crew, which flew earlier this fall, tested the Tempus Pro, a commercial product that collected data on blood pressure and other measures of astronaut health.[17] To this day, cardiovascular studies continue on board the International Space Station.[18] The health of the men and women who fly into space is paramount, and researchers want to better understand how the human body responds to the stress of spaceflight and develop countermeasures to protect those living and working in space. That vital information builds upon the data first gathered in 1962 during America's first orbital spaceflight. ■

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NASA ORAL HISTORY

That Time NASA Helped Save the Lives of 33 Chilean Miners

» By **Sandra Johnson**, Oral History Lead

NASA specialists visit the rescue operation at the San Jose Copper Mine in Chile in 2010. (Credit: U.S. Embassy, Santiago, Chile)

TWO MONTHS AFTER the first artificial satellite launched into space on October 4, 1957, the United Nations (UN) created an ad hoc Committee on the Peaceful Uses of Outer Space (COPUOS). The UN General Assembly established the permanent COPUOS in 1959 to support the principles of international cooperation and provide an opportunity for open information exchange related to space activities between governments and non-governmental entities.

At the 53rd annual COPUOS meeting, Juan Fernando Acuña Arenas from the Chilean Space Agency met NASA's Deputy Administrator Lori Garver and Deputy Associate Administrator for International and Interagency Relations Albert Condes. The fortuitous meeting in June 2010 helped forge the way for a future partnership between the two countries and strengthened the bond of cooperation on Earth as well as in space.

The following August, two months after the COPUOS meeting, a portion of a gold and copper mine in the Atacama Desert collapsed, trapping 33 men 2,300 feet underground. After the rescue team discovered that the miners had survived, the government began to look for guidance in planning the recovery operations.

The NASA history office conducted oral histories with the NASA team that responded to the Chilean government's request for help. In his interview, Condes explained how they first became involved in the rescue efforts.

> Not too long after the cave-in, Lori Garver got an email from the gentleman that we had met when we were at the United Nations in June, asking for...psychological and medical support for the trapped Chilean miners. Ms. Garver sent me the email she received and asked if I could help to respond.
>
> I think it was a great opportunity for us to use some of the capabilities that we've developed in space to have a practical application here on Earth.... Some of the stuff we're doing in space has huge positive benefits here on Earth for people in their everyday lives.... It's a return on the U.S. taxpayers' investment.

"I think it was a great opportunity for us to use some of the capabilities that we've developed in space to have a practical application here on Earth...."

—Albert Condes

The next step was pulling together a small team from NASA to travel to the accident site in Copiapó, Chile. Dr. Al Holland, an operational psychologist at Johnson Space Center (JSC), supports the astronaut corps with training on the psychological aspects of long-duration spaceflight. He described the NASA team that first traveled to Chile and what they found on arrival.

> We had a telecon with the Minister of Health who was down at the mining site in Chile.... We made some suggestions about how they might go about doing some interventions. Then we were formally

President Barack Obama (left) meets in the Oval Office with some of the Americans involved in the Chilean mine rescue, Wednesday, October 28, 2010, in Washington. NASA participants shown include Clint Cragg, J. D. Polk, Al Holland, and Michael Duncan. (Credit: White House/Pete Souza)

asked by the Chilean government to go down. There were four of us. Mike Duncan is the leader of the band, Clint Cragg is the engineer from Langley, J. D. Polk, prime medical individual, and myself as the psychology representative. We did a lot of preparation work within our own disciplines before we went down. I met with my group at JSC, which is the Behavioral Health and Performance Group.... I collected their ideas, which is essentially what we have always done for long-duration space flights, so there weren't any new surprises there.

We had been given some information about the situation.... There was very high heat down in the mine, very high humidity. There were thirty-three people...trapped in the mine. We knew that they had no training for this. We knew they had been down there seventeen days before communications between topside and the miners had been established. We were told there was only a 528-square-foot refuge that had been built into the mine... very, very small, and they had no food and very little potable water.... Just from a psychological point of view...to put that many people in that small an area, I thought it could be a real bloodbath if we didn't intervene quickly.

We got down there, and all those things were true except for the 528 square feet. They also had about a mile and a half of rough tunneling in addition to the small refuge that they could go out in. Although it wasn't safe, it was volume.... The humidity, the heat, the volume, the number of people in that volume, how long are you going to be in the volume, communication—those in large part determine a person's psychological capabilities and the stress load. So to find out they had more volume was a huge load off my mind...there was more hope."

Dr. J.D. Polk, deputy chief medical officer at JSC, helped guide how to feed the starving miners during their forced confinement without causing additional medical problems.

We knew the gentlemen were starving. They had been essentially eating a spoonful of tuna, a quarter of a canned peach, and an ounce of dried milk every other day. When you re-feed folks that have been starving, usually greater than five to seven days, that has to be done in a very methodic and purposeful manner. Otherwise you get into a horrible complication."

Polk's team at JSC had studied re-feeding syndrome because of the possibility of an accident in space during the Hubble Space Telescope deployment. If the Shuttle was struck, they would use the spacecraft as a safe harbor until rescue, and plans were in place on how to keep the astronauts alive long term by "down-regulating the crew's calories to about 1,000 a day."

When you're starving, you down-regulate your insulin...and your metabolism starts to slow down because your body realizes it's not getting enough calories and it wants to keep your brain alive.... If you give someone too much carbohydrate initially, they get a surge of insulin.... It's not unlike running shy of gasoline in a car. Then when suddenly you have a dietary load...the cells begin to burn that energy to consume that food [and] you can actually have cardiac failure. So it was paramount that they were re-fed in a low and slow process.... And because they did that in textbook fashion, out of the thirty-three

> miners they had not a single complication.
>
> The reason we were relevant in any way was because of our long-duration space-flight experience and lessons we had learned throughout the Shuttle-Mir Program and throughout the ISS Program. So my approach was to mobilize all those lessons we had learned from those different environments.... I knew from the moment I heard about [the accident it] was something we could actually contribute to. It's rare to have your work transfer so directly to a completely different situation or application. I was just exceedingly fortunate that what I had learned from space, space simulations, submarines, polar science stations, and the work I had done in the past, was so cleanly transferable to the mine situation.... So it was a very rapid impact.

Dr. Michael Duncan, who served as the deputy chief medical officer in the Space Life Science Directorate at JSC, led the NASA team that traveled to the disaster site. Duncan shared his thoughts about other concerns the miners faced.

> In my opinion, I think the biggest help we provided them was from the psychological aspect. In preparing for long-duration space flight, we put our astronauts and their families through some training programs... and talk to them about some dynamics that can develop. If you're armed with that kind of knowledge, then maybe those dynamics won't develop, or not to the extent of difficulties that could otherwise develop.... The miners, obviously, weren't prepared to be entrapped, and the families weren't prepared.

"In my opinion, I think the biggest help we provided them was from the psychological aspect."

—Dr. Michael Duncan

Clint Cragg joined the team because of his expertise as an engineer. The Chilean government did not ask for engineering help initially, but the insight from Cragg and the NASA Engineering and Safety Center (NESC) was welcomed when planning the rescue method.

> One of the things I suggested to the minister of health was about the rescue capsule. We had talked to people at the mine site and we [asked] how long do you think this extraction is going to take once they get down to these miners? We heard anywhere between one and four hours.... I told the minister of health that NASA could help them flesh out some of these requirements and provide them some suggested design requirements."

After returning to Langley Research Center, Cragg met with the NESC Technical Fellows, and together they wrote a NASA requirements document for the capsule design and sent it to Chile.

> I didn't hear much about it for a couple weeks, and I sent a note to the Chilean Navy doctor that we had met down there. [He] told me that he was intimately involved in the design process, and they utilized or accepted most of our recommendations into the final design. All we did was provide suggestions. The Chileans actually did the design and the building, and that's the real hard part, and I think they did a great job at that. We were just providing advice."

The advice and consultation continued after the NASA team returned home and as they followed the rescue progress. On October 10, 2010, after 69 days underground, the trapped miners emerged from their confinement and into the arms of their waiting loved ones.

The Artemis Accords, first signed by NASA and seven partner countries in October 2020, established a set of principles and cooperation among the participating nations for future human exploration of space. Four years later, and 14 years after the rescue, the Republic of Chile became the 47th nation to sign the Artemis Accords. Administrator Bill Nelson proclaimed, "Today we welcome Chile's signing of the Artemis Accords and its commitment to the shared values of all the signatories for the exploration of space. The United States has long studied the stars from Chile's great Atacama Desert. Now we will go to the stars together, safely, and responsibly, and create new opportunities for international cooperation and the Artemis Generation." ■

Explore the full oral history interviews

"It Was the Night Before Launching"

Poetry by Former NASA Creatives

» By **Christine Shaw**, NASA Chief Archivist

Flight controllers work in the Launch Control Center at Kennedy Space Center during the Apollo 8 mission launch activities on December 21, 1968. Apollo 8 was the first crewed lunar orbit mission. (Credit: NASA)

WHEN THINKING ABOUT NASA, artists and artistic expression are not typically the first things that come to mind. Thoughts of astronauts, science, and rockets usually come before paintings, photography, and poetry, so it might be surprising to some that NASA has artists in its workforce. Some, like photographers, video producers, animators, and graphic designers, are hired for their artistic talents, while others pursue art for fun, but all use their ingenuity to help NASA achieve its mission.

As the holidays approach, it is appropriate to highlight two poems by NASA employees relating to the season. "The Night Before Apollo" by Dr. Joseph Shea and "SolarMax Flies Again" by Barbara Scott highlight two important NASA projects in verse. Dr. Shea was the manager of the Apollo Spacecraft Program Office in Houston. He read his poem at an Apollo News Symposium on December 15, 1966, before the first crewed flights of the Apollo program. Shea, a known punster, took a day off punning and shared his wishes for the program with his poem. He hoped to convince the public that Apollo was a serious program and would be successful. Unfortunately, a month later, on January 27, 1967, the Apollo 1 mishap occurred, and the lives of three astronauts were lost. Devastated, Dr. Shea left NASA roughly six months later. Ultimately, the Apollo program was successful, with Apollo 11 completing its mission of landing on the Moon.

"SolarMax Flies Again" was written by Barbara Scott, an employee of Goddard Space Flight Center who worked on multiple projects throughout her career, including the Television Infrared Observation Satellite (TIROS), Solar Maximum Mission (SolarMax), the Extreme Ultraviolet Explorer (EUVE), and Hubble Space Telescope (HST). She wrote the poem over several months after mission STS-41C, the Space Shuttle mission that repaired SolarMax, took place. SolarMax launched on February 14, 1980 and was designed to provide coordinated observations of solar activity, specifically solar flares. Unfortunately, SolarMax suffered from an electronics failure in September 1980; in November of the same year, its Attitude Control System failed. It remained in a wobbling orbit for more than three years until STS-41C could capture and repair the spacecraft. Scott's poem details the repair mission and captures the emotions felt throughout the process. When the astronauts of the repair mission visited GSFC, Scott gave each of them a copy. As a child, Scott memorized the famous poem "A Visit from St. Nicholas" (often called "The Night Before Christmas") and decided that her poem would be read at the same meter.

The Night Before Apollo

By Dr. Joseph Shea

It was the night before launching
and all through the center
everyone wondered how soon they'd reenter.
The spacecraft atop of the Saturn stood bare
in hopes that the last black box spare was soon there.
The NASA's were nestled all snug in their beds
convinced that we finally had beaten the Reds.
And Julian in kerchief and Paul in his cap
had just settled down in the last PAO flap.
Next morning at dawn the bird rose with a clatter.
We were still on schedule

"It Was the Night Before Launching" (continued)

trend charts did not matter.
The end of the decade had come like a flash.
We had spent 19 billion and still had some cash.
The moon was the quest on which we spent that dough.
Apollo was finally all systems go.
To the eyes of the world, the launch came through clear.
We never start missions in any rain, dear.
The Saturn IC boosted lively and quick.
The tower came off nice and slick.
Second stage, third stage, in one orbit came.
We whistled and shouted and called them by name.
Now CM, now SM, please don't need no fixing.
On LM, on S4B, old engine keep mixing.
From the Center in Houston, we sent out the call,
the systems are working, so dash away y'all.
They took leave of earth orbit in a hurry to fly
through the great lunar obstacle course in the sky.
Docking was easy on course they now flew
with a bay full of space and experiments too.
The sextant from twinkling stars got the proof
that the instrument unit had worked without goof.
After three days the spacecraft was going around
the moon in an orbit over the site we were bound.
The hatches were opened and two guys crawled through
to find the LM systems were working like new.
The LM moved away, there was no turning back.
The guidance computer confirmed the right track.
The engine worked well, the bell glowed like a cherry.
The touchdown was gentle, the crew shook—not very.
The systems checked out—for a day we were go
but the surface looked soft, like new driven snow.
They opened the hatch with their hearts in their teeth
and found the dust thin with good hard rock beneath.
It was a broad place in a round little valley.
It looked like a great place for spacecraft to rally.
Each experiment carried on LM's lower shelf
had to be set up to run by itself.
That done in moon's g, they leaped over their head.
complained that the LM had no bed.
They spoke not a word as they did the hard work
packing up moon rocks for some scientist's work.
With cargo aboard, the front hatch they did close
when the CM is in sight, the ascent stage rose.
Rendezvous done the SM proved a good missile
and back home they flew, their beards by now bristle.
And I heard them exclaim as they finished their flight
we never were worried, the team did the job right.

SolarMax Flies Again

By Barbara Scott

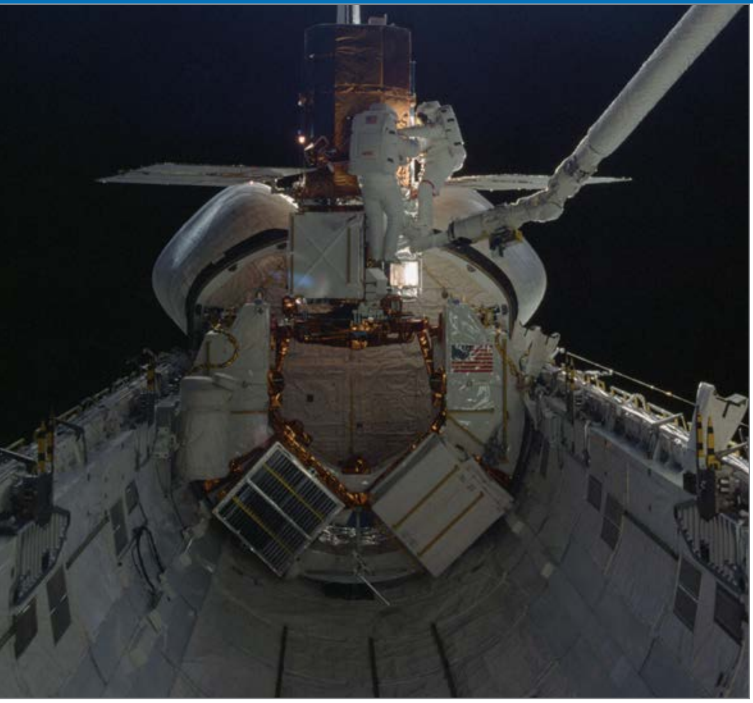
The Mission of STS 41-C
Had LDEF, two fabulous cameras, and bees;
But the challenging task for the brave crew of five
Was not the deployment, the filming, or hive.
No, the hardest assignment (and these are the facts)
Was to capture, repair, and release SolarMax.

This satellite had been in top-notch condition
Four years ago when it was launched on its mission
To study the sun from above the earth's air
Examining sunspots, coronas, and flares.
But in eight months fine pointing control was in doubt,
As the attitude module fuses gave out.
And a month before that, though prevention was tried,
The C/P's Main Electronics Box died.
Though a sick satellite is not really rare,
<u>This</u> one was designed for in-orbit repair!

After Crip, Dick, and T.J. had made the house call,
Doctors Pinky and Ox would take care of it all.
Well that was the plan as our crew left the earth
With supplies to effect SolarMax's rebirth.
The countdown went smoothly, the weather was grand.
The April 6th launch went exactly as planned.
In addition to LDEF they also had with them
A cradle device called the Flight Support System.
With lots of electronics, and one other thing—
To secure SolarMax, a 6-foot berthing ring.
A locker for tools came along for the ride,
Plus an attitude module on the left side.
The LDEF and FSS checked out OK.
All in all it had been a fantastic first day.

Day two was the day that the LDEF would be
Deployed from the arm and allowed to drift free.
It came out of the bay and T.J. did not falter;
His release was as steady as the "Rock of Gibraltar."
With that done, the Challenger took up the chase
For the SolarMax ten miles above it in space.

At last the third day of the mission was here
For which we had waited for more than a year.
It was April the 8th, and in order to see,
Everyone gathered around the TV.



Astronauts George D. "Pinky" Nelson, right, and James D. "Ox" van Hoften repair the captured SolarMax Satellite in the aft end of Challenger's cargo bay on April 11, 1984. (Credit: NASA)

Pinky had gotten his MMU on,
And flew out of the bay at the first light of dawn.
The target began as a circle of light
And grew to a spacecraft amazingly bright.
We watched Pinky approaching the gold satellite
In the blackness of space, what a beautiful sight!
(It was finally real! This was no simulation.
There was no one to throw in a bad complication.
Now things would go just exactly as planned
'Cause the Sim Sup at Johnson was not in command.)

The SolarMax spun in a one degree roll.
Pinky soon saw the pin that would be his next goal.
He flew right along with it to match its roll rate,
Then approached it head on to accomplish the mate.
The TPAD made contact but there was no dock.
He tried two more times but the jaws wouldn't lock!
Because of these contacts the crewmen now saw
That the rates were too high both in pitch and in yaw.
In order to stop that, he then backed away
And tried grabbing on to a solar array.
No joy in that either; it wouldn't stay still.
Crip told Pinky, "Come on back." I began to feel ill.
Then we lost the transmission. Now what would be done?
This couldn't be happening. Hey, this is no fun!

"It Was the Night Before Launching" (continued)

When the orbit returned them in to AOS,
We found that the crew had not met with success.
They had tried four times with the arm to grab hold.
It was "Close, but no cigar" we were told.

While back at the POCC at the console positions,
It was time to assess SolarMax's condition.
The engineers looked at their data and said,
"In ten hours or less SolarMax will be dead."
As the satellite turned from the sun's precious rays,
There was nothing to charge up the solar arrays,
And the battery power was draining away.
The confident feelings had turned to dismay.
Commands were sent quickly to lighten the load.
All systems were put in a low power mode.
In an hour the software was doing no better.
The spacecraft was tumbling as badly as ever.
So before all equipment on SolarMax died,
A new torquer bar program called BDOT was tried.
The crew went to bed, but back at the POCC
And at JSC everyone worked 'round the clock.
The JSC teams used existing conditions
To simulate ways to accomplish the mission.
Now BDOT was working. Hope sparked for a minute.
The power was low, but BDOT could de-spin it.
But no one could guarantee once it de-spun
That the SolarMax panels would point at the sun.
A few hours later things really turned sour.
They even turned off the transmitter for power.
When they switched it back on and the data returned,
A miraculous event had just happened they learned.

The once tumbling bird had stopped right on the sun,
And recharging the batteries was already done!
Such wonderful feelings of joy and elation!
But we only had time for a small celebration.
For the next sixteen hours precautions were taken
Which steadily improved the whole situation.
They turned on the systems and heaters and then
The original software was loaded again.
Though the press yesterday had looked on with suspicion
SolarMax was returned to a stable condition.
At Goddard the POCC had done all they could do.
Would the rotating grapple maneuver come through?

It was April the 10th and everyone knew
That the mission was back in the hands of the crew.

"It Was the Night Before Launching" (continued)

They approached SolarMax over the Indian Ocean.
We watched data which showed us the small coning motion.
As Challenger got close, all the loop traffic stopped.
It grew so quiet you could have heard a pin drop.
We were listening for clues as to what was transpiring,
And I don't mind telling you I was perspiring!
And just as the coning angle got worse,
And the RMS arm began its traverse,
We lost voice transmission and now it would be
Six minutes before we would pass Yarragadee.
It seemed like that six minutes lasted forever,
We all held our breath in both Control Centers.
And you couldn't tell when Crip said, "We've got it,"
Which team cheered the loudest, Johnson or Goddard.

T.J. had captured it on the first try,
And Crip only used <u>part</u> of the small fuel supply.
A short time later the TV returned.
It was tough to do berthing in darkness we learned.
T.J. carefully guided each pin to its spot
On the berthing platform, then the jaws closed and locked.
The pivot and rotate was something to see,
As the satellite moved so majestically.
For the rest of the day the POCC checked its condition,
As SolarMax sat in the repair position.

In the wee morning hours of April 11,
Two crewmen emerged for their work up in heaven.
Item one on their long list of things to be done–
Replace the failed module with a new one.
Ox handled the job with the greatest of ease
With the aid of a power wrench called MST.

By the time we were back in the range of TV,
The crew had begun on the old MEB.
At the end of the arm they were working together;
One locked in the foot restraint, one merely tethered.
Removing the old one was handled by Ox,
Then Pinky's job was to install the new box.
Things went just as planned and exceedingly quick,
Except that some sticky-back tape wouldn't stick.
There was one more repair item which had been sent–
The XRP Baffle was placed on its vent.

Back on earth it was time when most folks were just waking,
When Pinky began some unique picture taking.
On the RMS arm he took photographs of
The arrays and the instruments from high above.
Then Ox used the rest of the long EVA
To check out the spare MMU in the bay.
And though they would say they're "just doing their duty,"
The pictures they sent back were full of much beauty.

The repair was complete and now all that remained
Was to unberth and deploy the antenna high-gain.
The dish was commanded and worked like a charm
With the satellite out on the end of the arm.
All through the night some more checkouts were run
To make sure that successful repairs had been done.
"The attitude module was fine" we were told, then
Came word that "The MEB checkout was golden."
All appeared to be well, and none can compare
To the job that was done by ACE Satellite Repair.

April 12th was the day which had caused all the rest–
The day SolarMax would be put to the test.
For a few days the Challenger gave it a home,
But now it was time to go out on its own.
Said the POCC Director, "The spacecraft is ready."
The release from the arm was so smooth and so steady.
When commanded to use its new attitude hold,
The spacecraft responded exactly as told.
Then Challenger slowly began its retreat.
SolarMax was now healthy. The job was complete.
Again the sun's hidden facts could be learned
Because the fine pointing control was returned.
So now it was truly the end of an era,
As the crew was preparing to head back to terra.

It was good to recall that not all went as planned.
And things even managed to get out of hand.
But with Crip, Scobee, Nelson, Van Hoften, and Hart,
Along with two Centers each doing their part,
With quick thinking, skill, and hard work, not to mention
Some of what I call Divine Intervention,
The final results were the best they could be
On the Mission of STS-41C. ■

← Electronics work at NASA continued across all NASA centers in some form, just as it had in the NACA era, given that electronics was an inescapable component of the agency's mission. Here, lightweight thin-film solar cells (which use semiconductors) are being tested in the Space Environmental Chamber at Lewis Research Center (known as Glenn today). Lewis's Photovoltaic Fundamentals Section investigated thin-film alternatives to the standard rigid and fragile solar cells. As NASA researchers worked to improve the performance of these specific semiconductors, it is worth noting that they made use of the Space Environmental Chamber, an example of unique, mission-enabling infrastructure. (Credit: NASA)

Innovation, the Private Sector, and NASA

Lessons from the Electronics Research Center

» By **James Anderson**, NASA Historian

FACETS OF NASA'S ROLE in the semiconductor revolution have been written about over the years, especially the connection to the development of integrated circuits and their use on the Apollo Guidance Computer.[1] Less well known is that from 1964 to 1970, NASA had an entire center devoted to electronics research: the Electronics Research Center (ERC) in Cambridge, Massachusetts. Its history and impact have received comparatively little attention.[2]

What can the history of electronics at NASA tell us about the limits of how the agency can prepare for the future? The answer is directly related to the intertwined components of infrastructure and politics. To understand the landscape when the ERC opened in 1964, it is worth considering what electronics looked like at NASA's predecessor organization, the National Advisory Committee for Aeronautics (NACA).

After its establishment in 1915, the NACA spent the next four decades building the world's greatest collection of wind tunnels. This testing and research infrastructure directly supported the development of commercial and military aviation. In addition to providing cutting-edge testing facilities that private industry wanted to use but did not necessarily want to build or invest in themselves, the NACA established a culture of both fundamental and applied research that NASA inherited when the NACA laboratories and flight research facilities became NASA's research centers.

Before mainframes supplanted early electronic computers, the NACA employed commonly available tools of the time for data reduction and analysis: pencils, paper, slide rules, and tables.[3] Microelectronics were incorporated into tunnel and flight-testing instruments like transducers and thermocouples, all in the service of data collection. Electronics was a means to an end at the NACA in an era that radio and vacuum tubes dominated. The innovation that the NACA intentionally pursued was in tunnel design

→ An aerial view of the foundation construction for NASA's Electronics Research Center (ERC) at Kendall Square in Cambridge, Massachusetts. The location for the center did run up against some issues related to urban renewal and friction with a few local businesses, but overall, there was strong local support for having the center. (Credit: NASA)

and the application of aerodynamic theory. There was no compelling argument for the NACA to seriously pursue electronics as a field.[4]

NASA, on the other hand, did have a compelling argument. As the civilian agency newly responsible for spaceflight and reliant upon more than a decade of ballistic missile development via the armed forces, electronics represented a significant fraction of rocket and spacecraft cost. Official estimates in early 1963 showed that electronics components accounted for "over 40 percent of the cost of… [rocket] boosters, over 70 percent of the cost of… spacecraft, and over 90 percent of the cost of the resources going to tracking and data acquisition." It was clear to NASA "that the existing technical base was not adequate to the growing electronics requirements."[5] As a bulwark against potential waste and fraud, the agency needed to bolster its technical expertise in this field that accounted for large sums of money.

…electronics represented a significant fraction of rocket and spacecraft cost.

NASA's proposed solution was to establish a new center to provide technical expertise, direction, and oversight for electronics work at the agency. Decisions about where in the country to make significant investments are always political. The established hubs of high technology were obvious choices at the time. Boston (i.e., Cambridge), Los Angeles, and New York were the top three choices for the ERC in NASA's argument to Congress. NASA already had a research center in what would become the Silicon Valley, but no one at the time could have seriously predicted the full extent of the rise of Silicon Valley or the incredibly rapid advancements in computer chip technology broadly that enabled the digital revolution.[6] Furthermore, the semiconductor revolution was not restricted to Silicon Valley in its early years. Route 128, already an established high-tech corridor around Boston, made sense. The ERC's proposed location was also within walking distance to the Massachusetts Institute of Technology (MIT). For these reasons, NASA argued to Congress that the Boston area was the objectively superior location.

Since these decisions are ultimately political, some members in Congress protested. In the time that elapsed between the initial site location study and the opening of the ERC, the president's brother, Edward Kennedy, had been elected to his first term as a senator from Massachusetts. It was impossible to escape the optics of what appeared to some to be blatant favoritism. Congressional representatives from the Midwest also felt shortchanged and ignored by the federal government with respect to NASA spending. Worse, NASA Administrator James Webb proposed the ERC's creation in a manner that short-circuited a protracted debate in Congress over many of the particulars related to the center's founding. The resulting process was expedient,

ERC ELECTRONICS RESEARCH CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NEWS

Vol. 1, No. 39 Cambridge, Massachusetts August 1, 1969

WELCOME HOME — WELL DONE

ERC WELCOMES HOME the Apollo 11 astronauts. Overflow crowds gathered in front of every available television receiver for the critical points in the mission and the remarkable splashdown. On hand at Mission Control for the flight and happy conclusion was ERC Director James C. Elms.

Merit Promotion Policy Seeks Better Candidates

This is the second of a series of six articles on the Revised Federal Merit Promotion Policy.

In each promotion action there is an "area of consideration" which consists of the part of the agency in which an intensive search is made for eligible candidates to fill a vacancy. The area may be the headquarters office in Washington, D. C., a division office in a field installation, or other appropriate part of the agency. It must be as broad as practicable so that enough highly qualified candidates can be located and employees have adequate opportunities for advancement.

Higher grade jobs generally have broader areas of consideration than lower grade ones because there are fewer eligible candidates and fewer job opportunities at the higher grades. Under the revised Federal Merit Promotion Policy, for jobs at GS-14 and above the area will be the entire agency, unless this area would produce too many candidates or the nature of the jobs makes such broad consideration inappropriate.

There are two other new features in the promotion policy to assure selection of highly qualified candidates and to increase advancement opportunities for employees. First, the agency generally must broaden the area of consideration when fewer than three high-

Continued on Page 4

ERC 'SummerThing' Booked; At Hanscom Field Aug. 22

ERC's Recreation Association today announced that a 1969 "SummerThing" will be held at Hanscom Field on the evening of Friday, August 22.

Tickets will go on sale in a few days. They will be priced at a reasonable $3 each.

The party — a "stand-up," heavy buffet cocktail party — will be held in the ballroom and adjoining Concord Room of the Officers' Club. The outside patio will also be used, weather permitting.

The SummerThing begins at 7 p.m.. At least two cash bars will be operating offering drinks at military prices (average of 50 cents for cocktails).

A musical combo will be on hand for dancing.

The food will be the club's best buffet offering and will include shrimp bowls, chicken drummettes, sliced ham, turkey, beef and a

Continued on Page 4

Place ERC Disc On Moon

URGE TO GO "ALWA

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A SILICON DISC, shown in insert, carrying statements by Presidents Eisenhower, Kennedy, Johnson and Nixon and messages of goodwill from leaders of 73 countries throughout the world carried in Apollo 11 and left on the moon. ERC managed preparation of the disc on which the messages were reduced 200 times. At left, Maureen Balzarini of ERC's Computer Services Branch, holds the disc. At right are enlarged excerpts of some of the messages.

ERC made a historic contribution to Apollo 11 in the form of a small silicon disc bearing messages of goodwill from leaders of 73 countries throughout the world.

Continued on Page 4

↑ The cover of the ERC newsletter shortly after the return of the crew of Apollo 11. In the bottom right photo, Maureen Balzarini of the ERC's Computer Services Branch holds up a small silicon disc containing goodwill messages from 73 world leaders and four U.S. presidents that was left on the Moon. The newsletter notes that the disc was produced "in the same manner as production of an integrated circuit." The ERC worked with the semiconductor division at Sprague Electric in Worcester, Massachusetts, to produce the discs. A second disc was produced that flew to the Moon after additional messages arrived from world leaders right before the deadline. (Credit: NASA)

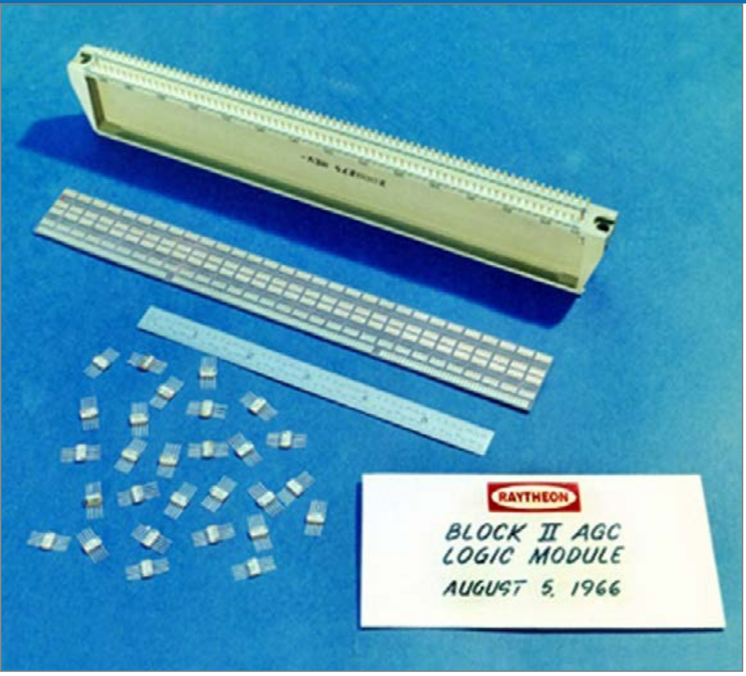
but in this particular case, shortsighted. One result was that as Apollo funding subsided and austerity took hold by 1970, President Nixon had little incentive to protect the ERC from closure.[7] America had landed on the Moon, and there were more pressing concerns for the country to address. In the closing deal that was struck, the ERC's buildings were transferred to the Department of Transportation (DOT), laboratory equipment transferred to other NASA centers, and ERC's personnel either moved to DOT, went to other NASA centers, or left government employment entirely.

Over the course of the ERC's existence, its research portfolio had been comprehensive. ERC personnel worked in areas ranging from obvious ones like miniaturization and mitigating the effects of radiation on hardware, to perhaps less obvious topics like laser communication and holography. Those topics are still relevant today, but research alone does not fully support one of the central arguments for the ERC's establishment in the first place: making sound procurement decisions given the high fraction of spaceflight costs associated with electronics. The semiconductor revolution witnessed many of those associated electronics component costs come down. In this respect, the establishment of the ERC was part of NASA and Webb's larger vision for technocratic investment as a means to uplift the country. That investment went far beyond any one center.

ERC personnel worked in areas ranging from obvious ones like miniaturization and mitigating the effects of radiation on hardware, to perhaps less obvious topics like laser communication and holography.

Roughly 90 percent of NASA's expenditures during Apollo "flowed into the private sector—and [NASA] even pioneered the noncompetitive contract in order to save time and foster specific skills in a number of firms throughout industry."[8] In addition to private industry, many universities across the country—not just the established and endowed universities—founded new science and engineering programs or new laboratories because of NASA and defense funding dedicated to the nation's response to the Cold War.

Building a lasting future and doing it with some efficiency requires, in part, an understanding of the past. How can the ERC's history inform our understanding of the relationship between government and technological innovation? In short, it is an ecosystem. Webb believed that "the larger the effort in science and technology, the larger those changes will be, and the more rapidly they will occur."[9] Those changes went beyond building rockets and landing on the Moon. The ERC was merely one part of this larger investment in science and technology. Beyond its political liabilities with respect



↑ The Apollo Guidance Computer logic module. The Instrumentation Lab at MIT (later renamed the Charles Stark Draper Laboratory) worked with one of the foundational Silicon Valley companies, Fairchild Semiconductor, which produced the integrated circuits. Fairchild later licensed the design to Philco, which made the integrated circuits used in the Apollo Guidance Computer. (Courtesy of Gwen Bell via Computer History Museum)

to Nixon, the ERC also was fairly easy to close since it did not have any immovable infrastructure critical to the nation. It had highly skilled talent, but the buildings were just office space that easily transferred to DOT.

Brick-and-mortar infrastructure is still essential. Another lesson here is that the infrastructure that NASA inherited from the NACA was critical to NASA's mission. New buildings at the other new NASA spaceflight centers, too, brought unique, mission-oriented infrastructure with them in the 1960s. In the case of the ERC, however, NASA's alternatives to either distribute in-house electronic expertise at multiple centers or centralize the technical base at one existing center might have worked better, but those options were turned down because of a sense that it would be either too decentralized or too much for an existing center to manage, so the idea for a distinct center won.

In the end, the ERC was short-lived, but NASA's mission during the space race resulted in significant investments in the very companies and industries that ended up driving the technological revolution we have inherited today. ■

Endnotes

1 Paul Ceruzzi has written extensively on the history of computing and electronics. For an article covering this particular topic on the Apollo Guidance Computer and integrated circuits, see "Apollo Guidance Computer and the First Silicon Chips," **https://airandspace.si.edu/stories/editorial/apollo-guidance-computer-and-first-silicon-chips** (accessed December 6, 2024).

2 Two good starting places for overviews of the Electronics Research Center are chapter 8, "NASA's Electronics Research Center," in Thomas P. Murphy, *Science, Geopolitics, and Federal Spending* (Princeton, NJ: Heath Lexington Books, 1971) and Andrew J. Butrica, "The Electronics Research Center: NASA's Little Known Venture into Aerospace Electronics," AIAA 2002-1138. Murphy's book was published too soon after the closure to cover that part of the ERC's story. In addition to the ERC, Butrica has written more generally about microelectronics and NASA. See chapters 3 and 4, "NASA's Role in the Manufacture of Integrated Circuits" and "NASA's Role in the development of MEMS (Microelectromechanical Systems)" respectively, in Steven J. Dick, ***Historical Studies in the Societal Impact of Spaceflight*** (Washington, DC: NASA SP-2015-4803, 2015).

3 "Computers" once referred to employees, often women with advanced analytical skills, who performed calculations for NACA's research products and publications even though many of them did not receive credit or attribution as authors.

4 Guidance and control for missiles are essential, and electronics enables such capability. While the NACA eventually conducted related work through the Pilotless Aircraft Research Division, this kind of work with respect to electronics remained primarily a military endeavor.

5 NASA Administrator James Webb's letter to George P. Miller, Chairman of the House Committee on Science and Astronautics, printed in the FY 1964 NASA Authorization, 3014.

6 FY 1964 NASA Authorization, 3017. In a list of 16 total cities and regions, San Jose (which today calls itself "Capital of Silicon Valley") was, ironically, last. The NACA's second laboratory was established in 1939 and became NASA's Ames Research Center. Like the other NACA labs, electronics represented a tool to enable aspects of research; electronic research was not the focus of the NACA mission.

7 The ERC was still adding personnel in the late 1960s since it was still ramping up its planned 10 laboratories. Other centers, meanwhile, were beginning to ramp down due to overall NASA budget cuts.

8 Walter A. McDougall, *...the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985), pp. 381–382.

9 Ibid., p. 381.

Capturing Contemporary History

» By **Christine Shaw**, NASA Chief Archivist
and **Jillian Rael**, NASA Historian

For over 66 years, NASA's mission to "inspire the world through discovery" has enriched global, national, regional, and local history through the work in aeronautics and space. Indeed, the agency continues to build its historical contributions by driving collaborative innovation and ingenuity across not only its centers but also with domestic and international partners. In turn, it is the purpose of the archivists and historians of NASA's History Office to capture this ever-evolving history and share it with the world.

In the decades before the digital age, NASA personnel executed their work using copious paper documents and other physical media, leaving archivists a straightforward paper trail to collect, process, and store in service of future research. In today's paperless environment, however, capturing the history made in NASA's day-to-day work proves challenging. After all, the promulgation of NASA's history, and its effects across time and place, depend upon a symbiotic relationship between those producing source materials and the archivists who preserve them. Consequently, a look at the challenges faced by NASA archivists in this dynamic and dispersed environment, along with some proactive measures to combat the potential loss of significant documentary materials, proves useful. In the pursuit of contemporary history, the NASA History Office fosters a collaborative environment through which historians utilize the archives to share NASA's story for the benefit of humanity.

The Challenge: Analog vs. Digital Records

When considering archives, people typically think of records preserved in analog formats like paper, photographs, audio reels, or magnetic tape. While archives, including those of NASA, primarily consist of these formats, the amount of "born digital" material brought into archives is on the rise. In the past, accessioning paper records was the only option. Today, nearly all records that once existed solely in paper form have a digital equivalent. Memos and correspondence are sent out as emails; technical drawings are created using computer software; and project schedules, program plans, and final reports exist as Word documents or PDFs. While digital records provide easier access, collecting digital records can be an archival challenge. This challenge lies in gathering the context surrounding records and capturing the minutiae that add research value to an archival collection. While final versions of reports and documents are helpful to have, they do not tell the whole story. Archivists, historians, and researchers want access to records with more details. These details previously came in the form of notes written in margins, handwritten meeting minutes, extra records stashed in the same folder, or even a sticky note slapped on the front of a report sent from one colleague to another. Records that document how and why decisions were made are not always wrapped in a neat bow. In the digital landscape, these bits of information still exist but are spread across different storage locations, and the researcher must know where to look. When working with missions, programs, and projects at NASA, archivists ask creators to consider transferring many different types of records into the archives, not just the high-level materials.

The Life Cycle of Federal Records

The NASA Archives acquires records in several different ways: from current employees, from retirees and their families, and from the Federal Records Centers (FRC) after records in storage have met their retention periods and are ready for disposition. All these processes fit within the federal records life cycle of creation, maintenance and use, and disposition. Federal records are created at NASA every day, and the records schedule determines if a record falls into the categories of permanent, temporary, or non-record. Between two and five percent of records created by the government are permanent and go to the National Archives and

While digital records provide easier access, collecting digital records can be an archival challenge.

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NASA Science Mission Directorate

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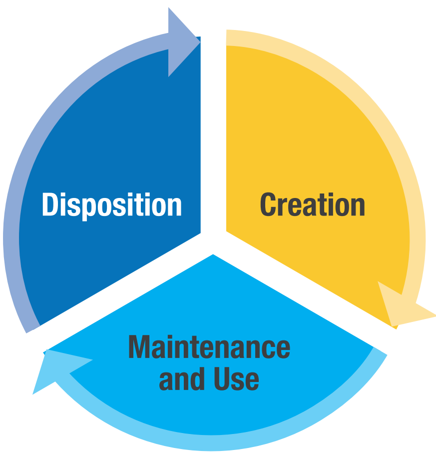
Aaron Bateman
Assistant Professor of History and International Affairs
George Washington University

Technology, Politics, and the Rise and Fall of the Strategic Defense Initiative

Capturing Contemporary History (continued)



The records life cycle has three phases: creation, maintenance and use, and disposition.

Records Administration (NARA), while 95 to 98 percent of records are temporary and can be destroyed after they have been created, used, and have met their disposition. The NASA Archives comes into play at the very end of the life cycle. Archivists collect temporary analog and digital records that have met their disposition and are historically significant, gathering them from employees, retirees, and the FRCs to make them available for research in the archives.

A Proactive Approach to Obtaining Records

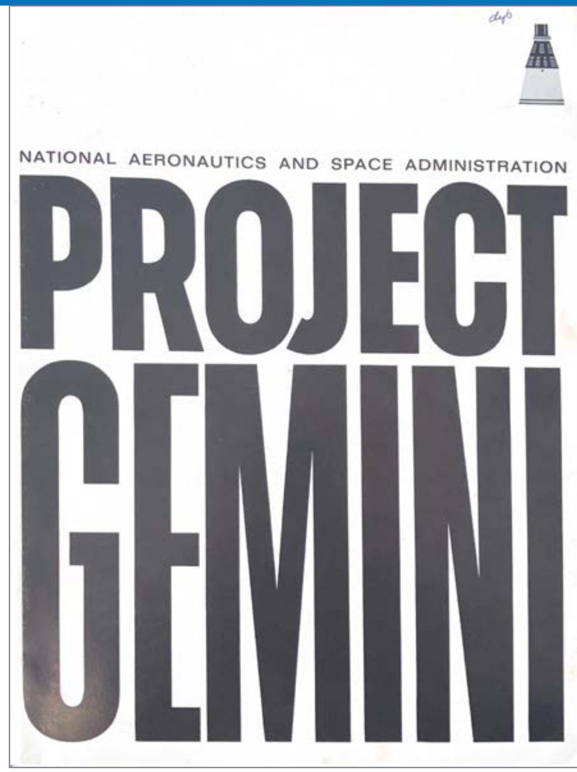
To better capture contemporary history and reduce the risk of important records getting lost to the digital ether, the NASA Archives is working with a few current missions, programs, and projects to prepare them for sending their records to the NASA Archives. Agency archivists share the collection scope and meet with leadership to discuss which portions of their records help to tell the story of their work. In the future, the NASA History Office aims to expand this aspect of their archival work to ensure history is captured as it happens. This proactive approach to records collection has been successful at multiple NASA centers, and its success shows that interpersonal relationships and information sharing work to expand the Archives program's efforts.

Conclusion

As NASA's engineers, scientists, partners, and leaders continue to enhance humanity's understanding of our planet, solar system, and the universe, historians work to share these stories with the public in engaging and insightful ways. By its very nature, the success of the NASA historians relies upon the expertise and foresight of agency archivists. Today's historians enjoy seemingly endless material across multiple mediums, thanks in large part to the work of archivists of the bygone era. Archiving work continues now, albeit under changing conditions and daunting digital challenges. Yet, as part of a collaborative team, historians have the opportunity to help their archival partners succeed in the proactive collection of materials across NASA's centers. As historians actively engage with NASA personnel through outreach efforts, agency-sponsored symposia and conferences, and other occasions, opportunities arise to contribute to this effort. By reminding colleagues about NASA's robust archive that actively seeks and relies upon good records retention, as well as by facilitating contact between program personnel and agency archivists, historians help lay the foundations of the History Office's future work. Together, archivists and historians work together to capture contemporary history and share NASA's mission of inspiration by effectively telling its story. ■

The Project Gemini Collection in the NASA Kennedy Archives

» By **Kylie Taffer**, NASA Archivist



↑ Front cover of a 1966 promotional brochure about Project Gemini.

ONE OF THE MORE fascinating and significant collections at the Kennedy Space Center Archives is the Gemini Collection. The most significant achievements of Project Gemini are highlighted in this collection, including materials detailing precision maneuvering in orbit and extending the duration of human spaceflight.

Made up of a variety of material housed in 11 boxes and 42 folders, this collection follows Project Gemini from inception to the termination of the program in 1967. Included are a launch facilities plan, contractor reports, management documents, test summaries, mission failure investigation plans, mission commentary transcripts, operation orders, mission recovery requirements, and technical reports, amongst other technical material. Materials from the Kennedy Space Center Press Site can also be found, including fact sheets, a press handbook, mission summaries, and a press conference on extravehicular activities.

The earliest record we have in this collection is a departure summary of the Gemini Launch Vehicle number 2 (GLV-2) from Baltimore, Maryland, dated July 11, 1964. But the predominant portion of this collection mirrors the most visible portion of Project Gemini: the period from 1965 to 1966, when the 10 crewed missions took place. Mission Operation Reports, fact sheets for each mission, photographs, and mission commentary transcripts provide a thorough look at all facets of Project Gemini. Of particular note are a series of documents called "History of Project Gemini at the Kennedy Space Center," which allow for a rare and unobstructed Kennedy Space Center perspective on Project Gemini.

Other items of interest in this collection include a 1965 article published in the *New York Times* that describes the unique pronunciation that NASA uses for "Gemini"; a photograph given to Kurt Debus of the launch and landing areas taken from the TIROS IX satellite; guest lists from each launch; thank-you letters to Gordan Harris (the first director of public affairs for NASA's Kennedy Space Center), who allowed prominent members of the community to come and view Gemini launches; and some interesting promotional material about Project Gemini and the future of the space program.

Archival collections like Kennedy's Project Gemini holdings offer diverse and unique primary source materials that cannot be found elsewhere.

Archival collections like Kennedy's Project Gemini holdings offer diverse and unique primary source materials that cannot be found elsewhere. This collection represents just a small corner of the trove of information available in the Kennedy Archives—a source of invaluable insights to aerospace history researchers. ■

Examples of the Project Gemini materials archived at Kennedy Space Center. »

The Project Gemini Collection in the NASA Kennedy Archives (continued)

↖ **Top left:** Astronauts Virgil I. Grissom (left) and John W. Young (right) in pressure suits climb into the Gemini Procedures Trainer for a flight-test profile and training session in preparation for the first crewed Gemini flight. This photo was taken in 1964.

↑ **Top center:** Gemini spacecraft is raised to top of gantry for mating to Titan launch vehicle on March 5, 1964.

↗ **Top right:** Gemini spacecraft mockup being checked out by astronaut John W. Young in 1963.

← **Center left:** Air Force Gemini launch crew stands below erector tower on complex 19 in 1965.

↙ **Lower left:** A letter addressed to Gordon Harris from H. B. Leschel, a local of Merritt Island and owner of a Buick dealership, asking whether it would be possible to obtain passes to the next Gemini launch, Gemini V.

→ **Center right:** Photo of Gemini III launch viewed from satellite TIROS IX and letter (**lower right**) addressed to Dr. Kurt Debus, first NASA Kennedy director, from Ernest Amman, part of the Cape Kennedy Spaceflight Meteorology Group, 1965.

BUICK

LESCHEL BUICK, Inc.

Telephone 636-2581 234 E. Merritt Island Causeway MERRITT ISLAND, FLORIDA

July 21, 1965

Mr. Gordon Harris
NASA Kennedy Space Center
Cape Kennedy, Florida

Dear Mr. Harris:

Mr. John Donovan, who is a good customer and friend of mine, was in yesterday having his car serviced and I inquired from him what the possibilities would be of obtaining two passes for Dr. H.H. Blou, a friend of mine from Miami and for myself, for the GT-5 shot, which I believe is scheduled around August 17th.

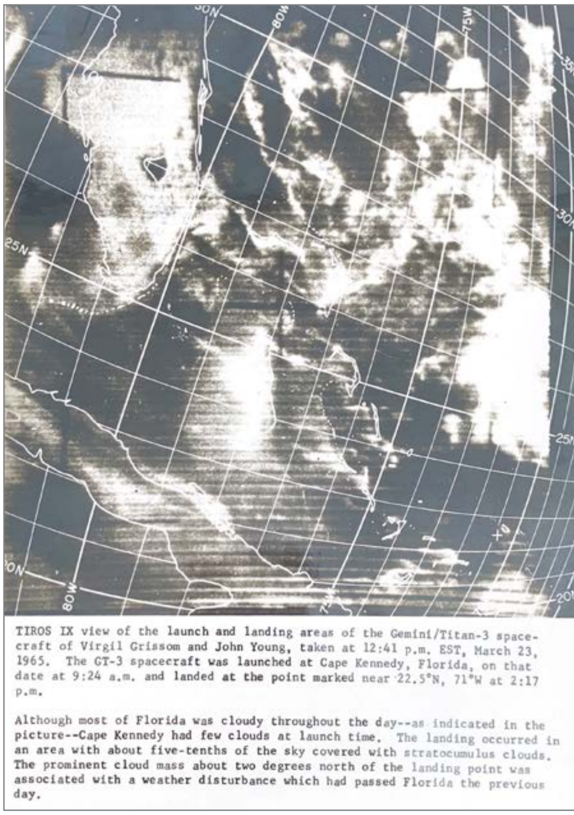
It would certainly be appreciated if this could be arranged as we would enjoy observing the shot.

Buick Motor Division and myself were very proud to have furnished Buick convertibles for the Grissom-Young parade that was held on Cocoa Beach on their return and would be most happy to oblige NASA at anytime in the future.

Yours Very Truly,

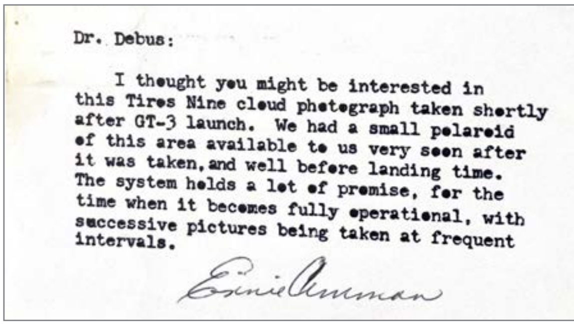
H.B. Leschel

WHEN BETTER AUTOMOBILES ARE BUILT BUICK WILL BUILD THEM



TIROS IX view of the launch and landing areas of the Gemini/Titan-3 spacecraft of Virgil Grissom and John Young, taken at 12:41 p.m. EST, March 23, 1965. The GT-3 spacecraft was launched at Cape Kennedy, Florida, on that date at 9:24 a.m. and landed at the point marked near 22.5°N, 71°W at 2:17 p.m.

Although most of Florida was cloudy throughout the day--as indicated in the picture--Cape Kennedy had few clouds at launch time. The landing occurred in an area with about five-tenths of the sky covered with stratocumulus clouds. The prominent cloud mass about two degrees north of the landing point was associated with a weather disturbance which had passed Florida the previous day.



Dr. Debus:

I thought you might be interested in this Tiros Nine cloud photograph taken shortly after GT-3 launch. We had a small polaroid of this area available to us very soon after it was taken, and well before landing time. The system holds a lot of promise, for the time when it becomes fully operational, with successive pictures being taken at frequent intervals.

Ernie Amman

Other Aerospace History News

American Astronautical Society (AAS) History Committee

The Apollo Lunar Surface Journal Receives the 2024 Ordway Award

» By **Michael Ciancone**

The American Astronautical Society (AAS) Ordway Award Selection Panel has selected the **Apollo Lunar Surface Journal (ALSJ)**, originated and curated by Eric M. Jones, as the recipient of the 2024 Ordway Award. The ALSJ was recognized as an exceptional, comprehensive, and accessible online multimedia resource for detailed study of the first human explorations of the Moon.

Started in 1995 in the early years of the Internet, the ALSJ began as a meticulously corrected transcript annotated with minute-by-minute commentary derived from Jones's in-depth interviews with 10 of the 12 Apollo Moonwalkers. Jones, with help from many volunteer contributors, expanded the ALSJ with additional documents, images, and commentary to become the definitive record of the activities of every Apollo lunar surface crew. Today, even as it is updated with new contributions, the ALSJ has become invaluable to spaceflight professionals, historians, and enthusiasts.

This ambitious three-decade-long project is a testament to the stewardship of its founding editor, Eric M. Jones, and to the passion of the worldwide space history community. The ALSJ has also been issued as a multivolume set of CDs to further disseminate this treasure trove of spaceflight history that Neil Armstrong praised as a "living document." ■

↓ The Apollo Lunar Surface Journal home page.

https://www.nasa.gov/history/alsj/

Upcoming Meetings

JANUARY 3–6, 2025
American Historical Association Annual Meeting
New York, New York
https://www.historians.org/annual-meeting

JANUARY 6–10, 2025
American Institute of Aeronautics and Astronautics (AIAA) SciTech Forum
Orlando, Florida
https://www.aiaa.org/SciTech

MARCH 20–22, 2025
Annual Robert H. Goddard Space Science Symposium
College Park, Maryland
https://astronautical.org/events/goddard/

MARCH 26–29, 2025
National Council on Public History Annual Meeting
Montreal, Quebec
https://ncph.org/conference/2025-annual-meeting/

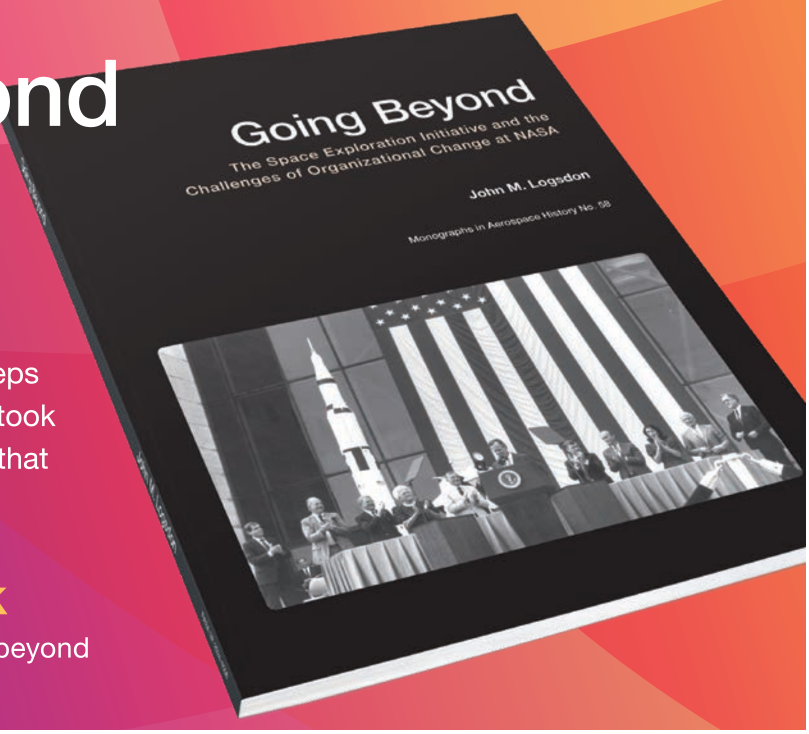
APRIL 3–6, 2025
2025 Organization of American Historians (OAH) Conference on American History
Chicago, Illinois
https://www.oah.org/conferences/oah25/

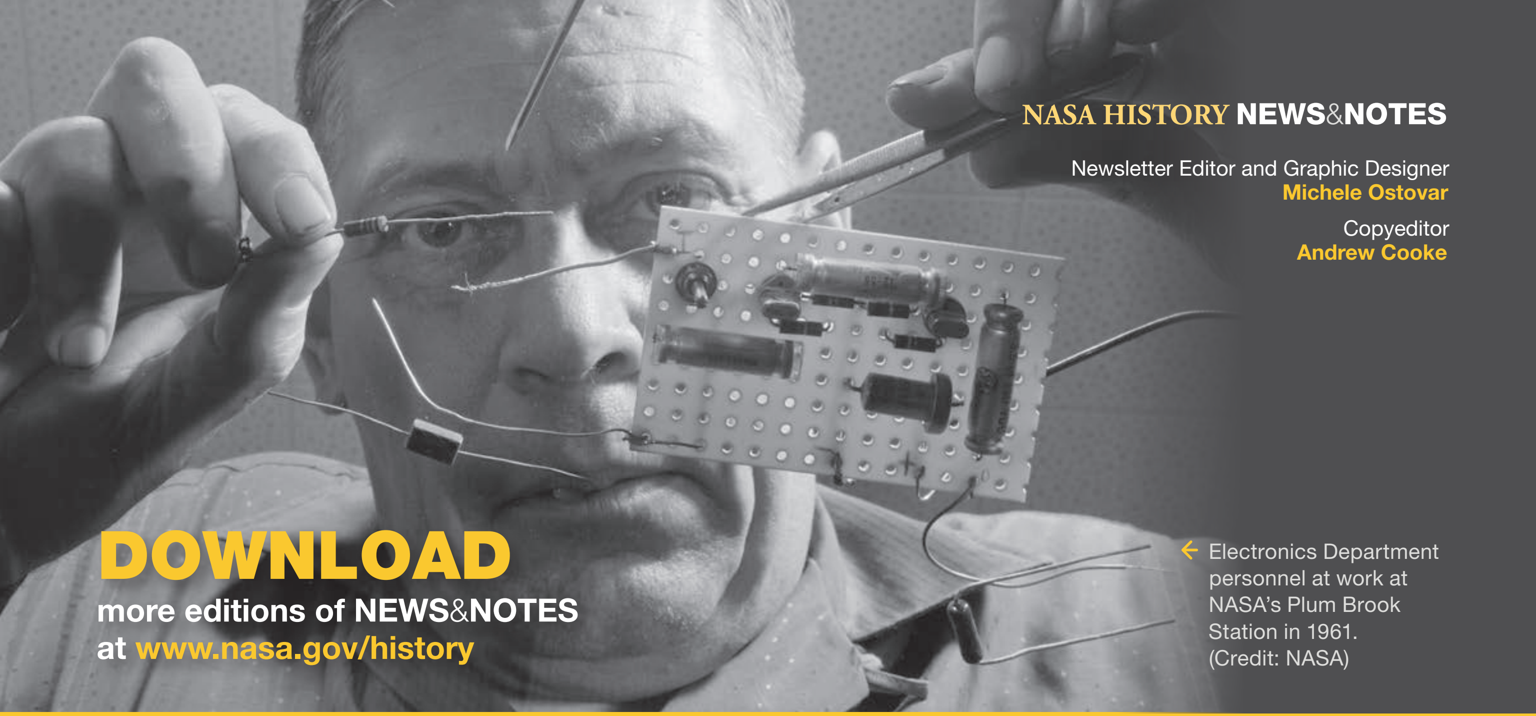
APRIL 7–10, 2025
40th Space Symposium
Colorado Springs, Colorado
https://www.spacesymposium.org/

APRIL 9–13, 2025
American Society for Environmental History (ASEH) 2025 Annual Conference
Pittsburgh, Pennsylvania
https://aseh.org/events

MAY 7–9, 2025
The Global Space Exploration Conference 2025
New Delhi, India
https://www.iafastro.org/events/global-series-conferences/global-conference-on-space-exploration-2025/

JUNE 4–7, 2025
Policy History Conference 2025
Charlotte, North Carolina
https://cai.asu.edu/phc2025





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Electronics Department personnel at work at NASA's Plum Brook Station in 1961. (Credit: NASA)

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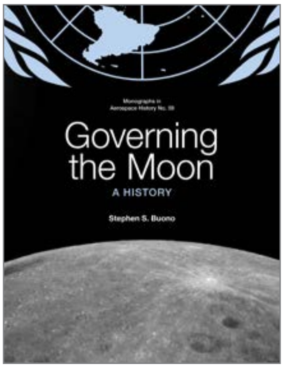

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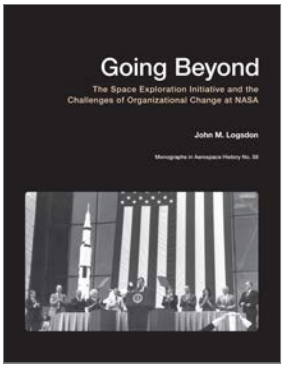
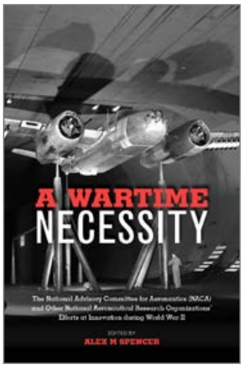
By Stephen S. Buono



Going Beyond
By John M. Logsdon



A Wartime Necessity
Edited by Alex M Spencer

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