National Aeronautics and
Space Administration

GLENN
RESEARCH CENTER
HALL OF FAME

2021
Induction Ceremony

Wednesday, September 14, 2022

GLENN
RESEARCH CENTER
HALL OF FAME

AGENDA

WELCOME

Anne Mills, History Officer and Records Manager

PRESENTATION OF COLORS

John Carroll University Army ROTC

NATIONAL ANTHEM

Star Spangled Banner

MASTER OF CEREMONIES

DaLaun Dillard, News 5 Cleveland Anchor

REMARKS

Dr. James A. Kenyon, Acting Center Director

KEYNOTE

Steven Clarke, Deputy Associate Administrator,
NASA Aeronautics Research Mission Directorate (ARMD)

HALL OF FAME VIDEO

INDUCTION PRESENTATIONS

HONOREES

Bruce Banks
Olga González-Sanabria
Dr. Heinrich "Henry" Kosmahl
Dr. Patricia O'Donnell
J. Anthony Powell
Bobby W. Sanders
John L. Sloop
O. Frank Spurlock
Jesse Strickland
Erwin "Erv" Zaretsky

CLOSING REMARKS

HONOREE GROUP PHOTO

RECEPTION

DaLaun Dillard

DaLaun Dillard is a two-time Emmy-award-winning anchor for News 5 Cleveland, where he serves as co-anchor for the weekday 5 p.m. newscast. In addition to his daily anchoring duties, he also field reports for the 11 p.m. newscast. Prior to joining News 5 Cleveland, Dillard held anchor/reporter roles in Omaha, Nebraska and Peoria, Illinois.

Dillard was born and raised in Battle Creek, Michigan, and is a graduate of Central Michigan University, where he studied broadcast journalism. His most memorable experience as ajournalist was covering local protests in response to the murder of George Floyd, and he eventually won a regional Edward R. Murrow Award for team coverage of the protests. Dillard has a true passion for telling stories that impact, spotlight, or uplift the Black community, and he has broken dozens of stories that have led to policy change.

Dillard is a proud member of Kappa Alpha Psi Fraternity, Inc., and the National Association of Black Journalists, he also serves on the board of directors for the Metro Cleveland Fellowship of Christian Athletes. Dillard is excited to live and work in Northeast Ohio, and he is grateful for the opportunity to tell the stories that impact you.

Dr. James A. Kenyon

Dr. James A. Kenyon is acting director of NASA's Glenn Research Center in Cleveland. He is responsible for planning, organizing, and directing the activities required to accomplish the missions assigned to the center. Glenn has a staff of more than 3,200 civil servants and support service contractors and an annual budget of approximately $900 million.

Prior to becoming Glenn's acting director, Kenyon served as director of the Advanced Air Vehicles Program in the Aeronautics Research Mission Directorate (ARMD) at NASA Headquarters in Washington. He was responsible for the overall planning, management, and oversight of the directorate's efforts to develop innovative concepts, technologies, and capabilities to enable revolutionary advances for a wide range of air vehicles. He supported the mission directorate and the ARMD associate administrator in a broad range of activities, including strategic and program planning, budget development, program review and evaluation, and external coordination and outreach.

Prior to joining NASA, Kenyon worked with Pratt & Whitney, where he held key leadership roles in business development, program management, and engineering, including serving as executive director of advanced programs and technology. Kenyon joined Pratt & Whitney after 17 years as a civilian in the Department of Defense (DoD), including six years in the Office of the Secretary of Defense, where he was responsible for strategic planning, policy guidance, and management oversight of DoD aerospace science and technology programs.

Steven Clarke

Mr. Steven Clarke is the deputy associate administrator for ARMD at NASA Headquarters in Washington, DC. He is responsible for leading long-term strategic, portfolio, and budget planning and analysis for ARMD to guide long-term portfolio requirements and program balance to meet national needs.

He oversees mission directorate operations and organizational development and supervises the Portfolio Analysis and Management Office. He authoritatively represents ARMD on behalf of the associate administrator as needed at agency governance councils, interagency councils, and with external stakeholders.

Previously, as the deputy associate administrator for exploration in NASA's Science Mission Directorate, Clarke served as the agency's interface between the NASA mission directorates, the scientific community, and other external stakeholders in developing and implementing Space Policy Directive-1 using an integrated approach to achieve science and human exploration objectives for the Moon and Mars.

Clarke returned to NASA after serving as a senior policy analyst with the Office of Science and Technology Policy (OSTP) in the Executive Office of the President, where he was responsible for leading a number of important initiatives, including space weather. He led the cross-government Space Weather Operations, Research, and Mitigation subcommittee as the OSTP co-chair.

Prior to his OSTP duties, Clarke was director of NASA's Heliophysics Division, where he led the formulation and implementation of a national research program that used scientific flight investigations and research grants to understand the Sun, its interactions with the Earth and the solar system, and how the observed phenomena impact life and society.

Clarke also served as director of NASA's Joint Agency Satellite Division, where he led reimbursable spacecraft and instrument development activities performed by NASA for partner agencies, including the Deep Space Climate Observatory, Joint Polar Satellite System, and the Geostationary Operational Environmental Satellite (GOES)-R series. He also supported the deputy associate administrator of the Exploration Systems Development Division at NASA Headquarters, where he was responsible for developing the architecture for human exploration beyond Earth orbit.

He has received numerous awards during his career, including the Presidential Rank Award and NASA's Exceptional Achievement Medal for outstanding leadership.

Clarke earned a Bachelor of Science degree in engineering and a Master of Science degree in engineering management from the University of Central Florida.

Bruce Banks

Bruce Banks not only made significant contributions to NASA's efforts in electric propulsion, thin-film coatings, surface texturing, and atomic oxygen protection, but he also had the uncanny ability to find an array of alternative uses for these technologies in the private sector.

Growing up in Rocky River, Ohio, Banks possessed an intense curiosity about how things worked and why things occurred. He earned his Bachelor of Science degree in physics from Case Institute of Technology in 1964 and a Master of Science degree in physics from the University of Missouri at Rolla in 1966. Banks worked briefly as a developmental physicist at General Electric before joining NASA's Lewis Research Center in June 1966.

After a short assignment with the Centaur Program, Banks began studying ion thrusters in the Electromagnetic Propulsion Division's Propulsion Components Section. He analyzed the thrusters' glass-coated accelerator grids and developed a hydroforming method to create large, closely spaced grids that increased thrust for deep space ion propulsion systems. Banks received four patents related to electric propulsion in 1971 and later received a Space Act Award for hydroforming grids.

In 1972 Banks was named head of the Small Thruster Section. This group investigated auxiliary propulsion applications for ion thrusters, such as satellite station-keeping. He developed a device that measured the flow of liquid metal by passing it through an electric field.

While working in electric propulsion, Banks determined that ion beams could also be used to modify surfaces and coat materials. In 1976 he became head of the Ion Beam Applications Section, which studied non-propulsion use of ion thrusters. Banks collaborated with medical professionals to study the use of ion beams to create unique textures on materials for prostheses and surgical implants. Studies revealed that the body accepted these modified devices at higher rates. He also utilized ion beams to create diamond-like carbon films for use in sunglasses, strain gauges, and star-trackers. Banks received the 1980 Arthur S. Flemming Award for his efforts in applying space technology to medical devices.

In 1985 Banks was named Chief of the Electro-Physics Branch. This team was responsible for developing new materials for space power applications, but Banks continued his technology transfer efforts as well. The branch was responsible for a large percentage of the center's technology transfer, and in 1988 Banks was recognized nationally for identifying potential commercial uses for intercalated graphite composites and transferring the technology to industry.

Atomic oxygen poses one of the biggest challenges for long-term space missions. Single oxygen atoms, naturally found only in space, corrode and weaken external components. In the 1980s Banks and James Sovey developed different protective coatings for polymers used to create thermal blankets for spacecraft. Banks' Electro-Physics Branch expanded upon this work in the 1990s. They developed a silicon dioxide thin-film coating that successfully protected the space station's solar arrays. This prevented the costly process of periodically replacing the blankets, which NASA later estimated would have cost the agency more than $15 billion. Banks and Sovey, along with colleagues Sharon Miller and Michael Mirtich, received a $40,000 Space Act Award in 2001 for their efforts.

Banks' team also studied coatings for the Hubble Space Telescope. In 1992 they quickly evaluated various coatings for the telescope's thermal shields prior to the first Hubble servicing mission. They conducted similar studies for four additional repair missions and were key contributors to the 1997 investigation of a Hubble insulation failure.

In the early 1990s Banks and Miller investigated ways to apply the damaging characteristics of atomic oxygen toward beneficial uses on Earth. These applications included the sterilization of medical implants, decontamination of aircraft components, and improvement of seals. They also found that atomic oxygen could be used to remove soot and other contaminants from artwork without injuring the pigment. In 2002 Banks and Miller won an R&D 100 Award and the R&D 100 Editor's Choice Award for Most Innovative New Technology for use of atomic oxygen for art restoration.

Banks was responsible for dozens of experiments flown on the space shuttle and space station over the years. Banks has been the principal investigator or co-investigator for over 20 Materials International Space Station Experiment (MISSE) space exposure experiments flown on the exterior of the International Space Station since 2001. Banks retired in 2007 after 41 years at NASA, but he continued his materials work as a NASA contractor. In 2009 he and Miller received a Federal Laboratory Consortium award for Excellence in Technology Transfer.

Banks has published 258 technical publications and 34 technical briefs. He has received more than 120 invention and meritorious performance awards from NASA and other organizations. His 39 patents are the most earned by an individual in center history. In addition to his many outstanding technical contributions, Banks also served as a valued mentor to dozens of researchers over the course of his career. His legacy of technology innovation and professionalism continues on through the work of the many engineers and scientists whose careers he nurtured.

Olga González-Sanabria

Olga González-Sanabria developed a fondness for chemistry and math while growing up in Patillas, Puerto Rico. She became interested in engineering at a career day in high school—chemical engineering, in particular, because of the 1970s energy crisis. She was one of only a few women studying engineering at the University of Puerto Rico. After earning her bachelor's degree in chemical engineering in 1978, González-Sanabria accepted a position at the NASA Lewis Research Center in Cleveland, Ohio. She earned her master's degree in chemical engineering from the University of Toledo in 1985.

González-Sanabria began her NASA career in 1979 researching energy storage technologies for space in the Electrochemistry Branch of the Solar and Electrochemistry Division. She and her colleagues worked to advance nickel–hydrogen fuel cells, a new type of battery that offered improved performance. They made key advances in improving the separators that isolate oxidation and reduce voltage losses. She contributed to over 30 technical papers and is the co-patentee on a separator technology for alkaline batteries. In 1988 she was part of a group that received an R&D 100 award for long cycle-life nickel–hydrogen batteries.

As part of the Energy Storage Branch in the mid-1980s, González-Sanabria analyzed advanced nickel-hydrogen battery designs and advances. She also collaborated with Patricia O'Donnell and Robert Cataldo to study various battery and fuel cell options for radioisotope thermoelectric generators to power potential Mars rovers.

In 1990 González-Sanabria moved into the Space Experiments Division's In-Space Technology Branch, which designed experiments requiring testing in space. She served as the group's liaison to the Headquarters Office of Aeronautics and Space Technologies. In 1993 she was awarded the Exceptional Service Medal for her outstanding development and coordination work in this capacity.

González-Sanabria officially transitioned from research to management in 1995 with her appointment as the center's executive officer. She was responsible for assisting the center director in planning, organizing, and managing the center's institutional and technical programs. In this role, she helped guide the center through the tumultuous reductions and reorganization that resulted from the agency's Zero Base Review.

From 1998 to 2002 González-Sanabria headed the Plans and Programs Office. She was responsible for ensuring that the center's research programs, plans, and policies aligned with agency objectives. In 2000 she coordinated the first Center Performance Review to measure the center's effectiveness in meeting agency goals. She also led the center's effort to establish ISO 9000 certification.

In 2002 González-Sanabria was appointed to Senior Executive Service (SES) and put in charge of the Systems Management Office. She was the first Latina at the Center to receive an SES designation. The Systems Management Office was established in 2000 to implement the agency's new Program and Project Management Processes and Requirements policy.

In 2002 she received the Outstanding Leadership Medal. In 2003 she was inducted into the Ohio Women's Hall of Fame for her technical achievements and being a leading professional Hispanic. In 2007 she was awarded the Presidential Rank of Meritorious Executive for her leadership in integrated engineering services and the Hispanic Engineer National Achievement Awards Conference's Executive Excellence Award.

González-Sanabria was named director of Engineering and Technical Services in 2004. The directorate was responsible for the center's engineering design, fabrication, facility management, and systems engineering. Following a reorganization in 2008, González-Sanabria served as director of the new Engineering Directorate. The directorate offered a new approach to organizing engineering services.

González-Sanabria retired in December 2011 with 32 years of NASA service. In addition to her professional accomplishments, González-Sanabria was an active mentor for both students and mid-career professionals.

Dr. Heinrich "Henry" Kosmahl

Dr. Henry Kosmahl revolutionized the field of microwave tube amplifiers through the development and continual refinement of the multistage depressed collector. Kosmahl's work has been recognized internationally and led to the emergence of the Glenn Research Center as a leader in space communications.

Kosmahl was born in 1919 in Wartha, Germany. He earned a degree from the University of Dresden in 1943 and a doctorate from the University of Darmstadt in 1949, where he was an assistant professor in 1949 and 1950. He then worked as a research physicist from 1950 to 1956. Kosmahl emigrated to the United States in 1956 as Cold War tensions escalated across Central Europe.

Kosmahl joined NASA's Lewis Research Center in Cleveland, Ohio, in 1963 as a member of the Space Technology Division's Electromagnetic Technology Section. He studied plasma accelerators, a type of electric propulsion used to propel spacecraft. He also sought to optimize the performance of magnetic brakes, in part to facilitate experiments in the center's new 500-foot drop tower.

In 1966 the center initiated a modest communications program and tapped Kosmahl to head the new Tube Development Section. The group studied two types of tube amplifiers–traveling wave tubes (TWTs) and klystrons. NASA had recently begun incorporating TWTs, which had been devised in the 1930s, into its early space communications satellites.

In 1967 Kosmahl began developing a multistage depressed collector to be placed at the end of the tube to recycle charged particles from the tube's electron beam. The device consisted of a series of depressed plates with openings in the center and a conical spike at the end. An electron beam was shot through the openings to the amplifier. The plates collected electrons that fell away during the transmission and recycled them back to the power source. Without the collector, these unused electrons were wasted and had to be dissipated as heat.

Kosmahl's collector, which he patented in 1972, dramatically improved tube performance and reduced operating costs. This resulted in larger coverage areas and smaller ground receiving equipment. Kosmahl then improved the device by developing a tool to refocus the electron beam before it entered the collector. The improved TWTs became a standard component for nearly every subsequent NASA and industry communications satellite. NASA recognized Kosmahl's efforts in 1974 with the Exceptional Scientific Achievement Award. Kosmahl spent the rest of his career improving the performance and longevity of TWTs.

Kosmahl was named head of the Power Amplifier Section in the Applications Division in 1973. The group expanded the center's radio transmission efforts and specialized in the development of high-efficiency tubes for communications satellites.

The center undertook a joint program with the Canadian Department of Communications to demonstrate the feasibility of using higher frequencies on the Communications Technology Satellite (CTS), which launched in 1967. Over a three-year period, the CTS confirmed the power and affordability of high-frequency communications systems made possible by Kosmahl's inventions.

The military was also interested in utilizing the multistage depressed collector to improve its electronic countermeasures, or "radar jamming" capabilities. The center partnered with the Air Force in the mid-1970s to apply Kosmahl's collector and beam refocusing technologies to military tubes operating over a range of frequencies and power levels. The tubes used in contemporary military systems were not only inefficient but suffered thermal damage from the dissipation of unused electrons. The program focused on developing highly efficient, low-cost designs that were small enough to install on military aircraft.

The multistage depressed collector was also used to improve the efficiency of ultrahigh-efficiency (UHF) transmitters. In the 1980s Kosmahl helped develop klystron tube amplifiers for UHF transmitters that required only half the energy of normal transmitters. The effort resulted in significant savings for public broadcasters and others using the UHF bandwidth. The Public Broadcasting Service and NASA each received Emmy Awards in 1987 for implementing the technology, and the center presented Kosmahl with its largest cash award to date for his contributions.

For most of his NASA career, Kosmahl not only pursued his own research projects but also managed and inspired a team that included renowned researchers such as Peter Ramin and James Dayton and a new generation of engineers that carried the center's communications excellency forward. Kosmahl's legacy at NASA lives on both through his innovations and the cadre of communications specialists who have followed his lead.

Kosmahl retired from NASA in 1984 after 21 years of service but continued working at the center as a Distinguished Research Associate and a NASA contractor. He served as a consultant to several large corporations and became the principal scientist for start-up AmpWave Tech LLC. in the early 2000s.

Kosmahl authored over 40 articles and books and earned numerous patents for his inventions. He is broadly recognized for his revolutionary advancement of communications technology and has received a plethora of awards, including the Aviation Week Laurels Award, IEEE Technology Advancement Award, IEEE Major Inventor Award, the Cleveland Electrical/Electronics Conference and Exposition Centennial Award, R&D 100 Award, and most recently, induction of the TWT into the Space Technology Hall of Fame, 2020.

Kosmahl passed away in September 2011.

Dr. Patricia M. O'Donnell

Dr. Patricia O'Donnell was a leader in energy conversion and storage at the Lewis Research Center for 44 years. She researched the conversion of high-energy propellants to produce rocket thrust, the conversion of solar energy to electrical power, and the storage of converted energy in batteries.

After earning her bachelor's and master's degrees from Case Western Reserve University, O'Donnell joined the NACA's Lewis Flight Propulsion Laboratory in 1954 as an analytical chemist in the Propulsion Systems Division's Fuels Chemistry Section. The section was unique at the time in that women occupied four of its seven research positions.

The group analyzed a variety of high-energy liquid chemicals to determine their viability as propellants. They sought to determine how these chemicals, some of which were toxic, reacted with various materials and other chemicals. Initially, O'Donnell contributed to the study of a boron derivative, referred to as HEF–2, for the Navy-sponsored Project Zip. The investigation determined that this particular derivative was unstable, especially in the presence of oxygen.

In 1960 O'Donnell was transferred to the Chemistry Energy Conversion Division's Electrochemical Conversion Section. There she embarked upon a 15-year analysis of fluorine. Fluorine had superior theoretical potential as an oxidizer, but its corrosiveness posed significant issues. O'Donnell studied fluorine's reaction with a variety of metals used to construct propulsion systems. She went on to study the use of fluorination (coating the metal with a small amount of fluorine prior to engine ignition) to lower the corrosiveness.

O'Donnell later analyzed the potential use of fluorine to extract oxygen from simulated lunar materials to support potential sustainable life systems for Moon bases. O'Donnell's fluorine work yielded roughly 20 papers, a doctoral thesis from the University of Akron, and a patent (the center's first by a female). The research also earned her international recognition and invitations to lecture in Poland and Japan.

In 1976 O'Donnell served a 1-year detail in the Solar Energy Division at NASA Headquarters as NASA began studying terrestrial power systems in response to the energy crisis. She returned to Lewis the following year and began a new career in power systems as part of the Redox Project Office. Lewis researchers created the Redox system to store wind and solar-generated energy. O'Donnell was the integration manager for the successful demonstration test of the Redox system in 1979.

O'Donnell then became a member of the Terrestrial Photovoltaic Projects Branch, which partnered with external organizations to install NASA solar-power units in remote, impoverished villages. O'Donnell contributed to the establishment of power systems on the Papago Indian Reservation in Arizona and at a site in Gabon, Africa. She also served briefly as project manager for Lewis' effort to develop solar-powered vaccine refrigerators for the Centers for Disease Control.

O'Donnell shifted her focus to power systems for space applications in 1983 as head of the Space Propulsion Technology Division's Electrochemistry Fundamentals Section. In 1986 O'Donnell became deputy chief of the Electro-Chemical Technology Branch, where she managed 17 engineers working on fuel cells and batteries for space applications, including the International Space Station.

Nickel–cadmium fuel cells and batteries were performing poorly during pre-mission validation tests at the time. O'Donnell and Marvin Warshay contributed to a study that found improper storage of fuel cells caused degradation of separator material which resulted in internal shorts. The findings led to new NASA procurement policies and technological options.

The branch had been developing nickel–hydrogen batteries that could potentially outperform nickel–cadmium batteries, but the nickel–hydrogen batteries appeared lackluster in early testing. O'Donnell observed that the performance was hindered by the expansion of nickel electrodes during power transfer. By decreasing the porosity of the electrodes, she improved performance by a factor of ten. Nickel–hydrogen batteries were eventually employed on the space station, Hubble Space Telescope, and in numerous other space applications. In 1991 NASA presented O'Donnell with the Exceptional Engineering Achievement Medal for her work on nickel–hydrogen batteries.

As program manager for the NASA Aerospace Flight Battery Systems Program, O'Donnell was responsible for guiding the agency's battery research and determining battery requirements for future space missions.

In addition to her technical and managerial accomplishments, O'Donnell helped pave the way for women in the center's research community. She was also active in the center's social activities and Business and Professional Women's Club.

After 44 years at the NACA and NASA, O'Donnell retired in 1998.

J.Anthony Powell

J. Anthony Powell became interested in science and engineering, particularly electronics, while growing up in Lexington, Kentucky, and was drawn to physics while earning his undergraduate degree in electrical engineering at the University of Kentucky. A professor recognized this interest and allowed Powell to work summers in his solid-state laboratory. There Powell analyzed single calcium oxide crystals and created processing furnaces. Powell completed his master's degree in physics in 1963 and began looking for professional employment in Ohio, which had significantly more scientists and engineers than Kentucky.

Powell accepted a position in the Instrument Research Division at NASA's Lewis Research Center in Cleveland, Ohio. The center was expanding its workforce as part of the agency's effort to land a man on the Moon by the end of the decade. In September 1963 the 25-year-old Powell purchased a new car, packed a few belongings, and headed north to start a new life.

As a member of the Measurements Section (1963 to 1965) and the Electronic Systems Section (1966 to 1970), Powell helped initiate the center's research on silicon carbon crystals. He recognized that silicon carbide electronics offered significantly better electric field strength breakdown, bandgap, thermal conductivity, and higher operating temperatures than pure silicon, but there was no established process to grow silicon carbide crystals of uniform size and consistent quality.

Powell explored several avenues for silicon carbide growth in the late 1960s and had some small-scale success. Despite its promise, the technology was not commercially viable without silicon carbide substrates of adequate quality and purity. Lewis cancelled the program in the early 1970s and, with the exception of the Soviet Union, nearly all silicon carbide electronics research ceased.

In 1974 Powell was assigned to the Electronic and Laser Applications Section of the Airbreathing Engines Division. The group sought to improve methods of accurately measuring the conditions inside of operating aircraft engines. Powell and his colleagues developed a laser anemometer that detected air stream particles as they passed through two intersecting laser beams. Researchers could calculate the velocity of the particles from the time and the distance data. The device could take thousands of measurements per second at the compressor's complex set of rotating fan blades.

In 1981 Powell became a member of the Electronics and Electro-Optics Section, which was developing electronic monitoring systems for aircraft engines. Engine manufacturers required semiconductors for electronics that could function in a high-temperature environment, renewing Powell's interest in silicon carbide. He and William Nieberding authored a report asserting that silicon carbide semiconductor electronics could significantly impact modern aircraft engines. The paper spurred the center to reinvest in silicon carbide electronics research.

Visiting faculty fellow Dr. Shigehiro Nishino introduced the Lewis team to a unique chemical vapor deposition (CVD) strategy to grow silicon carbide crystals on silicon wafers. Powell and his colleagues constructed a laboratory to apply the CVD and successfully worked through the various processing issues. The CVD growth of high-purity silicon carbide layers would prove to be a key breakthrough that made silicon carbide electronic devices a reality. Research & Development Magazine included this process on its renowned R&D 100 list of exceptional technologies for 1983. Silicon carbide research quickly expanded around the globe.

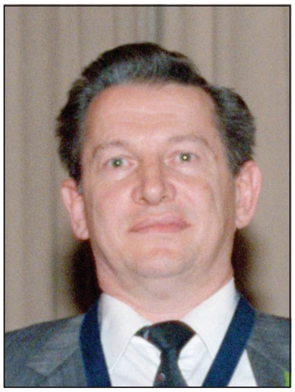
As a member of the Engine Sensor Technology Branch, Powell understood that future commercialization of silicon carbide semiconductors would require low densities of crystal defect. In the mid-1980s he partnered with regional universities to develop strategies to eliminate crystalline defects. Powell's landmark 1989 paper on the use of CVD to grow low-defect silicon carbide layers on commercially available silicon carbide wafers paved the way for the development of high-quality silicon carbide electronic devices.

Powell's pioneering application of CVD for silicon carbide growth is one of the technical foundations of what has blossomed into a global industry. Silicon carbide electronics are utilized by renewable energy grids, computer power supplies, nuclear power-generating systems, electric vehicles, hybrid electric aircraft, and space vehicles. The increased use of silicon carbide electronics in electrification systems has contributed to the reductions of global greenhouse emissions.

Exploration of the planet Venus has long been hampered by the inability to design equipment to survive the planet's high temperature and pressures. In the early 1990s Powell argued that transmitters using silicon carbide electronics would survive the harsh conditions. NASA researchers have subsequently made silicon carbide a key component of the planned Long-Lived In-Situ Solar System Explorer (LLISSE) mission to Venus. The resilience of silicon carbide, predicted by Powell, has been verified by long-duration testing under simulated Venus conditions.

Powell published over 30 technical papers and earned several patents while at the center. NASA recognized Powell's impact with a series of awards, including a Special Achievement Award (1973), Lewis Technical Publication of the Year (1980), Exceptional Engineering Achievement Award (1990), and Exceptional Service Award (2002). In addition, his projects were included on the IR 100 and R&D 100 lists in 1983 and 2004. He has served on steering committees, chaired numerous international conference sessions, and served as an advisor and reviewer for national research organizations.

Powell retired in the early 2000s but continued his work in the private industry. In 2012, he was a member of a team that received the NorTech Innovation Award for nearly perfecting silicon carbide manufacturing. Despite being an internationally recognized figure, Powell remained humble and eager to learn from others. His family recalls him excitedly setting off each morning for what he referred to as "the best job in the world."



Bobby W. Sanders

Bobby Sanders as a nationally recognized leader in the advancement of engine inlet technology for over 50 years. He was engaged in the conceptualization, design, and testing of a diverse array of inlets for both military and commercial applications.

Sanders joined the NASA Lewis Research Center in 1963 as part of the Advanced Development and Evaluation Division. At the time, the division was testing space vehicles in the 8- by 6-Foot Supersonic Wind Tunnel (8×6) and the 10- by 10-Foot Supersonic Wind Tunnel (10×10).

One of Sanders' first assignments was the aerodynamic shroud testing for the Mariner-C spacecraft and the Atlas–Agena launch vehicle. The tests verified the dynamic performance of the oversized shroud and vehicle. Sanders went on to compare the data with similar tests of the Agena/Lunar Orbiter shroud. Sanders also performed wind tunnel testing of the Apollo Command Service Module and its escape tower. The tests determined the effect of the escape tower's control flaps on its overall aerodynamic stability.

As the center reorganized in the mid-1960s to increase its aeronautics research, Sanders became a member of the Inlets Section in the new Wind Tunnels and Flight Division. Initially, this group focused on issues related to supersonic transport propulsion systems. Sanders helped prepare the center's F–106 Delta Dart to support this research effort.

During this period, Sanders developed and tested many inlet bleed geometries and bleed airflow control strategies in the center's wind tunnels to increase the range of stable airflow in supersonic mixed-compression inlets. This led to the development of bleed systems for supersonic inlets that improved performance and increased stability. The inlet bleed system, which draws small amounts of air from the inlet's porous surfaces, stabilizes the supersonic shock wave system in order to maximize performance. It also mitigates disturbances in the incoming airflow and in engine airflow demand. This reduces flow through the compressor to prevent stall and choking. Sanders and Glenn Mitchell patented a passive-bleed airflow control system in 1971.

Subsequent testing of this passive-bleed control system on an inlet from the SR–71 aircraft in the 10×10 demonstrated that the bleed system significantly increased inlet stability. Sanders' inlet bleed stability research has been fundamental to the development of many subsequent high-speed inlet designs.

The center reorganized in 1983, and Sanders became a member of the Aerodynamics and Engine Systems Division. There he led a joint NASA and industry team that supported the design of a supersonic cruise demonstrator aircraft by investigating technological issues in the largely ignored Mach 3 to 6 range. Several agencies used data from testing of the vehicle's ramjet engine inlet in the 10×10 to validate computations fluid dynamics (CFD) predictions. It was the first demonstration of a large-scale, high-performance, Mach 5 cruise inlet.

In 1986, Sanders was named deputy chief of the Propulsion Systems Division's Hypersonic Technology Branch. The branch was responsible for performing analysis and testing of hypersonic inlets, nozzles and combustors to support the National Aerospace Plane (NASP) program. Sanders defined the parameters for the NASP inlet/combustor combination and led a series of research tests that provided definitive information on inlet performance and interaction issues.

Sanders also initiated the center's study of a variable diameter centerbody (VDC) inlet for supersonic propulsion. He designed an inlet diffuser using a folding-leaf mechanism for the variable diameter centerbody, a configuration that offered high performance and stability. The innovative system provided the required area variation while permitting inlet bleed without leakage and maintaining acceptable aerodynamics in the diffuser. The inlet was successfully demonstrated during wind tunnel testing as part of the High-Speed Research program.

Sanders received awards for his contributions to the VDC inlet, Mach 5 inlet, and NASP program.

In 1991 NASA awarded Sanders the Exceptional Service Award "for outstanding personal dedication, engineering insight, and leadership in defining, conducting, and guiding high-speed inlet research."

In 1996, Sanders was named chief of Inlet & Propulsion Airframe Integration Technology Branch. He retired later that year after 33 years at NASA.

Sanders was not finished with inlets, though. He founded TechLand Research Inc. where he collaborated with NASA, the military, and industry for another 20 years. At TechLand he conceived several new designs, including an external-compression supersonic inlet, a variable geometry concept supersonic cruise inlet, a rotary airflow control valve and isolator for a pulse detonation engine (PDE), and an over-under dual-flow hypersonic inlet.

Sanders patented three more inlet concepts, a bleed valve concept, and the PDE valve during his time at Techland. He was among those receiving NASA's Steven Szabo Engineering Excellence Award in 2005 and Distinguished Publication Award in 2009.

Sanders passed away in 2020 at the age of 81.

John L. Sloop

John L. Sloop led the center's efforts in the 1950s to understand basic rocket engine principles and determine optimal high-energy fuels. This led to the utilization of liquid hydrogen in the Saturn and Centaur upper-stage rockets in the 1960s. Sloop was a key figure at Headquarters that decade, selecting the original launch vehicles for the space program and managing power and propulsion work at the research centers. In the 1970s, Sloop meticulously documented the history of liquid hydrogen development, emphasizing the research performed at the Lewis Research Center.

Sloop joined the center as a research engineer in 1941. During World War II, he investigated spark plug ignition. After a major reorganization at the end of the war, Sloop found himself, literally overnight, among a small group within the Combustion Branch studying rocket propulsion issues such as cooling, combustion, and thermodynamics. The group's small size and the aeronautical agency's lack of support for rocket work provided the group a great deal of autonomy. They decided early on to focus on the relatively unexplored field of high-energy liquid propellants. Theoretical analysis of various potential fuels was followed up by testing in small 100-lb-thrust engines in the rudimentary test cells of the new Rocket Lab facility.

Sloop was the group's primary spokesperson in front of various committees and at events such as the NACA Inspections. When the rocket work was expanded in 1949, Sloop was selected to lead the new Rocket Branch. Sloop became a rocket propulsion proselytizer in the 1950s, speaking frequently at staff seminars, technical conferences, community meetings, and in classrooms.

During Sloop's first 5 years, the branch doubled in size to 25, received funding for the Rocket Engine Test Facility, and obtained a liquefier to create liquid hydrogen. Sloop was the NACA representative on the Subcommittee on Rocket Engines from its inception in 1950 to its termination in 1958. At a NACA conference on fuels in January 1950, Sloop stated that liquid hydrogen, in combination with either oxygen or fluorine, would provide the best performance for missiles. This was the center's first statement to the larger community on hydrogen's potential. Lewis's first successful liquid-hydrogen–liquid-oxygen run was completed in November 1954 with a 5,000-lb-thrust rocket engine.

Lewis Associate Director Abe Silverstein began closely following the hydrogen studies in the mid-1950s with an eye on possible aeronautical applications. So did others, including representatives from Pratt & Whitney and individuals who would become the members of Defense Advanced Research Projects Agency (DARPA). At the NACA's key Flight Propulsion Conference in November 1957, not long after the Sputnik launch, Sloop led a team that presented a paper that discussed high-energy propellants and their application for a range of missions—including missiles, satellites, and a lunar landing.

In the late 1950s Sloop's group expanded its research to include pumping and storage of the cryogenic propellant, and he helped review new rocket engine proposals. In 1959, Administrator T. Keith Glennan personally thanked Sloop and his team for their technical assessment of proposals for a 1-million-lb-thrust rocket engine. In 1958, Silverstein transferred to Headquarters to serve as director of Space Flight Programs and coordinate the new NASA space agency. In this position, Silverstein, with his knowledge of Lewis' hydrogen work, convinced Wernher von Braun and others that hydrogen-powered upper stages were necessary for the Saturn vehicle.

In 1960 Silverstein brought Sloop to Washington, DC, to serve as his technical assistant. Sloop participated in committees reviewing launch vehicles, including Saturn, and planning the Apollo missions. In 1961 Sloop was named deputy director of the Launch Vehicles and Propulsion Division, where he managed the Scout, Delta, Atlas–Agena, and Atlas–Centaur vehicles. Sloop's critical review of General Dynamics' work on Centaur in 1961 led to NASA taking greater control over the program.

As the director of Propulsion and Power Generation in the Office of Advanced Research and Technology (OART), Sloop managed solid and liquid rockets and onboard space power. In 1964 he was promoted to assistant associate administrator of Advanced Research and Propulsion, which managed the work on aeronautics, space vehicles, propulsion, electronics, and basic research at NASA's three research centers. Sloop retired in 1972 after 31 years of NACA and NASA service.

With the success of the Apollo Program, Sloop was asked in 1971 to prepare a conference paper on the development of liquid hydrogen in the 1950s. The resulting paper included a bibliography with over 200 reports and references. NASA historian Eugene Emme recommended that Sloop develop a hydrogen timeline that could be published in the NASA chronology series. Sloop delved into creating a full history of hydrogen development that expanded far beyond the work of the NACA. Nearly 5 years later, the 325-page "Liquid Hydrogen as a Propulsion Fuel, 1945-1959" was published in 1978. It was the first publication to discuss the center's history since George Gray's "Frontiers of Flight" 30 years before and has been an important resource for nearly all subsequent Glenn histories. The book's focus on a single technology was unique to NASA histories at that time. Sloop attacked the liquid hydrogen subject from a variety of novel angles, including early German work, post-war studies at other U.S. institutions, the military's role, the secret Project Suntan, and the selection of hydrogen for the Saturn stages.

Sloop published 45 documents and wrote over 100 unpublished talks and papers. He cofounded and once headed the Cleveland–Akron Section of the American Rocket Society. Sloop was an American Institute of Aeronautics and Astronautics (AIAA) fellow. He shared the AIAA's 1974 Goddard Award "for significant contributions to the development of practical LOX-hydrogen rocket engines which have played an essential role in the national space program and in the advancement of space technology."

Sloop passed away in 1992.

Omer “Frank” Spurlock

Frank Spurlock created a unique computer code that directly impacted NASA’s launch vehicle operations, including many of its highest profile and most demanding missions, for decades. This code, referred to as DUKSUP, provided mission planners with highly accurate launch vehicle trajectories for space probes, satellites, and space telescopes. Application of this code established Lewis Research Center as the agency’s preeminent trajectory analysis center.

Spurlock was a brilliant student growing up in Hobbs, New Mexico. In the fall of 1957, he was accepted into the honors program at the University of New Mexico, where he became a member of a national mathematics fraternity and received a Sandia Fund grant for academic excellence. Upon graduating in 1961, Spurlock received a Woodrow Wilson Fellowship to pursue a master’s degree in physics.

Spurlock opted to work on his degree at Case Western Reserve University in Cleveland, Ohio. The move coincided with President Kennedy’s announcement that the United States would send humans to the Moon within the decade. NASA Lewis, located just across town from the university, was in the midst of a massive recruiting drive to meet this goal. A professor, aware of NASA’s need for individuals with strong backgrounds in math and physics, notified Spurlock of an open analytical position. The 21-year-old Spurlock decided to forgo his fellowship and joined the center’s new Powered Flight Analysis Section. He eventually completed his master’s degree in mathematics at Cleveland State University in 1971.

In March 1962 Spurlock joined a group of 12 others providing researchers with data on the impact of advanced engine systems—including nuclear engines, ion thrusters, and the 260-in.-diameter engine—on potential payloads. Spurlock and his colleagues modified an existing code for space probes, “N-Body,” for use with launch vehicles by substituting the gravitational pull of the Earth for that of the Sun. The center’s limited computing capabilities meant they had to use the nonstandardized FORTRAN IV language and forgo the simpler gradient ascent calculation technique for the mathematically complex calculus of variations. They doggedly identified and fixed the errors in the code until the derivative calculation issues were resolved.

In the fall of 1962, the center was assigned responsibility for the Centaur upper-stage rocket program. NASA was relying on the Centaur to launch a series of Surveyor spacecraft to analyze the lunar surface prior to the Apollo landings. Lewis was responsible for ensuring the vehicle was flight ready, integrating the Surveyor with Centaur and its Atlas booster, and managing the launches.

NASA soon began planning more complex missions for Atlas–Centaur, including the launch of commercial satellites that would require multiple engine firings. The only existing method of optimizing the flight trajectory for these missions was to calculate two separate flight segments. This was time consuming and imprecise. In addition, these new missions included commercial satellites that required increased accuracy.

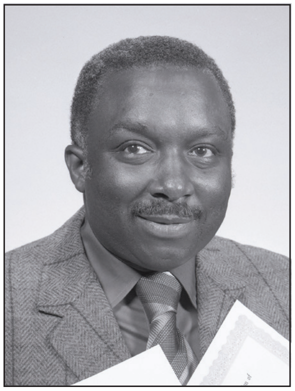
For these new missions, Spurlock undertook the daunting task of reformulating the calculus of variations code to reduce its size and computer memory requirements. The new and far superior tool, which he dubbed DUKSUP (duck soup), maximized the payload capability by optimizing the vehicle’s thrust direction and the unspecified orbital injection elements. DUKSUP was the first analytical tool that could optimize geostationary orbit flights in a single step. DUKSUP’s speed and capability surpassed that of any contemporary U.S. or Russian flight optimization tool. The data was used to determine maximum payloads within a pound, plan trajectories, demarcate launch windows, provide range safety data, and facilitate tracking by ground stations. Impressed by DUKSUP’s accuracy, NASA and industry frequently called upon Spurlock to provide trajectory data for specific missions before the payload was even designed. The missions could not take place without DUKSUP’s data.

Spurlock became a formal part of the Centaur Program in the early 1970s. He managed the center’s overall mission design and trajectory work while contributing to the analysis for each specific Atlas-Centaur and Titan–Centaur launch. Over the years, DUKSUP supported 65 Centaur missions, including communications satellites, space telescopes, and probes sent to every planet except Pluto. The probes included the Pioneer 10 and 11 interstellar spacecraft; Voyager 1 and 2 outer planet spacecraft; the Viking landers on Mars; and Cassini-Hyugens, the Saturn orbiter and probe. In 1983 Spurlock was named head of the Mission Design and Performance Section. He updated DUKSUP for the Shuttle–Centaur Program, which sought to deploy Centaur stages from the space shuttle. The DUKSUP calculations expanded the launch window for Galileo, Shuttle–Centaur’s first scheduled mission. In 1991, Spurlock was named deputy chief of the Systems Analysis Office, where he analyzed the ability of Russian launch vehicles to reach what would become the International Space Station. Lewis led the agency’s efforts to partner with Russia in space in the post-Soviet period. Spurlock spearheaded an attempt to improve Lewis’ increasing interactions with their Russian counterparts. He assisted Lewis librarian and Russian émigré Irene Shaland in the development of a 40-hour course to educate Lewis employees on aspects of Russian history, culture, and language.

Later in his career, Spurlock became a tireless recruiter and mentor to early-career employees. His dedication and character inspired a generation of senior-level managers and engineers who benefited from his patient counseling, encouragement, and assistance. In the early 1990s Spurlock became an active recruiter for the center, particularly of young African Americans. NASA presented Spurlock with its Outstanding Leadership Medal in 1990 for his recruiting and mentoring activities. The North End Foundation of Berea, a nonprofit community organization, memorialized Spurlock’s commitment to youth and science education by renaming its summer camp the Frank Spurlock Science Camp.

Spurlock’s retirement in 1997 after 35 years at NASA coincided with the retirement of DUKSUP after the Titan IV–Centaur Cassini mission. By the 1990s, the advancements in computing systems made simpler systems, such as the direct ascent technique, more attractive than Spurlock’s exceptional, but complex, DUKSUP. In retirement, he consulted on mission design, trajectory, and space transportation architecture for NASA and for private firms.

Spurlock passed away in 2014.



Jesse Strickland

Jesse Strickland was an architect who specialized in breathing new life into the center's older buildings and standardizing construction specifications across the agency.

Strickland was born in Philadelphia on April 5, 1923. Several years later his family relocated to Cleveland, where he graduated from East Technical High School. During World War II, he enlisted in the Army Air Corps, where, according to his family, Strickland assisted in the drafting plans for some of the facilities at Elgin Air Force Base in Florida.

Strickland held a variety of jobs after the war, including working as a draftsman for the father of close friend Robert P. Morgan. Strickland and Morgan subsequently pursued architecture degrees at the University of Buffalo and Western Reserve University. Morgan, who became a successful architect himself, noted, "[Strickland] had what we call a great pencil: He could draw very well." The two later partnered on several projects.

In 1950 the NACA hired Strickland into the Drafting Section at its Lewis Flight Propulsion Laboratory in Cleveland. With the transition of the NACA to NASA in 1958, the drafting group was integrated into the new Architectural Design Branch of the Facilities Engineering Division. The branch was responsible for managing the architectural aspects of all facility design and construction projects at the center. This included both new structures and the modernization of existing buildings. They created conceptual designs, specifications, and drawings, while also providing cost estimates and supervising contracts with architectural firms.

In the early 1960s Strickland contributed to the design of the Development Engineering Building and the rehabilitation of the library in Building 60. He was also was responsible for the Space Power Facility's architectural work at Plum Brook Station (today, Neil Armstrong Test Facility).

Strickland proposed that all NASA centers use standardized construction specifications to facilitate interactions between designers, engineers, and contractors. In January 1966 NASA authorized the use of this procedure across the agency to improve institutional processes and recognized Strickland's contribution. The Cleveland Chapter of the Construction Specifications Institute selected Strickland as its president for 1970 and 1971. He was the first African American to hold that position.

In the early 1970s Strickland was responsible for the Lewis Facilities Improvement Program—an effort to renovate many of the center's buildings that were built in the early 1940s. Strickland oversaw the modernization of the Administration Building lobby and auditorium, the Guerin House, the main cafeteria, the small dining room, the Central Control Building, and other projects. In the late 1980s he was a key contributor to the conversion of Building 15 into the Edward R. Sharp Employee Center.

In the 1980s Strickland was responsible for the automation of the center's construction specifications for computer hardware and software systems. He served on an agency team that applied construction specifications at the centers.

In addition to his professional duties, Strickland was active in the community as a counselor and speaker. He began performing community volunteer work in the mid-1950s. He took particular interest in programs that provided training and counseling to poor or undereducated young people. He served on the board of the Blossom Hill School for Girls and the Cleveland Boys School and held a leadership role with Youth Enrichment Services. He served as an advisory board member to the Cleveland Board of Education's Clara Morris Work Study Program, which was established specifically to give high school dropouts a chance to complete their education. President Richard Nixon recognized Strickland's "excellent record of service in a wide variety of educational and civic activities in your area, particularly your work with teen-agers."

When Lewis established its first Equal Employment Opportunity (EEO) Committee in 1966, Strickland was among its first members. As an EEO counselor, Strickland made an effort to reach out to all new African American employees at the center.

Strickland also gave hundreds of presentations as a member of NASA's Speakers Bureau, often using his architectural background to discuss activities in space.

Jesse Strickland retired in 1983 after 33 years of service to the NACA and NASA. In retirement he continued his lecturing for NASA and on his own. He became known for his "Life Beyond Earth" talk regarding space colonization. He also consulted on various architectural projects.

Strickland passed away in 2011.

Erwin "Erv" Zaretsky

Erv Zaretsky is an internationally recognized authority in the field of tribology. His groundbreaking work on rolling-element bearings, high-temperature lubrication, probabilistic life prediction, and ceramic and hybrid bearings has had direct effects on the design of aircraft, helicopters, and the space shuttle.

Zaretsky entered the Air Force Flight School after graduating from Illinois Institute of Technology in 1957. To appease a persistent professor, Zaretsky agreed to meet with officials from the National Advisory Committee for Aeronautics (NACA) in Cleveland, Ohio, before beginning flight school. The interview went well, and Zaretsky accepted an offer to work temporarily at the NACA on heat transfer issues. That summer Zaretsky shortened his Air Force obligation by forgoing flight school and enlisting as an engineer assigned to the NACA.

After being stationed overseas, Zaretsky was detailed to the center in January 1959 and was assigned to the Bearings Section of the Fluid Systems Division under William Anderson. One of Zaretsky's first assignments was to bring Anderson's concept of a multiple-ball-bearing tester to fruition. This five-ball fatigue test rig accelerated the pace of bearing fatigue testing by operating around the clock for extended durations. The rig, and several others that soon followed, operated for more than 500,000 hours over 25 years and became a standard industry tool.

In 1965 Zaretsky, Anderson, and Richard Parker developed and published a method for increasing the life of the rolling contact bearings by up to 500 percent. They continued their efforts to apply the hardness differential concept to other bearing applications. The culmination of the group's efforts came in 1973 with a 2500-hour, high-speed test of two ball bearings incorporating the group's advanced technologies. Zaretsky, working with industry partners, designed a test rig to simulate the conditions inside an advanced turbine aircraft engine. The bearings operated at faster speeds, higher temperatures, and significantly longer durations than typical bearings. The technology is now standard for the design of all aircraft engine bearings. Zaretsky received Industrial Research Magazine's IR-100 Award for this effort.

In 1964 Zaretsky was named a section head within the Bearings Branch. He successfully advocated for an expansion of his section's work to include gears and mechanical drive systems. The section, renamed the Bearing Materials and Gearing Section, designed test machines to study new designs, materials, and lubrication to improve reliability and lifespan of these components. The section created several new facilities to test gears and transmissions, including the 500-horsepower helicopter transmission facility. As a result, the center added drive systems to its competencies and an array of new transmission designs were developed for rotorcraft and automotive gas turbine applications.

In the early 1970s Lewis partnered with the U.S. Army Propulsion Laboratory on the Helicopter Transmission System Technology Program. Zaretsky's group studied the effect of new component designs on contemporary transmissions and investigated novel, experimental transmission designs. The program, which produced over 85 papers, contributed toward quieter and more efficient transmission systems with higher power-to-weight ratios and significantly improved life and reliability.

The Lewis tribologists also expanded their efforts to include structural life prediction, particularly regarding the components for the Space Shuttle Main Engine (SSME) turbopumps. Anderson and Zaretsky warned that the SSME turbopump bearings had not been sufficiently tested for the conditions they would experience in flight, which could result in a catastrophic failure. It was an unpopular position given the pressure to get the program underway, and in 1984 Zaretsky successfully lobbied for a new policy to limit the use of individual turbopump bearings to a single shuttle flight. He received a NASA Special Act Award for this effort. After the Challenger accident in 1986, Zaretsky led a Lewis team that assessed the reliability and life expectancy of the SSME turbopump for the next shuttle mission.

The agency requested Zaretsky's expertise when the SSME oxygen pump bearings cracked during a December 1988 shuttle flight. He determined that the bearing material had a stress corrosion problem that was related to the installation date and calculated that bearings installed on two other shuttles could potentially fail. Zaretsky's forceful urging resulted in the replacement of the turbopumps prior to the next scheduled flight in February 1989. Zaretsky's efforts were recognized by NASA's Manned Flight Awareness Program.