Katherine Goble Johnson & The Role of Other Black Women at NASA.

By Sister Elise Kriss, October 28, 2022

Introduction

My talk today on Katherine Goble Johnson & The Role of Other Black Women at NASA was inspired by the movie, *Hidden Figures*, and the book on which the movie was based, *Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*.

The book, by Margot Lee Shetterly, was released in September 2016 and quickly became a best seller. It provides the social, political, and scientific context for the lives of the three women featured in the movie which was released in 2017. Shetterly grew up in Hampton, Virginia, where she personally knew many of the women in *Hidden Figures*. She is an Alfred P. Sloan Foundation Fellow, and the recipient of a Virginia Foundation for the Humanities grant for her research on women in computing. *Hidden Figures* is well-researched and tells the story of the black female mathematicians at NASA whose calculations helped fuel some of America's greatest achievements in space.

When I first saw the movie, I wondered why I hadn't even heard about Dorothy Vaughan, Mary Jackson and Katherine Johnson and the role they, and their peers, played in the history of the American space program. While NASA had been sharing their story for years, the successful book and major motion picture took the story to a much larger audience. NASA participated with 20th Century Fox in the production of the movie to provide historical guidance and advice, giving NASA the opportunity to tell a remarkable and important story of its past, as well as the progress the organization made toward the future of diversity and inclusion.

Summary of the Hidden Figures Story

Even before John Glenn orbited the earth or Neil Armstrong walked on the moon, a group of dedicated female mathematicians known as "human computers" used pencils, slide rules and adding machines to calculate the numbers that would launch rockets, and Astronauts, into space.

Among these problem-solvers were a group of exceptionally talented African American women. They were originally math teachers in the South's segregated public schools when they answered Uncle Sam's call during the labor shortages of World War II. In their new jobs at the fascinating, high-energy world of the Langley Aeronautical Laboratory in Hampton, these gifted professionals found jobs that would push their skills to the limits.

Starting in World War II and moving through the Cold War, the Civil Rights Movement and the Space Race, the lives of Dorothy Vaughan, Mary Jackson, Katherine Johnson, and many other women like them, participated in some of NASA's greatest successes. During their careers, over nearly three decades, they faced challenges, forged alliances, and used their intellect to change their own lives, and their country's future.

We will briefly explore how three of these black women computers from the West Wing of Langley used their drive, and their brains, to take themselves to the height of mathematical and scientific accomplishments that seem unimaginable even today. In an era when the faces of NASA represent a variety of backgrounds and ethnicities, it's easy to overlook the people who paved the way for the agency's current robust and diverse workforce and leadership.

Dorothy Vaughan

Dorothy Vaughan was born on September 20, 1910. She received her B.A. in Mathematics from Wilberforce University in 1929. She was the first of the three outstanding black women to arrive on the scene at Langley Field. Those who speak of NASA's pioneers rarely mention the name Dorothy Vaughan, but as the head of the National Advisory Committee for Aeronautics (NACA) segregated West Area Computing Unit from 1949 until 1958, Dorothy was both a respected mathematician and NACA's first African American manager. Vaughan came to Langley in 1943, during the height of World War II, leaving her position as a math teacher in Farmville, VA, to take what she believed would be a temporary war job.

Two years after President Roosevelt signed Executive Order 8802 into law, prohibiting racial, religious, and ethnic discrimination in the country's defense industry, Langley began hiring black women to meet the skyrocketing demand for processing aeronautical research data. Urgency and twenty-four-hour shifts prevailed—as did Jim Crow laws which required newly-hired "colored"

mathematicians to work separately from their white female counterparts. Dorothy Vaughan was assigned to the segregated West Area Computing unit, an all-black group of female mathematicians, who were originally required to use separate dining and bathroom facilities. Over time, both individually and as a group, the West Computers distinguished themselves with contributions to virtually every area of research at Langley.

The group's original section heads were white women, but in 1949, Dorothy Vaughan was promoted to lead the group, making her the NACA's first black supervisor, and one of its few female supervisors. The Section Head title gave Dorothy rare laboratory-wide visibility, and she collaborated with other white computers on projects such as compiling a handbook for algebraic methods for calculating machines.

Dorothy was a steadfast advocate for the women of West Computing, and even intervened on behalf of white computers in other groups who deserved promotions or pay raises. Engineers valued her recommendation as to the best "girls" for a particular project. For more challenging assignments they often requested that Dorothy personally handle the work.

Dorothy helmed West Computing for nearly a decade. In 1958, when the NACA made the transition to NASA, segregated facilities, including the West Computing office were abolished. Dorothy and many of the former West Computers joined the new Analysis and Computation Division, a racially and gender-integrated group on the frontier of electronic computing. Dorothy became an expert FORTRAN programmer and contributed to the Scout Launch Vehicle Program.

Dorothy Vaughan retired from NASA in 1971. She sought, but never received, another management position at Langley. Her legacy lives on in the successful careers of notable West Computing alumni, including Mary Jackson, Katherine Johnson, Eunice Smith, and Kathryn Peddrew, as well as the achievements of second-generation mathematicians and engineers such as Dr. Christine Darden. Dorothy Vaughan passed away on November 10, 2008.

Langley Air Force Base

Langley Air Force Base, originally known as Langley Field, is one of the oldest facilities of the Air Force, established on December 30, 1916, prior to the entry of the United States into World War I in April 1917. The field is named for aviation and aerodynamics pioneer and former Secretary of the Smithsonian Institution, Samuel Pierpont Langley. The NACA established the need for a joint airfield and proving ground for Army, Navy and NACA aircraft.

Several buildings had been constructed on the field by late 1918 and housed aircraft used by Langley's School of Aerial Photography and World War I bombers. In the early 1920's, Langley was the site where bombing runs were led over captured German warships anchored off the coast of Virginia and North Carolina. These tests set the precedent for the airplane's new role of strategic bombardment.

At the outbreak of World War II Langley developed detector equipment used in antisubmarine warfare. In 1946, the headquarters of the newly formed Tactical Air Command were established at Langley. During the Cold War its mission was to organize, train, equip and maintain combat-ready forces capable of rapid deployment to meet the challenges of peacetime air sovereignty and wartime air defense. The arrival of the Tactical Air Command and jet aircraft marked the beginning of a new era in the history of the field, and in January 1948 Langley Field officially became Langley Air Force Base.

Mary Jackson

Mary Winston Jackson was born on April 9, 1921, and grew up in Hampton, VA. After graduating with highest honors from high school, Mary continued her education at Hampton Institute, earning her Bachelor of Science Degrees in Mathematics and Physical Science. Following graduation, Mary accepted a job as a math teacher at a black school in Calvert County, Maryland.

Mary's path to an engineering career at the Langley was far from direct. Hampton had become one of the nerve centers of the World War II home front effort, and after a year of teaching, Mary returned home, finding a position as the receptionist for the King Street USO Club, which served the city's black population. It would take three more career changes before Mary landed at the

Langley's segregated West Area Computing section in 1951, reporting to the group's supervisor Dorothy Vaughan.

After two years in the computing pool, Mary received an offer to work for engineer, Kazimierz Czarnecki, in the Supersonic Pressure Tunnel, a 60,000-horsepower wind tunnel capable of blasting models with winds approaching twice the speed of sound. Czarnecki offered Mary hands-on experience conducting experiments in the facility, and eventually suggesting that she enter a training program that would allow her to earn a promotion from mathematician to engineer. Trainees had to take graduate level math and physics in after-work courses managed by the University of Virginia. Because the classes were held at then-segregated Hampton High School, Mary needed special permission from the City of Hampton to join her white peers in the classroom. Mary received the permission she needed, completed the courses, earned the promotion, and in 1958 became NASA's first black female engineer.

Mary began her engineering career in an era in which female engineers of any background were a rarity. In the 1950's, she very well may have been the only black female aeronautical engineer in the field. For nearly two decades she enjoyed a productive engineering career, authoring or co-authoring a dozen or so research reports.

For Mary Jackson, a love of science and a commitment to improving the lives of the people around her were one and the same. In the 1970's, she helped the science club at Hampton's King Street Community Center build their own wind tunnel and use it to conduct experiments. "We have to do something like this to get them interested in science," she said in an article for the local newspaper. "Sometimes they are not aware of the number of black scientists, and don't even know of the career opportunities until it is too late."

As the years progressed, the promotions slowed, and she became frustrated at her inability to break into a management-level position. In 1979, seeing that the glass ceiling was the rule rather than the exception for the center's female professionals, she left engineering and took a demotion to fill the open position of Langley's Federal Women's Program Manager. There, she worked to impact the hiring and promotion of the next generation of the NASA'S female mathematicians, engineers, and scientists.

Mary retired from Langley in 1985. Among her many honors were an Apollo Group Achievement Award and being named Langley's Volunteer of the Year in 1976. She was a Girl Scout troop leader for more than three decades, and a member of the National Technical Association (the oldest African American technical organization in the United States). A 1976 Langley Researcher profile captured Mary's spirit and character, calling her a "gentlelady, wife and mother, humanitarian, and scientist." For Mary Jackson, who passed away on February 11, 2005, science and service went hand in hand.

NACA becomes NASA

The National Advisory Committee for Aeronautics (NACA) came into being, much like its successor organization, the National Aeronautics and Space Administration (NASA), in response to the success of others. By the beginning of World War I in 1914, the United States lagged Europe in airplane technology. To catch up, Congress founded NACA on March 3, 1915. It started with a chairman and a committee of 12 members representing the government, military, and industry with one employee. The task of the committee was to coordinate efforts already underway across the nation. The mission and workforce soon grew to cover a greater role in aeronautics research in the U.S.

The NACA committee added the position of an executive officer in 1919. NACA's expanding role led to the creation in 1920 of Langley Aeronautical Laboratory, its first research and testing facility. By 1925 the staff had grown to over 100 employees. During the 1910's and 1920's, NACA conducted many types of flight tests, involving both models and full-scale aircraft. Many of the test flights took place in a series of wind tunnels. Streamlining studies to improve the aerodynamics of aircraft resulted in greatly increased aircraft speed and range. Over the next three decades, NACA continued to expand its influence in the field of aviation by recruiting top notch engineers and scientists to work in ever larger and more advanced technological facilities.

In the 1930's and 1940's, the threat and reality of a new world war forced rapid development and testing of new aircraft. Using wind tunnel testing, NACA developed new shapes for wings and propellers which eventually found their way into the design of many US aircraft, including several World War II-era aircraft, such as the P-51 Mustang. After World War II, NACA worked closely with the US

Air Force and Bel Aircraft to design the first supersonic aircraft. This paved the way for further research leading to the development of swept wings as well as a new shape for the aircraft. Other scientific break throughs led to the appearance of most modern combat aircraft.

During the 1950's, as the Cold War deepened, NACA devoted more time and research to missile technology. Initially the focus was on missile warheads but was later applied to the possibility for manned vehicles. NACA was responsible for developing the tactics and designs for the reentry of space vehicles. During this time, NACA began to look ahead to the possibility of manned space flight and developed a heat shield, a worldwide tracking network, and dual controls that would give the pilot of the craft greater control. These would all become part of the space program, but not under NACA.

On October 4, 1957, the Soviet Union launched Sputnik 1, the world's first artificial satellite. In 1958, responding to the national fear of falling behind the Soviets in the utilization and exploration of outer space, Congress passed the National Aeronautics and Space Act of 1958, which formed NASA. On October 1, 1958, NACA turned over its operations, and its missions and projects were incorporated into NASA which would be responsible for human, satellite, and robotic space programs, as well as aeronautical research. Many of NACA's talented personnel took high level positions in NASA and were responsible for the earliest decisions and successes of the human space program.

Katherine Goble Johnson

Katherine Goble Johnson was born on August 26, 1918, in White Sulphur Springs, West Virginia. Her intense curiosity and brilliance with numbers vaulted her ahead several grades in school. By 13, she was attending high school on the campus of historically black West Virginia State College. At 18, she enrolled in the college and made quick work of the school's math curriculum. She found a mentor in Professor Schieffelin Clayton, only the third African American to earn a PhD in mathematics. Katherine graduated with highest honors in 1937 and took a job teaching at a black public school in Virginia.

When West Virginia decided to quietly integrate its graduate schools in 1939, West Virginia State's president, Dr. John W. Davis, selected Katherine and two men to be the first black students offered spots at the school. Being handpicked

to be one of just three black students to integrate West Virginia's graduate schools was just one of several breakthroughs that marked Katherine Johnson's long and remarkable life. She left her teaching job and enrolled in the graduate math program. At the end of the first session, she decided to leave school to start a family with her husband, James Goble. She returned to teaching when her three daughters got older, but it wasn't until 1952 that a relative told her about open positions at the all-black West Computing section at NACA's Langley Laboratory, headed by fellow West Virginian, Dorothy Vaughan. Katherine began work at Langley in the summer of 1953. After the death of her husband in 1956, Katherine married James Johnson in 1959.

Just two weeks into her tenure in the office, Dorothy Vaughan assigned Katherine to a project in the Maneuver Loads Branch of the Flight Research Division, and this temporary position soon became permanent. Katherine spent the next four years analyzing data from flight tests.

Katherine provided some of the math for the 1958 document, *Notes on Space Technology*, a compendium of a series of lectures given by engineers in the Flight Research Division and the Pilotless Aircraft Research Division. Engineers from those groups formed the core of the Space Task Force, the NACA's first official foray into space travel. Johnson, who worked with many of them since coming to Langley, "came along with the program" as the NACA became NASA later that year. She did trajectory analysis for Alan Shepherd's May 1961 mission, Freedom 7, America's first human spaceflight. In 1960, Katherine and Ted Skopinski coauthored a report laying out the equations describing an orbital spaceflight in which the landing position of the spacecraft is specified. It was the first time a woman in the Flight Research Division had received credit as an author of a research report.

In 1962, as NASA prepared for the orbital mission of John Glenn, Johnson was called upon to do the work for which she would become most known. The complexity of orbital flight had required the construction of a worldwide communications network, linking tracking stations around the world to IBM computers in Washington, Cape Canaveral, and Bermuda. The computers were programed with the orbital equations that would control the trajectory of the capsule in Glenn's Friendship 7 mission from liftoff to splashdown.

The astronauts were wary of putting their lives in the care of the electronic calculating machines, which were prone to interruptions and blackouts. As part of the preflight checklist, Glenn asked engineers to "get the girl", meaning Katherine Johnson, to run the same numbers through the same equations that were programmed into the computer, but by hand, on her desktop mechanical calculating machine. "If she says they're good," Katherine remembers the astronaut saying, "then I'm ready to go." Glenn's flight was a success and marked a turning point in the competition between the United States and the Soviet Union in space. Katherine also worked on the calculations that helped synch Project Apollo's lunar Module with the lunar-orbiting Command and Service Module. She worked on the Space Shuttle, the Earth Resources Technology Satellite, known as Landsat, and authored or coauthored 26 research reports. Katherine retired in 1986, after 33 years at Langley.

In her memoir Katherine stated that "even in my most vivid imagination—and I had a pretty creative one as a child—I could not envision the life I would live." This included living through 18 US presidents of which her favorite was Barack Obama. It was one of her greatest honors to be invited to the White House in November 2015, at the age of 97, to be awarded the Presidential Medal of Freedom, America's highest civilian honor. Katherine received more than two dozen other recognitions over the years. While working at Langley she was awarded the NASA Langley Research Center Special Achievement award multiple times. Several universities honored her with Honorary Doctoral degrees. She received the Congressional Gold Medal in 2019 and was inducted into the National Women's Hall of Fame in 2021. Katherine Goble Johnson passed away on February 24, 2020, at 101. She will be remembered as an American hero for her pioneering legacy.

NASA and Space Exploration Today

NASA was established for the research and development of vehicles and activities for exploration of space within and outside the Earth's atmosphere. The organization is composed of four mission directorates: Aeronautics Research, for the development of advanced aviation technologies: Science, dealing with programs for understanding the origin, structure, and evolution of the universe, solar system, and Earth; Space Technology, for the development of space science

and exploration technologies; and Human Exploration and Operations, concerning the management of crewed space missions, including those to the International Space Station.

After a seemingly decades-long lack of activity at NASA, the space industry is making a major comeback. The dawn of a new era in astronomy began as the world got its first look at the full capabilities of NASA's James Webb Space Telescope, which will observe the first galaxies that formed in the early universe and peer through dusty clouds to see stars forming planetary systems. The telescope's first full-color images and spectroscopic data were released in July 2022.

In recent weeks the NASA spacecraft, DART (short for Double Asteroid Redirection Test), rammed an asteroid 7 million miles away at 14,000 mph and succeeded in changing the position of the asteroid. This was the first attempt to shift the position of a natural object in space.

NASA also spent five years building the Artemis moon exploration program. Artemis I, now planned to launch in November, is the first in a series of increasingly complex missions that will enable human exploration to the Moon and beyond. NASA is also planning new unmanned deep-space exploration.

Increasingly, today's return to space is being driven by private sector innovation and for-profit companies, which made 2021 the best year for space growth in decades. The players now are firms like SpaceX, Relativity, Virgin Galactic, Blue Origin and Rocket Lab, which has recently announced a new mission to explore the gases of Venus. 90% of the more than 1,000 spacecraft launched this year have been backed by commercial firms. Most notable are the hundreds of Starlink internet satellites launched by Elon Musk's Space X, which beam broadband service to customers around the world bringing cyberspace to the developing world.

SpaceX advances have dramatically lowered the cost of spaceflight so that it is 85 times cheaper today than when the space shuttle first launched in 1981. SpaceX is preparing to establish a permanent presence on the moon and launch a crewed mission to Mars.

Conclusion

While the space industry no longer relies on human calculators like Katherine Johnson and her peers, today's accomplishments would not be possible without these early pioneers. The next time you read about advances in space travel and research, think of Katherine Johnson, Mary Jackson, and Dorothy Vaughan. If you have not seen the movie, *Hidden Figures*, I highly recommend it. And, if you are even more curious about the research behind the movie, read Margot Lee Shetterly's well-researched book by the same title.

References:

Johnson, K. *My Remarkable Journey: A Memoir*. New York, N.Y.: HarperCollins Publishers, 2021.

National Aeronautics and Space Administration, https://www.nasa.gov/

Shetterly, M. L. *Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*. New York, N.Y.: HarperCollins Publishers, 2016.