News & Notes

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From the Chief Historian

Welcome to our annual thematic issue. This year is the 40th anniversary of the frequently overlooked Skylab missions, so we are focusing this issue on the topic of space stations in history. I had intended to devote this message to space stations as well, but the recent government shutdown prompts me to write on another topic.

As many of you know, while the National Aeronautics and Space Administration's (NASA's) Web sites and social media accounts went dark for 16 days, fans unwilling to miss their "fix" of NASA information mounted their own crowd-sourced effort on Twitter using the #ThingsNASAMightTweet hashtag. There were over 15,000 tweets made using this hashtag—an average of nearly 1,000 for each day of the shutdown. To me, this was gratifying confirmation of the reach of NASA's social media efforts and the History Program's small contribution to that work.

When we returned to the office on 17 October, we were delighted with the overwhelming positive response to our initial posts on Twitter and Facebook. However, out of all of the comments, there was one (and only one) negative response. It simply said: "How much is this Facebook page costing me?" It was a reasonable question, and I felt compelled to respond with the comment that everything NASA does takes less than half a penny of your tax dollar. This prompted a riposte noting that paying someone to do Facebook takes money away from space exploration and that these efforts are

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Special Issue: Space Stations

Glenn Research Center's Space Station Power Systems

By Bob Arrighi

Having only a minimal role in the development of the Space Shuttle, Glenn Research Center (formerly named Lewis Research Center) was hit hard by NASA's budget decreases in the 1970s. The staff was significantly reduced, programs were cut, and morale was low. In 1982, new Center Director Andy Stofan implemented a new management system and spearheaded the Center's first strategic plan, which sought to capitalize on the Center's inherent strengths and actively pursue several new high-profile programs, including the electric power system for what would become known as Space Station Freedom (later the International Space Station). Glenn has remained active in powering space stations for over 30 years. The Center led the development of the power-generation system for Freedom, used that technology to lengthen the operation of the Russian space station Mir, and is responsible for the testing and operation of the hardware for the International Space Station's power system.

The Center's experience with space power systems dates to the 1950s, when researchers began exploring solar, nuclear, radioisotope, and solar dynamic methods for generating power for spacecraft and satellites. In the 1960s, Lewis expanded its efforts on the use of photovoltaics for both space station and terrestrial applications. This led to the development

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In This Issue:

From the Chief Historian (continued)

nothing less than "marketing." Leaving aside the fact that almost all of our social media work is done by unpaid interns (something one of our other Facebook fans helpfully pointed out), the exchange highlights the question of why we expend any effort at all on social media.

Are Facebook and other social media just a fad, and is NASA's use of them a money-wasting indulgence of our tech-loving inclinations? While it certainly does pander to those inclinations for some of us, the social media response to the shutdown clearly shows the value and impact of this new method of communication. The National Aeronautics and Space Act of 1958, NASA's founding law, charges the Agency with providing "for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof." Fifty-four years ago, this directive led NASA's first Administrator, T. Keith Glennan, to hire our first Chief Historian and set him the task of producing history publications for NASA. About 20 years ago, this same directive prompted then–Chief Historian Roger Launius to invest in creating a presence on the Internet for NASA History. Now, as then, we need to go where the people are. This is a responsibility we owe to American taxpayers and a service we provide (as mandated by law) to all of humanity. It is far from a marketing program sucking valuable resources from our other priorities. While there is some supervisory overhead cost to our social media presence, it is actually an astoundingly cheap and powerful way to "meet" people in a very public forum. It is so potent a force that when we turned it off for 16 days, people from around the world took the time to research and post the information that our interns might otherwise have produced. (A remarkable number of the #ThingsNASAMightTweet items were historical.) If you want to see the newest way we are providing for the widest practicable and appropriate dissemination of NASA's historical information, why not join the 130,000-plus folks who follow/like us on Twitter/Facebook? I'll see you there.

Godspeed,

Bill

William P. Barry
Chief Historian

Special Issue: Space Stations—Glenn Research Center's Space Station Power Systems (continued)

of thin-film solar cells and solar dynamic power system technology. The large, flexible thin-film cells could be produced in sheets that could be furled, or rolled up, during launch. Henry Brandhorst worked with Lewis pilots to develop a unique method of calibrating solar cells at varying altitudes using a Martin B-57B aircraft. Using a limited set of data points, Brandhorst could determine the estimated power for a particular solar cell at any altitude.

In 1960, Lewis contracted with Thompson Ramo Wooldridge (TRW) to develop a solar power conversion system using a mercury Rankine system. The system, known as Project Sunflower, produced a relatively small amount of power but provided basic knowledge of solar dynamic power systems for spacecraft. The solar dynamic system operated more efficiently than the large arrays and reduced size and drag. A solar collector mirror receives sunlight and focuses it into a small power converter unit. The heat is stored in a molten salt before being transferred into a fluid. The engine uses the hot water to drive a turbine and create electricity. Lewis improvements to the design of the components and circuits led to the development of the high-frequency, two-directional resonant driven converter.

In August 1966, Lewis hosted a conference on Advanced Technology in Space Power Systems. The Center's experts discussed advances with solar mirrors, batteries, fuel cells, isotope and thermoelectric generators, and the Systems for Nuclear Auxiliary Power (SNAP-8) space power system. In the 1970s, researchers used a Solar Simulator Cell to test a number of flat-plate solar collectors and high-efficiency single-junction solar cells. In 1978, Lewis successfully created the first solar electric village in Schuchuli, Arizona. This was repeated the following year in Tangaye, Upper Volta.

After the Space Shuttle Program became operational in 1981, NASA resurrected its dormant plans to construct an orbiting space station. The space station would require power to operate the electronics, maintain its orbital position, and conduct experiments. Lewis began campaigning to manage the power system. During this period, there was intense competition among the NASA Centers for a limited number of new programs and funding. Other Centers questioned Lewis's technical ability to contribute to the space station power system, let alone serve as the program's lead Center. NASA had come to view Lewis as an aeronautics-based research center, incapable of handling large development programs. Center management, on the other hand, felt confident in its past experience managing complex space development programs such as the Centaur rocket.

Stofan and members of the Solar and Electrochemistry Division advocated relentlessly for the program throughout 1982. At an Institute of Electrical and Electronics Engineers (IEEE) Photovoltaic Specialists Conference in September 1982, Brandhorst stated, "We are the Center with the largest gathering of expertise in space power. That should give us an important role in the space station effort." By the end of the year, Lewis was selected to lead what was to be called Work Package 4. Lewis considered itself the space power center, not only for the new space station, but also for future lunar bases, the exploration of Mars, and future space stations.

Work Package 4 included the design, construction, testing, and evaluation of the electrical power generation, storage, and distribution systems. Two types of power-generating devices would be used—photovoltaic power modules (solar arrays) and a solar dynamic power device (solar mirror). Space Shuttle astronauts would assemble and maintain the system in space.

NASA's main space station development group was initially based near Houston, but the other Centers were heavily involved. From 1984 to 1986, Lewis undertook an intensive effort to define the station's power requirements and develop a system to meet those requirements that was within budgetary limitations. Lewis worked with Rocketdyne and TRW to analyze six different power system variations. The 75-kilowatt power requirement was the largest ever undertaken in space. Since space stations pass through Earth's shadow every orbit, rechargeable energy storage devices are required. Additional hurdles included the assembly in space, the use of power during assembly, and collapsibility for transport.

In 1985, Lewis created a four-division directorate to consolidate all of the Work Package 4 efforts. Chief Ron Thomas managed the 250-person staff. Rocketdyne was the prime contractor; Lockheed was responsible for the solar array; and Loral was responsible for the batteries. Development of the flight hardware began in 1987. That same year, Lewis began constructing a 26,000-square-foot Power Systems Facility (PSF) to develop, test, and monitor the space station electric power system. The facility, which included a 100-foot-square, 63-foot-high class 100,000 clean room, was considered the hub for the entire directorate's testing and a repository for the test data.

The power system consisted of four subsystems for generation, storage, distribution, and control. The photovoltaic power modules consisted of two 39-foot by 108-foot solar array wings, a radiator, and nickel-hydrogen batteries. The silicon solar cells were affixed to deployable blankets that could be folded in an accordion-like array for launching. Due to the inherent drag in the arrays, their design and articulation were critical. The design also included a solar dynamic power unit to generate additional power.

Three power modules were to supply an average of 56 kilowatts of electric power. The lightweight nickel-hydrogen batteries would be charged during sunlight and discharged during the eclipse portion of the orbit. There were in-depth studies to determine the most efficient frequency and voltage for the power distribution. A power management controller was used to coordinate all of the station's power needs, and each module had its own controller that could be operated separately.

The space station design changed dramatically several times in the mid-1980s, which resulted in budget overruns and schedule slippage. In 1987, the design was scaled back and modified to incorporate post-Challenger safety measures. Political arguments over the funding and technical debates regarding the design continued throughout the 1980s.

The amount of power the station would require after each of these modifications was a primary concern. The Work Package 4 technical requirements went through numerous revisions throughout 1988 and 1989. Originally, the station was designed with two 37.5-kilowatt solar arrays. Bowing to pressure from the scientific community, Congress insisted on two more arrays. For the initial configuration, photovoltaic arrays would supply 75 kilowatts of power. Phase II would include the solar dynamic power system.

By the summer of 1988, the staff at Lewis realized that the 75-kilowatt system would be stretched to its limits. In March 1990, Congress ordered NASA to subject the station to another major redesign when it was determined that some of its components would fail before the entire project was even complete. The redesign, officially announced in March 1991, reduced the station's size by 50 percent. The reduction in the number of externally mounted experiments meant that less energy would be required. The number of solar arrays was reduced from four to three, and the addition of the solar dynamic power system was delayed indefinitely. Lewis's Solar Dynamic Power Module Division was eliminated at this point.

President Bill Clinton ordered a new redesign of the space station in January 1993, when it was revealed that the cost estimates had escalated once again. NASA had not yet completed these new "Alpha" modifications when Congress canceled the program that summer. After nearly a decade and $11.2 billion spent, very little hardware had even been built, let alone launched into orbit.

The United States and Russia created a joint space initiative following the collapse of the Soviet Union in 1992. In September 1993, the White House announced an expanded partnership with Russia to develop a new space station. Three-quarters of the design was based on the latest Freedom modifications. The partnership would ease the budgetary strain and accelerate the development schedule. Thus, the International Space Station (ISS) was born. Lewis's staff continued throughout 1993 with its preparations for the assembly of the photovoltaic power module in the new Power Systems Facility.

That fall, however, Congress also ordered NASA to restructure the space station program to reduce the number of personnel involved. All management functions were to be performed at the project office at Johnson Space Center. There were massive cutbacks at the other Centers. Lewis's Space Station Freedom Directorate was disbanded in January 1994.

Concurrently, Lewis was assigned the management of the Mir Cooperative Solar Array program. The United States and Russia partnered in an effort to extend the life of Russia's ailing power system for the Russian Mir space station. Russia designed the array's support structure, and the United States added photovoltaic power modules designed for the canceled Freedom program. Lewis also tested and installed a solar collector that had been developed for Freedom. The system was successfully launched on Space Shuttle Atlantis in May 1996 and installed on Mir.

The Center was also involved with, but not leading, the development of the photovoltaic power modules and power distribution system for the ISS. The ISS power system, which was the largest and most advanced ever created, was very similar to the Mir configuration. The initial plan was for the ISS to have two 10,000-watt solar units. The Power Systems Project Office under Sandy Reehorst coordinated all 17 of the Center's ISS activities. In September 1996, approximately 100 personnel were involved in the project. The Center oversaw life-cycle testing of the nickel-hydrogen batteries and a 1997 deployment test of the photovoltaic radiator in the Space Power Facility at Plum Brook Station, tested the system's gimbals for rotating the solar arrays, and investigated tools used by astronauts to assemble the components in space. Glenn continues to be responsible for the testing and operations of power system flight hardware and the computer modeling used to predict the power system's performance.

Langley Research Center's Space Station Research

By Gail Langevin

Research work for space stations has been a part of Langley's portfolio from its early days as a NASA Center. Since then, Langley has reviewed concepts and studied materials, structures, and components to make the goal of living and working in space a success.

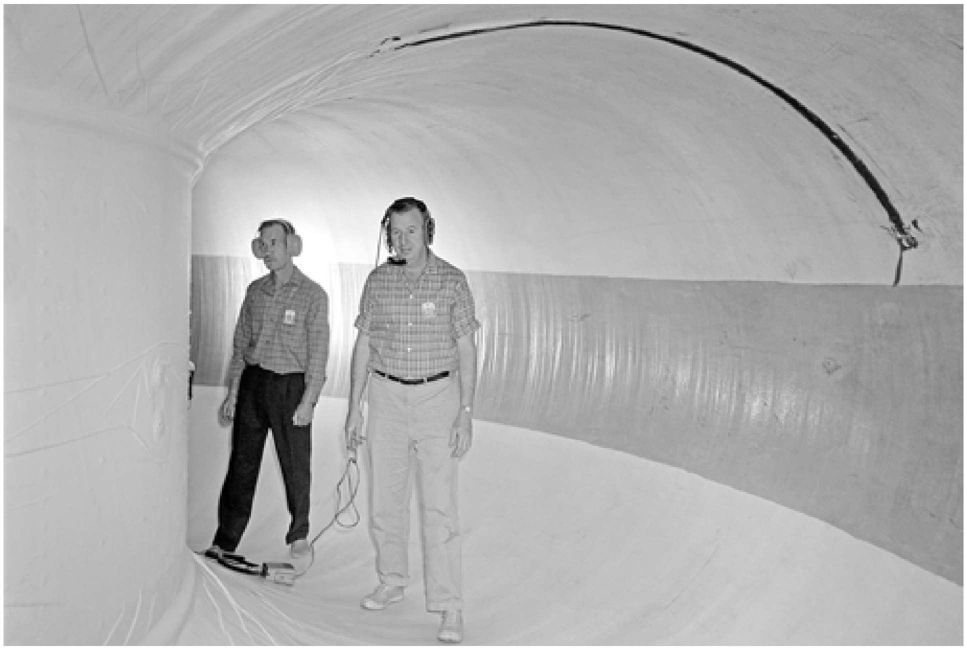
Langley's earliest experiences with space stations are documented in Dr. James Hansen's book *Spaceflight Revolution*. Before the goal to put humans on the Moon and before the United States had experience with human spaceflight, Langley leadership began thinking about the next step after Project Mercury to put an American in space. In the late 1950s and early 1960s, many thought that America's next space project would be the establishment of a crewed space station. It was believed at the time that spaceflights to other destinations would originate from this station.

In May 1959, Langley's Laurence K. Loftin, Jr., the technical assistant to Langley Associate Director Floyd Thompson, attended the Agency's Goett Committee, an inter-Center committee that looked at plans for space exploration after Project Mercury. Loftin presented an idea named Advanced Man in Space, or Project AMIS. The concept called for a permanent space station and a transport spacecraft, perhaps a version of the Department of Defense's Dyna-Soar then being planned, that would be capable of rendezvousing with the space station.

Before the AMIS presentation in the summer of 1959, Loftin helped Floyd Thompson form a 15-person group known as the Manned Space Laboratory Research Group to tackle the challenge of planning a space station. Dr. John Houbolt was assigned to the committee because of his known expertise in the as-yet-untried technique of spacecraft rendezvous. In coming years, Houbolt would become known as the leading advocate for lunar orbit rendezvous for the Apollo program.

As the country's astronauts had not experienced time in zero gravity, a key element in early space station designs was creating artificial gravity by slowly rotating the

Full-sized space station version that was displayed for a December 1961 visit by then–NASA Administrator James Webb.



Langley engineers inside the 24-foot inflatable torus space station concept.

Model of hexagonal concept, partially unfolded.

Model of a hexagonal concept, fully unfolded.

station while it was in orbit. Early Langley concepts for space stations included a torus and a hexagonal-shaped inflatable structure, both of which could be packaged into a launch container and inflated once orbital altitude was reached.

Langley's Paul Hill and Emanuel Schnitzer worked with Goodyear Aircraft Corporation on a 24-foot-diameter inflatable torus, or ring. The concept was designed to fold into a launch container, would have 0 to 1 g of artificial gravity, would have a rendezvous and docking capability, would have variable-demand power supply, and would have a regenerative life-support system for a six-person crew. Langley built several models of this configuration, including a full-sized version that was displayed for a December 1961 visit by then–NASA Administrator James Webb.

Some concerns with this concept included micrometeorite punctures and "wobble" induced when people or equipment moved within the station or when a spacecraft docked with the station. A U.S. patent application was filed for this design in April 1961, and Emanuel Schnitzer was granted U.S. patent 3,144,219 for a piloted space station in August 1964.

During the summer of 1961, Langley engineer Rene Berglund and North American Aviation personnel worked on a more rigid but still inflatable hexagon-shaped concept. This concept had six modules that were connected by three inflatable spokes to a nonrotating hub. Planned to be 75 feet in diameter, it would be constructed on Earth, folded into a container, and launched on a Saturn rocket. This concept included airlocks to shut off sections that were threatened by micrometeorites. Although the hexagon was designed to rotate to create an artificial gravity of 1 g, it would be connected via inflatable spokes to a hub suspended by bearings that would rotate in the opposite direction at a rate that canceled the effects of the artificial gravity rotation. This configuration allowed for zero-gravity research in a laboratory and a rendezvous dock for spacecraft in the hub. A U.S. patent was filed for this concept in May 1962, and Rene Berglund was granted patent 3,169,725 for an erectable modular space station in February 1965.

Langley researchers in the early Space Age also turned their attention to other challenges associated with space stations. They looked at attitude control and designed a concept with four small pulse jets mounted at 90-degree intervals on the exterior of the space station to solve the challenge. To counteract a possible "wobble" when people and equipment moved in an inflatable space station or when spacecraft docked, a flywheel that produced countervailing torque was designed. In 1964, the Echo 2 balloon satellite was launched to learn more about the long-term durability of the unique metallized plastic that made up the balloon satellite to evaluate it and similar materials proposed for components of other spacecraft, including early versions of a crewed space station.

Providing power for a station proved to be contentious, with one group advocating solar energy and another nuclear energy. Solar cells of the era were not advanced enough to provide all the power needed. Nuclear energy came with

The $2.3 million ILSS arrives at Langley by barge from its manufacturer, the Convair Division of General Dynamics, in August 1965. Below is the home of the huge, 30-ton life-support tank in Building 1250. Test subjects occupied this facility for as long as 28 days at a time.

heavy shielding that would not be optimum for low launch weights and had health and safety concerns. The Langley Manned Space Laboratory Research Group reviewed other power system concepts from NASA, the military, and the Atomic Energy Commission, but it was unable to come to a decision. For the inflatable hexagonal concept, North American Aviation chose solar energy.

Similar studies were conducted for breathing oxygen and water systems. A viable solution for a water system was not found during this design phase.

The challenge of creating a shirtsleeve environment that provided protection from micrometeorite impact was considered. North American's wall designed for the hexagonal concept of an outer aluminum wall backed by a plastic filler that overlaid a bonded aluminum honeycomb seemed to be the best design, but no one was sure of micrometeorite velocity, so the researchers were unsure how much energy the wall would need to withstand.

While some challenges seemed solvable prior to spaceflight, a symposium at Langley in July 1962 concluded that for some challenges, more experience in spaceflight would be needed.

In 1963, Langley engineers proposed a ground facility where life-support systems for a space station could be studied. The proposed facility would be capable of testing integrated water, sanitation, oxygen regeneration, and heat exchange systems and would accommodate test subjects. A contract was awarded to General Dynamics Corp. for the design and construction of an Integrated Life Support System (ILSS). The 18-foot-tall, 18-foot-diameter chamber was delivered in 1965. Research in the ILSS included several crewed and uncrewed tests about topics such as human occupancy in a closed system and microbiological research on possible toxic contaminants.

Following a 1962 space station symposium, Langley leadership revised the Center's space station research so that concepts would more closely coincide with emerging Apollo spacecraft designs. The Langley Manned Space Laboratory Research Group developed a new concept known as the Manned Orbiting Research Laboratory (MORL), and its goal was to provide a laboratory in space for biomedical, scientific, and engineering experiments. The new design gained from America's limited experience in space, such as no longer requiring a space station to revolve to provide artificial gravity for the crew.

The MORL had an ambitious schedule. The plans called for a 1965 or 1966 launch of an uncrewed MORL into an Earth orbit. After a checkout, two astronauts would be launched in a Gemini (yet to be designed) spacecraft and rendezvous and dock with MORL. Two weeks later, two additional astronauts would launch and rendezvous with MORL to bring the complement up to four astronauts. Periodically, one astronaut would launch to replace one of the four-person crew with a goal of one person serving one continuous year on the space station and the remaining crew serving a few months. Every 90 days, an uncrewed spacecraft would dock with MORL with fresh supplies.

In 1963, Langley released a request for proposals to industry to provide detailed plans for the MORL concept. Early in 1963, NASA Headquarters canceled Langley's space station research efforts. In the spring of 1963, Headquarters reinstated the study after Langley Associate Director Charles Donlan traveled to Headquarters to present the benefits of a spaceborne laboratory. By June, Director Floyd Thompson had chosen 11 proposals for Phase I. Thompson had also formed selected Langley employees into three groups to support MORL—the MORL Technology Steering Committee, a MORL Studies Office, and a new Space Station Research Group. For Phase II of the MORL study, a 43-person NASA Technical Team, of which 36 came from Langley, was assembled to assess the proposals. In September 1963, a concept by Douglas Aircraft Company was chosen. In August 1964, Douglas presented its concept, which featured modules instead of a prebuilt structure. The modules were part of Douglas's vision for a space laboratory that would encompass many scientific disciplines and enable research on interplanetary vehicles. Douglas even proposed a system to orbit the Moon to map and photograph it for planned lunar landing missions.

Langley's MORL was not the only space station concept to be put forward. Marshall Space Flight Center, the Manned Spacecraft Center in Houston (later Johnson Space Center), and the Department of Defense were also working on versions of a space station. By the summer of 1967, Langley knew that its space station concepts must become even more closely aligned to the Apollo designs because of increasing budget pressure. The Apollo Extension System became the new Agency concept for a space station, followed by the Apollo Applications Program. In 1968, the Langley MORL Studies Office issued the "Intermediate Orbital Workshop System Study," which called for a smaller crewed orbiting workshop followed by a larger space station similar to MORL in design. Later in the year, congressional budget cuts shortened the Apollo program to seven missions to the Moon, with the remaining Apollo hardware converted to use for three short-duration space laboratory missions. These missions became known as Skylab and began in May 1973.

In the 1980s, as the Agency's plans for long-duration human spaceflight turned toward Space Station Freedom, Langley analyzed potential concepts, systems, and structures. Computational modeling concepts were developed to look at the dynamic response and possible control forces of Space Station Freedom to docking by a Space Shuttle. An integrated environmental control and secondary propulsion system was studied as a method to process metabolic waste gases and water into oxygen and other gases to provide constant small thrust for the station. A systems analysis study was conducted to look at orbital inclination implications on in-orbit assembly.

A side view of LDEF attached to the Shuttle arm.

Materials researchers at Langley designed an experimental framework that held trays that exposed materials, coatings, thermal systems, photovoltaics, electronics, optics, solid rocket materials, and debris and dust collection materials to the space environment to learn more about how candidate materials for space use would react to long exposure in the space environment. Known as the Long Duration Exposure Facility (LDEF), it was 30 feet long and 14 feet in diameter and had 86 exterior experiment trays. It was launched from the cargo bay of Space Shuttle Challenger in 1984. It remained in space until it was retrieved by Space Shuttle Columbia in 1990. As a result of the stabilized orbit and the large exposed surface area, LDEF provided a unique source of information about the low-Earth orbit particulate environment.

An alternate mobile transporter (MT) concept and extravehicular activity (EVA) assembly procedure were developed at Langley and tested in neutral buoyancy by pressure-suited test subjects in the early 1990s. A three-bay orthogonal tetrahedral truss beam of 44 2-inch-diameter struts and 16 nodes was assembled repeatedly. The truss bays were 15 feet long. All the truss joint hardware was found to be EVA compatible. The average unit assembly time for a single pair of experienced test subjects was 27.6 seconds per strut, which was about half the time derived from other truss assembly tests.

As the Agency has transitioned to the International Space Station, Langley has continued to research new materials for use in space. Several "suitcase"-type experimental frames have been used to expose materials and coatings to the space environment. Known as the Materials International Space Station Experiment (MISSE), the experiment studies the effects of atomic oxygen, ultraviolet radiation, direct sunlight, radiation, and extreme heat and cold on candidate space materials. Thus far, seven MISSE experiments have been conducted.

Dodging Bullets: Skylab and the Langley Miniature Light-Gas Gun

By Robert C. Moyer

During his five months aboard the International Space Station (ISS), Expedition 35 Commander and Canadian Space Agency (CSA) astronaut Chris Hadfield gained nearly one million followers on Twitter and close to 400,000 on Facebook. Hadfield's surge in popularity among social media sites had much to do with his talent for bringing daily life aboard the ISS to his followers through a mix of breathtaking photographs from orbit and explanations of how mundane day-to-day tasks are accomplished in microgravity. On 29 April 2013, however, Hadfield sent a message to his followers that revealed one of the risks of operations in low-Earth orbit. His tweet that day read, "Bullet hole—a small stone from the universe went through our solar array…glad it missed the hull," and it included a photo that showed a hole in a solar panel created by a 1- to 2-millimeter micrometeoroids and orbital debris (MMOD) impact.

NASA researchers and engineers realized the hazards that micrometeoroids posed to spacecraft from the beginning of the space program. The question of how to simulate the effects of micrometeoroid impact on the ground, however, was not easy to answer. The kinetic energy (KE) equation that we all learned in high school physics ($KE = \frac{1}{2}MV^2$) reveals that the velocity (V) of a moving object has a much greater effect than its mass (M). The average velocity of orbital debris is roughly 10 kilometers per second, and average micrometeoroid velocities are even higher, from 20 to 40 kilometers per second. Humans have had the ability to launch small projectiles at high velocities since around AD 1000, when the gun was invented in China, but the muzzle velocities of the fastest modern rifles are only around 1 kilometer per second, far slower than the impact velocities that would be encountered by a spacecraft in Earth orbit.

Don Humes, a retired researcher from NASA Langley Research Center, devoted most of his 44-year career to this problem. According to Humes, there are several ways to increase a rifle's projectile velocity, such as replacing the rifle bullet with a lightweight plastic projectile, replacing the rifle powder with faster-burning

Don Humes, a retired NASA researcher who spent his 44-year career at NASA's Langley Research Center, points to the diaphragm separating the first and second stages of the Langley Miniature Light-Gas Gun. The breech of the 220 Swift rifle that serves as the first stage is clearly visible in the foreground.

In the foreground of this photo of the Langley Miniature Light-Gas Gun, the breech of the first stage, a modified 220 Swift rifle, can be seen. In the background is an add-on vacuum chamber that was used for larger targets.

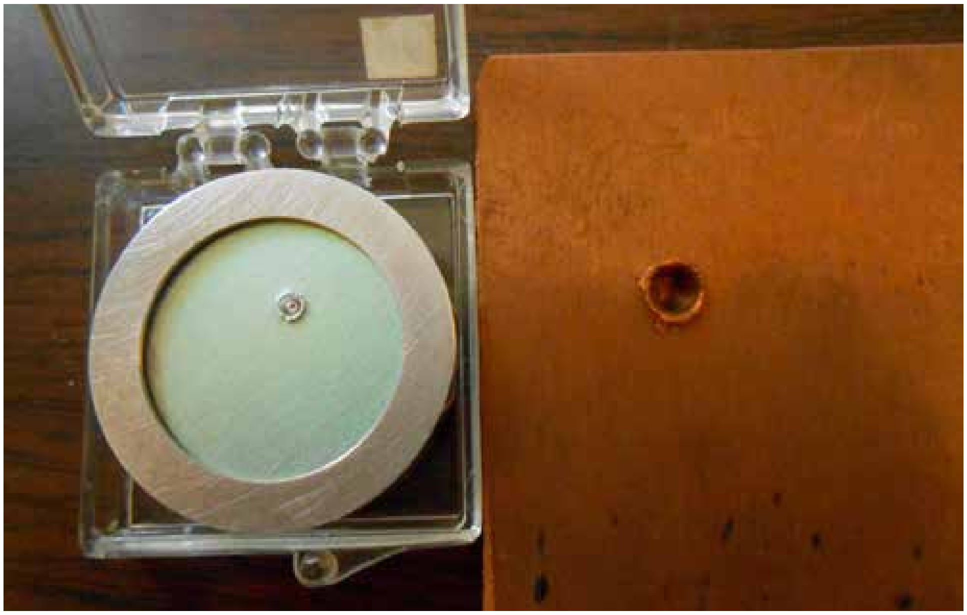
gunpowder for pistols, and changing the rifled barrel to a smoothbore. When Langley researchers took these steps, they were able to increase the muzzle velocity to 2 kilometers per second. Humes noted, however, that the nitrocellulose gases from burning gunpowder that propel a gun projectile "are very heavy, and there is a limit to how fast nitrocellulose gas can expand…because of its weight."

Researchers had developed a solution to this problem even before Humes began his career in the early 1960s, in the form of the light-gas gun. As Humes explains, "the idea of the light-gas gun is to make a two-stage gun in which you use a conventional gun to shoot a projectile" that "acts as a piston and compresses hydrogen to very high pressures."[1] The gas is held in check by a diaphragm that ruptures once the first-stage projectile has compressed the hydrogen, releasing the gas into "a second stage, which is another barrel, and in that gun barrel is the projectile that you intend to have hit the target." Humes stated that hydrogen was used because it is "the lightest gas there is, and it can expand at much faster speeds than the nitrocellulose gases, so you get much higher velocities out of it." By using light-gas guns to fire lightweight projectiles through a vacuum chamber at their targets, Langley researchers could achieve impact velocities around 9 to 10 kilometers per second, approaching the average velocity of orbital debris.

However, the light-gas guns that were in use when Humes began working at Langley had another limitation—cost. According to Humes, "When I came [to Langley], the light-gas guns that we had were very large…. The barrels were very long, five feet long or so, and very expensive." This created a catch-22 situation for researchers: "In trying to obtain the highest velocities—you always wanted to get the highest velocities because we were at the low end of the actual impact speeds that meteoroids would produce—you want to push the gun. But when you push the gun, you tend to wear it out." Humes developed a smaller, less expensive version using a 220 Swift rifle for the first stage and commercially available superpressure tubing for the second stage. Because the second stage (which is the section most prone to failure on a light-gas gun) only cost about a dollar to replace, researchers could push Humes's new design to its operational limits without worrying about repair costs. Humes's design would be known as the Langley Miniature Light-Gas Gun.

The data collected through hundreds of test shots fired from the Miniature Light-Gas Gun proved to be quite valuable in May 1973, shortly after the uncrewed launch of the Skylab space station. Spacecraft telemetry revealed that at approximately 63 seconds after launch, while Skylab and its Saturn V launch vehicle were still in the atmosphere, a portion of the station's micrometeoroid shield prematurely deployed, causing the shield to be ripped away in the slipstream. The loss of the micrometeoroid shield, which also provided passive thermal protection,

1. Donald Humes, interview in "Developing the Light Gas Gun," NASA Langley Cultural Resources Geographic Information Systems, November 2012 (published on YouTube 30 January 2013), available online at *http://www.youtube.com/watch?v=BgyG414-bAs*.



The impact craters generated by the Langley Miniature Light-Gas Gun proved to be remarkably similar to MMOD impacts in low-Earth orbit. On the right is a copper plate from a Miniature Light-Gas Gun test. On the left is an actual MMOD impact crater from the Long Duration Exposure Facility (LDEF) satellite that was deployed and retrieved via the Space Shuttle.

caused temperatures inside the station to soar to 130°F and left the converted Saturn V third stage unprotected from micrometeoroid impact. While engineers scrambled to find a solution to the heating issue, Humes was asked to evaluate the impact risk to the station. Using Miniature Light-Gas Gun data, Humes determined that the probability that the unprotected portion of the station would not be penetrated by a micrometeoroid impact was .987 if the urethane insulation inside Skylab's hull was intact; that probability was reduced to .823 if the insulation had deteriorated due to the heat, compared to a probability of at least .999 for any sections that might be covered by remnants of the shield. Humes also evaluated the effects of deploying a makeshift shield in orbit made of material developed for Langley's Dual Air Density Explorer balloon satellite, determining that this solution would raise the probability for unprotected portions of the station's hull to between .979 and .996, depending on the condition of the hull insulation.

After receiving Humes's evaluation, Skylab program management decided that the meteoroid impact risk to the station in its postlaunch condition was acceptable and focused their efforts on the thermal-control issue. On 26 May 1973, Pete Conrad's Skylab 2 crew entered the station and deployed a lightweight parasol sunshade through Skylab's 8-inch by 8-inch scientific airlock, after which it expanded to cover an area of the hull that was 23 feet square. Overnight, the temperature aboard Skylab cooled to 90°F, and it continued to cool over the next three days to a comfortable operating environment. Skylab would serve as a home, workspace, and laboratory to three different three-member crews over

In this Skylab photo, the parasol sunshade that was deployed by the Skylab 2 crew to provide thermal protection is clearly visible. The micrometeoroid shield that was lost during the unpiloted launch of the station had encircled the hull and covered the area between the two light-colored bands above and below the sunshade.

a period of eight months, setting new records for long-duration spaceflight and conducting an array of physical science, biomedical science, Earth applications, and space applications experiments.

From Dream to Reality: Marshall Space Flight Center's Role in Developing Space Stations

By Tracy McMahan

As NASA celebrates its 55th anniversary this year, many people at Marshall Space Flight Center in Huntsville, Alabama, support International Space Station (ISS) operations. Although today's space station is vastly different from the Cold War station imagined by early rocket pioneers, in many ways it still fulfills some of the main missions that they envisioned, such as helping people learn to live in the hostile environment of space and conducting research that can serve as a springboard for exploration and benefit people on Earth.

In early 1952, years before NASA was created, Dr. Wernher von Braun, who in 1960 became Marshall's first Director, wrote about his dreams in *Collier's* magazine:

This artist's depiction by Chesley Bonestell depicted Dr. Wernher von Braun's early space station concept, a 250-foot-wide wheel that would rotate to provide artificial gravity.

"Development of the space station is as inevitable as the rising of the sun; man has already poked his nose into space and he is not likely to pull it back."[1]

Von Braun described a majestic, 250-foot-wide wheel that would orbit 1,075 miles above Earth and rotate to provide artificial gravity. Von Braun's ideas and an artist's concept by Chesley Bonestell inspired the station in the movie *2001: A Space Odyssey*.[2] In von Braun's grand scheme, a station would have been built before human voyages to the Moon—a plan he outlined in a subsequent *Collier's* article. He described the station as "the ever-watchful guardian of the peace" and continued on to say, "the station will provide the springboard for one of the greatest scientific advances in history: the lunar journey men have dreamed of for centuries." His station of the 1950s resembled a combination fortress and research lab capable of housing 80 crewmembers. He and other experts featured in *Collier's* predicted that the station could be built by 1967 for a cost of $4 billion (in 1952 dollars) and called it "the next long step in space," to be followed by lunar missions by 1977.[3]

Plans changed. The United States wanted to beat the Soviet Union to the Moon, and President John F. Kennedy set a goal to get to the Moon before the end of the 1960s. Von Braun put his ideas for a space station on hold and focused on leading teams at Marshall as they worked with industry to build the Saturn rockets that would send humans to the Moon. Even as the United States raced to the Moon, Marshall engineers—inspired by von Braun's ideas and NASA Associate Administrator George E. Mueller's desire to look beyond the Apollo Moon missions—continued to study space stations through what became the Apollo Applications Program. As early as 1962, Marshall engineers proposed concepts to outfit refurbished Saturn rocket stages that were readily available in NASA's inventory. Some concepts involved connecting clusters of spent rocket stages to form a large station that could be gradually expanded.[4] This idea led to Skylab, a precursor of today's International Space Station. Skylab was a two-level workshop made from a converted Saturn V S-IVB stage. Skylab—the first American space program wholly dedicated to scientific research—was staffed by three crews who performed hundreds of experiments for more than 171 days from May 1973 to February 1974.

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1. Wernher von Braun, "Crossing the Last Frontier," *Collier's* (22 March 1952): 26.
2. Von Braun, "Crossing the Last Frontier," p. 25.
3. Wernher von Braun, "Man on the Moon," *Collier's* (18 October 1952): 51.
4. David Compton and Charles D. Benson, "From Spent Stage to Orbital Cluster, 1965–1966," in *Living and Working in Space, A History of Skylab* (Washington, DC: NASA SP-4208, 1983), pp. 22–39.

Skylab, still a product of the U.S. Cold War strategy, was an economical way for the United States to compete with the Soviet Union, which by the early 1970s had abandoned its quest to send humans to the Moon and was already operating a space station. Von Braun's large wheel station would have been constructed by hauling prefabricated parts to space and assembling the station in orbit—much as the International Space Station was constructed from 1998 to 2011.[5] As budget pressures mounted in the late 1960s and early 1970s, NASA determined that the most affordable way to build Skylab was the "dry workshop" concept, which involved assembling Skylab on the ground and outfitting the orbital outpost on Earth with everything needed for survival and research in space. The Apollo capsule transported limited cargo to Skylab when each crew arrived.[6]

NASA selected this approach because of dwindling budgets for space exploration. Throughout President Lyndon B. Johnson's and President Richard M. Nixon's administrations, NASA's future direction after Apollo, including the plans for the Skylab workshop, waxed and waned.[7] As early as 1968, the United States had already slowed down production of the Saturn vehicle, and NASA leadership was examining the next steps for human spaceflight, which were outlined in a 1969 plan.[8] Von Braun presented a roadmap to Nixon's Space Task Force, chaired by Vice President Spiro T. Agnew.[9] President Nixon made it clear that he would not approve von Braun's plans that included a large space station; a space shuttle for traveling between Earth, the station, and the Moon; more lunar voyages; and eventual trips to Mars by no later than the end of the 20th century.[10] President Nixon and Congress only authorized funding for proceeding with Skylab and for the Space Shuttle Program.

NASA changed the name of the Apollo Applications Program to Skylab in February 1970. Activity ramped up at Marshall as it began working to outfit the orbital outpost and build equipment for experiments.[11] The entire lab and all its equipment launched into space a little more than 40 years ago, on 14 May 1973, aboard the last Saturn V rocket ever to travel in space.

Almost immediately, the team learned a lesson in real-time operations and working outside in the harsh space environment. During the launch, Skylab's sun and micrometeoroid shield was ripped away and one of its solar arrays was damaged.

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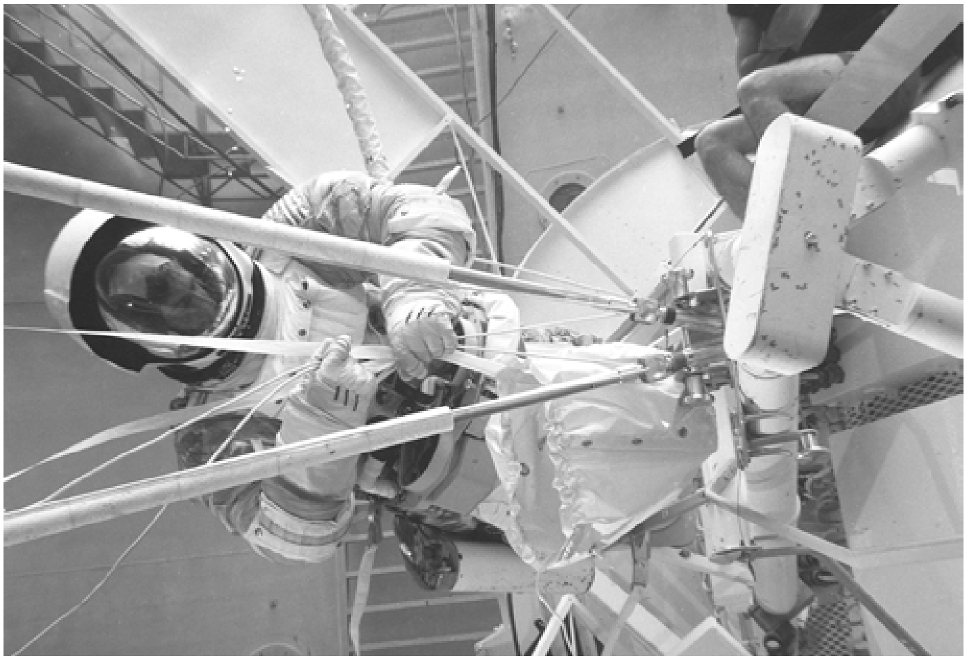
5. Von Braun, "Man on the Moon," p. 51.
6. Compton and Benson, pp. 22–39.
7. Compton and Benson, pp. 106–112.
8. "An Integrated Program of Space Utilization and Exploration for the Decade 1970 to 1980," NASA Technical Memorandum, NASA-TM-74851, 16 July 1969.
9. Wernher von Braun, "Manned Mars Landing," presentation to the Space Task Group, 4 August 1969.
10. Mark O. Hatfield, Senate Historical Office, "Spiro Theodore Agnew (1969–1973)," *Vice Presidents of the United States, 1789–1993* (Washington, DC: U.S. Government Printing Office, 1997), pp. 481–488, available at *http://www.senate.gov/artandhistory/history/resources/pdf/spiro_agnew.pdf*.
11. Compton and Benson, pp. 114–115.



Skylab helped NASA learn about living and working in space for long periods. Here, an astronaut practices an emergency repair procedure in Marshall's Neutral Buoyancy Simulator, a huge water tank that simulated the weightless environment of space. Skylab suffered damage to its sunshield during its launch on 14 May 1973, and just 10 days after the launch, the first crew had to perform a complex repair during an extravehicular activity.

Without the shield, temperatures inside the lab soared. Teams from Marshall and Johnson Space Center in Houston, which was responsible for Skylab operations, had to devise plans for the repair of the station before astronauts could be sent to the lab. The team developed a temporary repair, and the first Skylab crew used Marshall's underwater Neutral Buoyancy Simulator to practice the repair procedures. Ten days later, the first Skylab crew traveled to the lab and undertook what at the time was the most complicated repair ever attempted during an extravehicular activity. They installed a temporary sunshield and removed the damaged solar array. Crews on the ground and in space learned about the complications of working outside the spacecraft. The successful repair enabled the Skylab science missions to get under way.[12]

Skylab experiments confirmed many of von Braun's predictions about space research by providing the foundations for understanding how humans could live in space for extended periods, but they disproved others. Skylab showed that humans could survive without artificial gravity as included in von Braun's early space station concept. Skylab experiments revealed that microgravity was not only beneficial, but also even necessary for some research. During the last 55 years, NASA has learned that humans can live in microgravity and that microgravity is itself a key area of scientific activity, with benefits in the form of

12. Compton and Benson, pp. 253–276.

This photo shows Spacelab, a laboratory that fit inside the Space Shuttle's payload bay, during its first mission, which launched a little over 30 years ago on 18 November 1983. Spacelab was the European Space Agency's contribution to the Space Shuttle Program. Marshall engineers had originally conceived of the idea of a modular laboratory that would fly in the Shuttle bay, and the Center managed many of the Spacelab missions. Spacelab laid a foundation for international cooperation in a lab in space and helped space and ground crews learn how to conduct science in orbit.

improved products and processes back on Earth and even in uncovering physics and physical phenomena that cannot be seen on Earth. In low gravity, fires burn differently; cellular processes are transformed; and physical processes, especially those involving fluids, operate differently.

Marshall engineers used their experience developing hardware and experiments for Skylab on Spacelab—the reusable laboratory flown inside the Space Shuttle from 1983 to 1998. Marshall managed the Spacelab Program, which completed 800 investigations in 36 missions flown both on external pallets and in pressurized modules. According to a NASA report, "Spacelab was not only a precursor to the International Space Station, but played a role in collaborative research with Russia's space station Mir."[13]

Marshall developed a multiple-user rack system, which was tested aboard Spacelab and now houses experiments inside the space station. Real-time, around-the-clock science operations were pioneered during Spacelab missions

13. Arnauld Nicogossian, "Report Introduction," in *The Spacelab Accomplishments Forum*, ed. J. Emond (proceedings from a forum held at NASA Headquarters, Washington, DC, 10–11 March 1999; NASA-CP-2000-210332, June 2000), p. 1.

from the payload operations center at Marshall. Perhaps most importantly, Spacelab established another precedent: it became the first program that included broad participation with international partners. In 1973, NASA and the European Space Agency (ESA) signed a Memorandum of Understanding creating Spacelab and signaling a time of cooperation rather than competitiveness. The ESA built the Spacelab module and other equipment in exchange for flying experiments and European astronauts in space. Japanese and German space agencies sponsored entire dedicated research missions. This cooperation shifted the paradigm from one of the United States conquering space to one in which the United States led an international coalition conducting space missions. Along the way, Marshall pioneered managing a program with hardware built in multiple places around the globe and with investigations conceived by an international community of researchers.[14]

As NASA and the world used Spacelab to learn how to conduct science in orbit and to identify the most pertinent research questions to be explored on longer missions, Marshall engineers continued to contribute to the Agency's plans for a larger station. Fifteen years ago, in November 1998, Roscosmos launched the first module of the ISS. One month later, in December 1998, the first U.S.-built element—the Unity node—of the International Space Station was placed in orbit, and the dream of a large orbiting lab began to take shape. The ISS supports a crew of up to seven; has an internal, pressurized living and working space; and externally is about the size of a football field. It is not a wheel-shaped space station, nor an all-American space fortress that some in the Cold War era imagined. Today's International Space Station was built not by 1 nation, but by 15 nations working together on the largest peacetime, multinational program ever attempted.

Unity, along with the U.S. Destiny laboratory, the Quest airlock, and experiment racks and facilities, was built by the Boeing Company in the same Marshall facilities where the Saturn V was first manufactured. Another Saturn V–era building houses the Marshall team that designed the Station's environmental control and life-support system, which provides clean air and water; others on the team are now working on life-support systems that could be used for habitats on Mars or other locations. Some parts of the life-support system were used to develop a portable system for providing clean water during disasters on Earth.

Marshall's role in payload operations, which began during Spacelab, continues today on the ISS. In 2001, with the delivery of the Destiny laboratory, Marshall began staffing the Payload Operations Integration Center, the command post for Space Station science, every day of the year. The Marshall team works with the Mission Control team at Johnson Space Center to conduct the Station's science operations.

14. John Schumacher, "Spacelab's Role in Fostering a Global Community," in *The Spacelab Accomplishments Forum*, ed. J. Emond (proceedings from a forum held at NASA Headquarters, Washington, DC, 10–11 March 1999; NASA-CP-2000-210332, June 2000), pp. 11–16.

The Boeing Company manufactured the first element to be delivered to the ISS, the Unity node, launched on 4 December 1998, as well as the Destiny Laboratory, launched on 7 February 2001. Both were built in the same Marshall Space Flight Center building as parts of the Saturn V launch vehicle.

Even while the crew sleeps, the ground team, which works around the clock, operates experiments and sends data to investigators. As of this writing, the payload operations team has worked with investigators around the world to complete more than 1,600 investigations. The International Space Station Program Science Office at Johnson Space Center has documented the beneficial knowledge gained from ISS experiments, such as using technologies employed in the Canadian robotic arm to conduct brain surgery, gaining an understanding of combustion in space and in rocket engines, developing vaccines, and discovering why some cells become cancerous.[15]

Today, humans can gaze into the night sky and see the International Space Station, an unprecedented scientific and technological feat built through the cooperation of many countries. As von Braun wrote in *Collier's* more than 60 years ago, "If we do it [build a space station], we can not only preserve the peace but we can take a long step toward uniting mankind."[16] Marshall's first Center Director may not have been right about all the technical details, but he was right about such a space station's important role as a peaceful, cooperative endeavor; about its ability to serve as a springboard for exploration; and about its place in preparing humans to live and work in space.

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15. Julie Robinson, executive ed., "International Space Station Benefits for Humanity" (NASA Johnson Space Center, NASA NP-2012-02-003, February 2012) available online at *http://www.nasa.gov/pdf/626862main_ISS_Benefit_for_Humanity.pdf*.
16. Von Braun, "Crossing the Last Frontier," p. 24.

Marshall Space Flight Center designed and built the life-support systems that provide the crew of the International Space Station with clean air and water and a comfortable, safe work environment. The simulators shown here were used to develop the closed-loop system that allows the crew to recycle water and air aboard the station.

The Payload Operations Integration Center at Marshall is the command post for science on the International Space Station.

News from Headquarters and the Centers

NASA Headquarters

History Program Office

By Bill Barry

The year 2013 has been turbulent in lots of ways for the History Program. We've seen our Division Director (Alan Ladwig) retire in the spring, the acting Division Director (Debbie Rivera) retire in the summer, and a new acting Division Director (Kris Brown) arrive. As mentioned in the last *News and Notes*, Associate Administrator for Communications David Weaver told us that we would see changes to the organizational structure in the Office of Communications later in the year. Perhaps the most significant sign of change is that the two existing Divisions will (by the time you read this) reside in one location, rather than being separated by seven floors in the Headquarters building. Building bridges between the News and Multimedia Division (effectively the old Office of Public Affairs, on the 9th floor) and the Public Outreach Division (the organizational home of the History Program Office, on the 2nd floor) was not made any easier by the old building geography. However, almost the entire Office of Communications is merging on the 5th floor of Headquarters. (The Historical Reference Collection [HRC] will be staying on the concourse [basement] level, as will the NASA TV studio.) To my mind, this is a very positive development and one that reflects the growing mutual appreciation between the two Divisions; it bodes well for more integrated operations. Certainly our News and Multimedia colleagues have developed a greater appreciation for what the History Program Office can provide in terms of background, perspective, and research assistance. Although this has kept us a bit busier, it is very gratifying to see the positive immediate effects of our work in addition to the long-term contributions.

Another major aspect of this year's turbulence has been the impact of the Headquarters building renovation on the Historical Reference Collection. You can read more details about this in Chief Archivist Jane Odom's section (immediately following this). I'm incredibly proud of the work done by Jane and her team in getting ready for packing up the Reference Collection. The entire history team at Headquarters (and a few other folks from the Public Outreach Division) pitched in on the work, but the organization and the bulk of the "grunt work" were carried out by Jane, Colin, John, and Liz. They've done a fabulous job on a huge project, and the investment in planning will pay big dividends when we move back into the renovated space. Unfortunately, it looks like they won't let us move back in the spring as originally planned. For safety reasons, the building renovation team wants us to wait until the entire concourse renovation is complete. This means that we won't start moving the paper collection back into the HRC until summer. When we have the collection back in place, we are planning a grand reopening event—but that probably won't be until late summer (or early fall) 2014. As I noted last time, I think the newly renovated space will be well worth the work and the wait. We'll all just need to be patient a bit longer than we'd expected.

Our fall interns were one of the more stabilizing influences of the year. History major Joey Vars was with us nearly full time while he did the coursework for his junior fall semester virtually at the University of South Florida. Maria Seidel, a senior at George Washington University majoring in English with history and Spanish double minors, was with us on a more part-time basis (all day Monday, plus half days on Wednesdays and Fridays). They both carried the load for us on the social media front while also working on a number of other ad hoc projects. You can see some of their work online in the form of articles on *http://www.nasa.gov* and *http://history.nasa.gov*, as well as in our many other products.

After an absence of too many years, the NASA History Program will participate in a panel at the American Historical Association (AHA) Annual Meeting in Washington, DC, 2–5 January 2014. The Thursday afternoon (2 January) AHA Session 2 will be entitled "Aerospace History: Changes in the Field Through the Eyes of AHA Aerospace History Fellows." The panel will focus on changes in the field and on the impact of the longstanding NASA-AHA Fellowship in Aerospace History. I'll be chairing the panel, and my predecessor who started the Fellowship, Dr. Sylvia Kraemer, will comment. The panel itself will include three former Fellows: Margaret Weitekamp (now at the National Air and Space Museum and Fellow in 1997), Hugh Slotten (now at the University of Otago and Fellow in 1998), and Monique Laney (now at American University and Fellow in 2011). This should be a really interesting event and a chance to reflect on some of the contributions made by NASA in the field of aerospace history. If you are attending the AHA Annual Meeting, I hope to see you there.

If you will be in the Washington, DC, area in January, you are in for a double treat. The American Institute of Aeronautics and Astronautics (AIAA) will be holding its 52nd Aerospace Sciences Meeting (SciTech2014) at National Harbor, Maryland, 13–17 January 2014. There will be two panels sponsored by the AIAA History Technical Committee at the meeting, both on Monday, 13 January. The morning panel will be "Aerospace Archives: All Is NOT Lost—Keepers of the Right Stuff." This panel will include our very own Chief Archivist, Jane Odom. Later that afternoon, the second history panel will be "Pioneering Contributions to Aeronautics." The History Technical Committee will also be meeting that evening. Monday at SciTech2014 looks to be a great day for those of us with an interest in history.

The Tuesday (14 January) awards luncheon at SciTech2014 may also be of interest to you. A book sponsored by the NASA Science Mission Directorate and managed by the History Program Office will be presented with the 2014 Gardner-Lasser Aerospace History Literature Award. Dr. Bill Clancey's *Working on Mars: Voyages of Scientific Discovery with the Mars Exploration Rovers* was chosen as the "best original contribution to the field of aeronautical or astronautical historical non-fiction literature published in the last five years dealing with the science, technology, and/or impact of aeronautics and astronautics on society.” Bill’s work is a fascinating and very original work about the team exploring Mars with the Spirit and Opportunity rovers. It is very gratifying for us to have had a small association with the creation of this award-winning book. Congratulations, Dr. Clancey!

Despite all of the other activity, we have also managed to have a pair of great Headquarters quarterly lunchtime speakers this fall. On 19 September, Dr. Mike Neufeld of the National Air and Space Museum gave a talk on the origins of the New Horizons mission (now on its way to Pluto). We had a full house in the room, and quite a few folks joined us by WebEx (including New Horizons Primary Investigator Alan Stern). In early December, our quarterly speaker was Dr. Rob Ferguson, who joined us to speak about his (and our) new book, *NASA’s First A: Aeronautics from 1958 to 2008*. Complimentary copies of the book were provided to those in attendance.

Historical Reference Collection

By Jane Odom

The Headquarters History Office renovation will have begun by the time you receive this newsletter. The staff packed nearly 2,000 cubic feet of archive materials and books, which were transferred to storage at a NASA warehouse in Maryland. The contract archival staff moved to temporary swing space in another location in the building in early November. All of this is part of a broader building renovation by the property owner.

With the Historical Reference Collection packed up, archival operations will be greatly impacted. Nearly everything in the office will be stored off-site for 6 to 8 months. Reference services will continue, with staff able to conduct searches of our digital collections only. Beyond that, we will have to refer those who wish to conduct in-depth research to the Center History Offices, the National Archives and Records Administration (NARA), the Presidential Libraries, and other repositories, as well as to *https://mira.hq.nasa.gov/history/*, where thousands of our PDFs of archive materials from the HRC have been published externally. Check this space and our Web site for periodic updates on renovation progress and the subsequent archives restoration.

As expected, it seems that the number of those visiting us in person to conduct research has nearly tripled in the last several months. We have hosted researchers from Headquarters; Goddard Space Flight Center; the National Air and Space Museum; the National Research Council; George Washington University; Fordham University; the Georgia Institute of Technology (Georgia Tech); the University of California at Long Beach; the Massachusetts Institute of Technology; and the University of Southampton, United Kingdom.

Archival processing and digitization projects primarily took a back seat to packing and warehousing. They have resumed now that the contract staff has moved to its temporary space in early November. Of particular interest to researchers, a great deal of scanning (to reduce volume) occurred in the months prior to the commencement of packing. Next year, we anticipate that much of this digital content will become available for research use. Stay tuned!

Ames Research Center (ARC)

By Glenn Bugos

There continues to be strong interest in the request for proposals (RFP) to manage Moffett Federal Airfield and to reskin Hangar One, and the Web site for that RFP continues to grow with details about the historic airfield (*http://historicproperties.arc.nasa.gov/hangar1/*). We have begun a focused effort to find the official records of Moffett Field from 1930 through the end of Navy tenure in 1994. They appear to have been dispersed, and anyone who happens to know where to find Moffett Field records is invited to contact us.

In other history news, Konstantin Kakaes visited Ames on 18 September to talk about his new e-book, *The Pioneer Detectives*, which discusses the careful science behind the investigation of the Pioneer anomaly. Tom Gano of Carmel Valley, a town a short drive south of Ames, has been working diligently to get a plaque to mark the historic significance of the Jamesburg Earth Station, which relayed the first messages from the surface of the Moon to the American people. Donald L. Carpenter is bringing to completion a manuscript on very-low-frequency radio research at Stanford University, which did important work on the magnetosphere, especially at the dawn of the Space Age. A new documentary, *Sunnyvale: Then and Now*, directed by David Manzo in conjunction with the Sunnyvale Historical Society, does a superb job of telling the story of how Moffett Field came to Sunnyvale, including newly found footage of a film shown by Laura Thane Whipple to generate interest in the site.

We bid a happy retirement to Stephanie Langhoff, ARC Chief Scientist for the past 15 years and a big supporter of Ames history. Stephanie managed the selection processes for the Ames Fellows, the Ames Hall of Fame, and the H. Julian Allen Award for best scientific paper, as well as many other activities that helped highlight the people and events that defined Ames's institutional culture.

As our newest archival intern, we welcome Mikael Wester from San Jose State University, who will be digitizing and describing photographs from the Galileo probe program; they are in high demand by our spacecraft engineers. Archivist April Gage has digitized a good portion of our most in-demand audiovisual media, including 14,500 feet of 16-millimeter film, 123 videotapes, and 33 audio reels. We are hoping to have those available for researchers soon.

On 20 December 2014, Ames will celebrate its 75th anniversary, and Carolina Rudisel and Karen Bradford have already begun planning events that will engage the entire Center and our many communities. We will query other Centers about how they have celebrated significant anniversaries, and we are especially excited about the prospect of a truly *open* open house.

Dryden Flight Research Center (DFRC)

By Christian Gelzer

In August, I participated in a Technical Advisory Panel meeting for planning the new Samuel Oschin Air and Space Center at the California Science Center. That same month, I completed the peer review for *The Spoken Word III: Recollections of Dryden's History—the Shuttle Years*, which Dryden anticipates will be published before year's end; an e-book version will follow. In addition to gathering material for the two long-term projects on which I am working (PRANDTL-D and Towed Glider Concept), I have started research on a short monograph about Dryden's Flight Loads Laboratory (FLL) in anticipation of the lab's 50th anniversary in June 2014.

The lab was originally built to support the X-15. Previously, thermal stress was given little attention simply because nothing had flown fast enough or high enough to generate sufficient thermal stress for it to become a factor either in an aircraft's structural integrity or in its control. Not long after the program began, X-15 engineers realized that thermal stresses in flight were adulterating structural loads measurements (portions of the planes were also buckling because of the expansion). The Flight Research Center engineers designed a laboratory in which they could apply thermal and dynamic loads simultaneously to replicate those experienced on the aircraft in flight. During the 1970s, the FLL performed similar tests on the YF-12, work that helped cement the lab's importance to those inside and outside the Center. The lab performs structural research, work that now extends to performing nondestructive testing of composite materials. The lab's customers include other NASA Centers, the Air Force Research Lab, other military facilities, universities, and the aerospace industry. Ironically, the lab is better known *outside* Dryden than it is within the Center.

Peter Merlin completed his draft manuscript, *Unlimited Horizons: Design and Development of the U-2*, for the NASA Aeronautics Research Mission Directorate's (ARMD's) Office of Education and Communications. He also finished the final edit of *A New Twist in Flight Research: The F-18 Active Aeroelastic Wing Project* (NASA SP-2014-606), which is due for publication in January 2014. Both will appear in the NASA Aeronautics Book Series. At Edwards Air Force Base, he distributed copies of *Crash Course* (NASA SP-2013-600) to the Global Hawk Combined Test Force and to the U.S. Air Force (USAF) Test Pilot School. The latter continues to use *Breaking the Mishap Chain* (NASA SP-2011-594) as a textbook for the school's human factors course. Recently, Peter was interviewed, along with coauthor Gregg Bendrick, by *Popular Science* magazine for an article about human factors in aviation accidents during which he had an opportunity to discuss *Breaking the Mishap Chain* and *Crash Course*. For Dryden's recent unmanned aerial vehicle (UAV) media day, Peter gave a presentation on the evolution of remotely piloted research vehicles derived from the chapter he wrote for *NASA's Contributions to Aeronautics*, vol. 2 (NASA SP-2010-570). He also answered various information requests from internal and external customers and supported Public Affairs activities related to Dream Chaser.

On 1 October, Peter transferred from ARMD Education and Communications to a permanent position with Dryden Public Affairs. I am very pleased to see him move from a year-to-year contract into a permanent position, but there will be a void in the history program. Fortunately, we haven't lost a colleague; he remains a resource to the NASA History Program.

And at the end of October, Betty Love was awarded the Milton O. Thompson Lifetime Achievement Award in recognition of her service to NASA as a computer and engineer. Betty began her career in 1952 at the National Advisory Committee for Aeronautics (NACA) High Speed Flight Research Station working as a computer, rendering raw flight data into information engineers could understand. She moved into a formal engineering position, eventually coauthoring several papers before she and her husband retired and moved away. Since 1996 and her return to Antelope Valley, she has been volunteering in Dryden's History Office; she continues to do so today, providing an extraordinary and irreplaceable link with the past. Those of us who work with Betty know that this recognition is well deserved and overdue.

Glenn Research Center (GRC)

By Anne Mills

Historian and author Mark Bowles is harnessing the power of social media as a tool for humanities education. Bowles has rewritten his book *Science in Flux*, about the Plum Brook Reactor Facility, as a series of 756 tweets. He says, "Re-writing the book in tweets is an attempt to compose 'sound byte' aphorisms that convey the narrative in new ways. It also invites conversation in a way that traditional book publication cannot." @TheHistoryFeed began tweeting the book on 1 September and will tweet the book three times a day with the hashtag #ScienceInFlux. Bowles is the author of several NASA history books and is a professor of history at American Military University.

Planning is under way for several events to celebrate the 50th anniversary of the first successful Centaur launch. A reception for Centaur program retirees was held on 22 November at the Glenn Research Center Visitor Center at the Great Lakes Science Center. Retirees had an opportunity to give brief oral histories at the event.

Many congratulations to Glenn archivist Bob Arrighi (WYLE), who was awarded the NASA Exceptional Public Service Medal for his outstanding contributions to the documentation and preservation of NASA history. He was also featured in the latest issue of the *Federalist*, the newsletter of the Society for History in the Federal Government.

Marshall Space Flight Center (MSFC)

Some Published Works Regarding Spacelab

By Mike Wright

This year marks the 30th anniversary of the first Spacelab mission, launched on 28 November 1983 on board the Space Shuttle. This mission initiated a series of successful science missions carried out by international crews. For NASA and Marshall Space Flight Center, Spacelab bridged the Apollo era of lunar exploration and a new era focused on operations and research in low-Earth orbit. Spacelab provided a way to turn the Space Shuttle into an orbital laboratory. Early on, Marshall engineers proposed a concept called "sortie lab," which used a modular system to create a laboratory that could be flown in the Shuttle's payload bay. The European Space Agency (ESA) embraced this idea and, in 1973, signed an agreement with NASA to build the modular Spacelab components as Europe's contribution to the Space Shuttle Program. In exchange, ESA was able to send its own crewmembers and experiments into space aboard the Shuttle, marking a new era of international cooperation.

During the 1970s, Marshall provided technical management of Spacelab and worked closely with ESA during hardware development, testing, and preparation for flight. During the 1980s and 1990s, Marshall managed the Spacelab science missions, including staffing the Payload Operations Center, which was the command post of Spacelab science. Investigators from around the world came to Marshall during missions. The first Spacelab mission and others that followed included on-orbit investigations in life sciences, atmospheric physics, Earth observations, astronomy, solar physics, space plasma physics, and materials science and technology. The Spacelab missions not only contributed to scientific discoveries but also helped prepare NASA and various international agencies for the cooperation needed to build and operate the International Space Station.

Some of the major historical works related to Spacelab are described below.

In 1983, NASA published Educational Publication EP-165, *Spacelab: An International Short-Stay Orbiting Laboratory*, written by Walter Froehlich. That publication sought to define Spacelab and described the effort that NASA devoted to Spacelab as well as the contributions of the 10 European nations that jointly designed, built, and financed Spacelab through the European Space Agency.

In 1986, Douglas R. Lord, who served as Spacelab manager in Washington, published one of the first extended histories related to Spacelab. His *Spacelab: An International Success Story*, published as NASA SP-487, also featured a heavy focus on the development phase of Spacelab and covered operations through 1986.

Stennis Space Center (SSC)

By Daphne Alford

Besides testing Space Shuttle main engines that carried astronauts and supplies to the International Space Station, the John C. Stennis Space Center interacted with an ISS component closer to Earth.

An International Space Station Node Structural Test Article (STA) was stationed at Stennis for four years. Built in the mid-1990s by Boeing/McDonnell Douglas at Marshall Space Flight Center in Huntsville, Alabama, it was used for primary structure qualification testing on the Node 1 (Unity) flight hardware for the ISS, with the possibility that it would fly as the primary structure for Node 2. Instead, Node 2 and Node 3 were built by the Italian Space Agency and successfully added to the Space Station.

The node STA was transported from MSFC to Kennedy Space Center's (KSC's) Operations and Checkout building in Florida, where it stayed until modifications to that facility forced it to be moved to NASA's Michoud Assembly Facility (MAF) in New Orleans. There, it was instrumental in helping Lockheed Martin personnel develop aluminum-lithium welding repair techniques and was the first module successfully welded in the ISS Program. When the ISS Program no longer needed the module, KSC donated the article to Stennis for eventual display. Shipped from MAF to Stennis in December 2006, the ISS node arrived via barge and tugboat through Stennis's canal system. It returned to KSC as part of a general consolidation of Station hardware on an Aero Spacelines Super Guppy Aircraft in 2010.

The ISS node arrives at Stennis in 2006.

NASA History Program Office: The Intern Experience

By Cody Knipfer

For most students searching for a workplace experience, the idea of intern work elicits thoughts of paper pushing and coffee fetching. This was decidedly not the case at the NASA History Program Office. Not knowing what to expect when I first showed up, I quickly realized that the work was, for me, rich and rewarding. Along with my fellow intern Drew Simpson, I worked on a number of engaging and, at times, challenging tasks. This work included maintaining and updating the office's Facebook and Twitter pages, contributing to the editing and production of manuscripts on the history of NASA and spaceflight, helping with a number of NASA events, and performing various other duties in and around NASA Headquarters. My experience at the NASA History Program Office was the most defining experience of my life. I've always had a passion for space and spaceflight, but before arriving at NASA, I was not yet sure what I wanted to do with my life or pursue as a career. This internship changed that: the exciting work, fantastic atmosphere, and wonderful people have convinced me that working for NASA and contributing to our country's future spaceflight endeavors is my niche and my calling.

Perhaps one of my favorite intern duties was helping update the NASA History Program Office's Facebook and Twitter pages. Together, Drew and I researched and wrote most of the posts and tweets that went out during our stay. The Facebook page's popularity, if you'll forgive the play on words, "blasted off," more than doubling during our tenure. We attribute this success to our diverse interests and to our deep passion for finding, learning about, and then sharing exciting and fascinating information about NASA. Researching the interesting facts, figures, anniversaries, and dates in the history of spaceflight was, for me, an incredible learning experience. Though I thought I knew much about the history of spaceflight going into the internship, I realized that the depth and breadth of knowledge and facts to be learned about the subject are enormous. With each new discovery, my interest in, passion about, and sense of awe over the incredible accomplishments we've achieved in the last 50 years of spaceflight and last 100 years of aviation increased. I still have a long ways to go before I can consider myself learned in these subjects. Watching other people share, like, and discuss this information once posted made me realize how much I enjoy spreading my passion for space to others.

Another project I worked on during my stay was helping with the office's transition from the GReat Images in NASA (GRIN) Web site to Flickr, another image-hosting site. This work mostly involved manipulating images on Adobe Photoshop and Lightroom and inputting metadata, information about when and where the picture was taken along with other details. Doing this allowed the data that appear on the GRIN Web site to appear on Flickr also. I actually enjoyed this project greatly. I literally got to look at some of the coolest, most awe-inspiring photos from the history of our space program for hours on end, and then got to read all about them as I was putting in the caption data. The amount of knowledge I gained from this task was incredible. Ever since my involvement in this project, I can look at most of the iconic images from NASA (such as those found on calendars or on posters) and describe what they depict, who is in them, and when they were taken without even needing to read the caption. I've found this to be a very fun way to really impress people.

It's not every day that something you wrote gets posted on the front page of a federal agency's Web site, but, because of my time here, I found it happening to me. I researched and wrote an article on the anniversary of two pioneering events in the history of spaceflight: the flights of Valentina Tereshkova and Sally Ride, the first women from the Soviet Union and the United States to enter space. As was the case with all the other intern duties, the research and writing involved was engaging, fascinating, and fun. I learned the process of writing an article and the intensive and extensive process of editing an article. In the end, I was enormously pleased with the result. Having it published on the NASA Web site was an added bonus—I am now a published author. Before this summer, I would never have thought that I'd write an article for NASA and have it published. That experience was just one of the many incredible things that came out of my time with the History Program Office.

I discovered that working for NASA sometimes feels like working for an exclusive club. I found myself involved in a number of functions and events I never would have attended otherwise and meeting people whom I never would have dreamed of meeting. I was invited to a reception at the Canadian embassy for the returning astronauts of ISS Expedition 35, during which time I met and talked to astronauts Chris Hadfield and Tom Marshburn. Shaking hands with the astronauts was an incredibly cool experience; though they fly into space, they are some of the most down-to-Earth people you'll ever meet. I also participated in the National Air and Space Museum's Suited for Space social event, during which I was given an exclusive tour of a not-yet-opened exhibit showcasing the spacesuits used throughout the history of human spaceflight. I was also given a behind-the-scenes tour of the NASA TV studio and even helped run the camera for a NASA awards ceremony. Not only did I get to experience and learn about NASA and spaceflight, but I also got some hands-on experience with TV production. You never know what you might get to put on your résumé after an experience with the History Program Office.

While working in the office that studies the history of spaceflight, I found myself on a personal voyage of discovery and exploration. I have always been interested in NASA, space, and spaceflight. I run my school's astronomy club; I've read tons of books on the subject; and I frequent local astronomical societies and events. Yet, given my deep passion for these fields, I never knew what, or if, I could do anything with them. Like many college students my age, I felt my life lacked direction and hoped that I would eventually find something to do with my life. This all changed with my experience this summer. I learned how diverse the offices and work involved in making spaceflight a reality are and that so many people contribute to that goal. I was treated with extreme kindness and exposed to a positive, uplifting, and supportive work environment. I was doing work every day that not only kept me busy but also kept me interested and reinforced my passion.

I have always been told to follow my dreams and my interests. I can now no longer imagine myself working happily anywhere other than at NASA. I recognize now how I can contribute to the Agency, our space program, and humanity's future. Perhaps the most important experience I took away from my time this summer was that I now have direction and a vision for my future. I cannot think of anything more important or valuable than these for a college student to possess.

My suggestion for anyone who is interested in spaceflight or the history of NASA, or who wants to have a life-changing experience: apply for this internship. It will engage you, challenge you, excite you, and help you learn more about both our space program and yourself. Humanity's ventures into outer space are some of the coolest, most inspirational, and most exciting things to learn and talk about. The amount of knowledge you will gain and number of people to whom you can spread that knowledge will amaze you. If given the option to do it again, I would happily take this internship in a heartbeat. I'd like to thank my fellow intern, Drew Simpson, for his support, his help in the work, and his constant kindness and humor. I'm enormously grateful for the continual support and mentorship from the History Program Office's staff; they are some of the most interesting and learned people you will ever meet. I would especially like to thank Bill Barry and Yvette Smith for their constant guidance, continual support, and deep passion for what they do. Without them, my summer experience would not have been nearly as profound and enjoyable as it was.

Perspectives: The AHA-NASA Fellowship in Aerospace History

By Andrew T. Simpson

"The AHA-NASA Fellowship totally changed the trajectory of my career," said Margaret Weitekamp, Fellowship recipient for 1997–98. "It introduced me to scholars who are still my colleagues. It immersed me in the field of space history. And it put my research project on a different level, allowing it to be recognized by scholars nationwide." Weitekamp's experience is not unique among past Fellowship recipients, several of whom credit the program with helping them to gain entry into the growing field of aerospace history. Since 1986, the American Historical Association (AHA)–NASA Fellowship in Aerospace History has helped scholars at all stages of their careers by supporting a range of research and writing projects with the goal of promoting a better understanding of how public and private aerospace has reshaped the world from the beginnings of human flight to the present.

Why Promote Aerospace History?

In the early to mid-1980s, the field of aerospace history was undergoing a period of growth and professionalization. Prior to that time, most aerospace histories tended to focus narrowly on technical development and celebrate, rather than critically examine, Agency and industry actions.[1] The turning point for the field was the emergence of the New Social History and an understanding, as former NASA Chief Historian Sylvia Fries (Kraemer) has noted, that "the NASA story is about a great deal more than airplanes and spacecraft. It is about people, American culture, the research that goes on in our universities, and the structure and functioning of our largest organizations." To promote this broader understanding of the contours of the field, Kraemer turned to the American Historical Association and the then–executive director, Samuel R. Gammon, to create a fellowship funded by NASA, but administered by the AHA, to promote the development of a new generation of aerospace historians.

Why Apply for the AHA-NASA Fellowship in Aerospace History?

In a survey conducted in the summer of 2013, award winners were asked to describe how they felt this Fellowship benefited their careers. One answer cited by most respondents was that not only did the Fellowship afford them the ability to use the NASA collections at the Agency's Headquarters and Field Centers, but it also provided sufficient funding to support research at other repositories like the National Archives and the Library of Congress. Several Fellows, including Marcia Holmes, 2013, and Eric Schatzberg, 1988, also noted that the six to nine months of support from the Fellowship allowed them to gain experience dealing with long-duration archival research early in their careers. Several other respondents noted that the Fellowship's benefits extended beyond research, allowing them to complete manuscript chapters or peer-reviewed articles in leading journals.

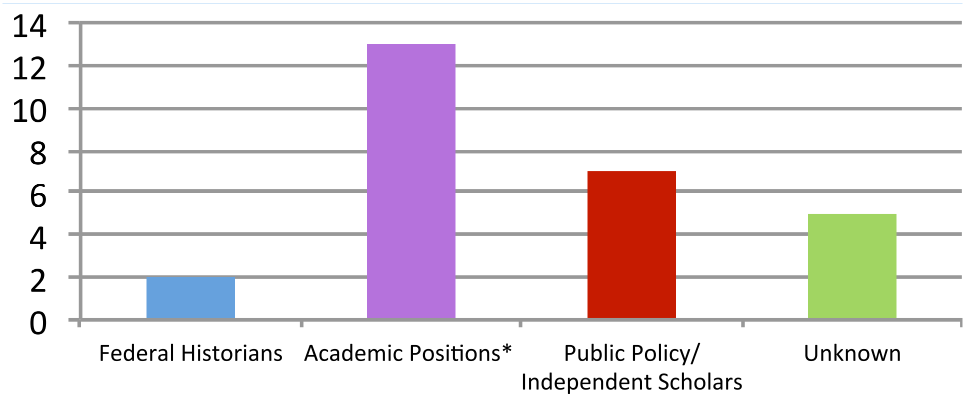
Proximity to NASA's History Program Office, the Smithsonian Institution's National Air and Space Museum, and the Department of Defense's various history programs also was cited as important for encouraging interaction between AHA-NASA Fellows and like-minded scholars working in the government or private sectors. As several Fellows remarked, this personal connection facilitated conference

1. Roger D. Launius has called this shift the "New Aerospace History." See Roger D. Launius, "The Historical Dimension of Space Exploration: Reflections and Possibilities," *Space Policy* 16, no. 1 (2000): 23–38. For helpful historiographical overviews that build on Launius's work, see Asif A. Siddiqi, "American Space History: Legacies, Questions, and Opportunities for Future Research," and Margaret A. Weitekamp, "Critical Theory as a Toolbox: Suggestions for Space History's Relationship to Other Disciplines," in *Critical Issues in the History of Spaceflight*, ed. Steven J. Dick and Roger D. Launius (Washington, DC: National Aeronautics and Space Administration Special Publication [SP] 2006-4702, 2006), pp. 433–480 and pp. 549–572 respectively. More recently, Glen Asner has argued that despite the emergence of the New Aerospace History, more attention to social history should be paid by aerospace historians. See Glen Asner, "Space History from the Bottom Up: Using Social History to Interpret the Societal Impact of Spaceflight," in *Societal Impact of Spaceflight*, ed. Steven J. Dick and Roger D. Launius (Washington, DC: NASA SP-2007-4801, 2007), pp. 387–406.

presentations and peer reviews for articles and manuscripts. For example, Hugh Slotten, 1998, credits the connections he forged as an AHA-NASA Fellow with helping to facilitate his later work with the Smithsonian Institution as the Charles A. Lindbergh Chair in Aerospace History during 2010–11.

Who Are the AHA-NASA Aerospace History Fellows?

The Fellowship competition is open to applicants with a doctoral degree or enrolled students in degree-granting programs in history or closely related fields who have completed all the required coursework for a doctorate. The decision to include professionals and graduate students from disciplines other than history has resulted in a diverse array of interdisciplinary scholarship covering areas



* Includes current graduate students and postdoctoral scholars

including aircraft technology and design, the global role of commercial aviation, new understandings of engineering and management theory, satellites and commercial broadcasting, the cultural history of airline flight attendants, and the interaction between NASA and universities around issues of science and technology.[2]

Moreover, nearly all respondents noted that the AHA-NASA Fellowship helped to prepare them for a range of different careers (see chart). While most have continued with academic careers, many either have become federal historians or have pursued careers as public policy specialists or independent scholars. Especially important for this last group has been the experience provided by the Fellowship working in diverse and often highly technical collections, as well as the professional connections developed during their tenure as Fellows. Several Fellows have continued their contribution to NASA's historical efforts by serving as editors or authors for books in the NASA History Series.

2. See *http://www.historians.org/prizes/AWARDED/NASAWinner.cfm* for a full list of past winners and prizes.

How To Apply

NASA Chief Historian Bill Barry will lead a roundtable at the 2014 AHA Annual Meeting in Washington, DC, about the Fellowship. Panelists will take questions from the audience and will discuss a range of issues including how the Fellowship affects professional development, how the Fellowship can alter scholarship in new and dynamic ways, and how the Fellowship can help early-career scholars position themselves in a difficult job market. Application forms can be found at *http://www.historians.org/prizes/NASA.htm*. Key requirements are as follows: applicants must either possess a doctoral degree in history or a closely related field or be currently enrolled in a degree-granting program meeting the same stipulations; the Fellow must be willing to forgo any other major research grants or other outside employment and devote him- or herself fully to the proposed research project during the Fellowship tenure; and the Fellow is required to give at least one presentation to NASA historical staff. All applications, including up to four letters of recommendation, must be mailed to Fellowship in Aerospace History, American Historical Association, 400 A Street SE, Washington, DC 20003, postmarked on or before 1 April 2014, or submitted electronically to *awards@historians.org* by 1 April 2014. The application is peer-reviewed by representatives from the AHA, the Economic History Association, the History of Science Society, the Society for the History of Technology, the Organization of American Historians, and the National Council on Public History. Award notifications are typically announced in the summer.

Where To Learn More

Headed to the 2014 AHA meeting? This year's program will feature a panel about the AHA-NASA Fellowship in Aerospace History whose members include the following:

- **Bill Barry**, NASA Chief Historian
- **Sylvia Fries (Kraemer)**, retired NASA Chief Historian
- **Margaret A. Weitekamp**, 1997, National Air and Space Museum
- **Hugh Slotten**, 1998, University of Otago
- **Monique Laney**, 2011, American University

Other Aerospace History News

National Air and Space Museum (NASM)

By Mike Neufeld

Roger Launius (Associate Director for Collection and Curatorial Affairs and Space History Division) coedited, with John Krige and James I. Craig, *Space Shuttle Legacy: How We Did It and What We Learned* (American Institute of Aeronautics and Astronautics, 30 September 2013). Hardcover. ISBN-10: 1624102166. ISBN-13: 978-1624102165.

On Thursday, 19 September, Michael Neufeld (Space History) gave the Quarterly History Lecture at NASA Headquarters. His theme was "First Mission to Pluto: Policy, Politics, Science and Technology in the Origins of New Horizons, 1989–2003." On Tuesday, 24 September, he presented a shorter version of the same at the International Astronautical Congress in Beijing, China.

During a two-week speaking tour in Australia as part of National Science Week, Valerie Neal (Space History) gave talks on the International Space Station, research in microgravity, and developments in commercial spaceflight. Also on the Australia tour, senior curator Tom Crouch (Aeronautics Division) gave talks on technical revolutions in aeronautics, the NASA art collection, and topics in aviation history.

Jim David (Space History) published "What's Disrupting Our Satellite Operations? NASA, the Intelligence Community, and RF Interference," *Quest: The History of Spaceflight Quarterly* 20, no. 3 (2013): 42–50.

American Astronautical Society (AAS) History Committee

By Michael Ciancone, Chair

I am pleased to announce the recipient of the 2012 Emme Award for Astronautical Literature: Patrick McCray, for *Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future* (Princeton University Press). The recipient is selected by a panel of AAS History Committee members, chaired by Dr. Don Elder.

I am also pleased to report that Dr. Trevor Sorensen is leading a project to prepare an English-language translation of Hermann Oberth's seminal work, *Die Rakete zu den Plenetenräumen* [*The Rocket into Planetary Space*] (Oldenbourg, 1923). AAS has reached an agreement with Oldenbourg Verlag to publish the translation, along with a reissue of the 1925 edition, by the end of the calendar year.

As a result of the persistence and diligence of series editor Dr. Rick Sturdevant, Univelt is expected to publish the 2009 and 2010 IAA History Symposium proceedings in its History of Rocketry and Aeronautics series by the end of the calendar year.

Recent Publications and Online Resources

NASA Publications

Mark Bowles, professor of history at American Military University, has produced the first academic history book written for Twitter. Starting in September 2013, he began tweeting a complete rewrite of his award-winning book, *Science in Flux: NASA's Nuclear Program at Plum Brook Station, 1955–2005*. You can follow this ongoing experiment, which ends in May 2014, on Twitter @TheHistoryFeed or see the hashtag #ScienceInFlux on Twitter or Facebook. For more details, contact the author at *http://about.me/MDB* or visit *http://thehistoryfeed.blogspot.com/2013/08/science-in-flux-twitter-experiment.html*.

Commercially Published Works

Compiled by Chris Gamble

Alien Seas: Oceans in Space, edited by Michael Carroll and Rosaly Lopes (Springer, July 2013). In the early days of planetary observation, oceans were thought to exist in all corners of the solar system. Carbonated seas percolated beneath the clouds of Venus. Features on the Moon's surface were given names such as the Bay of Rainbows and the Ocean of Storms. With the advent of modern telescopes and spacecraft exploration, these ancient concepts of planetary seas have been replaced by the reality of something even more exotic. The book serves up the current research, past beliefs, and new theories to offer a rich array of descriptions of the "seas" on other worlds. It is organized by location and by the material composing the oceans under discussion, with expert authors penning chapters on their specialties. Each chapter features original art depicting alien seas, as well as the latest ground-based and spacecraft images.

China's Strategy in Space, by Stacey L. Solomone (SpringerBriefs in Space Development series, Springer, June 2013). This book addresses why China is going into space and provides up-to-date information on all aspects of the Chinese Space Program in terms of launch vehicles, launch sites and infrastructure, crew vehicles for space exploration, satellite applications, and scientific exploration capabilities.

Dreams of Other Worlds: The Amazing Story of Unmanned Space Exploration, by Chris Impey and Holly Henry (Princeton University Press, September 2013). The book describes the unpiloted space missions that have opened new windows on distant worlds. Spanning four decades of dramatic advances in astronomy and planetary science, this book tells the story of 11 iconic exploratory missions and how they have fundamentally transformed our scientific and cultural perspectives on the universe and our place in it.

Mission Mars: India's Quest for the Red Planet, by Ajey Lele (Springer, July 2013). The objective of the book is to find the rationale behind the human quest to explore Mars. As the author undertakes a comprehensive assessment, he considers technological, economic, geopolitical, and strategic perspectives. In addition to examining India's desire to reach Mars, the book looks at other nations' Mars programs for context.

NASA in the World: Fifty Years of International Collaboration in Space, by John Krige, Angelina Long Callahan, and Ashok Maharaj (Palgrave Macmillan, August 2013). The National Aeronautics and Space Administration is typically thought of in national terms—as an American initiative developed specifically to compete with the Soviet Union. Yet, from its inception, NASA was mandated not only to sustain U.S. leadership in space, but also to pursue international collaboration. Since that time, it has participated in more than four thousand international projects. Drawing on unprecedented access to Agency archives and personnel, this definitive study explores U.S.-Soviet cooperation during the darkest days of the Cold War; relations with Western Europe, India, and Japan; the development of the International Space Station; and many other aspects of scientific and technological collaboration. The book is a signal contribution to space studies and international diplomatic history.

Russia in Space: The Past Explained, the Future Explored, by Anatoly Zak (Apogee Prime, July 2013). This book is a unique attempt to visualize space exploration's future through the eyes of Russian space engineers and to describe that nation's plans in space. It is the first comprehensive illustrated book dedicated to the Russian vision for the future of crewed spaceflight from the dawn of human spaceflight until today.

The Silence and the Salvage—Losing the Space Shuttle Columbia and Recovering Its Pieces, by Lamar Russell (Tate Publishing, August 2013). This book gives the inside story of how NASA reacted to the Space Shuttle Columbia accident. Join the author as he describes the formation of a Rapid Response Team to comb the forests and grasslands of Texas. This fascinating memoir portrays those who traveled to Texas and other states and who picked up the pieces and mourned over each one. NASA's individuals teamed with people from other government agencies, enduring stress, cold, and grief while managing the collection and identification of Columbia's parts from a 200-mile-long debris field in Texas, as well as searching the ground track from the California coast across the southwestern states. This personal account provides a touching view of those who performed the cleanup.

The Space Book: From the Beginning to the End of Time, 250 Milestones in the History of Space & Astronomy, by Jim Bell (Sterling Publishing, May 2013). We live in a truly golden age of astronomy and space exploration that may allow us to unravel some of the biggest mysteries of all: How did the universe begin? Are there other Earth-like planets out there? Are we alone? *The Space Book* is a gateway into these questions and more for anyone interested in the worlds beyond our planet. The author presents 250 of the most groundbreaking astronomical events, from the formation of galaxies to the recent discovery of water ice on Mars. Beautiful photographs or illustrations accompany each entry.

SpaceX: Making Commercial Spaceflight a Reality, by Erik Seedhouse (Springer-Praxis, June 2013). The year 2012 was when the first-ever privately developed spacecraft, built by SpaceX, visited the International Space Station. This is the story of how one company is transforming commercial spaceflight. *SpaceX* explores the philosophy behind the success of SpaceX; explains the practical management that enables SpaceX to keep its products simple, reliable, and affordable; details the development of the Falcon 1, Falcon 9, and Falcon Heavy rockets and the technology of the Merlin engines; describes the collaboration with NASA; and, finally, introduces current SpaceX projects.

Stamping Through Astronomy, by Renato Dicati (Springer, July 2013). Stamps and other postal documents are an attractive vehicle for presenting astronomy and its development as well as the beauty and mystery of celestial objects. Written with expertise and enthusiasm, this unique book offers a historical and philatelic survey of astronomy and related topics on space exploration.

TIME New Frontiers of Space, by *TIME* magazine (*TIME*, July 2013). What's new in the universe? Recent advances in technology have helped astronomers put to rest centuries-old debates about space and the universe, but they have also raised newer, more intriguing questions: What is the nature of dark matter, and what does it tell us about the origins of the universe? Do new data strongly suggest that microbial life exists beyond Earth—in our own solar system? How does the discovery of far more exoplanets than scientists once estimated impact the odds that advanced life may exist elsewhere in the universe? Are space tourism and commercial asteroid mining feasible? *TIME* explores these topics and more in a stunning view of the final frontier.

To Orbit and Back Again—How the Space Shuttle Flew in Space, by Davide Sivolella (Springer-Praxis, September 2013). This book describes the structures and systems used each time the Shuttle was launched and then follows an imaginary mission, explaining how those structures and systems were used in orbital operations and in the return to Earth. Details of how anomalous events were dealt with on individual missions are also provided, as are the recollections of those who built and flew the Shuttle.

The History Program Office gives sincere thanks to volunteer Chris Gamble, who compiles this section for us every quarter. Please note that the descriptions have been derived by Chris from promotional material and do not represent an endorsement by NASA.

Upcoming Meetings

The annual meeting of the American Historical Association will be held **2–5 January 2014** in Washington, DC. Visit *http://www.historians.org/annual/next.htm* for details.

The 223rd meeting of the American Astronomical Society will be held **5–9 January 2014** in National Harbor, Maryland. Visit *http://aas.org/meetings* for details.

The American Institute of Aeronautics and Astronautics' SciTech2014 will be held **13–17 January 2014** in National Harbor, Maryland. Visit *http://www.aiaa.org/scitech2014/* for details.

The midwinter meeting of the American Library Association will be held **24–28 January 2014** in Philadelphia, Pennsylvania. Visit *http://alamw14.ala.org* for more details.

The 20th Annual Space Exploration Educators Conference will take place on **6–8 February 2014** at the Space Center Houston in Houston, Texas. Visit *http://spacecenter.org/education-programs/teacher-programs/teachers-seec/* for more details.

The 45th Lunar and Planetary Science Conference will be held **17–21 March 2014** in Texas. Please see *http://www.hou.usra.edu/meetings/lpsc2014/* for more details.

The annual meeting for the Organization of American Historians will be held **10–13 April 2014** in Atlanta, Georgia. Please see *http://www.oah.org/meetings-events/* for more details.

The 30th National Space Symposium will be held **19–24 May 2014** in Colorado Springs, Colorado. Please see *http://www.spacesymposium.org* for more details.

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