your window to space

capcom

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Artemis: to the Moon—to stay

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Editor: Mike Bryce | President: David J Shayler| Secretary: Dave Evetts | Honorary Member: Helen Sharman OBE

Global Space News

NASA'S Statement on Artemis and Returning to the Moon

What is Artemis?

NASA is committed to landing American astronauts, including the first woman and the next man, on the Moon by 2024. Through the agency's Artemis lunar exploration program, we will use innovative new technologies and systems to explore more of the Moon than ever before. We will collaborate with our commercial and international partners to establish sustainable missions by 2028. And then we will use what we learn on and around the Moon to take the next giant leap – sending astronauts to Mars.

Why Go to the Moon?

With the Artemis program we will:

- Demonstrate new technologies, capabilities, and business approaches needed for future exploration including Mars
- Establish American leadership and a strategic presence on the Moon while expanding our U.S. global economic impact
- Broaden our commercial and international partnerships
- Inspire a new generation and encourage careers in STEM

How Do We Get There?

NASA's powerful new rocket, the Space Launch System (SLS), will send astronauts aboard the Orion spacecraft a quarter million miles from Earth to lunar orbit. Astronauts will dock Orion at the Gateway where they will live and work around the Moon. The crew will take expeditions from the Gateway to the surface of the Moon in a new human landing system before returning to the orbital outpost. Crew will ultimately return to Earth aboard Orion.

When Will We Get There?

Ahead of the human return, we will send a suite of science instruments and technology demonstrations to the lunar surface through commercial Moon deliveries.

The agency will fly two missions around the Moon to test its deep space exploration systems. NASA is working toward launching Artemis 1 in 2020, an uncrewed flight to test the SLS and Orion spacecraft together. Artemis 2, the first SLS and Orion flight with crew, is targeted for launch in 2022. NASA will land astronauts on the Moon by 2024 on the Artemis 3 mission and about once a year thereafter.

What Will We Do There?

While Mars remains our horizon goal, we have set our sights first on exploring the entire surface of the Moon with human and robotic explorers. We will send astronauts to new locations, starting with the lunar South Pole. At the Moon, we will:

- Find and use water and other critical resources needed for long-term exploration
- Investigate the Moon's mysteries and learn more about our home planet and the universe
- Learn how to live and operate on the surface of another celestial body where astronauts are just three days from home
- Prove the technologies we need before sending astronauts on missions to Mars, which can take up to three years roundtrip

Going forward to the Moon will be the shining moment of our generation. This moment will belong to you – the Artemis generation. Are you ready?

We are sending astronauts to the Moon by 2024. And this is how. Special thanks to William Shatner for lending his voice to this project.

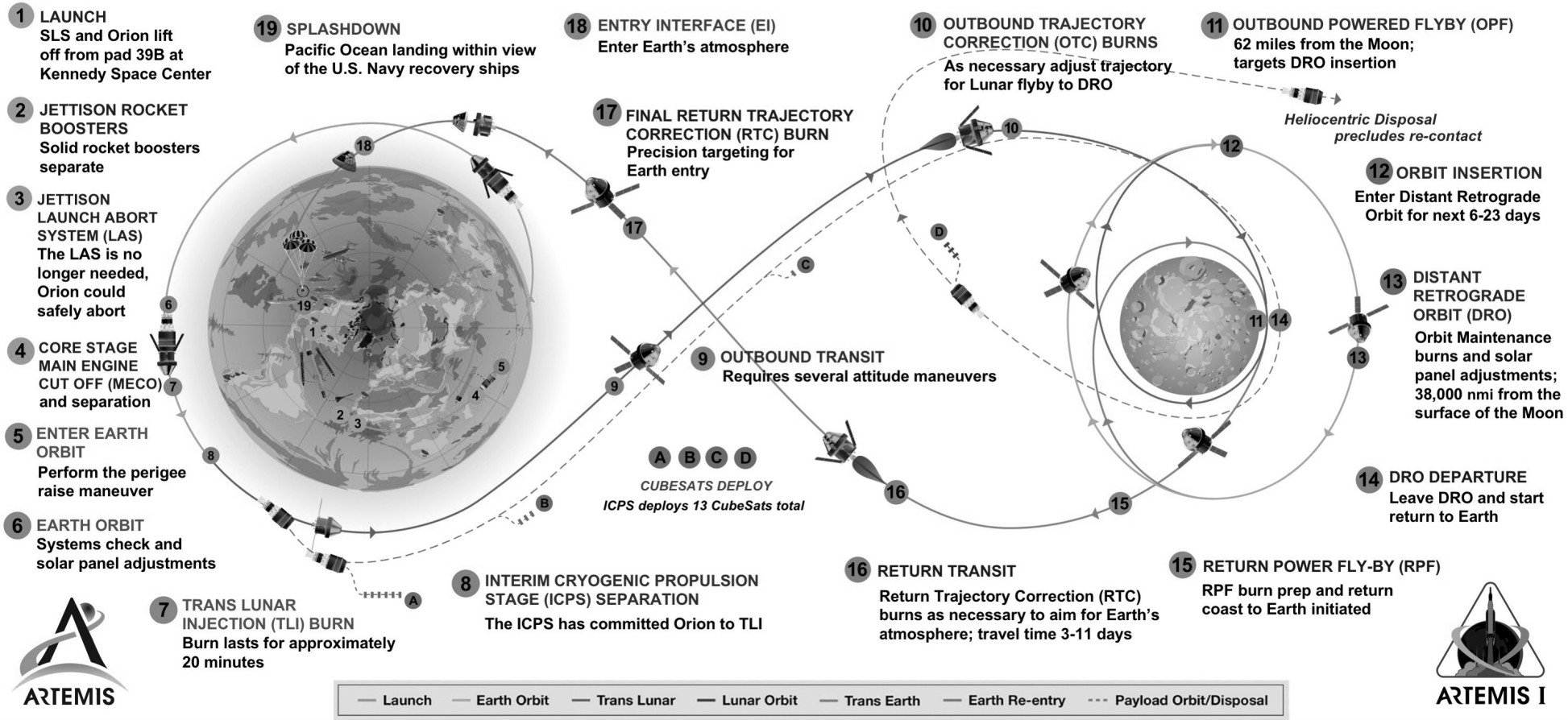
Where Did The Name Artemis Come From?

Artemis was the twin sister of Apollo and goddess of the Moon in Greek mythology. Now, she personifies our path to the Moon as the name of NASA's program to return astronauts to the lunar surface by 2024, including the first woman and the next man. When they land, our American astronauts will step foot where no human has ever been before: the Moon's South Pole.

NASA
www.nasa.gov

ARTEMIS I

The first uncrewed, integrated flight test of NASA's Orion spacecraft and Space Launch System rocket, launching from a modernized Kennedy spaceport



Total distance traveled: 1.3 million miles – Mission duration: 26-42 days – Re-entry speed: 24,500 mph (Mach 32) – 13 CubeSats deployed

Artemis I will be the first integrated flight test of NASA's deep space exploration system: the Orion spacecraft, Space Launch System (SLS) rocket and the ground systems at Kennedy Space Center in Cape Canaveral, Florida. The first in a series of increasingly complex missions, Artemis I will be an uncrewed flight that will provide a foundation for human deep space exploration, and demonstrate our commitment and capability to extend human existence to the Moon and beyond. During this flight, the uncrewed Orion spacecraft will launch on the most powerful rocket in the world and travel thousands of miles beyond the Moon, farther than any spacecraft built for humans has ever flown, over the course of about a three-week mission.

NASA
www.nasa.gov

All Instruments onboard Rosalind Franklin Rover

The full suite of scientific instruments, including cameras that will give us our eyes on Mars, the drill that will retrieve pristine soil samples from below the surface, and the onboard laboratory that will seek out signs of life are all installed on the ExoMars rover.

The rover, named after the pioneering scientist Rosalind Franklin, is part of the ESA-Roscosmos ExoMars programme, and is nearing completion at Airbus Defence and Space, Stevenage, UK. The rover is now seen with its recently added PanCam, which sits on top of a mast that rises 2 m above the ground. PanCam will be fundamental in the day-to-day scientific operations of the rover to assist with scientific decisions on where to drive and drill.

Determining whether life ever existed on the Red Planet, or still does today, is at the heart of the ExoMars programme. While spacecraft exploring Mars in the last decades have shown that the surface is dry and barren, billions of years ago it was much more reminiscent of Earth, with water flowing in rivers and lakes, perhaps seas. If life ever began in this very early period, scientists think that the best chances to find evidence for it is to look underground, in ancient regions of Mars that were once influenced by water.

The Rosalind Franklin rover will land in what scientists think might have been an ancient ocean, close to the boundary where channels from the southern highlands of Mars connect to the smooth northern lowlands. After the initially wet era in the planet's early history, lavas from volcanic eruptions covered large areas of Mars, some resisting erosion until today. This means that the landing site's underlying materials may only have been exposed recently, initially protecting them from space radiation and later making them accessible to the rover and its analytical tools.

Full Story at: European Space Agency

http://www.esa.int/Our_Activities/Human_and_Robotic_Exploration/Exploration/ExoMars/

Comet's Collapsing Cliffs and Bouncing Boulders

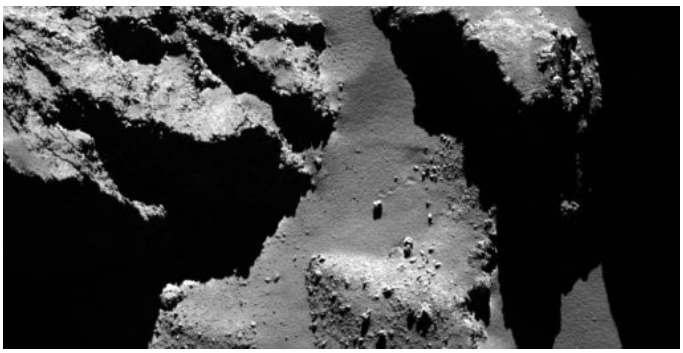
Scientists analysing the treasure trove of images taken by ESA's Rosetta mission have turned up more evidence for curious bouncing boulders and dramatic cliff collapses.

Rosetta operated at Comet 67P/Churyumov-Gerasimenko between August 2014 and September 2016, collecting data on the comet's dust, gas and plasma environment, its surface characteristics and its interior structure.

As part of the analysis of some 76,000 high-resolution images captured with its OSIRIS camera, scientists have been looking for surface changes. In particular, they are interested in comparing the period of the comet's closest approach to the Sun – known as perihelion – with that after this most active phase, to better understand the processes that drive surface evolution.

Loose debris is seen all over the comet, but sometimes boulders have been caught in the act of being ejected into space, or rolling across the surface. A new example of a bouncing boulder was recently identified in the smooth neck region that connects the comet's two lobes, an area that underwent a lot of noticeable large-scale surface changes over the course of the mission. There, a boulder about 10 m-wide has apparently fallen from the nearby cliff, and bounced several times across the surface without breaking, leaving 'footprints' in the loosely consolidated surface material.

Studying boulder movements like these in different parts of the comet helps determine the mechanical properties of both the falling material, and the surface terrain on which it lands. The comet's material is in general very weak compared with the ice and rocks we are familiar with on Earth: boulders on Comet 67P/C-G are around one hundred times weaker than freshly packed snow.



Full Story at: European Space Agency

http://www.esa.int/Our_Activities/Space_Science/Rosetta/Comet_s_collapsing_cliffs_and_bouncing_boulders

Commercial Crew Program Testing Fosters Improvements in Parachute Safety

As part of NASA's Commercial Crew Program, SpaceX has been developing and testing the Crew Dragon parachute system, which is comprised of two drogue parachutes and four main ring-sail parachutes—the same type of parachutes that have been commonly and successfully used for human spaceflight in the past.

In the last four years, SpaceX has completed 30 drop tests and 18 system-level tests of their parachute system, including the successful Demo-1 mission flight test. Through this test campaign, the SpaceX team, in partnership with NASA, has gained insight that could change the way parachutes are developed, tested and integrated into spacecraft design. Throughout this process, NASA has shared lessons learned from its own human spaceflight heritage to assist in parachute development.

One of the most relevant benefits originating from the rigorous, multi-year parachute testing campaign is a better understanding of how to safely design and operate parachute clusters. Specifically, NASA and SpaceX now have greater insight into what is termed "Asymmetry Factor," an integral part of how safety in design is measured and weighed. This asymmetry factor is an indicator of uneven load distribution between individual suspension lines attached to the parachute canopy. As a cluster of parachutes is deployed, the first parachute to open may crowd or bump others as they open up, causing an uneven load distribution on the main parachutes. If the lines or the joints are not designed to account for the unevenness or asymmetry, they might get damaged or even fail.

In April 2019, SpaceX performed a developmental test designed to simulate the loss of one of its four main parachutes. During the test, there was an unexpected failure which has offered a unique insight into parachute loading and behavior. The test results have ultimately provided a better understanding of parachute reliability and caused a closer examination of the current industry standard used to calculate the asymmetry factor.

SpaceX is using this new data to calculate structural margins and influence parachute design. The unique results allow more accurate prediction of reliability in the flight parachute configuration. In fact, this new data further verified SpaceX's most recent successful developmental test, which simulated a pad abort, where the vehicle is tumbling at low altitude before parachute deploy.

Through testing, SpaceX has sought to better characterize margins on their current and future parachute designs, using more robust materials, operational mitigations, and continuation of model refinement based on data from almost 50 recent tests and counting, 19 Cargo Dragon parachute landings, and the successful Demo-1 mission, to ensure that Crew Dragon has the safest parachute design possible. Additionally, these new findings are being shared within NASA to ensure that all human spaceflight applications are assessed for adequate margin and reliability.

NASA's Commercial Crew Program is a public-private partnership with Boeing and SpaceX to take the experience of NASA and couple it with new technology and designs being pioneered by private industry. Together, we are making space travel safer and available for all. This is one of many steps that advances NASA's goal to return human spaceflight launches to U.S. soil on commercially-built and operated American rockets and spacecraft and prepare for a human presence on the Moon with the ultimate goal of sending astronauts to Mars.

NASA
www.nasa.gov

Parachute test proves Starliner can land safely in extreme circumstances

The CST-100 Starliner passed another major test on June 24 when Boeing teammates successfully demonstrated that the spacecraft's parachute landing system can provide a safe landing for the capsule and its onboard crew even in extreme circumstances. The test was the fifth and final required to qualify the landing system for flight.

Conducted on the U.S. Army's White Sands Missile Range in a remote region of south-central New Mexico, the test featured a flight-sized test version of the Starliner capsule. During a nominal return from space, two drogue parachutes and three main canopy chutes will open to slow the descent of the spacecraft, followed by six landing airbags that will cushion the impact. For this test, the team introduced not one, but two, intentional failures.

"We never want a system to fail during flight, but when it comes to crew safety it's important to know what our tolerance for failure is," said Mike McCarley, landing system lead for Starliner. "We pulled the plug on one drogue and one main chute, and the other parachutes handled the additional pressure quite well."

Engineers coupled the capsule to a large helium-filled balloon that ascended 40,000 feet (12,192 meters) into the lower levels of the Earth's stratosphere, where the capsule was then released. During its four-minute descent toward Earth, the capsule achieved velocities that would occur during an actual mission.

"We saw everything we wanted to from the data we captured, and the system performed just as it should even in this extreme case," said John Mulholland, Starliner vice president and program manager. "The entire design and test team did a great job in ensuring we successfully met the objectives and getting the capsule on the ground safely."

The Starliner is scheduled for its first uncrewed flight-test mission to the International Space Station later this year, followed by a crewed mission. A United Launch Alliance Atlas V rocket will carry the Starliner into space from Space Launch Complex 41 at Cape Canaveral Air Force Station in Florida.

The Starliner will be the first American space capsule to return to a land-based recovery location. Previous capsules have all returned to Earth using sea-based recovery locations.

"When people ask me what my job is, I always tell them, 'It's to bring [Boeing astronaut] Chris Ferguson home safely,'" McCarley said. "With this test behind us, we're one step closer to making that a reality."

Boeing
www.boeing.com

NASA Commits to Long-term Artemis Missions with Orion Production Contract

NASA is setting in motion the Orion spacecraft production line to support as many as 12 Artemis missions, including the mission that will carry the first woman and next man to the Moon by 2024.

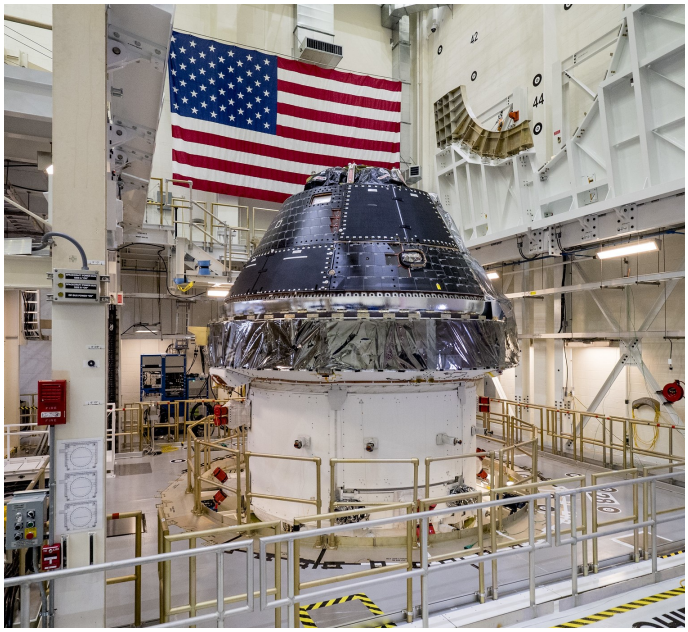


***Image Left**: NASA completed building and outfitting the Orion crew capsule for the first Artemis lunar mission in June 2019. The spacecraft is being prepared for its un-crewed test flight atop NASA's Space Launch System (SLS) rocket. Artemis 1 is the first test flight of the SLS and Orion spacecraft as an integrated system and will send Orion thousands of miles beyond the Moon and back to Earth.*

Credits: NASA/Radislav Sinyak
www.nasa.gov

The agency has awarded the Orion Production and Operations Contract (OPOC) to Lockheed Martin of Littleton, Colorado. Spacecraft production for the Orion program, managed at NASA's Johnson Space Center in Houston, will focus on reusability and building a sustainable presence on the lunar surface.

"This is a great day for the men and women at Johnson Space Center. They are crucial to our national space program, and have an undeniable legacy and record of success in advancing America's leadership in the human exploration of space," said Sen. Ted Cruz of Texas. "I am pleased that Administrator Bridenstine has heeded my calls and is taking significant steps to ensure that Johnson continues to grow with the exciting future of manned exploration that lies ahead. More needs to be done, and I look forward to production ramping up in the weeks and months to come and to more opportunities with NASA."

OPOC is an indefinite-delivery/indefinite-quantity contract that includes a commitment to order a minimum of six and a maximum of 12 Orion spacecraft, with an ordering period through Sept. 30, 2030. Production and operations of the spacecraft for six to 12 missions will establish a core set of capabilities, stabilize the production process, and demonstrate reusability of spacecraft components.

"This contract secures Orion production through the next decade, demonstrating NASA's commitment to establishing a sustainable presence at the Moon to bring back new knowledge and prepare for sending astronauts to Mars," said NASA Administrator Jim Bridenstine. "Orion is a highly-capable, state-of-the-art spacecraft, designed specifically for deep space missions with astronauts, and an integral part of NASA's infrastructure for Artemis missions and future exploration of the solar system."

With this award, NASA is ordering three Orion spacecraft for Artemis missions III through V for $2.7 billion. The agency plans to order three additional Orion capsules in fiscal year 2022 for Artemis missions VI through VIII, at a total of $1.9 billion. Ordering the spacecraft in groups of three allows NASA to benefit from efficiencies that become available in the supply chain over time – efficiencies that optimize production and lower costs.

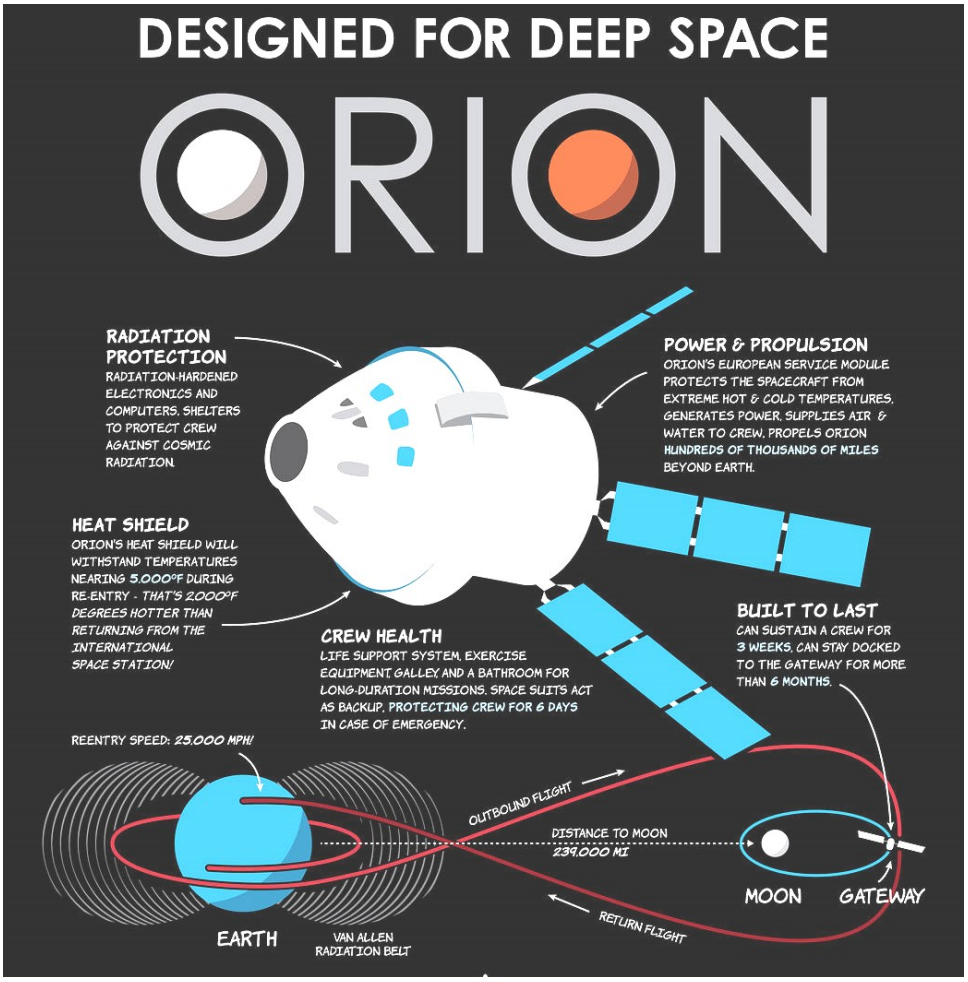
Spacecraft reusability – itself a significant cost saver for the agency – will help NASA build the capabilities for sustainable exploration at the Moon and beyond. The long-term plan is to reuse the recovered crew modules at least once. The first phase of reusability will start with Artemis II. Interior components of the spacecraft, such as flight computers and other high value electronics, as well as crew seats and switch panels, will be re-flown on Artemis V. The Artemis III crew module will be re-flown on Artemis VI.

The first six spacecraft will be acquired by cost-plus-incentive-fee ordering. Because the cost of a complex, high-tech system generally decreases over time as the design stabilises and production processes mature, NASA will negotiate firm-fixed-price orders for future missions to take advantage of the anticipated spacecraft production cost decreases. Furthermore, the cost incentives on the cost-plus-incentive-fee orders are designed to motivate favourable cost performance during early OPOC production and drive substantially lower prices for any subsequent firm-fixed-price orders issued under this contract.

"As the only vehicle capable of deep space exploration, the Orion spacecraft is critical to America's continued leadership," said Rep. Brian Babin of Texas. "Today's announcement signals that we are moving closer towards operation and production. While I look forward to learning more of the details, it's encouraging to see that

***Image Right**: For Moon missions a thousand times farther than the International Space Station, NASA's Orion spacecraft must be able to sustain astronauts on its own for weeks at a time and be robust enough to reliably operate in the harsh space environment near the Moon and beyond where the safety of Earth is days away. Orion features technology advancements and innovations that have been incorporated into the spacecraft's design and its systems have been developed to facilitate integration of new technical innovations as they become available in the future. Orion is the spacecraft that will carry astronauts from Earth to the Gateway ahead of lunar surface missions beginning in 2024, and bring them safely home.*

NASA
www.nasa.gov



this program is moving along as it should be. I am proud of the Orion program team and contractor partners at Johnson Space Center as they move towards getting the vehicle 'flight ready.' Without the brilliant minds and extraordinary leadership of the hard-working men and women at Johnson, our country would not be the preeminent spacefaring nation in the world."

Work under this contract also will support production of NASA's lunar-orbiting Gateway and evolving mission requirements. Production of certain spacecraft components already designed and qualified for Orion will be provided for Gateway use, eliminating the need for the Gateway Program to develop and qualify similar components.

"The men and women at Johnson Space Center represent the best and brightest scientific minds, and I'm confident with additional Orion spacecraft they will push the limits of exploration to the Moon and beyond," said Sen. John Cornyn of Texas. "I commend the Trump Administration for recognizing the importance and tradition of Houston as the center of human spaceflight and exploring the next frontier."

Houston has long been the hub of America's human space exploration program, from the early days of Gemini, Mercury, and Apollo to Artemis. With NASA's accelerated return to the Moon, Johnson Space Center now is managing more major human spaceflight programs than ever before. In addition to the Orion program, the Texas facility also manages NASA's Gateway and International Space Station programs, and is home to the Mission Control Center and America's astronaut corps – the next moonwalkers. Johnson also manages the agency's Commercial Lunar Payload Services, the first two deliveries for which are targeted to launch to the Moon in July 2021.

"No other spacecraft in the world can keep humans alive hundreds of thousands of miles from Earth for weeks at a time with the safety features, crew accommodations, technical innovations, and reliability that Orion provides," said Mark Kirasich, Orion Program manager at Johnson. "With the design and development phase of Orion largely behind us, this new contract will enable us to increase efficiencies, reuse the spacecraft, and bring down the cost of reliably transporting people between earth and the Gateway."

NASA is working to land the first woman and next man on the Moon in five years as part of the agency's Artemis program. Orion, the Space Launch System rocket and Gateway are part of NASA's backbone for deep space exploration. Work is well underway on both the Artemis I and II Orion spacecraft. Engineers at Kennedy Space Center in Florida have completed and attached the crew and service modules for Artemis I and are preparing the spacecraft for environmental testing. Meanwhile, teams at Kennedy are integrating thousands of parts into the crew module for Artemis II in preparation for the first crewed Artemis mission.

The Artemis program is the next step in human space exploration. It's part of NASA's broader Moon to Mars exploration approach, in which we will quickly and sustainably explore the Moon and use what we learn there to enable humanity's next giant leap, sending astronauts to Mars.

For more information about Orion, visit:
https://www.nasa.gov/orion

Australian Government Commits to Join NASA in Lunar Exploration and Beyond

Australian Prime Minister Scott Morrison has announced his nation's intention to join the United States' Moon to Mars exploration approach, including NASA's Artemis lunar program.

The announcement took place at a ceremony Saturday at NASA Headquarters in Washington during which NASA Deputy Administrator, Jim Morhard, and Head of the Australian Space Agency, Megan Clark, signed a joint statement of intent. Secretary of Commerce Wilbur Ross, Australian Ambassador to the United States Joe Hockey and U.S. Ambassador to Australia Arthur Culvahouse Jr. also participated in the ceremony.

The statement foresees potential Australian contributions in areas of mutual interest such as robotics, automation, and remote asset management – similar to that currently used by Australia in mining operations – and builds on a unique history of space cooperation between the U.S. and Australia that dates back to the Apollo era.

As part of Australia's commitment to partner with NASA, Morrison pledged to more than triple the Australian Space Agency budget to support Artemis and Moon to Mars.

"We are honored by today's statement and the commitment of our friends from Australia to support us in our mission to return to the Moon by 2024 with the Artemis program," Morhard said. "The strong relationship between NASA and the Australian Space Agency affirms NASA's commitment to establish sustainable exploration with our commercial and international partners by 2028."

Although the Australian Space Agency is relatively new, established a little over a year ago, Australia has a long tradition of working closely with the U.S. in space activities. A formal agreement between NASA and the Commonwealth Scientific Industrial Research Organisation (CSIRO) signed in 1960 allows for tracking and communication of NASA missions through the Canberra Deep Space Communication Complex (CDSCC) at Tidbinbilla, as well as the Data Relay Satellite facilities in Alice Springs, Northern Territory, and Dongara, Western Australia. The CDSCC serves as an integral component of NASA's Deep Space Network.

In August, the Mars 2020 and ExoMars rover science teams honed their skills in the Australian Outback, where the rocks are of similar age to the terranes on Mars, in preparation for their respective missions to launch to the Red Planet next summer in search of signs of past life on Mars.

Saturday's joint statement strengthens the relationship between Australia and the U.S. and broadens the community of nations joining NASA in further exploration of the Moon, Mars, and beyond. Through Artemis, NASA will send the first woman and next man to the surface the Moon by 2024, and establish sustainable exploration with our commercial and international partners by 2028. NASA's Artemis program is the next step in human exploration and is a part of America's broader Moon to Mars exploration approach.

Australian Space Agency: https://www.space.gov.au
NASA: https://www.nasa.gov/moontomars

India Finds Its Lost Vikram Lander on the Moon, Still No Signal

India's Chandrayaan-2 orbiter circling the moon has spotted the country's lost Vikram lander on the lunar surface, but there is still no signal from the lander, according to Indian media reports.

K Sivan, chief of the Indian Space Research Organisation, said today (Sept. 8) that the Vikram lander was located by Chandrayaan-2 and efforts to restore contact the probe will continue for at least 14 days, according to a Times of India report.

"We have found the location of Lander Vikram on [the] lunar surface and Orbiter has clicked a thermal image of Lander," Sivan told the ANI news service in an interview, adding that attempts to communicate with the lander are ongoing.

Full story at space.com:
https://www.space.com/india-moon-lander-found-by-chandrayaan-2-+orbiter.html

South Korea to push back lunar orbiter development to 2022, increase size of probe

South Korea will push back the development date of its lunar orbiter by less than two years to July 2022 and increase the size of the probe to enhance the probe's capabilities and reflect the requests of local scientists, the science ministry said.

The delay comes amid the need to sort out differences and implement demands by scientists and engineers engaged in the project that aims to place an unmanned probe in lunar orbit, according to the Ministry of Science and ICT.

"The decision was reached by the National Space Committee, with the extra time to be used to make some changes to the plan," Choi Won-ho, the head of the ministry's Space and Big Science Division, said.

The orbiter will weigh 678 kilograms and will be programmed to fly for nine months out of its one-year operational lifespan in an elliptical orbit that will maximize the scope of exploration it can carry out.

Originally, Seoul wanted to build an orbiter weighing 550 kilograms by late 2020 that would fly for 12 months in a circular orbit around Earth's satellite.

Due to the new date, the ministry is currently in talks with the U.S. National Aeronautics and Space Administration (NASA), which wanted to place a sensor on the orbiter, and space transportation company SpaceX, which will launch the probe.

The project, which began in January 2016 and is set to cost 197.8 billion won (US$166 million), will be equipped with a host of cameras, sensors and a spectroscope to collect data on the moon as well as conduct space connectivity tests.

If successful, South Korea will follow in the footsteps of Russia, the United States, Japan, the European Union, China and India in placing an orbiter around the moon.

Yonhap News Agency
https://en.yna.co.kr/index

China launches two new BeiDou satellites

China successfully sent two satellites of the BeiDou Navigation Satellite System (BDS) into space from the Xichang Satellite Launch Center in Sichuan Province at 5:10 a.m. Monday.

Launched on a Long March-3B carrier rocket, the two satellites entered orbit. They are the 47th and 48th satellites of the BDS satellite family.

The new satellites and the carrier rocket were developed by the China Academy of Space Technology (CAST) and the China Academy of Launch Vehicle Technology, under the China Aerospace Science and Technology Corporation.

After in-orbit tests, the new satellites will work with BDS satellites already in orbit to improve the positioning accuracy of the system.

Full Story at *Xinhua Net*
http://www.xinhuanet.com/english/2019-09/23/c_138414889.htm

Joint Statement on Cooperation in Lunar Exploration between NASA and JAXA

On 24 September, 2019, Dr. Hiroshi Yamakawa, President, the Japan Aerospace Exploration Agency (JAXA) and Mr. Jim Bridenstine, Administrator, the National Aeronautics and Space Administration (NASA), met to discuss future bilateral cooperation in lunar exploration.

During their meeting, both leaders acknowledged their extensive cooperation across all mission areas, including on the International Space Station. They expressed their desire to expand their agencies' scientific and technological cooperation to realise sustainable exploration on the lunar surface and in the lunar vicinity leading to exploration of Mars. Dr. Yamakawa and Mr. Bridenstine signed a joint statement of intent outlining these goals.

Joint Statement announced by
Hiroshi Yamakawa, President, JAXA
James F. Bridenstine, Administrator, NASA

Japan Aerospace Exploration Agency (JAXA)
https://global.jaxa.jp
National Aeronautics and Space Administration (NASA)
https://www.nasa.gov

Fast-Track to the Moon: NASA Opens Call for Artemis Lunar Landers

NASA is seeking proposals for human lunar landing systems designed and developed by American companies for the Artemis program, which includes sending the first woman and next man to the surface of the Moon by 2024.

The final call to industry comes after NASA issued two drafts, in July and August, encouraging companies to send comments to help shape a key component of the agency's human exploration Artemis partnerships. NASA is expected to make multiple awards to industry to develop and demonstrate a human landing system. The first company to complete its lander will carry astronauts to the surface in 2024, and the second company will land in 2025.

Proposals to build a landing system are due by 1 November, an ambitious timeline consistent with the sequence of events leading to this point—however, companies have been preparing for, reviewing, and commenting on several drafts of NASA's broad agency announcement since mid-July and should be ready for this tight timeline.

Full Story at NASA
https://www.nasa.gov/feature/fast-track-to-the-moon-nasa-opens-call-for-artemis-lunar-landers

Russia Plans Reusable Rocket to Compete With Elon Musk by 2024 – RBC

Russia plans to build its own reusable Argo rocket to compete with Elon Musk and supply the International Space Station (ISS) by 2024, the RBC news website reported Monday.

Russia has previously accused Musk's SpaceX of squeezing it out of the carrier rockets market with the company's relatively low-cost Falcon 9 rockets. Last year, Russia's state-owned space corporation Roscosmos brushed off Musk's successful launch of his Falcon Heavy reusable rocket toward Mars as "a nice trick."

Full Story at The Moscow Times
https://www.themoscowtimes.com/2019/09/30/russia-plans-reusable-rocket-to-compete-with-elon-musk-by-2024-rbc-a67508

US Air Force awards ULA $1.18 billion contract to complete five Delta IV Heavy NRO missions

The Air Force Space and Missile Systems Center on 30 September awarded United Launch Alliance a five-year $1.18 billion contract to complete the last planned five Delta 4 Heavy National Reconnaissance Office missions from 2020 through 2024.

The award covers the launch operations costs for five classified NRO missions — NROL-44, NROL-82, NROL-91, NROL-68 and NROL-70. The Air Force already had acquired five Delta 4 Heavy rockets for these missions under previous contracts awarded to ULA in 2017 and 2018.

Full Story at SpaceNews
www.spacenews.com

***Image right**: A United Launch Alliance Delta IV-Heavy rocket carrying a National Reconnaissance Office payload launches on 28 August 2013, from Space Launch Complex-6 at Vandenberg Air Force Base, California. This was the second Delta IV-Heavy launch for Vandenberg AFB, with the first occurring on 20 January 2011. The rocket is the largest to ever launch from the West Coast of the United States.*

Credit US Air Force/Joe Davila
https://www.af.mil/News

Apollo 11: Meet the most famous crew in history

By Rob Wood

Following on from our Apollo 11 special in the last issue, Rob takes an in-depth look at the most famous spaceflight crew in history.

Neil Alden Armstrong was born 5 August 1930 in Wapakoneta, Ohio. He served in the United States Navy (USN), where he saw action in the Korean War of 1950 to 1953. Following graduation from University in 1955 he joined the National Advisory Committee for Aeronautics (NACA) which would later become NASA. He worked as a NACA/NASA test pilot on many pioneering high speed aircraft, including the 4000-mph X-15. In his career, he flew more than 200 different models of aircraft, including jets, rockets, helicopters and gliders. He joined NASA's second group of astronauts in 1962 and was the commander of Gemini 8 in 1966 and Apollo 11 in 1969.

He was interested in aircraft from early on. He had his first flight in an aircraft aged six and within a few years was building model aircraft, which soon filled up his bedroom. He was still in elementary school when he decided to be an aircraft designer. He also thought that a good aircraft designer should also know how to fly an aircraft. Aged fifteen he took an after school job and saved for flying lessons. He carried out aircraft maintenance at a small airfield near Wapakoneta until he was sixteen when he could actually start to pilot powered airplanes. He obtained his student pilot's certificate on his sixteenth birthday and soloed within weeks.

Still aged sixteen, he piloted a rented aircraft to go to his navy scholarship examination. He was successful in obtaining a USN scholarship under the Reserve Officers' Training Corps (ROTC) programme. The ROTC is a military scholarship programme funding students in return for military service following graduation. He entered Purdue University, Indiana, in September 1947. Unlike many later students studying under a ROTC scholarship, at this time, students were sometimes ordered to do military service mid-studies.

In February 1949, he reported for flight training at Naval Air Station (NAS) Pensacola in Florida. His marks during training were not particularly impressive but he got better as his training continued and as the 'First Man' biography describes, *"experienced an extraordinary good day at sea,"* on 11 August 1950, whilst making his final aircraft-carrier qualification landings on the USS Wright. On 23 August 1950, he received his navy wings.

In the 1947/1948 period, Fighter Squadron 51 (VF-51) had become the first operational jet fighter squadron in the USN. In November 1950, Armstrong was posted to the 'Screaming Eagles'. A slight problem for Armstrong at the time of posting was that he had yet to fly a jet aircraft, especially with the spectre of the Korean War (25 June 1950 – 27 July 1953) hanging over the squadron. On 5 January 1951, he made his debut flight in a jet, a Grumman F9F Panther. Further training followed and he made his first aircraft-carrier landing in the F9F on 7 June 1951 onto the USS Essex.

Further training followed before a combat posting on the USS Essex. His combat tour ran from August 1951 to March 1952 during which he flew 78 combat missions. It was on his seventh on 3 September 1951 that he had his closest call with death. He was on an armed reconnaissance mission and made a number of ground-attack runs, but then, as he was on another ground run, his F9F sliced through a cable resulting in the loss of nearly six feet of his left wing. The cable was probably a booby-trap aimed at bringing down attacking aircraft. He was just able to fly his aircraft to friendly territory before he had to eject. He landed in a rice paddy. He was safe but not completely unscathed. He had a cracked tailbone (a coccyx injury) but although this type of injury can be painful it is not considered serious.

Technically, he was part of the US Navy Reserve from 1 February 1952, but remained on active duty, and initially still on a combat tour. He returned to the US in March 1952. He spent five months with Air Transport Squadron 32 based at NAS San Diego as an aircraft delivery pilot before standing down from active duty on 23 August 1952. He remained in the USN reserve for eight years before resigning his commission on 21 October 1960.

After stepping down from active duty with the navy, Armstrong returned to Purdue University and completed his degree. He graduated from Purdue in January 1955 and joined NACA the following month. He was based at NACA's Lewis Flight Propulsion Laboratory in Cleveland, Ohio, as an Aeronautical Research Pilot. It was here that he had his first taste of spaceflight related research, studying high-Mach-number heat transfer using various air-launched test vehicles.

In July 1955, he transferred to NACA's High-Speed Flight Station based at Edwards Air Force Base (AFB) in Kern County, Southern California. Edwards AFB was the home of the United States Air Force (USAF) Test Pilot School, the USAF Test Center as well as NACA's test centre. Today, Edwards AFB's own website describes itself as 'The Center of the Aerospace Testing Universe' and that moniker could easily have been used in the 1950's. On 1 October 1958, NASA was established succeeding and incorporating NACA. Armstrong seamlessly moved from a NACA employee to a NASA employee.

In his time at Edwards, Armstrong flew over 900 flights accumulating 2,600 flying hours. Included amongst the many aircraft he flew were two from the X series of rocket-engine-powered aircraft; the Bell X-1B supersonic research aircraft and the North American X-15 hypersonic research aircraft that reached the edge of space (and in 1963 twice crossed it [100km] but that was after Armstrong had joined NASA's astronaut corps). During his sixth flight in the X-15 he reached a height of

Official NASA portrait of the Apollo 11 Prime Crew. Signed by the astronauts. Taken from a NASA Press Release from August 2013.

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about 63km, the highest he flew prior to his flight on Gemini. As pilot of a Boeing B-29 Superfortress, a four-engine propeller-driven heavy bomber aircraft, he participated in the air-launch of over 100 rocket aircraft research flights.

Armstrong was selected as an astronaut in 1962 (NASA Group 2). Nine astronaut-candidates were named by NASA on 17 September 1962, although they had been informed privately on 14 September 1962. They reported for training on 1 October 1962. Deke Slayton, a former Mercury 7 astronaut who was in charge of astronaut selection and astronaut flight assignments (subject to NASA Headquarters oversight) from 1962 to 1972, said of NASA Group 2 in his autobiography 'Deke', *"…that second group of astronauts is probably the best all-around group ever put together."*

In early January 1963, as well as doing their basic training, the new astronauts were given technical assignments as representatives of the Astronaut Office. Armstrong was made the representative for simulators. This was an obvious choice by the Astronaut Office as Armstrong had more experience with flight simulators than the other astronauts. In July 1964, NASA announced that Armstrong was in charge of the Operations and Training branch of the Astronaut Office. He was the first Group 2 astronaut to be given a management position and he had many of NASA's astronauts working under him. NASA's Group 3 astronauts that had been named in October 1963 were all assigned to the Operations and Training branch together with Group 2 astronauts James Lovell and Elliot See.

By 1964, Deke Slayton had earmarked Armstrong as a Command Pilot (CP) for Gemini. On 16 February 1965, NASA announced his assignment as back up CP for Gemini 5. After serving as back-up CP for Gemini 5 (flew 21-29 August 1965), NASA confirmed he would command Gemini 8. Armstrong performed the first successful docking of two spacecraft in space on Gemini 8 (flew 16-17 March 1966) when as CP he flew his spacecraft to an Agena unmanned target vehicle. His co-pilot was Dave Scott, also making his spaceflight debut. Unfortunately, they would shortly gain an unwelcome space first when they had to make the first emergency return to Earth.

Shortly after docking with Agena the two spacecraft begin to spin

out of control. At this point the astronauts were out of contact with the ground, so they got no help in identifying the problem, but they suspected the problem was related to the Agena. The Gemini spacecraft series had performed well so far but the Agena series, as noted by Armstrong, *"…had had quite a few problems in its development."* They were wrong. They undocked and as they tried to bring Gemini under control they found they could not. It dawned on them that it was their spacecraft that was causing the problem.

When they came in contact with ground stations, Dave Scott reported *"We have serious problems here. We're … we're tumbling end over end up here. We're disengaged from the Agena."* Things were getting worse and Armstrong was worried they would lose the ability to function and become unconscious leading to an obvious end. He decided that the only way of recovering the situation was to use the Re-entry Control System. Initially, the situation stabilized, then the problem resurfaced and it was clear that there was a malfunctioning thruster. It was number eight of Gemini's Orbit Attitude and Manoeuvring System.

Having identified the problem, Armstrong brought Gemini under control but mission rules dictated an emergency return to Earth was required. Splashdown was made at a contingency site southeast of Okinawa, Japan. A Douglas C-54 Skymaster, a four-engined transport aircraft, soon dropped navy frogmen. The seas were rough and Armstrong and Scott had to wait for the recovery ship. *"The Gemini is a terrible boat,"* recorded Armstrong later, *"a good spacecraft, but not a good boat."* Neither astronaut had taken their motion sickness medication. They regretted this but fortunately they had been too busy to eat and did not have a great deal in their digestive systems to make a return journey.

Normally, recovery of manned spacecraft was completed by an aircraft-carrier but due to their emergency landing Armstrong and Scott had to make do with being picked up by a destroyer; the USS Leonard F Mason. The ship had been named after a Medal of Honor winner who had received the award posthumously for actions during the Battle of Guam (1944) in the Second World War. The destroyer took the astronauts to Okinawa from where they were flown to Hawaii pending a return to the Kennedy Space Center in Florida. Although the emergency had not lasted as long or is as well-known as the Apollo 13 drama in 1970, it was probably as equally dangerous and could have ended with the death of both astronauts.

Armstrong rounded out his service on the Gemini Programme as the back-up CP for Gemini 11 (flew 12-15 September 1966). The Gemini Programme ended with Gemini 12 in November 1966. The scene was now set for NASA's third manned spacecraft, Apollo, to come to the fore. By January 1967, the first scheduled manned launch was close. At this time, Armstrong did not have a crew assignment and was a long way from becoming the first man to walk on the Moon. But that changed. On 27 January 1967, the Apollo 1 crew were killed as a result of a fire during a launch simulation exercise.

In the aftermath of the fire, Deke Slayton formed a new Apollo crew of Neil Armstrong, James Lovell and Buzz Aldrin. They were assigned to back up the third manned flight of Apollo, which would shortly be given the name of Apollo 9. The assignment was later changed to the second manned Apollo flight due to developmental problems involving the Lunar Module. Deke Slayton had previously developed the three mission rotation idea that would see a back-up crew skip two missions and then be prime for the third. The change in assignment put Armstrong in line to command Apollo 11 instead of Apollo 12.

During his Moon landing training, Armstrong had another close call. The Lunar Landing Research Vehicle (LLRV) was a vertical takeoff and landing aircraft that simulated the Moon's 1/6th gravity and enabled astronauts to practice for landing on the lunar surface. Armstrong had already flown the LLRV a number of times from March 1967 to April 1968 when on 6 May 1968 he made another training flight. He was making typical lunar landing trajectories and was on final approach when he lost control. The LLRV pitched forward and Armstrong realized he was unable to recover. At a little over 50 feet he ejected. The LLRV crashed but Armstrong landed safely with only a few minor injuries. If he had ejected a fraction of a second later he most probably would have been killed.

Armstrong served as back-up Commander (CDR) for Apollo 8 (flew 21-27 December 1968) and on 6 January 1969, Slayton told Armstrong, Michael Collins and Buzz Aldrin that they were officially the prime crew for Apollo 11. He told them that their flight might very well be the first to land on the Moon. It still needed everything to go well with Apollo 9 and Apollo 10 but it was looking increasingly likely that they would shortly enter the history books as the crew of the first lunar landing mission.

Apollo 9 (flew 3-13 March 1969) and Apollo 10 (flew 18-26 May 1969) did go according to plan and NASA stepped up preparations for Apollo 11. In June 1969, Armstrong and Aldrin trained in an updated version of the LLRV, the Lunar Landing Training Vehicle. NASA management had wanted to scrap this vehicle as a training aid. They thought it was far too dangerous. Armstrong's crash was not the only one involving this type of vehicle but the astronauts were adamant that it was necessary and an excellent training tool. Christopher Kraft, Director of Flight Operations, notes in his book 'Flight', *"So with our fingers crossed, we let them keep it."*

Apollo 11 (flew 16-24 July 1969), Armstrong was the CDR and became the first human to walk on the Moon. Depending on where you were in the World the date was either 20 July 1969 or 21 July 1969.

After the postflight world tour, he returned to the Astronaut Office with aspirations of flying in space again. But, this was something that NASA's higher hierarchy and perhaps even higher would not contemplate. Armstrong was now a national treasure and would not be risked on a dangerous endeavour such as spaceflight. He was not told explicitly that he would not be allowed to fly in space again but that is what he understood the position to be especially when he was encouraged to accept a management post.

In the summer of 1970, Armstrong agreed to become the Deputy Associate Administrator for Aeronautics, NASA Headquarters, Washington, DC. In this position, he was responsible for the coordination and management of overall NASA research and technology work related to aeronautics. He was not unhappy in his new role but became increasingly frustrated by the demands on his time by NASA, Congress and the White House to attend events at which he was there to be 'shown off' as the first man on the Moon. He would have preferred to concentrate on aeronautical research.

In August 1971, after about a year in Washington, he resigned from NASA to accept a teaching position at the University of Cincinnati. His title was University Professor of Aerospace Engineering. He left the University in 1979 and entered private business, working with various companies until his retirement from corporate life in 2002. In 1986, he served as Vice-Chairman of the Rogers Commission, which investigated the Space Shuttle Challenger disaster of 28 January 1986. In March 1989, he joined the board of Thiokol who made the US Space Shuttle's solid-rocket boosters that had been partially to blame for the loss of Challenger. He served on Thiokol's board until 2000.

In 1991, he had a mild heart attack due to a tiny aberrant blood vessel but this left no permanent disability. The rest of his coronary arteries were clear of blockages. However, 21 years later things were different. On 6 August 2012, he attended hospital for tests and these showed significant problems. The following day he underwent quadruple coronary artery bypass surgery.

Initially, it was reported that he was recovering well and by 10 August had been able to get out of bed and sit in a chair, and then walk up and down the corridor. On 11 August 2012, he told his biographer James Hanson that he expected to go home in a day or so but then there was a gap without any news. Then on 25 August 2012, his family announced, *"We are heartbroken to share the news that Neil Armstrong has passed away following complications resulting from cardiovascular procedures."* He died on 25 August 2012 in Fairfield Mercy Hospital in Cincinnati, Ohio.

His academic achievements included a bachelor's degree in Aeronautical Engineering from Purdue University, Indiana (1955) and a master's degree in Aerospace Engineering from the University of Southern California (1970). He was awarded honorary doctorates from multiple universities and by the end of his life had received 19. Although he had served in the USN as a Lieutenant, he was classed as a civilian by the time he joined NACA.

Michael Collins was born on 31 October 1930 in Rome, Italy. His father James was a career US Army officer who was serving in Italy as the US Military Attaché at the time of his birth. Michael Collins was a graduate of West Point and the USAF Test Pilot School. He joined NASA's third group of astronauts in 1963 and was Pilot (PLT) for Gemini 8 in 1966 and Command Module Pilot (CMP) for Apollo 11 in 1969. After his astronaut career he wrote one of the best (some consider it is the best) astronaut autobiographies.

He met the ultimate definition of 'army brat'. Not just for the normal frequent and irregular changes of home that come with being a child of a career military officer but with the sheer number of family members who have the US Army on their CV's. His father, Major General James Collins, spent 38 years in the US Army, including service in both World Wars and winning the Silver Star in the first. An uncle who was also in both World Wars before serving as Chief of Staff of the US Army in the Korean War and yet another uncle who had been in the US Army. His older brother, James Jr, served in the US Army in World War Two and the Korean War (later also the Vietnam War and went on to make the rank of Brigadier General), and there was a cousin who served in the US Army.

He was approaching West Point graduation when he had to choose between the US Army and the USAF. Looking at his family's history you would have thought it was obvious. But he did not go for the obvious. He relates the reason he chose the USAF in his autobiography 'Carrying the Fire'. Having noted how many of his family had served or were serving in the US Army, he writes *"With no similar entanglements in the Air Force, I felt I had a better chance to make my own way. Certainly, there was no chance for nepotism, real or imagined."*

On graduation from West Point (1952), he attended basic flight training. He then took advanced training and qualified to fly the North American F-86 Sabre. After service as a fighter-bomber pilot he attended an aircraft maintenance officer course and then commanded a Mobile Training Detachment followed by a Field Training Detachment. In 1961, he was accepted into the USAF Test Pilot School at Edwards AFB, graduating in 1961. He worked as an experimental test pilot at the USAF Test Center at Edwards until 1963.

He was selected as an astronaut in 1963 (NASA Group 3), but this was not his first attempt to become an astronaut. He had also applied to join the second group that had been selected the previous year. The third group reported for training in February 1964. As well as doing his basic training, by the summer, he was also given responsibility as the Astronaut Office representative for pressure suits and extra-vehicular activity (EVA).

He was back-up PLT for Gemini 7 (flew 4-18 December 1965) before making his first spaceflight. He was PLT on Gemini 10 (flew 18-21 July 1966) and made two EVA's during the flight. The first EVA was whilst Gemini 10 was docked with an Agena unmanned target vehicle but this was ended early when an irritant caused an eye problem. The second EVA took place after Gemini 10 had undocked and rendezvoused with an earlier Agena. Although the two spacecraft were not docked, Collins was able to retrieve experiments from the Agena that were exposed to the space environment.

Following his Gemini flight, he was assigned as PLT (later to become known as Lunar Module Pilot or LMP) on the back-up crew for the second manned Apollo mission. This changed when one of the early Apollo missions was cancelled. Collins was moved to the Senior Pilot position (soon to become known as the Command Module Pilot or CMP) on the prime crew for the third Apollo flight. Following the Apollo 1 fire in January 1967, the mission became known as Apollo 9. But Apollo 9 would not be his second spaceflight.

In early July 1968, Collins lost his flight status as a result of a bone spur between his fifth and sixth cervical vertebrae. He would need surgery and was off the Apollo 9 crew. Following the success of Apollo 8 (flew 21-27 December 1968), the now fit again Collins was assigned to Apollo 11 as CMP. Apollo 11 (flew 16-24 July 1969) was Collins second and last spaceflight. Whilst he circled the Moon in the Command and Service Module, his crewmates Neil Armstrong and Buzz Aldrin descended to the Moon and were the first humans to walk on the Moon.

Shortly before his Apollo 11 flight, Deke Slayton had spoken to him about a future assignment. Slayton had offered him the command of the Apollo 14 back-up crew, which would have put him in line to command Apollo 17 and walk on the Moon but Collins declined. He had decided that the strain of the astronaut business on himself and his family was such that it was time to call it a day and he told Slayton that if Apollo 11 was successful he would bring his astronaut career to an end.

He retired from NASA in January 1970 and joined the State Department as Assistant Secretary of State for Public Affairs in Washington DC. He did not really enjoy his new job and in April 1971, he became the Director of the National Air and Space Museum in Washington DC. In 1974, his autobiography 'Carrying the Fire' was published. Unlike many astronaut autobiographies, he did not use a ghostwriter.

In 1978, he became Undersecretary of the Smithsonian Institution, a US Government administered organisation that looks after many museums and research centres including the National Air and Space Museum. In 1980, he entered the private sector and became Vice-President of LTV Aerospace in Arlington, Virginia before forming his own consulting firm, Michael Collins Associates in 1985.

His academic achievements include a bachelor's degree in Military Science from the United States Military Academy at West Point, New York (1952) and as a graduate of the Harvard Business School's Advanced Management Programme (1974). He also has several honorary degrees. He was no longer on active-duty with the USAF from 1970 but remained in the USAF reserves and attained the rank of Major-General in 1976. He retired from reserve-duty in 1982.

Edwin Eugene 'Buzz' Aldrin was born on 20 January 1930 in Montclair, New Jersey. Like Michael Collins, he was another West Point graduate. He flew combat missions during the Korean War of 1950-1953. He went on to attend the Massachusetts Institute of Technology (MIT) from where he earned a doctorate and this gave him the distinction of being the first NASA astronaut to hold a doctorate at the time of their selection. He joined NASA's third group of astronauts in 1963 and was the PLT for Gemini 12 in 1966 and LMP for Apollo 11 in 1969.

He graduated from West Point with a bachelor's degree in Mechanical Engineering (1951). He subsequently went to flight school and was commissioned into the USAF. Having gained his pilot wings in 1952, he was posted to Korea where he flew 66 combat missions in the North American F-86 Sabre and is credited with having shot down two Mikoyan-Gurevich MiG-15 jet fighters. After the Korean War he served in a number of postings before attending MIT from 1959. He completed his doctorate in early 1963. His doctoral thesis was 'Line-of-Sight Guidance Techniques for Manned Orbital Rendezvous'.

After his doctorate, he was assigned to the Gemini Target Office of the Air Force Space Systems Division, Los Angeles. He spent a couple of months working on the Agena unmanned target vehicle. Then he moved on to the Space Systems Division's detachment at NASA's Manned Spaceflight Center in Houston, where he worked on Department of Defense experiments being planned for the Gemini Programme.

He applied to join NASA's second group of astronauts selected in 1962 but was rejected because he was not a qualified test pilot. NASA quickly announced another selection for 1963. The good news for Aldrin was that for this selection the test pilot requirement had been dropped. Aldrin applied again. He was selected as an astronaut in 1963 (NASA Group 3). The third group reported for training in February 1964. As well as doing his basic training, by the summer, he was also given responsibility as the Astronaut Office representative for mission planning and flight trajectories.

He was originally appointed as back-up PLT for Gemini 10 but following the deaths of the Gemini 9 prime crew of Elliot See and Charles Bassett in an aircraft accident he was reassigned as back-up PLT for Gemini 9. This put him in line to rotate to the prime crew of Gemini 12, the last of the manned Gemini flights. If this change had not occurred it is unlikely that Aldrin would have found himself on the Apollo 11 crew.

He was back-up PLT for Gemini 9 (flew 3-6 June 1966) before making his first spaceflight as PLT on Gemini 12 (flew 11-15 November 1966). Gemini 12 was due to dock with an Agena unmanned target vehicle but radar contact between the two vehicles failed. Aldrin's doctorate had earned him the nickname Dr Rendezvous amongst his fellow astronauts and now it was time to live up to that name and put his studies to good use.

In his autobiographical work 'Return to Earth' he wrote of his thesis, *"It is some of the most tedious reading on record but it fulfilled its propose because it subsequently proved its practical application in space. That I happened to be the astronaut in space at the moment the theory needed to be tested was a stroke of divine good luck."* Aldrin used a sextant, slide rule, the onboard computer, and the rendezvous procedures and charts he had helped create for Gemini 6 (the first rendezvous flight). He furnished James Lovell, the CP of Gemini 12, with the information needed to carry out a successful rendezvous and docking.

It is fair to say that there had been significant problems with EVA's on earlier Gemini missions. It proved physically more difficult than expected to move around outside of the spacecraft and there were equipment failures. New and improved restraint and mobility aids had been added to the outside of Gemini and Agena, and Aldrin conducted three highly successful spacewalks, establishing a new record of 5½ hours on EVA.

In the aftermath of the Apollo 1 fire in January 1967, there was a reshuffle of early Apollo crews plus the forming of a new crew of Neil Armstrong, James Lovell and Buzz Aldrin. They were assigned to back up the third manned flight of Apollo, which would shortly be given the name of Apollo 9. Aldrin was in the back-up LMP position. In July 1968, he was promoted to back-up CMP because of Deke Slayton's rule that the CMP had to have spaceflight experience. Lovell, who was the back-up CMP, was moved to the prime crew because of Michael Collins' bone spur (see earlier biography for Collins). Aldrin's place as back-up LMP was taken by Fred Haise, a rookie astronaut.

In August 1968, the Armstrong, Aldrin and Haise crew was swapped to back-up Apollo 8 due to development problems involving the Lunar Module. This was not the end of the changes but not before he served as CMP on the back-up crew for Apollo 8 (flew 21-27 December 1968). Following the success of Apollo 8, the now fit again Michael Collins came back into the equation. Collins was given the CMP position on the prime crew for Apollo 11 and Aldrin reverted to the LMP role.

Aldrin's second spaceflight was as LMP on Apollo 11 (flew 16-24 July 1969) and during the mission he became the second human to walk on the Moon when he stepped onto the lunar surface 19 minutes after Armstrong. He was the only astronaut to act as back-up CMP and then become LMP for his follow on flight.

Following the World wide publicity tour of the Apollo 11 crew, Aldrin worked briefly on the early designs of the Space Shuttle. He then began to look to a future outside of NASA. He looked towards a return to mainstream service in the USAF and there opened a couple of possibilities: Commandant of Cadets at the USAF Academy in Colorado and commander of the USAF Test Pilot School at Edwards Air Force Base. Towards the end of his time with NASA, he had begun to suffer from bouts of depression and his mental state was not improved when the USAF offered him the position at Edwards. No mention was made of the posting to Colorado, which had been his preferred option.

He was persuaded to accept the position at Edwards and he took command on 1 July 1971. He later said that his time as head of the USAF Test Pilot School, *"had been one of the most stressful periods of my life."* He continued to suffer from periods of depression and eventually had to seek psychiatric help. He was hospitalised in late October 1971 and medicated. After a month in hospital he was discharged and returned to his command. He retired from the USAF on 1 March 1972; he had attained the rank of Colonel.

Over the next several years he dabbled in the commercial world including a television commercial for Volkswagen. He continued to have mental health problems with periods of depression that led him to drinking too much alcohol and eventually he was treated for alcoholism. He tried to help others with mental health problems even through the periods of his own difficulties and worked periodically with the National Association of Mental Health. He was also helped by many people and finally, in October 1978, he was able to quit alcohol for good.

How did he eventually quit alcohol? He explained this in another autobiographical work, 'Magnificent Desolation', *"Finally, in October*

1978, I laid down alcohol once and for all. My willingness to do so was not an act of willpower so much as a coming to the end of my own selfishness. I had always been self-centred, and because of my abilities or my intelligence or my fame, people had let me get away with it. When I began to see myself for what I really was, and had a group of fellow travellers who knew me for what I was—and were not impressed—I began to take baby steps toward getting well. Along the way, I learned that to truly keep something and hold onto it, you have to give it away."

He continued to help others with mental health problems, and has become a prolific author and advocate for space exploration. He still suffered from periods of what he described in Magnificent Desolation as *"blue funk"* which caused him to *"withdraw from the world"* for weeks at a time but he continued to abstain from alcohol. He frequently travels around the world giving lectures and with the adventurous spirit inside him surfacing again has visited the Titanic in a submersible (1996), travelled to the North Pole (1998) experienced weightlessness again with parabolic flights (2004) and become the oldest person to visit the South Pole (2016).

Notes, acknowledgements and sources:

All lift-off and landing (splashdown) dates are given in GMT unless otherwise stated.

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ISS Crew Compliment Becomes Nine, for a While

The nine International Space Station residents pose for a portrait inside the Zvezda service module. At the bottom row from left are, station cosmonaut Alexey Ovchinin, astronauts Luca Parmitano and Nick Hague, visiting astronaut Hazzaa Ali Almansoori of the United Arab Emirates, astronaut Jessica Meir and cosmonaut Oleg Skripochka. At the top are, astronauts Christina Koch and Andrew Morgan with cosmonaut Alexander Skvortsov. NASA astronaut Nick Hague returned to Earth with Ovchinin and visiting astronaut Hazzaa Ali Almansoori of the United Arab Emirates on Thursday 3rd October 2019.

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Radars, Volcanoes and Turkey:

25 Years Since STS-68

By Ben Evans

Twenty-five years ago, six astronauts rocketed into orbit aboard Space Shuttle Endeavour for a complex mission to map the Earth in unprecedented detail. The second Space Radar Laboratory (SRL-2)—equipped with the powerful Shuttle Imaging Radar (SIR) and an X-Band Synthetic Aperture Radar (X-SAR)—would be flying only a few months after its predecessor, SRL-1, in order to gather data and capture a snapshot of terrestrial change in the late spring and late summer. And in the pre-dawn hours of 30 September 1994, as STS-68 Commander Mike Baker led his crew out to Pad 39A, he cannot have been alone in having a flutter of nerves about what lay ahead.

Official crew portrait *of shuttle mission STS-68. Standing are, left to right, Michael A. Baker, mission commander; and Terrence W. Wilcutt, pilot. On the front row are, left to right, Thomas D. Jones, payload commander; and Peter J. K. (Jeff) Wisoff, Steven L. Smith and Daniel W. Bursch, all mission specialists.*

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Six weeks earlier, on the morning of 18 August, the crew had sat through a hairy shutdown of Endeavour's three main engines, right on the cusp of T-0. Coming only 1.9 seconds before the scheduled liftoff, it was the closest a Shuttle crew ever came to launching, without actually launching. In fact, they were so close to liftoff that the famous countdown clock at the Kennedy Space Center (KSC) Press Site displayed "T+00:00:00" on its blank face…and yet stunned spectators beheld only an ominous grey smudge of cloud as Endeavour's engines roared, then died.

The cause was later traced to a higher-than-allowable discharge temperature in the high-pressure oxidiser turbopump of the No. 3 engine. On Endeavour's flight deck, Baker, Pilot Terry Wilcutt and Mission Specialists Dan Bursch and Steve Smith tended to the immediate post-abort tasks of shutting down the Auxiliary Power Units (APUs) and safing other on-board systems, whilst on the middeck Mission Specialists Tom Jones and Jeff Wisoff instinctively prepared to evacuate the Shuttle in a so-called "Mode-One Egress".

"The launch countdown proceeded nominally with the main engines lighting at T-6 seconds," Wisoff told me in a recent interview. "When the main engines light, the Shuttle rocks back and forth on the pad, held down by launch bolts that will be blown when the Solid Rocket Boosters (SRBs) light. We felt the rumble of the main engines starting, when suddenly the master alarm klaxons went off and the engine rumble died out as the engines shut down under computer control.

"The crew trains for this type of scenario during a full dress rehearsal of the launch a few weeks before flight," Dr. Wisoff continued. "The flight crew in communication with the launch centre went through their safing procedures, while Tom and I, on the middeck, got unstrapped and prepared to open the hatch if necessary, to quickly egress the Shuttle. My seat position determined that I would open the hatch and egress first. I noted one big difference from our dress rehearsal and that was the vehicle was still rocking back and forth on the pad as I looked through the hatch window at the orbiter access arm. From my point of view, it looked like the access arm was unstable, moving back and forth. Fortunately, everything was safed nominally and eventually the ground crew came and helped us out. While we waited, Tom and I retrieved the one fresh sandwich we get to take to orbit for our first space meal and consumed it on the middeck while discussing how long it would take to change out the engines so we could do our mission."

For Dan Bursch, it was the second time in his astronaut career that

he had sat through an on-the-pad shutdown of the Shuttle's main engines. His crewmates came up with a gag that if Endeavour did not recognise the unlucky Bursch, they might launch successfully. When the six men arrived back at the Cape a few weeks later, Bursch wore a Groucho Marx sunglasses-and-moustache disguise. Years later, Wisoff remembered the gag, but could not recall which crew member instigated it.

The crew had been training for a little over a year. Tom Jones had been assigned in August 1993 as the payload commander, but was himself preparing to fly SRL-1 in April 1994 and so did not join his STS -68 crewmates until late in their training flow. Baker, Wilcutt, Smith, Bursch and Wisoff were assigned in October 1993 and trained for several months without him. Years later, Wisoff remembered the call to Chief Astronaut Robert "Hoot" Gibson's office and his surprise at receiving a second flight assignment so soon after his first mission. "Hoot called me on the phone and said he had something he thought I might like to do," he recalled. "It caught me by surprise, because my first flight, STS-57, had landed in July 1993, so I didn't expect to hear so quickly about the next assignment. I did not have any indicators this was coming. Nothing wrong with good surprises!" The crew enjoyed "great comradery", Wisoff told me, because he, Wilcutt, Bursch and Jones were all classmates from NASA's 1990 astronaut intake.

Finally, STS-68 launched at 7:16 a.m. EDT on 30 September 1994. "It felt great on board," seasoned Shuttle veteran Baker recalled, adding that they "jumped right up to 2.5 G", whilst first-timer flier Wilcutt pointed out that "the expression *kicked off the pad* is an accurate one!" Shortly after achieving orbit, the crew split into their two shifts to maintain 24-hour, around-the-clock operations with SRL-2. The blue team of Bursch, Jones and Smith bedded down for their first night's rest in orbit, whilst the red team of Baker, Wilcutt and Wisoff set to work activating the radars. It proved fortuitous for Smith, who had fallen foul of space sickness and needed a shot of the anti-nausea drug Phenegan.

For the next eleven days, Endeavour flew closely over the same sites as did SRL-1, which allowed the radars to examine seasonal changes on the planet's surface. Volcanoes were a key target and on the first mission Mount Pinatubo—which erupted in mid-1991, affecting global stratospheric temperatures and aerosol levels—was observed. But the STS-68 crew could not have anticipated what would happen only hours into their flight: Klyuchevskaya Sopka in Kamchatka, the highest active volcano in Eurasia, serendipitously erupted.

The red team was on duty on Endeavour's flight deck at the time. They spotted a tremendous black plume on the horizon, ahead of their flight path, which looked at first glance to be an enormous thunderhead. Baker quickly recognised it as a volcano. "It shows how much change nature can produce in a short period of time," Wisoff said later. "You had this huge eruption, but then by the end of the flight it had largely stopped erupting. There was still a small smoke trail, but it had re-snowed on top of the soot. In the span of ten days, it was almost white again!" In his memoir, *Skywalking*, Jones remembered being awakened by the blue team and yanked upstairs to the flight deck to behold the spectacle.

STS-68 Mission Insignia *This STS-68 patch was designed by artist Sean Collins. Exploration of Earth from space is the focus of the design of the insignia, the second flight of the Space Radar Laboratory (SRL-2). SRL-2 was part of NASA's Mission to Planet Earth (MTPE) project. The world's land masses and oceans dominate the center field, with the Space Shuttle Endeavour circling the globe. The SRL-2 letters span the width and breadth of planet Earth, symbolizing worldwide coverage of the two prime experiments of STS-68: The Shuttle Imaging Radar-C and X-Band Synthetic Aperture Radar (SIR-C/X-SAR) instruments; and the Measurement of Air Pollution from Satellites (MAPS) sensor. The red, blue, and black colors of the insignia represent the three operating wavelengths of SIR-C/X-SAR, and the gold band surrounding the globe symbolizes the atmospheric envelope examined by MAPS. The flags of international partners Germany and Italy are shown opposite Endeavour. The relationship of the Orbiter to Earth highlights the usefulness of human space flights in understanding Earth's environment, and the monitoring of its changing surface and atmosphere. In the words of the crew members, the soaring Orbiter also typifies the excellence of the NASA team in exploring our own world, using the tools which the Space Program developed to explore the other planets in the solar system.*

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Klyuchevskaya Sopka's eruption propelled an ash-cloud to an altitude of over 50,000 feet, which was then blown far to the east by the jet stream. "We soon had every camera zeroed-in on the eruption," Jones wrote, "as Endeavour gave us a dramatic, down-the -throat view of this impressive geology lesson."

By the sixth day of the flight, consumables were running at such good levels that mission managers extended STS-68 from ten to eleven days. The two shifts ate on the fly for lunch, but tended to meet at shift handovers, with one team enjoying breakfast and the other gobbling dinner. Whenever the Shuttle passed over California, native Mike Baker quickly scrambled for the nearest window to look at his home state. The radar's payload recorders performed well, although one had to be removed and replaced after it failed to play back properly. Rerouting the data stream between the remaining machines, the repair by Smith and Wisoff occurred over a comparatively empty Pacific orbital pass. "Being on opposite shifts, Steve and I had both been trained to replace it with a spare we had on-board," Wisoff told me. "It was decided that by installing the spare during crew handover, when both Steve and I could work together, we might be able to finish the replacement while passing over the Pacific Ocean, where little data would be lost. The whole crew pitched it and created an efficient operation, like a race-car pit stop."

The darkness of space forms the backdrop for this scene of the Space Shuttle Endeavour's cargo bay, 115 nautical miles above a cloud covered Indian Ocean. The Space Radar Laboratory (SRL-2) Multipurpose Experiment Support Structure (MPESS) is seen at bottom frame. Also partially seen are other experiments including other components of the primary payload. They are the antenna for the Spaceborne Imaging Radar (SIR-C), the X-band Synthetic Aperture Radar (X-SAR), the device for Measurement of Air Pollution from Satellites (MAPS) and some Getaway Special (GAS) canisters.

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Thick cloud in Florida on 11 October forced mission managers to redirect Endeavour to Edwards Air Force Base in California, where Baker brought his ship to a smooth landing at 10:02 a.m. PDT. All told, STS-68 gathered more than 110 hours' worth of radar data in 950 data-takes, recorded on 199 digital tapes and covering a surface area of 32 million square miles. Working closely with the Flight Dynamics Officer (FIDO) team, Bursch had put together an intricate series of manoeuvres (called "trim burns") to keep the SRL-2 flight path within 200 feet of the SRL-1 flight path to maximise the accuracy of the data.

The crew came home with 14,000 photographs, enough data to fill a stack of disks standing 15 miles high and completed over 400 manoeuvres and executed 22,000 keystrokes. "The SRL missions successfully measured the movement of volcano faces from orbit, revealed lost caravan trails under the Sahara Desert and successfully identified natural resources like tree stands from orbit," Wisoff told me in summary of these remarkable flights. "It demonstrated that space platforms have the potential to play an important role in early -warning systems for volcanic and earthquake detection, as well as supplying critical Earth resource-management data."

Yet one thing that did not come home aboard Endeavour in plentiful supply was turkey. Before launch, as the astronauts made their menu selections, Baker's love of smoked turkey—which he loved folding into tortillas—became the stuff of jokes. "When Bakes asked what was for dinner, the answer nearly always was...smoked turkey," wrote Jones. "Noticing our escalating laughter, by the third day our commander was convinced he was the victim of a practical joke instigated either by us or some of his 1985 astronaut classmates. We maintained our innocence and post-flight investigation showed the on-board turkey surplus was his own doing!"

Go Space Watch

spaceflight and astronomy for everyone

Presents:

"Magnificent Destination— The Apollo Moon Missions"

by Astronomer Dave Eagle FRAS

An audience participation presentation capturing the excitement of the magnificent Apollo Moon Landing Missions.

Friday 1st November 2019
at Kidderminster Town Hall
Vicar Street, Kidderminster. DY10 1DB.
between 7:00 pm and 8:30 pm

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This event is organised by Go Space Watch in Association with Wyre Forest District Council and Kidderminster Arts and Food Festival

Kidderminster Arts and Food Festival kaff

Wyre Forest District Council

Celebrating Apollo: A Report

On Saturday 20th July 2019 the World celebrated the 50th Anniversary of Apollo 11 Moon landing. Many organisations and individuals around the world arranged various events to commemorate mans' greatest achievement of the 20th Century.

Go Space Watch, a new commercial venture by CapCom Editor Michael Bryce, organised a day of lectures and an exhibition at Sutton Arts Theatre in The Royal Town of Sutton Coldfield, in the West Midlands.

The full day of events included five lectures by four speakers.

The exhibition area included the following exhibitors:

- A Virtual Reality system where visitors could find themselves inside the ISS or on a spacewalk, the equipment and tuition provided by David Wallbank;
- The ever popular Astro Info Service by David Shayler set up their comprehensive Book Stall;
- Space Boosters by Nick and Bryar Deakin had a selection of Mugs, coasters, key rings, magnets, tin signs, wallets, washbags, models, mission patches, mission pins, lanyards, astrotedd, t-shirts/caps, space-flown memorabilia, photos and photo packs.
- David Hardy at Astro Art displayed and sold some of his artwork.
- Mark Perman at BIS West Midlands displayed the BIS stand
- and a table displaying leaflets advertising Walsall and Birmingham Astronomical Societies.

The lectures began with Dr Steve Barrett from the University of Liverpool with a talk entitled "The Great Moon Hoax – Proving NASA did go to the Moon".

David Shayler from Astro Info Service then gave his first talk of the day entitled "The Gemini Project – Space Techniques to Support Apollo".

After lunch Michael Bryce from Go Space Watch gave a presentation about the Apollo Missions.

Space Artist David A Hardy gave his presentation "To the Stars on a Paint Brush".

The final lecture was given by David Shayler with a talk entitled "Apollo: the lost and Forgotten missions" looking at the possible outcome from Apollo if the program had been followed through without delays, accidents or cancellations and included an outline of possible future flights.

After each presentation a raffle took place and the lucky winners won books by David Shayler, donated by Astro Info Service, a David Hardy painting print donated by Hardy Art and a Stephen Hawking boxed DVD set donated by Go Space Watch.

Refreshments including sandwiches, tea, coffee and a licenced bar was available during the day.

In the evening a private buffet dinner was served during which the Channel 4 Live Streaming broadcast of the Apollo 11 Moon landing was shown.

The feedback from the event was positive with everyone enjoying the lectures and exhibition. This was the first public event organised by Go Space Watch and there are plans for more in the future.

Michael and Pauline Bryce, Go Space Watch
www.gospacewatch.co.uk

Midlands Spaceflight Society

Contact

Dave Evetts, Secretary,
Midlands Spaceflight Society
124 Stanhope Rd, Smethwick
B67 6HP
Tel. 0121 429 8606
(evenings & weekends only) or
e-mail mss.shop@midspace.org.uk

Web Site:

www.midspace.org.uk

Contributions to CapCom

The Editor welcomes contributions for CapCom. Articles on any aspect of space exploration are considered. Articles in Word format or text files should be sent by email to

capcom.editor@midspace.org.uk

The Society is not responsible for individual opinions expressed in articles, reviews or reports of any kind. Such opinions are solely those of the author. Material published in CapCom does not necessarily reflect the views of the Society. Any comments directly concerning the magazine should be addressed to the Editor via the email address above.

Copy Deadline

All contributions intended for the November—December 2019 issue should be emailed to the editor by **Friday 11 October 2019**