Historian Corner

By Barb Sande
barbsande@comcast.net

Program Profile

This issue profiles the first Space Shuttle launch (*Columbia* – STS-1) in recognition of the 40th anniversary of that milestone event on April 12, 2021. The profile is primarily about the actual mission, significant events and the major anomalies that occurred. At the end of the profile are resources (links) used for this article as well as links to other historical documents about creating and designing the Space Shuttle program.

STS-1 Mission Overview

Launch: 04/12/1981 12:00:03 UTC LC-39A, KSC, Florida
Landing: 04/14/1981, 18:20:57 UTC, Edwards Air Force Base, California, Runway 23
37 orbits completed in 2 days, 6 hours, 20 minutes, 53 seconds
Orbiter Vehicle Designation (OV-102): *Columbia*
Mission Designation: STS-1
Insertion Altitude: 145 nautical miles at -25.6 degrees
Perigee: 152 nautical miles
Apogee: 172 nautical miles
Inclination: 40.3 degrees
Orbital period: 89.4 minutes
Launch Window Duration: 4.7 hours
Crew: Commander John W. Young, Pilot Robert L. Crippen
Connection to Lockheed Martin/ULA: The major contributions of our heritage companies to the Space Shuttle program are noted in appropriate points the profile and listed at the end of this profile, after the crew biographies and before the links to references.

Commander John Young and Pilot Bob Crippen in *Columbia* Photo Credit: NASA

A New Era Dawns in American Space Travel

Early on the morning of April 12, 1981, an estimated crowd of more than 600,000 spectators gathered near Kennedy Space Center, Florida, and cheered as the first launch of American astronauts in six years roared and crackled into the dawn sky at 7:00 am EST. STS-1 (Space Transportation System flight 1) was finally on its way to Earth orbit in a demonstration of new and unprecedented space technologies. These new technologies included the Rockwell-designed sophisticated winged, reusable orbiter vehicle (OV) that would be launched vertically and then re-enter and land on designated runways ("the spaceplane"); recoverable solid rocket boosters; and a huge expendable cryogenic oxidizer/fuel storage and transfer system known as the External Tank (built by Martin Marietta) for the SSMEs (Space Shuttle Main

Engines), which also carried the structural load of the orbiter during ascent. The OV was designed to carry as many as seven astronauts and had a large payload bay (60 feet by 15 feet). The STS-1 launch coincidentally occurred exactly 20 years after the first human spaceflight (Yuri Gagarin, Vostok 1, USSR); the first launch attempt was on April 10, which was scrubbed at T-18 minutes when the IBM System/4 Pi computers on-board *Columbia* failed to provide the correct timing to the Backup Flight System. That technical problem required a software update, delaying the launch 48 hours. STS-1 was the only human space system (so far) that did not have an unmanned test flight to space prior to the first crewed mission, although drop tests of the orbiter systems for landing operations were performed with OV-1 (*Enterprise)*.

The Veteran, the Rookie and their Objectives

The 2-person crew of STS-1 was commanded by the veteran astronaut and moonwalker John Young; STS-1 was his fifth space mission and his fourth distinct launch vehicle/spacecraft configuration (Gemini, Apollo Command Module, Apollo Lunar Module, STS). The pilot position was assigned to rookie Robert Crippen, who was first assigned to the MOL (Manned Orbiting Laboratory) program, then became part of Astronaut Group 7 after MOL was canceled. The backup crew was Commander Joe H. Engle and Pilot Richard H. Truly, who both flew on STS-2. Biographies of both prime crew members are provided later in this profile.

The mission objectives for STS-1 were to accomplish a safe ascent into orbit and return to Earth for a safe landing of the Orbiter and crew. The only payloads carried on the mission were a Development Flight Instrumentation (DFI) package, with sensors and enhanced instrumentation and an Aerodynamic Coefficient Identifications Package (ACIP) pallet, containing equipment for recording temperatures, pressures and acceleration levels. The crew also had on board Extravehicular Mobility Units in the event that an emergency spacewalk was required. Operation of the OV required 22 manuals weighing a total of 63 pounds, due to the complexity of the controls, including 2,214 switches and displays in the cockpit (three times as many as the Apollo Command Module). One has to admire the evolution of spaceflight with the sleek design seen recently in the SpaceX Crew Dragon crew cabin.

Ascent to Orbit

The launch of STS-1 was most impressive to the observers and the viewers watching on television. That group of viewers included a packed house in the Engineering building cafeteria at the Martin Marietta Waterton facility (including yours truly; many people came in early to see the launch). The Morton Thiokol SRBs provided a combination of nearly 6 million pounds of thrust (vacuum) and this was also the first use of solid rockets for human spaceflight; the SRBs were the source of the "crackling" noises heard during ascent. The SRB thrust was coupled with three Rocketdyne RS-25 liquid cryogenic SSMEs fed by tanks in the ET that created an additional thrust at lift-off of 1.25 million pounds. These two propulsion systems were required to lift a typical system stack weight of 4.5 million pounds. The SSMEs ignited first, at T-10 seconds during the countdown. At T-0, the SRBs ignited after the SSMEs were or above 90% rated thrust and the explosive bolts were detonated simultaneously, releasing the stack from the pad. John Young observed that they could clearly hear the roar of the SSMEs, then the SRB ignition "kick" felt like a catapult launch off an aircraft carrier! I was fortunate enough to see an early shuttle launch (STS-4) in person from the NASA causeway on June 27, 1982 and it was most impressive, although not quite as powerful a rocket as the Saturn V; I was also blessed to witness the launch of Apollo 15 in July, 1971 (that's a story for the next MARS STAR!). I also saw other STS launches and landings over the years supporting Titan activities at CCAFS or while on vacation in Florida.

After clearing the tower, STS-1 began a right roll to an azimuth of 067 degrees (True) to help achieve the orbital inclination of 40.3 degrees. Simultaneously, the stack pitched downward to reduce loading on the OV wings. Control was passed from the KSC launch team to Mission Control in Flight Control Room 1 in Houston, under the direction of the Silver Team Flight Director (Neil Hutchinson). Astronaut Dan Brandenstein functioned as CAPCOM (Capsule Communicator, usually an astronaut). Apollo program veteran Gene Kranz was in the background as the Mission Operations Director on STS-1.

STS-1 Clears the Tower, April 12, 1981
Photo Credit: NASA

The ascent events occurred as follows (in Mission Elapsed Time or MET):

1) Max Q (at Mach 1.06) occurred at 1:06 minutes MET; SSMEs were throttled down before Max Q to 65% thrust to reduce the aerodynamic stress. The wind-corrected value at Max Q was 4.21 pounds per square inch (predicted was 4.0 psi and the limit was 4.31 psi).
2) SRB separation occurred at 2:117 MET at an altitude of 174,000 feet. The SRBs performed better than planned, lofting the trajectory and separating 9,200 feet higher than predicted. The SRBs deployed parachutes upon descent for recovery at sea by one of two specially-rigged NASA ships (*Freedom Star, Liberty Star*).
3) MECO (Main Engine Cut-off) occurred at 8:34 MET at an altitude of 388,000 feet.
4) The ET was jettisoned at 8:52.1 MET and broke up during re-entry, impacting the Indian Ocean. This ET and the one used on STS-2 were painted white; the paint was considered unnecessary and added weight (over 350 pounds) that could be eliminated. Missions starting with STS-3 had no paint on the ET.
5) Burn 1 of the two OMS (Orbital Maneuvering System) hypergolic AJ10-190 engines (provided by Aerojet) occurred at 10:34 MET and lasted for 86.1 seconds. Young and Crippen were surprised at how loud the OMS engines were during operation ("it sounded like a big cannon just fired" according to Bob Crippen). Each OMS engine was capable of 6,000 pounds of thrust using MMH (monomethylhydrazine) and N2O4 (Dinitrogen Tetroxide) and they could be reused for 100 missions or 1,000 starts. The OMS was co-housed with the aft Reaction Control System (RCS) engines, which were also hypergolic.
6) Burn 2 of the two OMS engines occurred at 44.02 MET for 74.8 seconds. This resulted in an orbit of 152.7 nm by 153.9 nm. The intended orbit was supposed to be precisely 150 nm circular. The reason for the subtle orbital change is explained in the section about the concerns for the Thermal Protection System.

Columbia **Achieves Orbit**

Once in orbit, Young and Crippen safed their ejection seats and unstrapped to start moving around the very roomy crew quarters, as compared to previous programs other than Skylab (Mercury, Gemini, Apollo). The next critical event was the opening of the payload bay door, which was essential to cooling of the OV via the door's space radiators. Failure to open the door would require an abort of the mission by orbit number 5. Fortunately, the door opened, but the crew observed that there was damage to the TPS tiles on the OPS pods, including several missing tiles; images of this damage were relayed to the ground.

The crew changed out of their ejection suits and began a series of systems tests of the OV. All of the mission objectives were accomplished, including Crew Optical Alignment Sight (COAS) calibration, star tracker performance, IMU (Inertial Measurement Unit) performance, manual and automatic RCS testing, radiation measurements, propellant cross-feeding for the OMS, hydraulics functioning, fuel cell purging and photography.

Two burns of the OMS engines, at 6:20:46 MET and 7:05:32 MET, raised the final orbit to 170.2 nm by 170.3 nm; the two burns demonstrated the single-engine cross-feed capability of the OMS system. The crew complained about the cold temperature conditions on-board during the first sleep period, which was alleviated by doing some temperature adjustments.

While conducting their on-orbit tasks, Crippen took time to pay tribute to three pad personnel who lost their lives after an incident on March 19, 1981 while processing *Columbia*. During a countdown test, a pure nitrogen atmosphere was introduced in the aft compartment of the OV to reduce the danger of explosion. The pad workers were given clearance to return to the work on the OV before the nitrogen was purged (a procedural error). John Bjornstad, Forrest Cole and Nick Mullen entered the compartment and lost consciousness. They were seen by another worker who tried to help, but also passed out; a security guard was alerted and another pad crew worker went in to help. The security guard, with an air pack, removed the five men from the compartment. Security procedures delayed the ambulances and Bjornstad died at the scene, Cole died the next day, and Mullen died on April 11. A three-month inquiry was held to ensure that pad safety procedures and communications were improved.

During the second day of the mission, the astronauts received a congratulatory phone call from Vice-President George H.W. Bush. President Reagan had sent his best wishes prior to launch but was still recovering from his attempted assassination that took place on March 30, 1981. The crew settled in for the second sleep period, waking earlier than usual because of the complex series of events about to unfold during re-entry and landing.

Worries About the Thermal Protection System

One of the biggest dramas of the short STS-1 flight revolved around the silica heat shield tiles. Previous spacecraft re-entering Earth's atmosphere used heavy ablative heat shields that were planned to be used once and burned off during re-entry. The Shuttle OV design required a light, reusable heat shield system, limiting designs to a few cutting-edge technologies that were available in the early 1970s. Before the stacked system finally launched, OV-2 (*Columbia*) had over two years of delays at Rockwell and in the Orbiter Processing Facility (OPF) at KSC having many of the fragile Thermal Protection System (TPS) heat shield tiles replaced, often more than once.

The TPS was mission critical and relied on several different technologies; the High-Temperature Reusable Surface Insulation (HRSI) tiles were among the most problematic subsystems before the long-delayed launch of STS-1. 20,548 of these HRSI tiles, manufactured by Lockheed Missiles and Space, covered the landing gear doors, the External Tank (ET) umbilical connection doors, and the orbiter's underside surfaces and each one took as long as 40 hours to place on the OV. Each HRSI tile was serialized and had a specific location on the orbiter and was composed of pure porous silica (Li-900) with a coating of Reaction Cured Glass to increase the heat sink properties. The tiles were glued to strain pads, which were then glued to the OV structure using RTV (room temperature vulcanizing) adhesive; they would fall off or were easily damaged during handling and were expected to withstand temperatures from -454 degrees F (space) to 2,300 degrees F (re-entry temperatures).

Example of an HRSI TPS Tile
Photo Credit: Science Museum of London, 1980

Low-Temperature Reusable Surface Insulation Tiles (LRSI) were used on the upper fuselage and parts of the OMS (Orbital Maneuvering System) Pods. Reinforced Carbon-Carbon (RCC) was used on the nose cap, landing gear doors (forward) and the orbiter wing leading edges due to its ability to withstand temperatures greater than 2,300 degrees F. This last system (RCC) was breached on the left leading edge wing by foam debris from the ET during the launch of STS-103 in January, 2003; this breach allowed for super-heated gases to cause the complete disintegration of the OV (*Columbia*) with the corresponding loss of the seven-person crew during re-entry on February 1, 2003.

The crew was unaware at the time of lift-off, but the mission directors and senior leadership at NASA were so concerned about the integrity of the heat shield tiles that they planned on an subtle orbital change to have the OV in place to be imaged by a classified spacecraft that was in another orbit (and also to take into account the 48-hour launch delay); this orbital change required a 4-second delay of T-0 into the window. As noted previously, the LRSI tiles on the OMS pods were damaged, exacerbating the concerns for the more critical HRSI tiles. The results of the imaging were not available for public release, nor were the details discussed publicly. However, the imaging apparently did relieve some of the concerns that the OV could burn up on re-entry.

Columbia **Returns to Earth**

The Crimson Flight Team, led by flight director Don Puddy and CAPCOM Joe Allen came on-board in Houston to support the preparations for the de-orbit burn and re-entry. The first critical event was the closing of the payload bay doors; Crippen was trained to do a one-person EVA if necessary to manually winch the doors closed if the power system had failed. Fortunately, no problems occurred and the crew strapped into their ejection seats after ensuring all cabin switch positions were in the proper state.

Meanwhile, at Edwards Air Force Base, a crowd of more than 225,000 spectators was gathering, overwhelming the access roads and crowd control measures. I moseyed over that day to the Waterton Engineering building cafeteria (I worked in the same building for Titan Airborne Electrical Design) and joined the huge crowd there waiting to see the landing on TV. JSC (Johnson Space Center) pilots Charlie Hayes and Ted Mendenhall were airborne over Edwards, checking weather conditions while flying one of the Shuttle Training Aircraft (STA), a modified Grumman Gulfstream II that was used to evaluate approach and landing conditions for returning shuttle missions. The OVs were essentially very heavy gliders, with no atmospheric engines, and each landing was a one-shot deal, with no opportunity to "go around" and try again. The fleet of four STAs would simulate the landing conditions so that the optimal landing approach could be relayed to the crew (STS-1 was mostly an automatic de-orbit and landing).

On-board *Columbia,* Auxiliary Power Units (APUs) 2 and 3 were started to provide flight control hydraulic pressure. On the 37th orbit over the southern Indian Ocean, the two OMS engines did a 160-second de-orbit burn, ensuring

atmospheric capture of the OV close enough to the landing site to have sufficient energy for the controlled glider landing, while also ensuring that the energy dissipation would not exceed structural capabilities. Young slowly pitched *Columbia* up to the nose high entry attitude; he and Crippen armed their ejection seats during this pitch around. APU 1 started about 30 minutes later, then shortly afterwards Columbia entered a 21-minute communications blackout (a combination of ionization and lack of ground station coverage across the mid-Pacific). Entry Interface (EI) was reached over the eastern Pacific Ocean 5,040 miles from Edwards at a speed of 17,550 mph. EI is nominally a geodetic altitude of 400,000 feet.

Most of this first OV re-entry was flown automatically. The initial angle of attack of 40 degrees had to be maintained through the most severe aerodynamic heating, after which it was gradually reduced. *Columbia* also had to maneuver "cross-range" over 362 miles of its orbital ground track to reach the planned landing site. When air density reached around 12 lb/sq ft, a roll into a right bank was performed (at a speed in excess of Mach 24 and at an altitude of 255,000 feet). Automatic roll reversals to control the energy dissipation rate and cross-range steering were performed at Mach 18.5 and Mach 9.8. Young and Crippen were able to observe the coast of California as *Columbia* crossed near Big Sur at 135,000 feet and Mach 8. The Mach 4.8 and Mach 2.8 roll reversals were automatically initiated and manually completed by Young. The last RCS firing took place at an altitude of 56,000 feet (lower than desired due to a predicted risk of combustion chamber explosion).

Young again took manual control for the remainder of the flight as the OV went subsonic, approaching the critical Heading Alignment Circle (HAC) near Edwards. A wide left turn was flown to line up with Runway 23 (lake bed) while the *Chase 1* T-38 (with astronauts Jon McBride and "Pinky" Nelson) joined the formation. The main gear touched down on runway 23 at 211 mph equivalent airspeed at 10:21 am PST on April 14, 1981, about ½ mile further down the runway than planned and slightly slower. John Young radioed the following as they rolled to a stop: "This is the world's greatest all-electric flying machine. I'll tell you that. That was super!". The crew waited for hazardous operations to give the green light (due to the hypergolics on-board the OMS and RCS) before descending from the OV and giving it a once-over and "kicking the tires". *Columbia* was returned to KSC atop one of the Shuttle Carrier Aircraft (modified Boeing 747s). After processing and anomaly corrective actions were implemented in the OPF in the VAB, STS-2 was rolled out and launched on November 12, 1981. The STS program was now underway!

STS-1 Landing, Edwards AFB, April 14, 1981
Photo Credit: Nasa

Significant Anomalies on STS-1

Approximately 70 anomalies were recorded during launch, orbital operations, and entry/landing during the STS-1 flight. A link to the full list of anomalies is provided at the end of the profile. The most significant anomalies are noted below:

1. Probably most significantly along with the TPS concerns, dynamics engineers seriously underestimated the amount of noise and vibration just after T-0. Shock waves from the SRBs were deflected up into the OV's tail section, leading to concerns for structural damage (and actual damage, which was discovered after the flight).

An improved water suppressant system was later installed on LC-39A before the STS-2 mission to dampen the vibrations. This overpressure deformed the FRCS (forward RCS) strut, causing it to fail at the Z-point. The same overpressure wave also forced the "body flap" (an extension on the OV underside that helps control pitch during re-entry) into an angle that *should* have ruptured the hydraulic system, nullifying any control authority during re-entry. Young stated at a later review that if they had known about the damages, they likely would have ejected during ascent; he was a skeptic about being able to survive that ejection.

2. During ascent up to SRB separation, Crippen reported seeing "white stuff" (likely paint) coming off the ET and splattering the windows. The white paint only lasted one more flight before being removed from the ET thermal foam.
3. As noted in previous paragraphs, the crew observed significant damage to the thermal protection tiles on the OMS/RCS pods at the OV's aft end. Post-flight inspection of *Columbia* confirmed that 16 undensified or low-temperature tiles near the OMS pods were lost during ascent. Design improvements to the TPS were an on-going science project during the 30-year course of the shuttle program.
4. *Columbia's* aerodynamics at high Mach numbers during re-entry differed significantly from pre-flight estimates. A misprediction of the location of the center of pressure caused the computer to extend the body flap by sixteen degrees rather than the expected eight or nine degrees. Also, the first roll maneuver resulted in lateral and directional oscillations that created side slip angles up to 4 degrees (twice predicted). This was due to the moments created by yaw RCS jet firings.
5. The ET tumble system after separation did not work.
6. Both radar altimeters lost lock at 75 feet above the ground (no valid data after that point).
7. The strike plate next to the forward latch of *Columbia's* ET door was melted and distorted during re-entry. This was attributed to an improperly installed tile adjacent to the plate.
8. The Payload Bay Door (PLBD) closure overlap was more than predicted. It was in excess of 3 inches at the number 12 hatch location; maximum design capability was 4 inches.
9. Cabin temperature controllers did not maintain selected temperatures.
10. The nose gear door thermal barrier fell off during landing gear deployment and was found 1.5 miles before touchdown point.
11. The right-hand main landing gear door buckled due to excessive heating during re-entry. John Young claimed he was unaware of this major anomaly until many years after the flight.
12. Three pad crew members were killed by suffocation due to exposure to 100% nitrogen in the OV engine compartment on March 19, 1981. A separate review board was convened for that incident and procedural corrective actions were implemented.

Forty Years Later…

The space shuttle program ended ten years ago with the 135th mission, STS-135 (*Atlantis)*, which launched on July 8, 2011 and landed at KSC on July 21, 2011. The program had enormous costs, both operationally and from a loss of OVs and crew due to the high risks associated with the stacked system design (*Challenger*, *Columbia*, 14 astronauts, several lives lost in ground incidents, including the three referenced in this profile who died just before the STS-1 launch). Many milestones were accomplished by the shuttle program, including deployments of Spacelab, major elements of the International Space Station, key interplanetary and observational payloads (Magellan, Galileo, Ulysses, Hubble Space Telescope, Chandra X-Ray Observatory) and several other NASA, Commercial and DoD payloads. The times have changed and we have now moved into the era of creative disruptors in the space business, like SpaceX, Sierra Nevada (Dreamchaser is another spaceplane concept), Blue Origin, Electron Space, Relativity and Virgin Galactic and NASA plans are still in work (as of mid-2021) to launch the Orion program using the Artemis launch system. An interesting summary of the shuttle program by mission is included in the links. Travelers interested in seeing the remaining OVs can view *Atlantis* at KSC, *Discovery* at the Udvar-Hazy Center near Washington, D.C., *Endeavour* at the California Science Museum, and the drop vehicle *Enterprise* at the Intrepid Air and Space Museum in New York.

STS-1 and STS-135 Crews Meet in 2011
From Left: Doug Hurley, Robert Crippen, John Young, Chris Ferguson, Sandy Magnus, Rex Walheim
Photo Credit: Nasa

John Young Biography

John W. Young was born in San Francisco, California on September 24, 1930. His father, William Young, lost his job during the Great Depression and the family moved to Georgia in 1932, then on to Orlando, Florida, in 1936. His mother was diagnosed with schizophrenia and was committed to the Florida State Hospital. John and his brother Hugh were left in the care of a housekeeper when their father joined the Navy during WWII; the father returned after the war and managed a citrus company. John attended Orlando High School, graduating in 1948.

Young received a Navy ROTC scholarship to the Georgia Institute of Technology, completing a midshipman cruise aboard the USS *Missouri*, where he worked alongside future Apollo 10 crewmate Tom Stafford. He graduated second in his class with a B.S. in Aeronautical Engineering and was commissioned in the US Navy in 1952. In 1953, he received orders to go to flight school at Naval Air Station Pensacola and was selected for helicopter training, but also flew fighter aircraft. He received his aviator wings in December, 1954 and was assigned to Fighter Squadron 103 at NAS Cecil Field and was deployed with the Sixth Fleet on the USS *Coral Sea.* He returned home to enroll in the Naval Test Pilot School, graduating second in his class again and working alongside future astronaut Jim Lovell.

In September 1962, Young was selected to join NASA Astronaut Group 2 and he moved with his family to Houston. He was selected as the pilot of Gemini 3, which was commanded by Gus Grissom. Gemini 3 launched on March 23, 1965; Grissom and Young successfully conducted orbital maneuver tests and part of the biological experiments and re-entered on the third orbit. The Gemini capsule landed 52 miles short of its target area and the crew waited more than 30 minutes for the rescue helicopters. Young gained infamy for having smuggled a corn beef sandwich on-board during the flight (the House Appropriations Committee actually held a hearing on that "incident").

Young and Mike Collins were assigned as the Gemini 10 Commander and Pilot in January, 1966. The primary mission of Gemini 10 was to dock with the assigned Agena target vehicle, a failed objective from the Gemini 8 and 9 missions. The Agena and Gemini 10 launched on July 18, 1966 and the crew was successful in rendezvousing and docking with the target vehicle. Using the Agena's engines, Gemini 10 maneuvered to a 180 by 470 mile orbit, setting a new altitude record, they then rendezvoused with the Gemini 8 Agena and immediately set another record of 475 miles. After returning to a lower orbit, Collins performed a stand-up EVA in the door of the capsule. After undocking from their own Agena, they returned to the Gemini 8 Agena and performed another successful rendezvous; Collins conducted an EVA to the nearby target vehicle and retrieved a micrometeorite experiment package. Re-entry on July 21 was in the western Atlantic Ocean, very close to the recovery vehicle. If I am still the historian in a few years, I hope to write the detailed stories of the Gemini missions for their 50th anniversaries (and that would include the Titans!).

Young, of course, had great success on the Apollo program. He was the command module pilot on Apollo 10, the "dress rehearsal" for the lunar landing that took place in May, 1969. He then commanded the Apollo 16 mission in April, 1972. The Apollo 10 mission was profiled in a MARS STAR in 2019 and the Apollo 16 mission will be examined in a MARS STAR Historian Corner profile for its 50th anniversary in 2022.

In January, 1973, Young was made Chief of the Space Shuttle Branch of the Astronaut Office. He then succeeded Alan Shepard as Chief of the Astronaut Office. He flew T-38 chase planes for several of the Approach and Landing Tests of the *Enterprise*. He resigned with the rank of Captain from the USN in 1976. In 1978, Young was assigned as Commander of the first STS mission, which was delayed until 1981 because of the TPS problems described elsewhere in this article. This energetic and driven astronaut was not done with space travel after STS-1, though. He also commanded STS-9 (*Columbia*) in November, 1983 with Brewster Shaw, Owen Garriott, Robert Parker, Byron Lichtenberg and West German Astronaut Ulf Merbold. This mission was the first to carry the Spacelab module into orbit.

Young remained as chief of the Astronaut office and was very critical of NASA management following the *Challenger* disaster in January, 1986; he testified before the Rogers Commission and suggested improvements to the system safety program. He was scheduled to fly as the Commander of STS-61-J to deploy the Hubble Space Telescope, but that mission was postponed for several years. He was replaced as Chief of the Astronaut Office in 1987 and he believes his reassignment to the Engineering, Operations and Safety Directorate was because of his public criticisms of system safety. He worked on several safety improvements, then was assigned in 1996 to be an Associate Technical Director for the development of the MIR and ISS programs. Young retired from NASA on December 31, 2004. He worked as a public speaker and advocated the importance of asteroid impact avoidance, colonization of the Moon, and climate engineering. His autobiography "Forever Young" was published in 2012, co-authored by James Hansen.

Young married Barbara White from Savannah, Georgia in December, 1955 and they had two children and two grandchildren. They were divorced in 1971 and he married Susy Feldman and resided in Houston. One of the most admired pilots, astronauts and administrators in NASA's history passed away at 87 on January 5, 2018 of complications from pneumonia and he was interred at Arlington National Cemetery. He received many honors and awards during his lifetime, along with inductions into several Aviation and Space Halls of Fame; if you ever drive from Orlando airport to Walt Disney World, you likely will be on Florida Turnpike 423, now named the John Young Parkway.

Robert L. Crippen Biography

Robert Crippen was born in Beaumont, Texas on September 11, 1937. After graduating from New Caney High School in New Caney, Texas in 1955, he enrolled at the University of Texas at Austin and received a B.S. degree in Aerospace Engineering. He was commissioned in the Navy through the Officer Candidate School program at Naval Air Station Pensacola. He was a naval aviator from mid-1962 until the end of 1964, then enrolled in the USAF Aerospace Research Pilot School at Edwards AFB. In October, 1966, he was selected for the USAF Manned Orbiting Laboratory (MOL) program as part of the second group of astronauts for that military program.

The MOL program was a joint venture between the USAF and the National Reconnaissance Office. Using a modified Gemini B capsule for the crew and Titan IIIM launch vehicle, the two-person crews would spend up to 40 days in polar orbit in the MOL Space station performing a variety of functions, including classified reconnaissance. An early test flight was conducted with a Titan IIIC on November, 3, 1966, with a refurbished Gemini spacecraft. The program was canceled in June, 1969, by President Nixon with much of the work already done to facilities at SLC-6 at VAFB and in the development of the stacked systems. Folks that worked at Martin Marietta during this time have told stories of having drawings done and released, only to have it all yanked away because of budget cuts. Crippen, along with several other MOL astronauts, became part of NASA Astronaut Group 7 in September, 1969.

Crippen participated in the Skylab Medical Experiment Altitude Test, a 56-day mission in 1972 in a vacuum chamber, examining how crews would handle long-term minor medical emergencies. Crippen also functioned as a CAPCOM for the Skylab and Apollo-Soyuz missions; he then moved on to support of the Approach and Landing (ALT) tests for Space Shuttle *Enterprise.* He was then assigned as pilot for STS-1.

After STS-1, Crippen went on to command three more shuttle missions. STS-7 (*Challenger*) was launched on June 18, 1983 and the crew deployed two commercial satellites and performed several experiments before landing on June 14. STS-41-C (*Challenger)* launched on April 6, 1984 and landed on April 13; this mission deployed the Long Duration Exposure Facility and the crew retrieved and repaired the Solar Maximum Mission. The flight also tested the Manned Maneuvering Units (MMUs) for the first time. STS-41-G (*Challenger)* launched on October 5, 1984 and deployed the Earth Radiation Budget Satellite and performed scientific experiments, landing on October 13, 1984.

After STS-41-G, Crippen was named commander of STS-62-A, which would have been the first shuttle launch from SLC-6 at VAFB, scheduled for July, 1986. That mission and all other VAFB shuttle operations were canceled after the *Challenger* disaster in January, 1986. Crippen probably felt like he was part of the "curse" of SLC-6, between the MOL program and this turn of events. He was part of the Mishap Review Board for the Challenger accident; starting in 1987, he was the Deputy Director of Shuttle Operations at KSC, then served as Director of the Space Shuttle program at NASA headquarters from 1990 to 1992, returning to KSC to be the site director until 1995.

Crippen left NASA in 1995 and was hired as the Vice President of Lockheed Martin Information Systems, leaving that job in 1996 to become President of Thiokol Propulsion, retiring in April 2001. He was married to Virginia Hill in 1959 and they had three daughters together and were later divorced; in 1987 he married Pandora Puckett, the first female lead Orbiter Project Engineer on the Space Shuttle Program. He is retired to private life in Florida and also had many awards and halls of fame inductions through his illustrious career.

Lockheed Martin Heritage Company Contributions

The largest subsystem for the STS stack was the External Tank, built by Martin Marietta/Lockheed Martin in Michoud, Louisiana. 135 external tanks were delivered and used in operations; the tank for STS-51-L (*Challenger*) did not achieve orbit and foam debris from the tank for STS-103 resulted in damage to the TPS on the OV (*Columbia*), resulting in loss of the OV during re-entry. The ET provided about 180,000 pounds per minute of liquid hydrogen and 67,000 pounds per minute of liquid oxygen to all three SSMEs. The ET was 153.6 feet long, with a diameter of 27.6 feet.

Lockheed Missiles and Space Systems designed and produced the TPS silica tiles used on the OV (see the section on the TPS in the profile).

Lockheed Martin and Rockwell/Boeing joined forces to form United Space Alliance in 1995, which became responsible for processing the shuttle fleet and ISS components at JSC and KSC. The joint venture was disbanded in 2019.

NOTE: A search for a complete list of subcontractors and suppliers for the Space Shuttle program was unsuccessful, with promising links through the NASA portals met with "denied access" results.

Resources and Links

NASA References

The Space Shuttle Decision
https://history.nasa.gov/SP-4221/sp4221.htm
History of the Space Shuttle (NASA Portal – some links are not available)
https://history.nasa.gov/shuttlehistory.html
The Space Shuttle and Its Operations
https://www.nasa.gov/centers/johnson/pdf/584722main_Wings-ch3a-pgs53-73.pdf
Processing the Shuttle for Flight
https://www.nasa.gov/centers/johnson/pdf/584723main_Wings-ch3b-pgs74-93.pdf
Space Shuttle Missions Summary
https://historycollection.jsc.nasa.gov/JSCHistoryPortal/history/reference/TM-2011-216142.pdf
STS-1 Anomaly Archive
https://web.archive.org/web/20061007035617/http://www.jsc.nasa.gov/news/columbia/anomaly/STS1.pdf
The External Tank
https://www.nasa.gov/returntoflight/system/system_ET.html
STS-1 40th Anniversary Histories
https://www.nasa.gov/subject/3299/sts1/

Space Shuttle Era Facts
https://www.nasa.gov/pdf/566250main_2011.07.05%20SHUTTLE%20ERA%20FACTS.pdf

Wikipedia Articles

Space Shuttle Program
https://en.wikipedia.org/wiki/Space_Shuttle_program
STS-1
https://en.wikipedia.org/wiki/STS-1
Space Shuttle Thermal Protection System
https://en.wikipedia.org/wiki/Space_Shuttle_thermal_protection_system
John Young Biography
https://en.wikipedia.org/wiki/John_Young_(astronaut)
Robert Crippen Biography
https://en.wikipedia.org/wiki/Robert_Crippen

On This Date in History

This section has milestones retrieved from publicly available information for LM, ULA and heritage programs from 10 to 60 years ago (2011, 2001, 1991, 1981, 1971, 1961). Delta launches prior to the formation of ULA, unless it included an LM or heritage company payload or upper stage, are not listed. No classified programs are identified, even if the program is now considered unclassified, with the exception of the Discoverer program (Corona). The events reflect milestone activity in the quarter previous to the release of the MARS STAR -- where appropriate, key press releases are also included; significant milestones are in bold. The list is not intended to be all-inclusive due to historical record inaccuracies. Occasionally, a major space milestone not accomplished by any of our heritage programs will be included due to its significance.

Events in April (10 to 60 years ago)

- **04/11/2011: Lockheed Martin Press Release: Lockheed Martin ships Juno Spacecraft to NASA**
- 04/14/2011: USA-229 launched by ULA Atlas V-411 from SLC-3E, VAFB
- **04/07/2001: LM 2001 Mars Odyssey launched by Delta II 7925-9.5; SLC-17A, CCAFS; As of 6/10/2021, Mars Odyssey is still operational**
- 04/19/2001: STS-100 (*Endeavour*) launched, LC-39A, KSC; 7-person crew, ISS mission with Canadarm2 and Raffaello module
- 04/06/1991: STS-37 (*Atlantis*) launched, LC-39B, KSC; 5-person crew, deployed Compton Gamma Ray Observatory
- 04/15/1991: Lockheed UGM-133 Trident II launched, USS *West Virginia*, ETR
- 04/18/1991: MM MGM-134 (Midgetman) launched, TP-01, VAFB
- 4/18/1991: Yuri 3H launched by GD Atlas I, LC-36B, CCAFS – **FAILURE –** upper stage turbopump
- 4/28/1991: STS-39 (*Discovery*) launched, LC-39A, KSC; 7-member crew, DoD experiments
- 04/01/1981: Lockheed UGM-96 Trident 1 launched, USS *Simon Bolivar,* ETR
- 04/07/1981: Three MM MGM-31A Pershings launched, LC-16, CCAFS; incomplete information
- **04/12/1981: STS-1 (*Columbia*) launched, LC-39A, KSC; first shuttle flight, subject of the program profile in this MARS STAR**
- 04/24/1981: Classified program launched by MM Titan III (34)B, SLC-4W, VAFB
- 04/05/1971: LAR-1 launched by GD Atlas E/F, ABRES-A-1, VAFB
- **04/19/1971: Salyut 1 launched by Proton-K, Baikonur 81/24, USSR – first manned space station (item of historical significance)**
- 04/22/1971: Classified program launched by MM Titan III(23)B, SLC-4W, VAFB; final flight of Titan III(23)B
- 04/08/1961: Discoverer 23 launched by Thor DM-21 Lockheed Agena B, LC-75-3-5, VAFB
- 04/11/1961: Lockheed UGM-27 Polaris A2 launched (two), LC-29A, CCAFS; **FAILURES**
- **04/12/1961: VOSTOK-1 launch, Baikonur 1/5, USSR; First man in space (Yuri Gagarin) – significant space milestone**
- 04/19/1961: Lockheed UGM-27 Polaris A1 launched, USS *Robert E. Lee*, ETR
- 04/21/1961: MM MGM-31 Pershing 1 launched, LC-30A, CCAFS
- **04/25/1961: Mercury-Atlas 3 launched by GD Atlas LV-3B, LC-14, CCAFS; FAILURE, destroyed by range after guidance failure**

Events in May (10 to 60 years ago)

- **05/07/2011: LM SBIRS-GEO 1 (first SBIRS) launched by ULA Atlas V-401, SLC-41, CCAFS**
- **05/16/2011: STS-134 (*Endeavour)* launched, LC-39A, KSC; last flight of Endeavour, 6-person crew, ISS mission**
- **05/25/2011: Lockheed Martin Press Release: NASA Selects OSIRIS-REx as next New Frontiers Mission**
- NO EVENTS IN MAY 2001
- 05/10/1991: Lockheed UGM-96 Trident I launched (two), USS *Mariano G. Vallejo*, ETR
- 05/14/1991 RCA NOAA-12 launched by GD Atlas E, SLC-3W, VAFB
- 05/23/1981: Intelsat V F-1 launched by GD Atlas SLV-3D Centaur-D1AR, LC-36B, CCAFS
- 05/05/1971: DSP launched by MM Titan III(23)C, LC-40, CCAFS
- 05/09/1971: Mariner 8 launched by GD Atlas SLV-3C Centaur D, LC-36A, CCAFS; **FAILURE** – gyroscope malfunction upper stage
- **05/30/1971: Mariner 9 launched by GD Atlas SLV-3C Centaur D, LC-36B, CCAFS; first spacecraft to orbit Mars**
- 05/01/1961: Lockheed UGM-27 Polaris A2 launched, LC-29A, CCAFS
- 05/01/1961: Lockheed UGM-27 Polaris A1 launched, USS *Abraham Lincoln*, ETR
- **05/05/1961: Mercury-Redstone 3 launched, LC-5, CCAFS; First American in space (Alan Shepard – see the article in the second quarter MARS STAR)**
- 05/08/1961: Lockheed UGM-27 Polaris A2 launched, LC-29A, CCAFS
- 05/13/1961: GD SM-65E Atlas launched, LC-11, CCAFS
- 05/17/1961: Lockheed UGM-27 Polaris A1 launched (5 missiles), USS *Abraham Lincoln*, ETR
- 05/19/1961: MM MGM-31 Pershing 1 launched, LC-30, CCAFS
- 05/23/1961: MM HGM-25A Titan I launched, LC-20, CCAFS
- 05/24/1961: GD SM-65D Atlas launched, LC-576B-2, VAFB
- 05/25/1961: Lockheed UGM-27 Polaris A2 launched, USNS Observation Island, ETR
- 05/26/1961: GD SM-65E Atlas launched, LC-13, CCAFS

Events in June (10 to 60 years ago)

- **06/10/2011: SAC-D launched by ULA Delta II 7320, SLC-2W, VAFB; last 7300 Delta II launch**
- 06/19/2001: ICO F2 launched by LM Atlas IIAS, SLC-36B, CCAFS
- 06/05/1991: STS-40 (*Columbia*) launched, LC-39B, KSC; 7-person crew, SLS-1 Spacelab
- 06/19/1981: Four Lockheed UGM-73 Poseidon C3 missiles launched, USS *Lewis and Clark*, ETR
- 06/23/1981: RCA NOAA-7 launched, GD Atlas E/F Star-37A-ISS, SLC-3W, VAFB
- **06/15/1971: Classified program launched by MM Titan III(23)D, SLC-43, VAFB; first flight of Titan IIID**
- 06/20/1971: MM LGM-25C Titan II launched, LC-395C, VAFB
- 06/29/1971: RVTO-2A-3 launched by GD Atlas E/F, ABRES A-3, VAFB
- 06/07/1961: GD SM-65E launched, OSTF-1, VAFB; **FAILURE**
- 06/08/1961: Discoverer 24 launched, Thor DM-21 Lockheed Agena-B, LC-75-3-4; **FAILURE**
- 06/09/1961: MM MGM-31 Pershing 1 launched, LC-30, CCAFS
- 06/12/1961: Lockheed UGM-27 Polaris A2 launched, LC-25A, CCAFS
- 06/16/1961: Discoverer 25 launched, Thor DM-21 Lockheed Agena-B, LC-75-1-1
- 06/23/1961: GD SM-65E Atlas launched, LC-11, CCAFS; **FAILURE**
- 06/24/1961: MM HGM-25A Titan I launched, LC-19, CCAFS; **FAILURE**
- 06/26/1961: Lockheed UGM-27 Polaris A2 launched, USNS Observation Island; **FAILURE**

Reference websites:
https://nssdc.gsfc.nasa.gov/planetary/chronology.html#2014
https://en.wikipedia.org/wiki/Timeline_of_spaceflight
https://www.ulalaunch.com/missions
https://news.lockheedmartin.com/news-releases?year=2021
https://space.skyrocket.de
http: www.astronautix.com

Next Edition

Check the next MARS STAR for the story of the, the Apollo 15 mission. The profile will blend the usual technical details of the mission with my personal remembrances of seeing the launch in 1971 and later meeting Astronaut Jim Irwin while I was in college. The History on the Road stories will be reinstated in a later MARS STAR.

Barb Sande, MARS STAR and MARS Facebook Page Historian. Contact me at barbsande@comcast.net or 303-887-8511 or find MARS Associates on Facebook.