



Launch nears for STS-103

It is a mantra often heard from the management of NASA and Kennedy Space Center: Safety comes first.



The agency and KSC proved their education to that motto

with the massive and meticulous inspections and repairs of the four Space Shuttle vehicles following an electrical problem during the launch of STS-93 in July.

The undertaking has been tedious for KSC workers, but Shuttle processing teams have carried out their role.

The most detailed examination of the Space Shuttle fleet in more than a decade will culminate with the launch of the orbiter Discovery on mission STS-103, the final Shuttle mission of the year.

The crew of Discovery will embark on the third servicing of the Hubble Space Telescope. Four spacewalks are planned during the flight.

The mission will be led by Commander Curtis L. Brown Jr. Scott J. Kelly will serve as Pilot and Steven L. Smith as Payload Commander. The Mission Specialists are C. Michael Foale, John M. Grunsfeld and Claude Nicollier and Jean-Francois Clervoy of the European Space Agency.

Spaceport News

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John F. Kennedy Space Center

FOOTPRINT on a century

As the 1900s dawned, space flight existed only in the imaginations of a few authors of fiction. As the century wanes, space flight is a reality taken for granted by all.

In a century dominated by rapid technological vaults, the most profound achievement has been the human conquest of space. And the epicenter of that previously unimaginable endeavor has been a swath of land straddling the Banana River on Florida's East coast – Cape Canaveral and Kennedy Space Center.

On July 24, 1950, a two-stage rocket called Bumper soared above the scrub land of Cape Canaveral, christening what would become the world's space flight capital.

KSC employees are well acquainted with the historic successes that followed, from the Mercury and Gemini programs through Apollo and the Space Shuttle and, finally, the beginning of construction of the International Space Station.

As KSC peers into the year 2000 and beyond, more sophisticated forms of space travel exist not in the exotic realm of science fiction but in the plans of NASA managers. Those plans already are taking shape in many projects at KSC.

With this issue, we offer a pictorial history of space flight on pages 2 through 5.

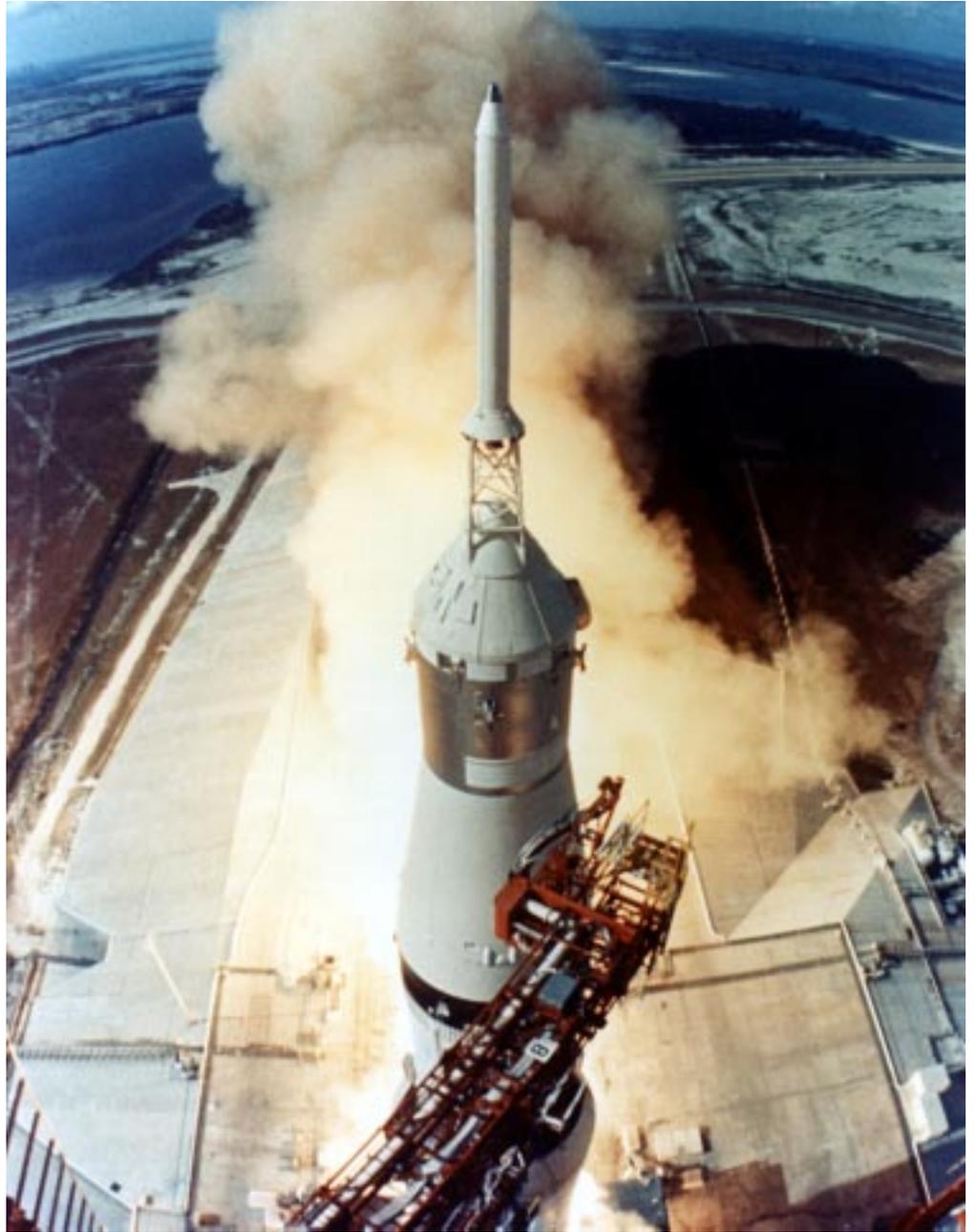


Clockwise from right: The original seven Project Mercury astronauts. ... The Gemini 7 capsule, carrying astronauts Frank Borman and James Lovell, is seen from the Gemini 6A capsule during a rendezvous in space. ... Astronaut Gordon Cooper walks from his living quarters at Hangar S early on May 15, 1963, trailed by Dr. H.A. Minners, Crew Flight Surgeon. Cooper was driven to Launch Complex 14 and launched on Faith 7, NASA's fourth manned orbital mission. ... An interior view of the Mission Control Center at KSC during the launch sequence of Sigma 7 on Oct. 3, 1962. ... A Mercury-Atlas 7 lifts off from Complex 14 on May 24, 1962. The rocket, named Aurora 7, carried astronaut Scott Carpenter on NASA's second manned orbital mission.





Clockwise from right: The swing arms of Launch Pad 39A move away and smoke rises as the Apollo 11 vehicle lifts off at 9:32 a.m. on July 16, 1969. The mission resulted in the first landing on the moon. ... Members of the Apollo 11 launch team watch anxiously from their consoles in the Launch Control Center in the final moments before liftoff. ... During pre-launch activities for Apollo 15 on July 26, 1971, a technician helps astronaut James B. Irwin with his suit in what was then known as the Manned Spaceflight Operations Building. ... An expended Saturn IVB stage drops away from the Apollo 7 module during transportation and docking maneuvers.



The rollout of history

If the ancient Greek myth of Icarus and Daedalus is any indication, people have fantasized about flying for many millennia. Daedalus fashioned wings of feathers and wax that were strapped onto his son and himself to flee their place of exile by flying. The road from mythology to actual flight, and especially into space, however, took more than dreams plus many centuries of discoveries and inventions, most of them in the 20th century.

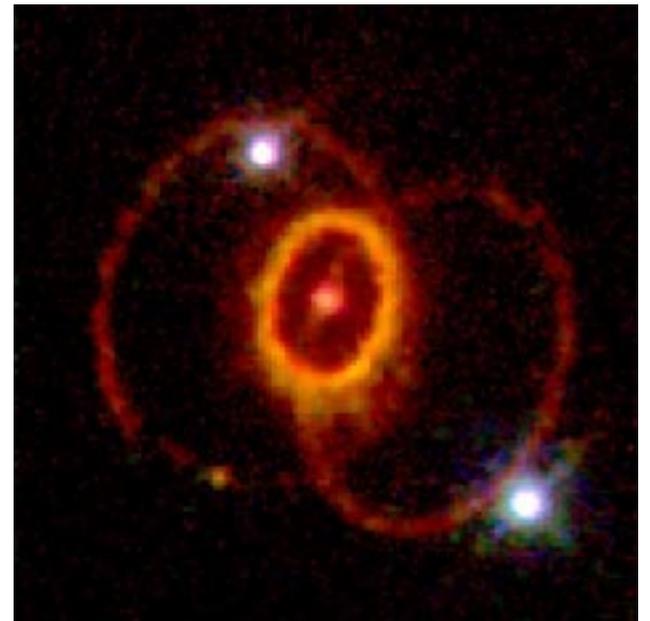
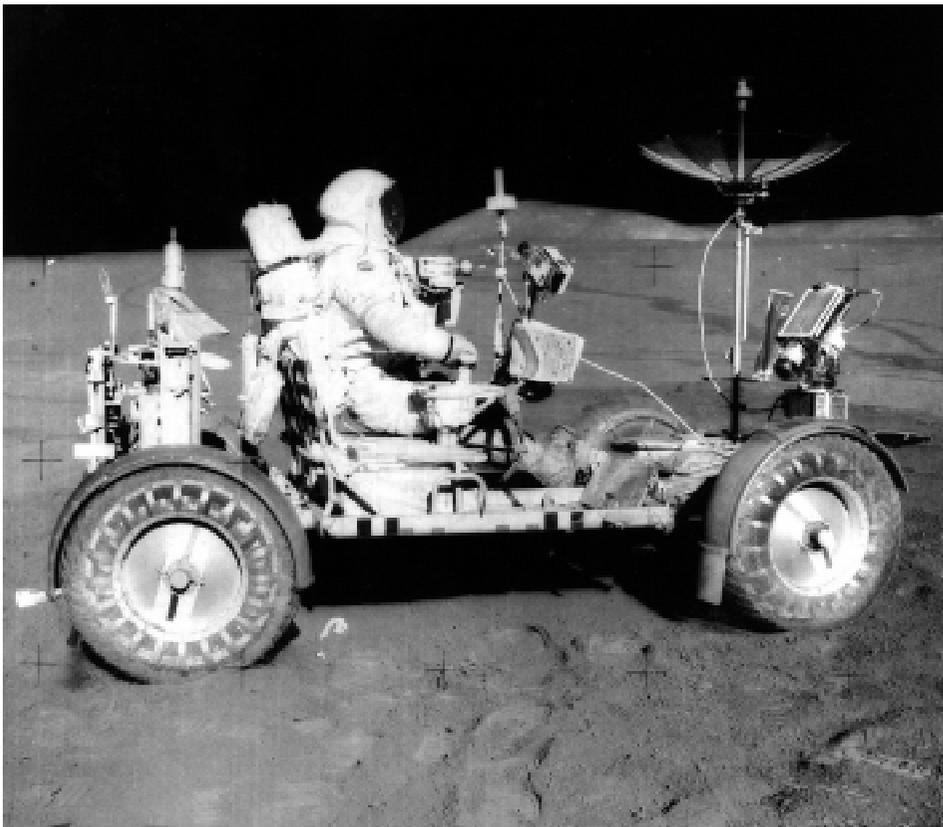
The road also followed a path from the Far East through Europe to North America, from explosives to engines, airplanes to rockets, as well as computers. Here are a few

key events that helped engage the minds of inventors and push the parameters of the technology we take for granted today.

1040 A.D. - Explosives or weapons were not even the impetus for China's research into gunpowder. Gunpowder was invented by alchemists seeking the elixir of immortality. Though gunpowder was invented around the third century B.C., the true gunpowder formula was first published about 1040 A.D. by Tseng Kung-Liang. The use of gunpowder and rockets formed an integral aspect of Chinese military tactics by 1045 A.D.

1241 - **The rocket** seems to





Clockwise from upper left: In the Operations and Checkout Building, astronaut Neil Armstrong prepares to enter the module for an altitude chamber test on March 18, 1969. ... The Earth is seen above the horizon of the moon during an Apollo mission. ... The "Hula Hoop" rings of Supernova 1987A as captured by the Hubble Space Telescope. ... An astronaut drives the Lunar Roving Module during Apollo 15.

have arrived in Europe around 1241 A.D. Accounts have described rocket-like weapons being used by the Mongols against Magyar forces in an invasion against Buda (Hungary). Rockets appear in Arab literature in 1258 A.D., also describing Mongol invaders' use of them to capture the city of Baghdad. Quick to learn, the Arabs adopted the rocket into their own arms inventory and, during the Seventh Crusade, used them against the French Army of King Louis IX in 1268. By 1300, rockets had found their way into European arsenals, reaching Italy by the year 1500, Germany shortly afterwards, and later, England. They continued to be used in some form down the

centuries in both Europe and America.

A **multi-stage rocket** was first developed by the Chinese to use in naval engagements. A woodcut from *The Fire-Drake Artillery Manual*, published in 1412, shows a five-foot tube with rockets bundled in two levels. This rocket flew in a flat trajectory, three or four feet above the water, for more than a mile. It was an uncanny forerunner of the modern Exocet surface-skimming naval rockets.

1492 - A flying machine designed by Leonardo DaVinci recalled the Greek myth of Daedalus. DaVinci's early design called for a wooden framework with two movable wings activated

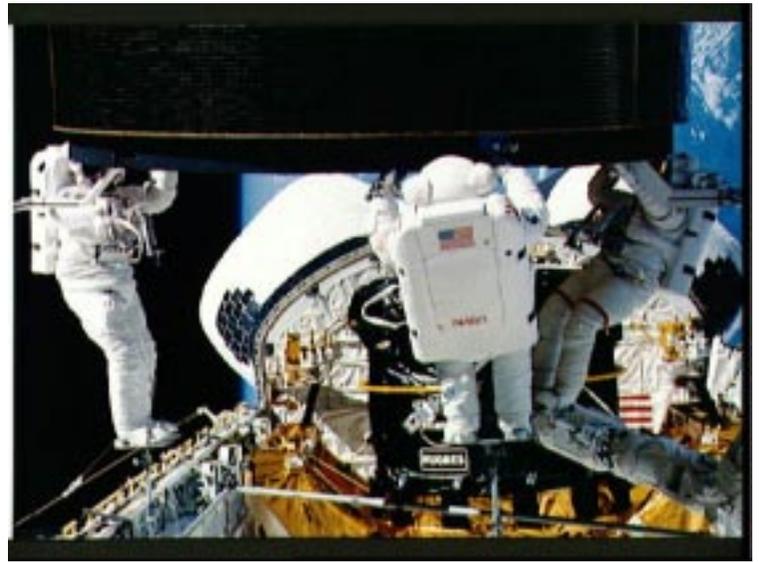
by the aviator who lies prone in the framework and works the wings by pulleys. DaVinci's later designs often had more than a single pair of wings, and the aviator is standing upright.

1738 - **Hot air balloons** gave more credence to the concept that man could escape the binds of Earth. The first balloon flight was made on June 5, 1783, in France. The balloon, using hot air for lift, was constructed by Joseph and Elieenne Montgolfier. It climbed to 5,906 feet and traveled nearly a mile. A few months later, on Nov. 21, Pilatre de Rozier and Marquis d'Arlandes made the first manned flight, also in a Montgolfier balloon.

1839 – Hydrogen fuel cells were invented by Sir William Grove, a Welsh judge, inventor and physicist. He mixed hydrogen and oxygen in the presence of an electrolyte, and produced electricity and water. The invention, which later became known as a fuel cell, didn't produce enough electricity to be useful. It took nearly a century more for fuel cell research in Germany, in the 1920s, to pave the way to the development of the carbonate cycle and solid oxide fuel cells of today.

In 1932, engineer Francis T. Bacon began his vital research into fuel cells. Bacon used a less

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Descending from left to right: ... The nose of the Space Shuttle glides above the Earth as seen from the Russian station Mir during STS-81. ... A trio of astronauts makes repairs to the Intelsat satellite in the payload bay during mission STS-49. ... Mission specialist Tamara Jernigan attaches the "Strela" crane to the International Space Station during a space walk on STS-96. ... The Space Shuttle Discovery rises above Pad 39B at the launch of STS-95 on October 29, 1998. ... The first two elements of the International Space Station, Unity and Zarya, in an image captured during STS-88.

Timeline ...

(Continued from Page 4)

corrosive alkaline electrolyte and inexpensive nickel electrodes. After 27 years, he perfected his fuel cell, demonstrating a five-kilowatt fuel cell that could power a welding machine. Bacon named his famous fuel cell design the "Bacon Cell." In October 1959, Harry Karl Ihrig, engineer for the Allis-Chalmers Manufacturing Company, demonstrated a fuel-cell-powered, 20 horsepower tractor, the first vehicle ever powered by a fuel cell. In the early 1960s, General Electric produced the fuel cell-based, electrical power system for NASA's Gemini and

Apollo space capsules. Today the space shuttle's electricity is provided by fuel cells, and the same fuel cells provide drinking water for the crew.

1903 - Orville and Wilbur Wright proved mechanical flight was possible with their construction and flight of the Kitty Hawk Dec. 17, 1903 on the Outer Banks of North Carolina. They made history's first powered, sustained and controlled airplane flights from level ground without any assistance at takeoff.

1914 - **Robert H. Goddard began rocketry experiments** in the United States, earning two

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Timeline ...

(Continued from Page 5)

patents for the first liquid-fueled rocket and the first modern multi-stage rocket. They were the first of 214 patents in all. Soon after, he developed the fundamental mathematics of rocket propulsion, and in 1920 he proposed that it might be possible one day to send a rocket to the moon.

World War II - Advances in flight came rapidly during and after WWII. The essentials of the modern turbojet were contained in a 1930 patent in England by Frank Whittle. His design was first tested in 1937 and flew in 1941. Independently, Germany produced a patent in 1935 and flew a turbojet-powered aircraft in 1939.

1944 - Modern rocket development during the 1930s and '40s opened the window to the space

age. Wernher Von Braun directed Germany's rocket development program, where he and his team of scientists built the famous V2 rockets used against England during World War II. Von Braun later went to work for the United States.

1946 - The first fully electronic computer, the ENIAC I, was developed by John Mauchly and John Presper Eckert for the U.S. military, which needed a calculating device for writing artillery firing tables. It took the team about one year to design the ENIAC and 18 months and \$500,000 tax dollars to build it. However, it was never used for its intended purpose because by the time it was built, the war was over.

1957 - The U.S.S.R. launched Sputnik, the first artificial satellite. Sputnik was equipped with transmitters to broadcast on frequencies at 20 and 40 MHz so everyone would know it was up



The frame of the Reusable Launch Vehicle hangar rises near the Shuttle Landing Facility in this photo taken in October. The hangar signifies the future of space flight at Kennedy Space Center.

there. The launch shocked Americans and spurred the efforts to launch an American satellite.

1958 - The U.S. launched its first satellite, Explorer I, from Cape Canaveral. In 1956, the Army Ballistic Missile Agency was

established at Redstone Arsenal under Wernher von Braun's leadership to develop the Jupiter intermediate range ballistic missile. A version of the Redstone rocket, known as the Jupiter C, was used to launch Explorer I on Jan. 31, 1958.

KSC opens fuel pumps to state

Cooperation between Kennedy Space Center and the Florida Department of Transportation (FDOT) has led to a Reimbursable Space Act Agreement to allow the FDOT to utilize the KSC Compressed Natural Gas (CNG) Fueling Facility. This has enabled the FDOT to deploy CNG-powered pickup trucks in Brevard County.

The initial fill-up of vehicles on Nov. 9 represents another milestone in our transition to clean-burning, domestically produced fuels. CNG-powered vehicles emit approxi-

mately 80 percent less harmful exhaust than gasoline. This mutually beneficial agreement was made possible by the cooperation of the NASA Central Budget office, Chief Counsel's office, Logistics Operations, JBOSC Energy Office, GSA Fleet Management and FDOT.

KSC's allowing the FDOT to refuel at its CNG fueling facility will enable the state agency to deploy approximately 10 CNG powered vehicles over the next two years to the North Brevard County area.

Holiday generosity



From left, Boeing Company employees Laurie McManus, Janine Gresham and Beth Blakeney display some of the donations received in the Toys for Tots campaign. The campaign runs through Dec. 16. Donations of new, unwrapped toys to any Boeing office at KSC or Cape Canaveral Air Station will go to children in Brevard.



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