

“That's one small step for a man; one giant leap for mankind.”

– Neil A. Armstrong

Explore the **Cosmos** New York

**A Student and Teacher Guide on the
History of Space Exploration**

Compliments of
Assemblyman

Marcos Crespo

**Author of an Assembly bill to allow
the NYS Department of Motor Vehicles to issue
commemorative license plates to honor the
historic achievement of New Yorkers who worked on
the Space Shuttle Program & International Space Station.**

Message by Assemblyman Marcos Crespo

Spring 2015



New York State has a long and rich history of contributing outstanding talent to the Space Shuttle Program and space exploration. The only two women to ever command a space shuttle both call Elmira and Rochester, New York their home. The pilot of the Atlantis, the historic last space shuttle mission, is a native

New Yorker who was born in Endicott, in our southern tier. These are just some of the interesting facts about space exploration that have roots in New York State.

New York contributed more astronauts to the Space Shuttle Program than any other state. Combined 30 astronauts, born and raised in New York, have participated in 75 Space Shuttle missions that yielded tremendous research activity, new discoveries, and the completion of the International Space Station. New York State needs to honor and commemorate its contributions to this historic achievement for humanity.

The Smithsonian Museum in Washington, DC, gave up the prototype Enterprise Space Shuttle to New York City's Intrepid museum. It was used for test flights in the 1970s. The Enterprise can be viewed up close on the deck of the Intrepid Sea, Air and Space Museum in Manhattan.

The next generation of space vehicles that will carry American astronauts, supplies and equipment are now being developed, with the Boeing CTS-100 spacecraft due to undergo human flight tests by 2017. Currently the unmanned spacecraft known as SpaceX, which delivers critical supplies, has been built, launched and rendezvoused with the International Space Station in January of this year.

Generations of children who aspire to be astronauts or work in science, engineering, technology, and mathematics will be inspired by the facts and figures listed in this brief overview of the accomplishments of human space exploration.

It is my hope that teachers, parents, and the children reading this resource will put the information to good use by striving to be part of the web of knowledge-building that allows us to grow the next generation of those that will help "Explore the Cosmos."

For additional copies or more information, please contact my office at 518-455-5514. Thank you.



**"Our future
lies with
today's kids and
tomorrow's
space
exploration."**

– Sally Ride

"We go into space because whatever mankind must undertake, free men must fully share...I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth."

– President John F. Kennedy

SPACE SHUTTLE ERA

Each space shuttle is named after influential ships of science and exploration. All were built in Palmdale, Calif., by Rockwell International.

Discovery, OV-103

Discovery, OV-103 was named after one of the two ships used by the British explorer Captain James Cook when he discovered Hawaii and explored Alaska and northwestern Canada in the 1770s. Discovery was the third operational shuttle and made its first flight, STS-41D, in August 1984. Discovery has flown more than any other shuttle with 39 missions under its belt. Discovery deployed NASA's Hubble Space Telescope, which has altered the way we see and think of our universe. Discovery was the first space shuttle retired from NASA's fleet, following its STS-133 mission to the ISS in February/March 2011.

Endeavour, OV-105

Endeavour, OV-105 was named by students in elementary and secondary schools across the nation after a ship chartered to traverse the South Pacific in 1768. Endeavour was the last space shuttle built and was ordered to replace Challenger. The shuttle made an immediate imprint on space history in May 1992 during its first mission, STS-49. Three spacewalking astronauts made the unprecedented effort to grab an orbiting satellite with their gloved hands and pull it into Endeavour's cargo bay so it could be repaired and re-launched from the shuttle. Endeavour also accomplished the first repair mission to NASA's Hubble Space Telescope, basically giving the telescope contact lenses so it could peer to the farthest edges of the universe. Endeavour was the second shuttle to retire after its successful 25th mission, STS-134, which delivered the Alpha Magnetic Spectrometer-2 (AMS) to the ISS in May/June 2011.

Atlantis, OV-104

Atlantis, OV-104 was named after the primary research vessel for the Woods Hole Oceanographic Institute in Massachusetts from 1930 to 1966. Atlantis



Women Astronauts

According to Assemblywoman Naomi Rivera, "The only two women to ever command a space shuttle both call Elmira and Rochester, New York their home.

The July 2011 pilot of the Atlantis, the historic last space shuttle mission, is a native New Yorker who was born in Endicott, in our southern tier."

Pamela Melroy (1st) & Eileen Collins (2nd)

Source: "Astronaut Fact Book." NASA. National Aeronautics and Space Administration, July 2003. Web. 8 Mar. 2012.

was the fourth operational shuttle and made its first flight, STS-51J, on Oct. 3, 1985. The shuttle sent probes to Venus and Jupiter and carried NASA's Destiny laboratory to the International Space Station. Atlantis also served as the final shuttle servicing mission, STS-125, for NASA's Hubble Space Telescope. Atlantis also served the final shuttle servicing mission, STS-135 marked the 33rd mission and final flight for Atlantis. July 8-21, 2011 was the final flight of the space shuttle program.

Enterprise

Enterprise was the first space shuttle, although it never flew in space. It was used to test critical phases of landing and other aspects of shuttle preparations. It was released over the vast dry lakebed at Edwards Air Force Base in California to prove it could glide and land safely.

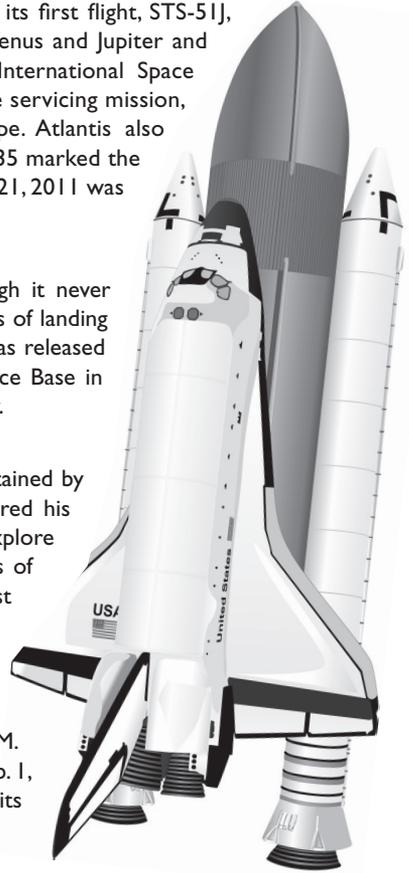
Columbia, OV-102

Columbia, OV-102 was named after a ship captained by Robert Gray, who on May 11, 1792, maneuvered his ship through dangerous inland waters to explore British Columbia and what are now the states of Washington and Oregon. Columbia was the first shuttle to fly into orbit on STS-1. Columbia deployed numerous satellites and operated several times as a laboratory in space during its missions and was the only shuttle to land at White Sands Space Harbor, in Las Cruces, N.M. Columbia and its seven astronauts were lost Feb. 1, 2003, when it broke apart during re-entry on its 28th mission, STS-107.

Challenger, OV-099

Challenger, OV-099 was named after the British Naval research vessel HMS Challenger that sailed the Atlantic and Pacific oceans during the 1870s. Challenger was the second operational shuttle and made its first flight, STS-6, on April 4, 1983. Challenger hosted missions that saw astronauts take the first-ever spacewalks with jetpacks, including the first mission to pull a satellite out of orbit, fix it and return it to service. Challenger and its seven astronauts were lost Jan. 28, 1986, when a seal on one of its boosters failed and hot gas burned through the external tank, igniting the propellants and causing the shuttle to break up in the resulting explosion. That flight, STS-51L, was Challenger's 10th mission.

Source: "NASA Facts: Space Shuttle Era Facts". NASA. National Aeronautics and Space Administration, 2011. Web. 27 Feb. 2012. <<http://www.nasa.gov>>.



"In questions of science the authority of a thousand is not worth the humble reasoning of a single individual."

– Galileo Galilei

Timeline: Human Space Travel Pre-International Space Station

Mercury-Redstone 3 Shepard May 5, 1961
Mercury-Redstone 4 Grissom July 21, 1961
Mercury-Atlas 6 Glenn Feb. 20, 1962
Mercury-Atlas 7 Carpenter May 24, 1962
Mercury-Atlas 8 Schirra Oct. 3, 1962
Mercury-Atlas 9 Cooper May 15 to 16, 1963
Gemini-Titan III Grissom, Young Mar. 23, 1965
Gemini-Titan IV McDivitt, White June 3 to 7, 1965
Gemini-Titan V Cooper, Conrad Aug. 21 to 29, 1965
Gemini-Titan VII Borman, Lovell Dec. 4 to 18, 1965
Gemini-Titan VI-A Schirra, Stafford Dec. 15 and 16, 1965
Gemini-Titan VIII Armstrong, D. Scott Mar. 16, 1966
Gemini-Titan IX-A Stafford, Cernan June 3 to 6, 1966
Gemini-Titan X Young, M. Collins July 18 to 21, 1966
Gemini-Titan XI Conrad, Gordon Sept. 12 to 15, 1966
Gemini-Titan XII Lovell, Aldrin Nov. 11 to 15, 1966
Apollo-Saturn 7 Schirra, Eisele, Cunningham Oct. 11 to 22, 1968
Apollo-Saturn 8 Borman, Lovell, Anders Dec. 21 to 27, 1968
Apollo-Saturn 9 McDivitt, D. Scott, Schweickart Mar. 3 to 13, 1969
Apollo-Saturn 10 Stafford, Young, Cernan May 18 to 26, 1969
Apollo-Saturn 11 Armstrong, M. Collins, Aldrin July 16 to 24, 1969
Apollo-Saturn 12 Conrad, Gordon, Bean Nov. 14 to 24, 1969
Apollo-Saturn 13 Lovell, Swigert, Haise Apr. 11 to 17, 1970
Apollo-Saturn 14 Shepard, Roosa, Mitchell Jan. 31 to Feb. 9, 1971
Apollo-Saturn 15 D. Scott, Worden, Irwin Jul. 26 to Aug. 7, 1971
Apollo-Saturn 16 Young, Mattingly, Duke Apr. 16 to 27, 1972
Apollo-Saturn 17 Cernan, Evans, Schmitt Dec. 7 to 19, 1972
Skylab SL-2 Conrad, Kerwin, Weitz May 25 to Jun. 22, 1973
Skylab SL-3 Bean, Garriott, Lousma Jul. 28 to Sep. 25, 1973
Skylab SL-4 Carr, E. Gibson, Pogue Nov. 16, 1973 to Feb. 8, 1974

Source: NASA Historical Data Book Volumes 1 and 11

October 4, 1957 **The Sputnik Capsule**

Country: USSR
Rocket: R-7
Cosmonaut: Unmanned
Fact: The first man-made object to orbit the Earth

May 5, 1961 **The Launch of Mercury 3 on Redstone Rocket**

Country: USA
Rocket: Redstone
Astronaut: Alan Shepard
Fact: The first American in sub-orbital flight

April 12, 1961 **The Vostok Rocket**

Country: USSR
Rocket: Vostok (R-7 Derivative)
Cosmonaut: Yuri Gagarin
Fact: The first man to enter Earth's orbit

April 24, 1968 **A Soyuz rocket and cosmonaut crash**

Country: USSR
Rocket: Soyuz
Cosmonaut: Colonel Vladislav Volkov
Fact: First confirmed human flight when capsule parachuted

April 12, 1981
**The Launch of the
Space Shuttle Columbia**

Country: USA
Rocket: Space Shuttle Columbia (OV-102)
Astronauts: John Young, Robert Crippen
Fact: The first flight of the
US Space Shuttle program

July 21, 2011
Landing of Space Shuttle Atlantis

Country: USA
Rocket: Space Shuttle Atlantis (OV-104)
Astronauts:
Chris Ferguson, Doug Hurley,
Rex Walheim, Sandy Magnus
Fact: The final flight of the
US Space Shuttle program

April 24, 1967
Space Shuttle Columbia
**Carrying Russian
Crewed upon re-entry**
Country: USSR
Rocket: Soyuz
Astronauts: Valeri
Borislav Vladimirovich Komarov
Fact: The first human fatality in space
as the parachutes fail to open

July 20, 1969
Apollo Lunar Module lands on Moon

Country: USA
Rocket: Saturn V
Astronauts: Neil Armstrong,
Edwin "Buzz" Aldrin, Michael Collins
Fact: Took the first men to land on the Moon

February 20, 1962
**The Launch of Mercury 7 on
an Atlas rocket**

Country: USA
Rocket: Atlas
Astronauts: John Glenn
Fact: The first American in Earth's orbit

Timeline: Milestones in Space Exploration

INTERNATIONAL SPACE STATION

The International Space Station (ISS) is an artificial satellite in low Earth orbit. It follows the Salyut, Almaz, Skylab, and Mir stations as the ninth space station to be inhabited. Its first component was launched in 1998. Like many artificial satellites, the station can be seen from Earth with the naked eye. ISS components have been launched by American Space Shuttles as well as Russian Proton and Soyuz rockets.

The ISS serves as a microgravity and space environment research laboratory in which crew members conduct experiments in biology, human biology, physics, astronomy, meteorology and other fields. The station is suited for the testing of spacecraft systems and equipment required for missions to the Moon and Mars.

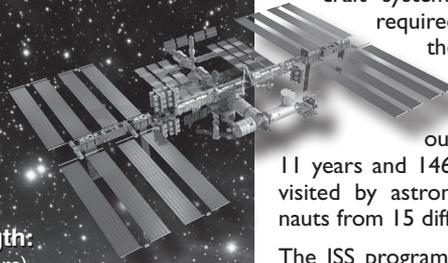
The station has been continuously occupied for 11 years and 146 days. It has been visited by astronauts and cosmonauts from 15 different nations.

The ISS program is a joint project between five participating space agencies, the American NASA, the Russian RKA, the Japanese JAXA, the European ESA, and the Canadian CSA. The station is divided into two sections, the Russian orbital segment (ROS) and the United States orbital segment (USOS), which is shared by many nations.

The ISS is maintained at an orbital altitude of between 205 and 255 miles. It completes 15.7 orbits per day. The ISS is funded until 2020, and may operate until 2028.

International Space Station Size & Mass

- **Module Length:**
167.3 feet (51 meters)
- **Truss Length:**
357.5 feet (109 meters)
- **Solar Array Length:**
239.4 feet (73 meters)
- **Mass:**
861,804 lb (390,908 kilograms)
- **Habitable Volume:**
13,696 cubic feet (388 cubic meters)
- **Pressurized Volume:**
32,333 cubic feet (916 cubic meters)
- **Power Generation:**
8 solar arrays = 84 kilowatts
- **Lines of Computer Code:**
approximately 2.3 million



- As of August 2011, there have been 135 launches to the space station since the launch of the first module, Zarya, at 1:40 a.m. EST on Nov. 20, 1998: 74 Russian vehicles, 37 space shuttles, two European and two Japanese vehicles.
- The final space shuttle mission on July 8-21 by Atlantis delivered 4 1/2 tons of supplies in the Raffaello logistics module.
- A total of 161 spacewalks have been conducted in support of space station assembly totaling more than 1,015 hours.
- The space station, including its large solar arrays, spans the area of a U.S. football field, including the end zones, and weighs 861,804 pounds, not including visiting vehicles.
- The complex now has more livable room than a conventional five-bedroom house, and has two bathrooms, a gymnasium and a 360-degree bay window.

Source: "International Space Station: Facts and Figures." NASA. Ed. Amiko Kauderer. National Aeronautics and Space Administration, 20 Sept. 2011. Web. 27 Mar. 2012. <http://www.nasa.gov/mission_pages/station/main/onthestation/facts_and_figures.html>.

SPACE SHUTTLE MISSION AND INTERNATIONAL SPACE STATION ASTRONAUTS FROM NEW YORK STATE

- Albany: Nicole P.Stott — STS-128, STS-133
- Amityville: Kevin R. Kregel — STS-70, STS-78, STS-87, STS-99
- Binghamton: Douglas H.Wheelock — STS-120, Soyuz TMA-19
- Buffalo: Edward Gibson — Skylab 4
- Buffalo: James Pawelczyk — STS-90
- Cooperstown: Robert L. Gibson — STS-41-B, STS-61-C, STS-27, STS-47, STS-71
- Elmira: Eileen Collins — STS-63, STS-84, STS-93, STS-114
- Endicott: Douglas G. Hurley — STS-127, STS-135
- Lockport: William G. Gregory — STS-67
- New York: Karol J. Bobko, first graduate of the United States Air Force Academy to become an astronaut — STS-6, STS-51-D, STS-51-J
- New York: Jay C. Buckley — STS-90
- New York (Queens): Charles Camarda — STS-114
- New York (Brooklyn): Martin J. Fettman — STS-58
- New York: Anna Lee Fisher — STS-51-A
- New York: Ronald J. Grabe — STS-51-J, STS-30, STS-42, STS-57
- New York (Brooklyn): Jeffrey A. Hoffman — STS-51-D, STS-35, STS-46, STS-61, STS-75
- New York: Bruce E. Melnick — STS-41, STS-49
- New York: Robert A. Parker — STS-9, STS-35
- New York (Bronx): Mario Runco, Jr. — STS-44, STS-54,
- New York (Queens): Jim Wetherbee — STS-32, STS-52, STS-63, STS-86, STS-102, STS-113
- Oceanside: Michael Massimino — STS-109, STS-125
- Plattsburgh: Michael Phillip Anderson, (1959–2003), died on the Columbia — STS-89, STS-107
- Rochester: C. Gordon Fullerton — STS-3, STS-51-F
Pamela Melroy — STS-92, STS-112, STS-120
- Southampton: Mary L. Cleave — STS-61-B, STS-30
- Syracuse: Lawrence J. DeLucas — STS-50
- Syracuse: Steven Swanson — STS-117, STS-119
- Warsaw: James C. Adamson — STS-28, STS-43
- Yonkers: Ronald J. Garan, Jr. — STS-124

Source: "Astronaut Birthplaces by State." Wikipedia. Wikimedia Foundation, 05 Jan. 2012. Web. 07 Mar. 2012.
<http://en.wikipedia.org/wiki/Main_Page>.

"What everyone in the astronaut corps shares in common is not gender or ethnic background, but motivation, perseverance, and desire—the desire to participate in a voyage of discovery."

—Ellen Ochoa

SPACE PROGRAM ASTRONAUTS BORN IN OTHER COUNTRIES

(Partial list)

ARGENTINA: Caldeiro

AUSTRALIA: Chapman, Thomas

BRAZIL: Pontes

CANADA: Chamitoff, Hadfield, MacLean, Payette,
D. R. Williams, Thirsk

CHINA: Anders, Lucid

COSTA RICA: Chang-Diaz

ENGLAND: Foale, Johnson, Sellers, Patrick

FRANCE: Eyharts, Chretien, Tognini

GERMANY: Schlegel, Thorne

INDIA: Chawla

ITALY: Collins, Nespoli, Vittori

JAPAN: Doi, Wakata, Noguchi

PACIFIC ISLANDS: Newman

PERU: Noriega

SPAIN: Lopez-Alegria

SWEDEN: Fuglesang

WALES: Llewellyn

MAJOR SPACE TELESCOPES

EXPLORING THE UNIVERSE

Hubble

NASA named the world's first space-based optical telescope after American astronomer Edwin P. Hubble (1889–1953). Dr. Hubble confirmed an “expanding” universe, which provided the foundation for the Big Bang theory.

Launch: April 24, 1990 from space shuttle *Discovery* (STS-31)

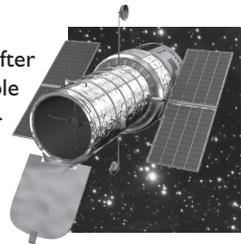
Deployment: April 25, 1990

Mission Duration: Up to 20 years

Optical Capabilities: *Hubble Can't Observe: The Sun or Mercury, which is too close to the Sun; Sensitivity to Light: Ultraviolet through infrared (115—2500 nanometers)*

First Image: May 20, 1990: Star Cluster NGC 3532

Source: "Hubble Essentials: Quick Facts." HubbleSite. National Aeronautics and Space Administration. Web. 27 Feb. 2012. <http://hubblesite.org/the_telescope/hubble_essentials/quick_facts.php>.



Spitzer

The Spitzer Space Telescope is a space-borne, cryogenically-cooled infrared observatory capable of studying objects ranging from our Solar System to the distant reaches of the Universe.

Launch Date: August 25, 2003

Launch Vehicle/Site: Delta 7920H ELV/Cape Canaveral, Florida

Estimated Lifetime: 2.5 years (minimum), 5+ years (goal)

Source: "Fast Facts - NASA Spitzer Space Telescope." NASA Spitzer Space Telescope. Spitzer Science Center. Web. 27 Feb. 2012. <<http://www.spitzer.caltech.edu/info/277-fast-facts>>.

Compton Gamma Ray Observatory

The Compton Gamma Ray Observatory was the second of NASA's great observatories. Compton, at 17 tons, was the heaviest astrophysical payload ever flown at the time of its launch on April 5, 1991 aboard the space shuttle *Atlantis*. Compton was safely deorbited and re-entered the Earth's atmosphere on June 4, 2000. The Observatory was named in honor of Dr. Arthur Holly Compton, who won the Nobel Prize in physics for work on scattering of high-energy photons by electrons—a process which is central to the gamma-ray detection techniques of all four instruments.

Source: "The CGRO Mission (1991 - 2000)." CGRO Science Support Center. NASA Astrophysics, 30 Nov. 2005. Web. 27 Feb. 2012. <<http://heasarc.gsfc.nasa.gov/docs/cgro/>>.

Chandra X-Ray Observatory

NASA's premier X-ray observatory was named the Chandra X-ray Observatory in honor of the late Indian-American Nobel laureate, Subrahmanyan Chandrasekhar (pronounced: su/bra/mon'/yon chandra/say/kar). Known to the world as Chandra (which means "moon" or "luminous" in Sanskrit), he was widely regarded as one of the foremost astrophysicists of the twentieth century. Since its launch on July 23, 1999, the Chandra X-ray Observatory has been NASA's flagship mission for X-ray astronomy, taking its place in the fleet of "Great Observatories." NASA's Chandra X-ray Observatory is a telescope specially designed to detect X-ray emission from very hot regions of the Universe such as exploded stars, clusters of galaxies, and matter around black holes.

Source: *Chandra: About Chandra.* Chandra X-ray Observatory. NASA, 22 Feb. 2012. Web. 27 Feb. 2012. <<http://chandra.si.edu/about/>>.

Pop Quiz: Test Your Knowledge of Space Exploration Facts!

- 1. What are the names of the 5 space shuttles?**
- 2. Which was the first space shuttle launched into orbit?**
- 3. When was the last space shuttle launched?**
- 4. What are the names of the two female astronauts to ever command a space shuttle?**
- 5. Who were the first men to land on the moon in 1969?**
- 6. Was the Hubble an Earth-based telescope or a Space-based telescope?**
- 7. What year was the first flight of the U.S. Space Shuttle Program?**
- 8. What is the name of the space station that is the size of a U.S. football field?**
- 9. How many space walks did it take to complete the International Space Station?**
- 10. Which are the five countries that collaborated to build the International Space Station?**



Credit: Chinese National Space Administration

FACT: Since the dawn of human spaceflight in 1961, only three countries have developed vehicles capable of launching astronauts into space and returning them to Earth. Russia and the United States began launching humans into space in 1961. China's first manned spaceflight blasted off in 2003.

“It is important for scientists to be aware of what our discoveries mean, socially and politically. It's a noble goal that science should be apolitical, acultural, and asocial, but it can't be, because it's done by people who are all those things.”

– Mae Jemison



Online Resources

Nasa.gov – National Aeronautics and Space Administration
<http://www.kennedyspacecenter.com> – Kennedy Space Center
mos.org – Museum of Science, Boston

MIT.edu – Massachusetts Institute of Technology
Stanford.edu – Stanford University

<http://www.nasm.si.edu/museum/> – Smithsonian, Washington DC
www.intrepidmuseum.org/ – Intrepid Sea, Air, and Space Museum, NY

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Research Support by Joanna Gonzales, 2012 Legislative Intern
Peer Reviewed by Maya Paolasso Martinez, 8th Grade Student***