A Versatile Vehicle

The first true aerospace vehicle, the Space Shuttle, takes off like a rocket. The winged orbiter flies to Earth, like a spaceship, and lands on a runway, like an airplane.

The Space Shuttle is designed to carry large and heavy payloads into Earth orbit. But unlike earlier manned spacecraft, which were good for only one flight, the Shuttle orbiter and solid rocket boosters can be used again and again.

The Shuttle also provides a new capability, to repair or service spacecraft in orbit, or return them to Earth for a more extensive overhaul and another launch. The Long Duration Exposure Facility (LDEF), a free-flying payload, remained in orbit almost six years before it was recovered and returned to Earth, where it yielded a wealth of new data on the space environment.

An INTELSAT commercial communications satellite stranded in a useless orbit was retrieved in dramatic fashion by Shuttle astronauts, repaired and then re-launched to its proper orbit to begin operation. The Hubble Space Telescope was successfully serviced and has helped unlock many of the mysteries of the universe since the repairs and improvements were made.

Satellites today play a major role in the fields of environmental protection, weather forecasting, navigation, fishing, farming, mapping, oceanography and many other space-borne applications. Satellites also provide worldwide communications, linking the people and nations of the world together. A single channel, out of 24 on many communications satellites, can provide television coverage to most entire nations. Satellites have become an indispensable part of the modern world.

The Shuttle’s usefulness as a platform for on-orbit servicing of spacecraft was demonstrated during the STS-61-Hubble repair mission. Endeavour’s payload bay was used to temporarily store the Hubble telescope while it was being repaired and upgraded.

Orbiter Insulation

Standing 154 feet (47 meters) long and 28 feet (8.5 meters) high when at full power, an orbiter produces 22,300 pounds (35,888 kilograms) of thrust at liftoff (at sea level). This figure is derived from four main engines, each producing 400,500 pounds (1.781 million newtons) of thrust when operating at 104 percent of their rated performance. The engines are located at the rear end of the orbiter. They operate the vehicle from the ground, and provide lift and propulsion on entry back into Earth’s atmosphere.

The orbiter is the only part of the Space Shuttle designed to last 100 flights minimum, and the solid rocket boosters can be used again and again. Unlike the expensive parachute descent and recovery technique used in the Mercury, Gemini and Apollo human spaceflight programs, satellites and spacecraft of the most expensive Shuttle components can be refurbished and made ready for another mission. The complex and expensive orbiter is designed to last 100 flights minimum, and the solid rocket boosters can be refurbished and used again.

On the first Space Shuttle flight — STS-1 in 1981 — Pilot Robert Crippen floats effortlessly in the microgravity of space, inside the middeck of the orbiter Columbia.

Mission specialists are scientists, physicians or other highly qualified specialists. Astronauts — including foreign citizens — who have piloted aircraft who also must meet other rigorous qualifications. Mission specialists are scientists, physicians or other highly qualified specialists.

The Parts of the Space Shuttle

The flight components of the Space Shuttle are two solid rocket boosters, an external tank and a winged orbiter. The assembled Shuttle weighs about 4.5 million pounds (2,041,000 kilograms) at liftoff.

The orbiter carries the crew and payload. It is 122 feet (37 meters) long and 57 feet (17 meters) wide. It has a wing span of 78 feet (24 meters) and weighs from 168,000 to 175,000 pounds (76,000 to 79,000 kilograms). It is about the size and general shape of a DC-9 commercial jet airplane. Orbiters may vary slightly from unit to unit.

The orbiter carries its cargo in a cavernous payload bay 60 feet (18.3 meters) long and 15 feet (4.6 meters) wide. The bay is flexible enough to provide accommodations for unmanned spacecraft in a variety of shapes and sizes, and for fully equipped scientific laboratories, such as the Spacelab or S PACEHAB. Depending on the requirements of the particular mission, a Space Shuttle can carry about 87,000 pounds (17,146 kilograms) into orbit.

The orbiter is equipped for flight with three main engines, each producing 400,500 pounds (1.781 million newtons) of thrust when operating at 104 percent of liftoff (at sea level). This figure is derived from a mixture of aluminum powder as the fuel, aluminum perchlorate as the oxidizer and iron oxide as a catalyst, all held together by a polymer binder. Flight experience indicates they produce about 2,908 million pounds (12,905 million newtons) of thrust each for the first few seconds after ignition, before gradually declining for the remainder of a two-minute burn.

Crew Accommodations

Nominal crew size for a Shuttle flight is up to seven people; 10 could be carried in an emergency. The crew occupies a two-level cabin at the forward end of the orbiter. They operate the vehicle from the upper level, the flight deck, with the flight controls for the mission commander and pilot located in the front. A station at the rear, overlooking the payload bay through two windows, contains the controls of a mission specialist astronaut to operate the Remote Manipulator System arm which handles elements in the payload bay. Mission operations displays and controls are on the right side of the cabin, and payload controls on the left. The latter are often operated by payload specialists, who are usually not career NASA astronauts. The living, eating and sleeping area for on-duty crew members, called the middeck, is located below the flight deck. It contains pre-packaged food, a toilet, bunks and other amenities. Experiments for the flight also may be stored in middeck lockers.

A typical Shuttle crew includes a commander and pilot, mission specialists and sometimes payload specialists. The commander and pilot are selected for the pilot astronaut corps, highly qualified individuals with at least 1,000 hours pilot-in-command time in jet aircraft who also must meet other rigorous qualifications. Mission specialists are scientists, physicians or other highly qualified specialists.

Payload specialists are persons other than NASA astronauts — including foreign citizens — who have specialized onboard duties. They may be added to Shuttle crews if activities that have unique requirements are involved.

Orbiter An aluminothermic reaction ignites the propellant, a mixture of aluminum and oxygen. The resulting heat feeds these propellants to the main engines of the orbiter throughout the ascent into orbit, and is then discarded.

Most of the Shuttle’s power at liftoff is provided by its two solid rocket boosters. Each booster is 149.1 feet (45.4 meters) high and 12.2 feet (3.7 meters) in diameter, and each weighs 1.3 million pounds (589,670 kilograms). Their solid propellant consists of a mixture of aluminum powder as the fuel, aluminum perchlorate as the oxidizer and iron oxide as a catalyst, all held together by a polymer binder. Flight experience indicates they produce about 2,908 million pounds (12,905 million newtons) of thrust each for the first few seconds after ignition, before gradually declining for the remainder of a two-minute burn.

The orbiter Columbia returns to Kennedy’s Shuttle Landing Facility, completing Mission STS-62 on March 18, 1994. All four orbiters in the Shuttle fleet are now equipped with a crew escape system. Two shrouds that are deployed during landing to assist in stopping and to provide greater stability in the event of a flat tire or steering problem.

The orbiter’s heat shield is the largest single item carried into space. The heat shield is made up of 69 modular assemblies that are stacked on top of one another. Each assembly is typical of those used on previous flights.

The orbiter is the only part of the Space Shuttle which has a name in addition to a part number. The first orbiter built was the Enterprise, which was designed to test the flight performance of the atmosphere rather than operations in space. It is now at the Smithsonian Museum at Dulles Airport outside Washington, D.C. Five operational orbiters were built: (in order) Columbia, Challenger (lost in an accident Jan. 28, 1986), Discovery, Atlantis and Endeavour (Challenger’s replacement).
Shuttle crews experience a designed maximum gravity load of 3g during launch, and less than 1.5g during re-entry. Special landing procedures are used for one-third the levels experienced on previous U.S. human spaceflights. Many other features of the Space Shuttle, such as a standard sea-level atmosphere, make spaceflight more comfortable for the astronaut.

**Typical Shuttle Mission**

The rotation of the Earth has a significant effect on the payload capabilities of the Space Shuttle. A due east launch from the Kennedy Space Center in Florida uses the Earth’s rotation as a launch assist, since the ground is turning to the east at that point at a speed of 915 miles (1,473 kilometers) per hour.

During the first untethered space walk in 10 years, Mission Specialist Mark Lee tests the new Simplified Aid for Extra-vehicular Rescue (SAFER) system. The 28th space walk of the Shuttle program took place on Mission STS-64 in September 1994.

**Improved Space Suit and Unique Rescue System Developed for Shuttle**

An improved space suit and an independent rescue system have been developed for the Shuttle by the Johnson Space Center, Houston, Tex. Johnson is responsible for mission planning, and provides ground control and support during each flight. The space suit is for use when a crew member is working outside the pressurized crew cabin, Spacelab or SPACEHAB modules.

**Space Station and Space Applications**

The Space Shuttle is scheduled to carry many of the component parts of the international space station into orbit and to provide an initial base for assembly operations. At 250 feet (76.2 meters) long and 361 feet (110 meters) across, the space station will be the largest assembly ever erected in space. It also represents the largest cooperative scientific program in space history, and will include contributions from NASA, Japan, Canada, the member nations of the European Space Agency and Russia.

People operating inside the microgravity of a space station can produce products difficult or impossible to make on Earth, such as power generation from sunlight. In addition, such an orbiting platform can provide astronomers and other scientists with an excellent vantage point above the distorting atmosphere from which they can study the composition and structures of our universe in ways not possible on the ground.

**Space Company**

Orbiting platforms exposed to space, called “pallets”) from the launch site. Two special recovery ships pull the parachutes out of the water and tow the rocket casings to land, where they are refurbished and sent back to the manufacturer to be refilled with propellants.

**Information Summaries**

The Space Shuttle is scheduled to carry many of the component parts of the international space station into orbit and to provide an initial base for assembly operations. At 250 feet (76.2 meters) long and 361 feet (110 meters) across, the space station will be the largest assembly ever erected in space. It also represents the largest cooperative scientific program in space history, and will include contributions from NASA, Japan, Canada, the member nations of the European Space Agency and Russia.

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