Spacecraft Classification

1. Flyby spacecraft

2. Orbiter spacecraft

3. Atmospheric spacecraft

4. Lander spacecraft

5. Rover spacecraft

6. Penetrator spacecraft

7. Observatory spacecraft

8. Communications spacecraft

Voyager 2

Galileo

Huygens

Pathfinder

Viking Mars Landers

Venera 13 Venus Lander

Surveyor Moon Landers

Deep Space 2

Deep Impact Mission to a comet

Sojourner

SIRTF

HST Hubble Space Telescope

Chandra X-ray Observatory

Compton Gamma-ray Observatory

TPF Terrestrial Planet Finder

NGST Next-Generation Space Telescope

P

SIM Space Interferometry Mission

TDRSS

Excerpt from Basics of Space Flight

Robotic spacecraft are specially designed and constructed systems that can function in specific hostile environments. Their complexity and capabilities vary greatly and their purposes are diverse. To make some sense of all these variables, this chapter arbitrarily designates eight broad classes of robotic spacecraft according to the missions the spacecraft are intended to perform:We illustrate these eight classes by offering one prime example of each pictured on this page and, in most cases, some additional linked examples. Be sure to select and read each prime example, plus several additional links. The JPL public website has an up-to-date listing of all past, current, future and proposed JPL robotic spacecraft missions. Spacecraft that carry human occupants are not considered here.Flyby spacecraft conducted the initial reconnaissance phase of solar system exploration. They follow a continuous solar orbit or escape trajectory, never to be captured into a planetary orbit. They must have the capability of using their instruments to observe targets they pass. Ideally, they can pan to compensate for the target's apparent motion in optical instruments' field of view. They must downlink data to Earth, storing data onboard during the periods when their antennas are off Earthpoint. They must be able to survive long periods of interplanetary cruise. Flyby spacecraft may be designed to be stabilized in 3 axes using thrusters or reaction wheels or to spin continuously for stabilization. Our prime example of the flyby spacecraft category is Voyager 2, which conducted encounters in the Jupiter, Saturn, Uranus, and Neptune systems. Click the Voyager image for details of the twin Voyager 1 and 2 spacecraft. Other examples of flyby spacecraft include:A spacecraft designed to travel to a distant planet and enter into orbit about it must carry with it a substantial propulsive capability to decelerate it at the right moment to achieve orbit insertion. It has to be designed to live with the fact that solar occultations will occur, wherein the planet shadows the spacecraft, cutting off any solar panels' production of electrical power and subjecting the vehicle to extreme thermal variation. Earth occultations will also occur, cutting off uplink and downlink communications with Earth. Orbiter spacecraft are carrying out the second phase of solar system exploration, following up the initial reconnaissance with in-depth study of each of the planets. These include Magellan, Galileo, Mars Global Surveyor, and Cassini. Our prime example of the orbiter spacecraft category is Galileo which entered orbit about Jupiter in 1995 to carry out a highly successful study of the Jovian system. Click the Galileo image for details of the Galileo spacecraft. Other examples of orbiter spacecraft include:Atmospheric spacecraft are designed for a relatively short

mission to collect data about the atmosphere of a planet or satellite. One typically has a limited complement of spacecraft subsystems. For example, an atmospheric spacecraft may have no need for propulsion subsystems or attitude and articulation control system subsystems at all. It does require an electric power supply, which may simply be batteries, and telecommunications equipment for tracking and data relay. Its scientific instruments may take direct measurements of an atmosphere's composition, temperature, pressure, density, cloud content and lightning.Typically, atmospheric spacecraft are carried to their destination by another spacecraft. Galileo carried its atmospheric probe on an impact trajectory with Jupiter in 1995 and increased its spin rate to stabilize the probe's attitude for atmospheric entry. After probe release Galileo maneuvered to change from an impact trajectory to a Jupiter Orbit Insertion trajectory. An aeroshell protected the probe from the thousands of degrees of heat created by atmospheric friction during atmospheric entry, then parachutes deployed after the aeroshell was jettisoned. The probe completed its mission on battery power, and the orbiter relayed the data to Earth. The Pioneer 13 Venus Multiprobe Mission deployed four atmospheric probes that returned data directly to Earth during descent into the Venusian atmosphere in 1978.Balloon packages are atmospheric probes designed for suspension from a buoyant gas bag to float and travel with the wind. The Soviet Vega 1 and Vega 2 missions to Comet Halley in 1986 deployed atmospheric balloons in Venus' atmosphere en route to the comet. DSN tracked the instrumented balloons to investigate winds in the Venusian atmosphere. (The Vega missions also deployed Venus landers.) While not currently funded, informal plans for other kinds of atmospheric spacecraft include battery powered instrumented airplanes and balloons for investigations in Mars' atmosphere.Our prime example of the atmospheric spacecraft category is Huygens, which is being carried to Saturn's moon Titan by the Cassini spacecraft. Click the Huygens image for details of the Huygens spacecraft. Other examples of atmospheric spacecraft include:Lander spacecraft are designed to reach the surface of a planet and survive long enough to telemeter data back to Earth. Examples have been the highly successful Soviet Venera landers which survived the harsh conditions on Venus while carrying out chemical composition analyses of the rocks and relaying color images, JPL's Viking landers at Mars, and the Surveyor series of landers at Earth's moon, which carried out similar experiments. The Mars Pathfinder project, which landed on Mars on July 4, 1997, and deployed a rover, was intended to be the first in a series of landers on the surface of Mars at widely distributed locations to study the planet's atmosphere, interior, and soil. A system of actively-cooled, long-lived Venus landers designed for seismology investigations, is being envisioned for a possible future mission.Our prime example of the lander spacecraft category is Mars Pathfinder. Click the Pathfinder image for details of the Pathfinder spacecraft. Other examples of lander spacecraft include:Surface penetrators have been designed for entering the surface of a body, such as a comet, surviving an impact of hundreds of Gs, measuring, and telemetering the properties of the penetrated surface. As of November 2000, no Penetrator spacecraft have been successfully operated. Penetrator data would typically be

telemetered to an orbiter craft for re-transmission to Earth. The Comet Rendezvous / Asteroid Flyby (CRAF) mission included a cometary penetrator, but the mission was cancelled in 1992 due to budget constraints.Our prime example of a penetrator spacecraft is the twin Deep Space 2 penetrators which piggybacked to Mars aboard the Mars Polar Lander and were to slam into Martian soil December 3, 1999. They were never heard from. Click the Deep Space 2 image for details of the penetrator spacecraft. Another example of penetrator spacecraft include:Electrically-powered rover spacecraft are being designed and tested by JPL as part of Mars exploration effort. The Mars Pathfinder project included a small, highly successful mobile system referred to as a micro-rover by the name of Sojourner. Mars rovers are also being developed by Russia with a measure of support from The Planetary Society. Rover craft need to be semi-autonomous. They are steerable from Earth. Their purposes range from taking images and soil analyses to collecting samples for return to Earth.Our prime example of a rover spacecraft is of course the famous Sojourner Rover, shown here in an image from the surface of Mars. Click the Sojourner image for details of the rover spacecraft.An observatory spacecraft does not travel to a destination to explore it. Instead, it occupies an Earth orbit or a solar orbit from where it can observe distant targets free of the obscuring and blurring effects of Earth's atmosphere.NASA's Great Observatories program studies the universe at wavelengths from visible light to gamma-rays. The program includes four Observatory Spacecraft: the familiar Hubble Space Telescope (HST), the Chandra X-Ray Observatory (CXO -- previously known as AXAF), the Compton Gamma Ray Observatory (GRO), and the Space Infrared Telescope Facility (SIRTF).The HST is still operating as of November 2000. GRO has completed its mission and was de-orbited in June 2000. CXO was launched in July 1999 and continues to operate. SIRTF is set to launch in January 2003. In the coming decades many new kinds of observatory spacecraft will be deployed to take advantage of the tremendous gains available from operating in space.Our prime example of an observatory spacecraft is the JPL SIRTF Project. Click the SIRTF image for details of the observatory spacecraft. Other examples of observatory spacecraft include:Communications spacecraft are abundant in Earth orbit, but they are largely incidental to JPL's missions. The Deep Space Network's Ground Communications Facility does make use of Earth-orbiting communications spacecraft to transfer data among its sites in Spain, Australia, California, and JPL.In the future, communications spacecraft may be deployed at Mars, Venus, or other planets to communicate with orbiters, rovers, penetrators, and atmospheric spacecraft operating in their vicinity. Their purpose would be to augment the Deep Space Network's capabilities to communicate with the resident spacecraft. None are in place as of November, 2000. This concept is revisited in Chapter 18. The communications spacecraft example offered here is NASA's Tracking and Data Relay Satellite System, TDRSS. Click the TDRSS image for details of this communications spacecraft. Here is a list of virtually every lunar and planetary mission ever flown or attempted by any nation, and those on schedule for future launch. The list is arranged by launch date, and each entry is linked to a page of facts about the mission.

Reference

Research Methods: Concepts and Connections

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