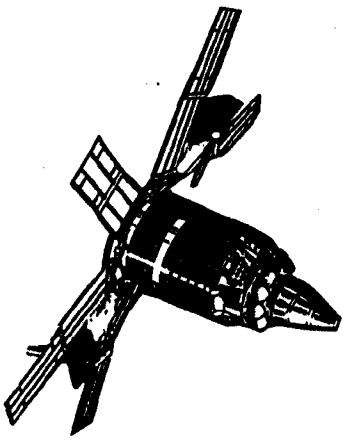
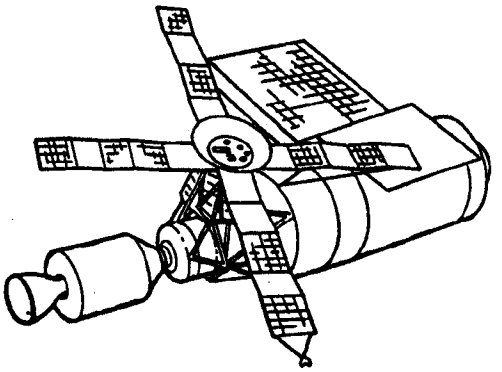
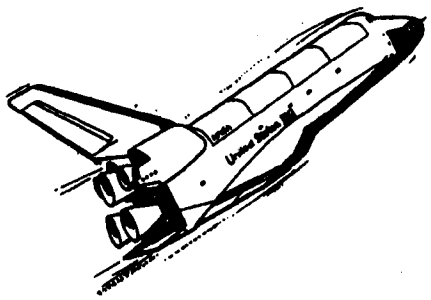
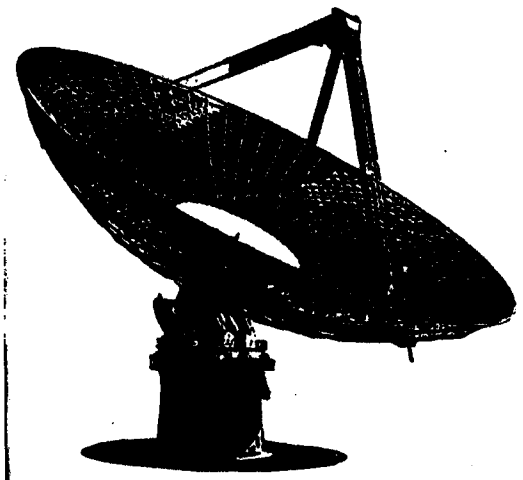
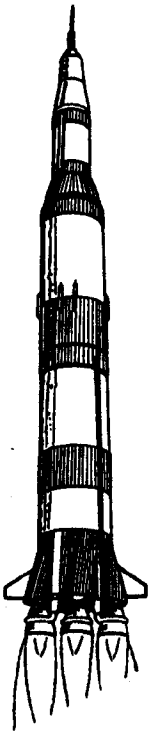






Space

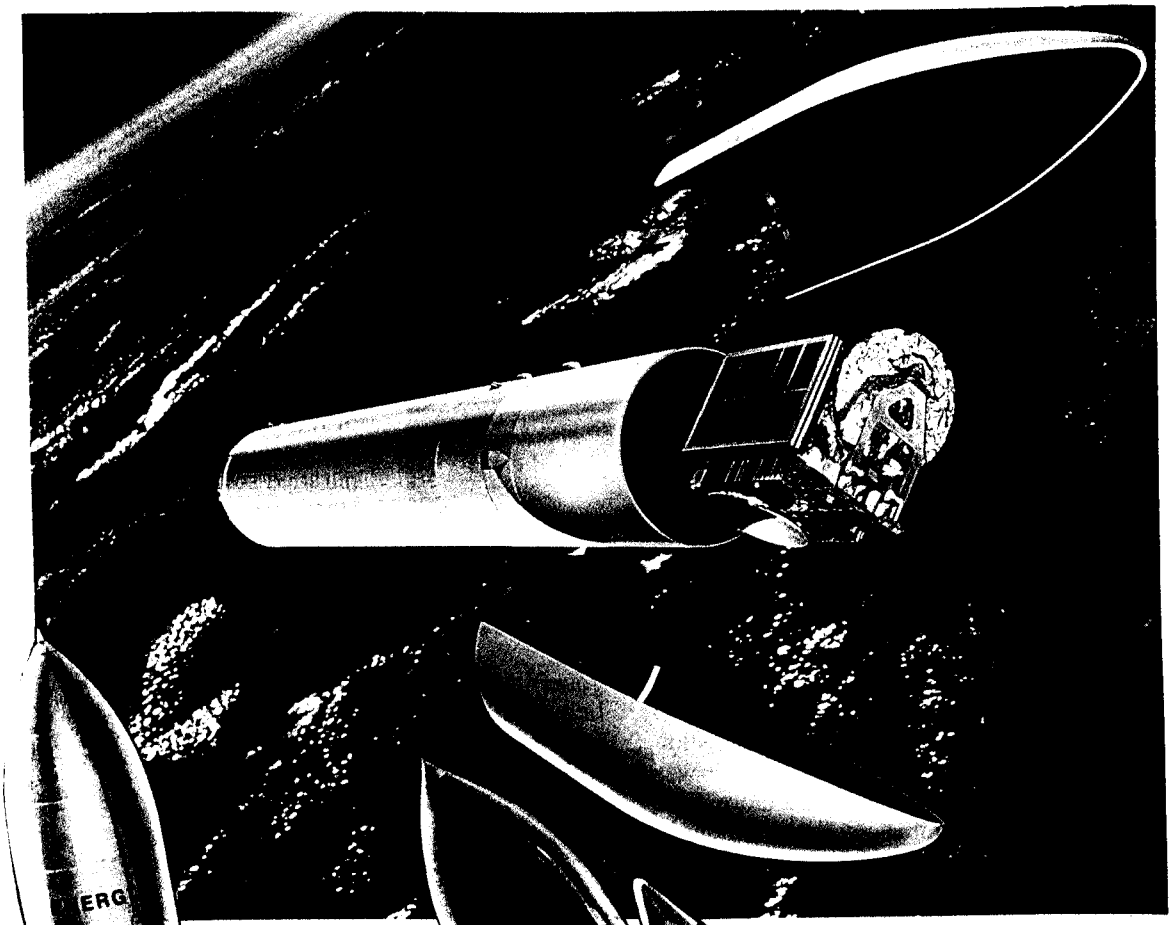


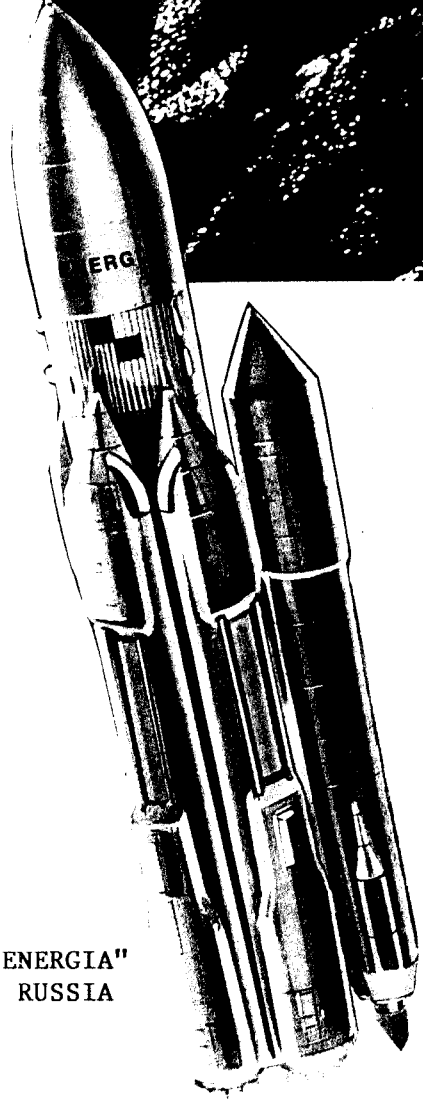


INTRODUCTION TO SPACE FLIGHT

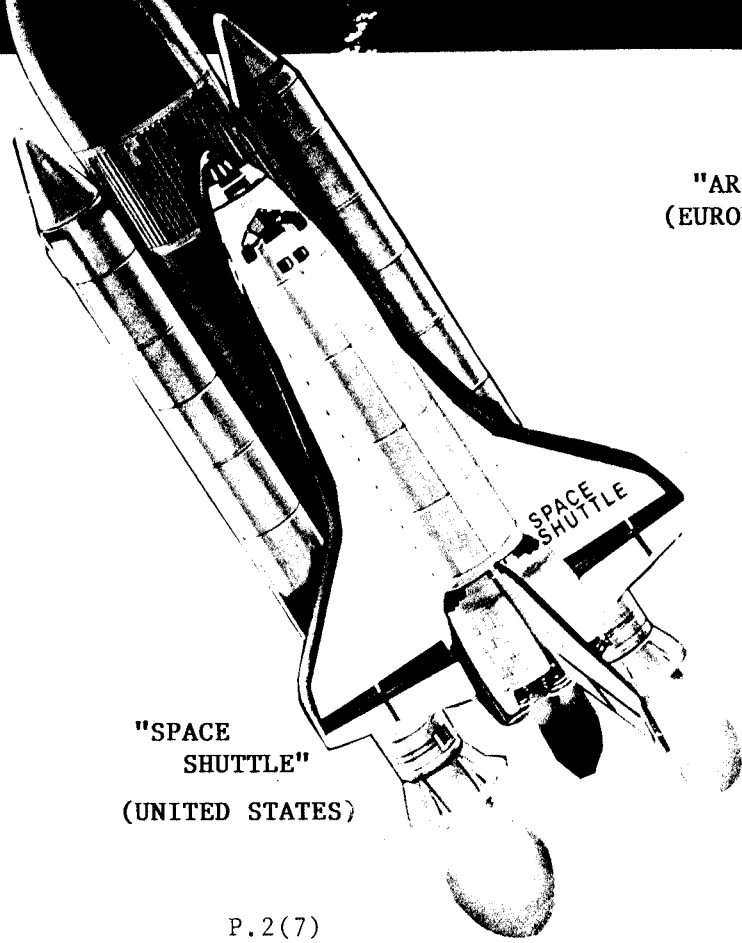
LAUNCH VEHICLES

POWERFULL ROCKET ENGINES ARE NECESSARY TO OFFSET THE EARTH'S GRAVITY IN PLACING OBJECTS IN SPACE TO ORBIT THE EARTH OR TO FLY ON INTO SPACE.

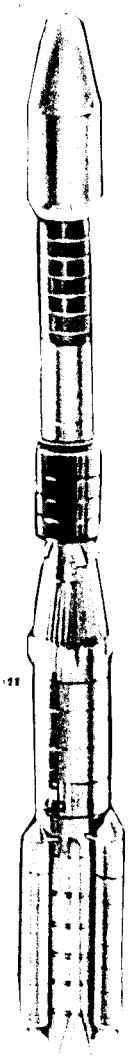




"ENERGIA"
RUSSIA



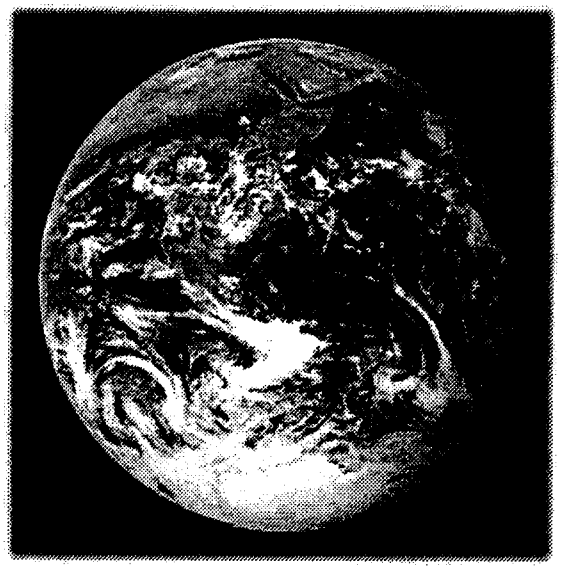
"SPACE SHUTTLE"
(UNITED STATES)



"ARIAN "
(EUROPE)

Outside

If you were in space, you would see the earth as a blue and brown ball covered by swirling masses of clouds. The earth is not a perfect sphere, however. It is bigger around the equator than it is around the poles, and it also bulges out very slightly below the equator, giving it a shape more like a pear than a sphere.

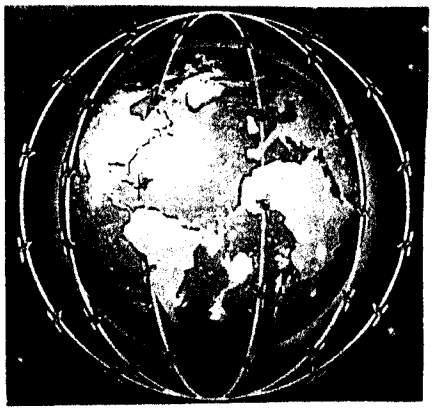


Diameter at equator: 7,926 miles (12,756 km)
Diameter at poles: 7,900 miles (12,714 km)
Circumference at equator: 24,902 miles (40,075 km)
Mass: 6,600,000,000,000,000,000,000 (6.6 sextillion) tons (6.0 sextillion metric tons)

Clouds float in a layer of air that surrounds the earth. This layer, called the *atmosphere,* contains mostly nitrogen and oxygen gases. The atmosphere shields the earth from harmful rays coming from the sun. It also keeps the earth from becoming too hot or too cold.

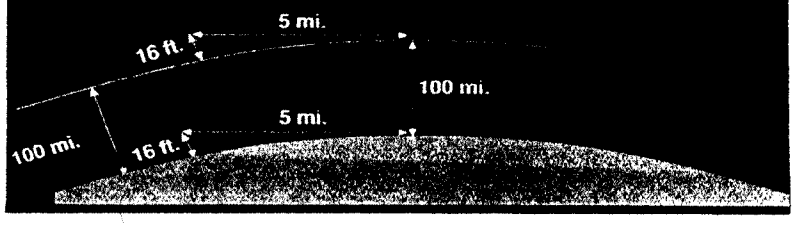
Land covers about 29% of the earth´s surface. Most of the land is broken into large pieces called continents. Smaller pieces of land are called islands. The tallest point of land on earth is the peak of Mount Everest, 29,028 feet (8,848 m) above sea level.

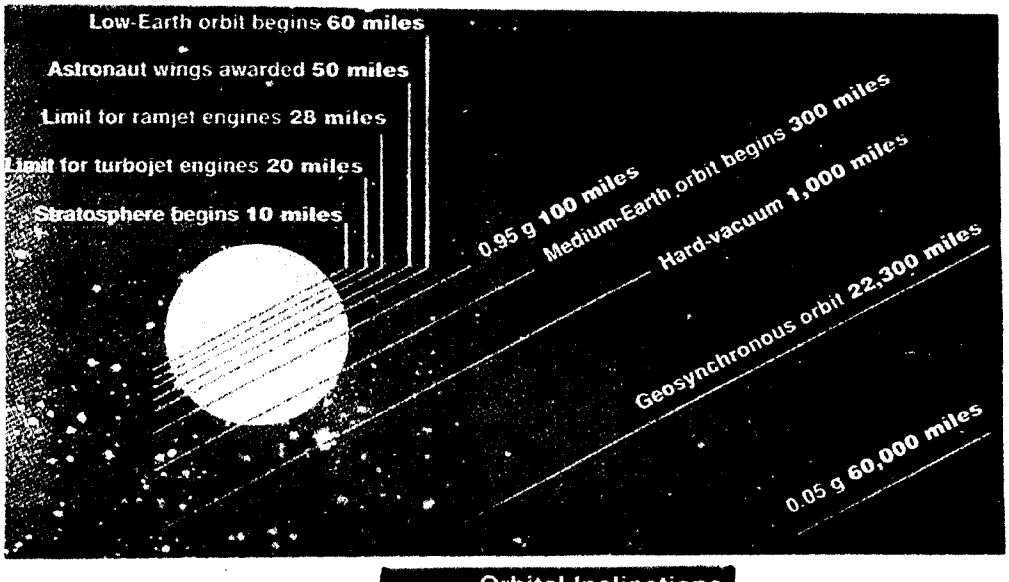
About 71% of the earth´s surface is covered with water. The deepest water is in the Mariana Trench in the Pacific Ocean, where the water measures 36,198 feet (11,033 m). Water helps keep the earth at a temperature that can support life.



Orbits

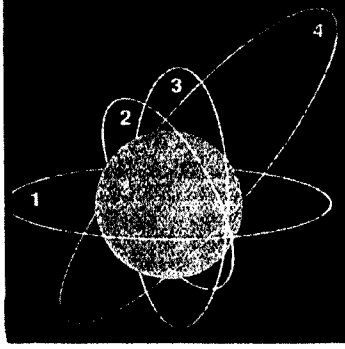
Orbits result from the mutual attraction of any two bodies with a force proportional to the product of their individual masses and inversely proportional to the square of the distance between them. The curvature of the Earth, on average, drops sixteen feet below the horizontal over a distance of about five miles. A spacecraft circling above would "fall" that same amount over the same distance. It travels five miles in one second if gravitational pull equals one G. Therefore, spacecraft velocity of five miles per second (18,000 mph) produces perpetual orbit at constant altitude, unless the spacecraft's flight is upset by perturbations, such as solar wind or mechanical anomalies.





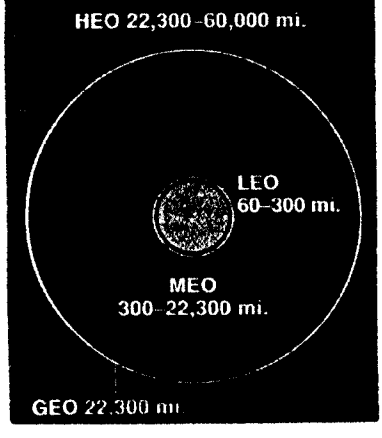
Orbital Inclinations

1 Equatorial
2 Sun-synchronous
3 Polar
4 Eccentric

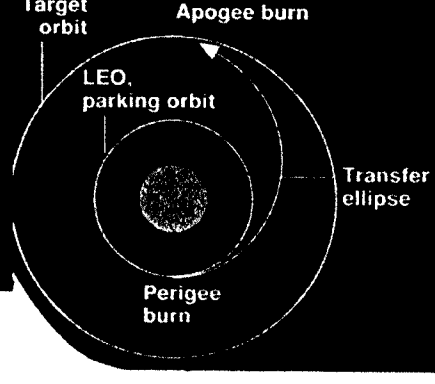


Orbital Radii

LEO—Low-Earth orbit
MEO—Medium-Earth orbit
GEO—Geosynchronous orbit
HEO—High-Earth orbit



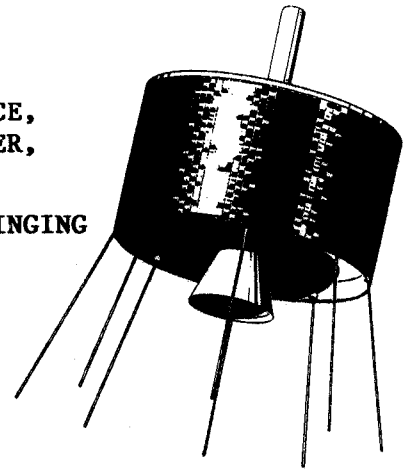
Geosynchronous Transfer Orbit



It is common procedure to pick an initial "parking" orbit, usually at LEO, then boost payloads to higher altitude. Engines are fired first (at perigee) to reach the apogee of an elliptical transfer orbit and then are fired again to put the spacecraft into a circular orbit at that higher altitude.

Illustrations are not drawn to scale

INTRODUCTION TO SPACE FLIGHT
SATELLITES



THERE ARE HUNDREDS OF SATELLITES CIRCLING OUR PLANET WITH MANY PURPOSES. SOME ARE FOR SCIENCE, OTHERS FOR COMMUNICATIONS, NAVIGATION , WEATHER, MILITARY RECONNAISSANCE AND ASTRONOMY.

TODAY COMPUTER LINKS THROUGH SATELLITES IS BRINGING EVEN THE MOST REMOTE AREAS ON EARTH INTO THE INFORMATION AGE.

HERE ARE SOME EXAMPLES:

Global Positioning System (GPS)
Constellation of twenty-four satellites used by many organizations to determine a precise location on Earth. A small receiver takes signals from three or more GPS satellites within view and calculates a position. First widespread wartime use in the Persian Gulf War, creating increased demand for receivers, which military suppliers had trouble meeting. Since then, DoD has deployed GPS terminals to many more users. GPS is used by a large number of civilian organizations worldwide, and DoD can broadcast both a highly accurate signal for use by specially equipped military receivers and a degraded signal for public use. Highly precise signal gives location within sixteen meters; the degraded signal is accurate to within 100 meters.

Meteorological Support
Operate weather satellites to provide data on worldwide and local weather systems affecting combat operations.

***Satellite Pour L'Observation de la Terre* (SPOT)**
Remote sensing satellite system developed by the French space agency, CNES. Owned and operated by the commercial firm, SPOT Image S. A. of Toulouse. SPOT's three satellites produce images with resolution as fine as ten meters and can be used for stereoscopic viewing for three-dimensional terrain modeling. DoD is one of the company's largest customers, purchasing the images for mission-planning systems, terrain analysis, mapping, and humanitarian relief missions.

International Maritime Satellite (INMARSAT)
Established in 1979 to own and operate satellites for mobile communications. Has seventy-seven member-countries.

NOAA-12 and NOAA-14
Two polar orbit satellites for long-term forecasting of weather, operated by NOAA. The satellites fly in a 450-nautical-mile orbit, carrying visible and infrared radiometry imaging sensors and ultraviolet sensors to map ozone levels in the atmosphere. Provide weather updates for all areas of the world every six hours.

International Telecommunications Satellite Organization (INTELSAT)
Established in 1964 to own and operate a global constellation of communications satellites. Had 134 members and twenty-four satellites as of early June. US signatory to INTELSAT is Comsat Corp. US military use of the system is for routine communications and to distribute the Armed Forces Radio and TV Services network.

Earth Observing System million. Mission to Planet Earth environmental project. Series of satellites to document global climatic change and observe environmental processes. Scheduled launches start 1998.

Environmental/Remote Sensing
Use space systems to create topographical, hydrographic, and geological maps and charts and develop systems of topographic measurement.

Commercial remote sensing
At least three private concerns were pursuing commercial high-resolution satellite programs in 1995, following a White House decision to allow US companies to launch such satellites, sell imagery, and even sell turnkey satellite systems under certain conditions. By 1998, the public should be able to purchase satellite images with objects as small as one meter clearly visible. Although satellite operators say the market for the images is primarily nonmilitary users who buy aerial photography, the pictures will be as good as some spy satellite photos and thus have military use.

AXAF
The Advanced X-Ray Astrophysics Facility spacecraft to study the composition and nature of galaxies, stellar objects, and interstellar phenomena.

Geostationary Operational Environmental Satellite (GOES)
NOAA operates GOES-7, GOES-8, and GOES-J, which was launched in late May. A European Meteosat 3 weather satellite augments the system. Satellites hover at 22,300 miles altitude over the equator, monitoring storms and tracking their movements for short-term forecasting. Satellites are a new design that has improved spatial resolution and full-time operational soundings of the atmosphere.

Landsat
US government's civilian remote sensing satellite system. Used in polar orbit since 1972. Carries a multispectral scanner able to operate at a resolution of thirty meters and provide imagery that can be computer enhanced to show deforestation, expanding deserts, crop blight, urban sprawl, and other phenomena. Operated by a private company, Earth Observation Satellite Co. Relies on an aging Landsat 5, and the government plans to launch a Landsat 7 satellite in 1998.

Tracking and Data Relay Satellite System (TDRSS)
NASA operates six TDRSS satellites to form a global network that allows low-Earth orbiting spacecraft, such as the space shuttle, to communicate with a control center without an elaborate network of ground stations. The geostationary TDRSS, with its ground station ir New Mexico, allows mission control in Houston, Tex., to maintain nearly constant contact with the shuttle. Other satellites using TDRSS include the Hubble Space Telescope, Compton Gamma Ray Observatory, Earth Radiation Budget Satellite, and military satellites. TDRSS satellites have been used since 1983. A next-generation system is being built for use with the shuttle, the space station, and satellites.

Space Station
Spaceflight. International manned space facility. Capacity for six persons. Systems design review was completed in 1994. Efficiencies gained through design changes and invitation to the Russians to enter into the international partnership.

US/Russian Cooperative Program,
Spaceflight. Program provides $100 million funding of contract with Russian Space Agency and mission costs for provision of Spacehab, Spacelab, and shuttle flights to Mir. The second, third, and fourth of seven joint shuttle-Mir missions scheduled for Fiscal 1996.

SOME INDICATION OF SPACE ACTIVITY

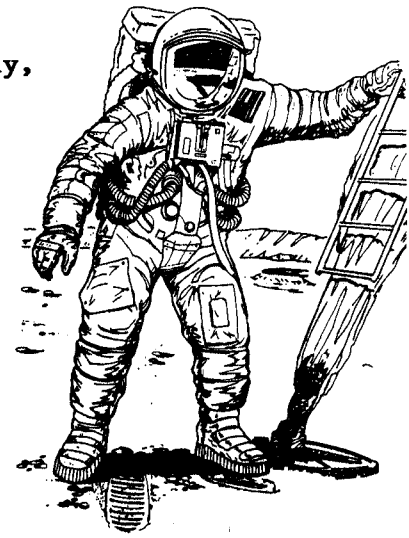
There are new accomplishments in space activity frequently, but here is some information to work with:

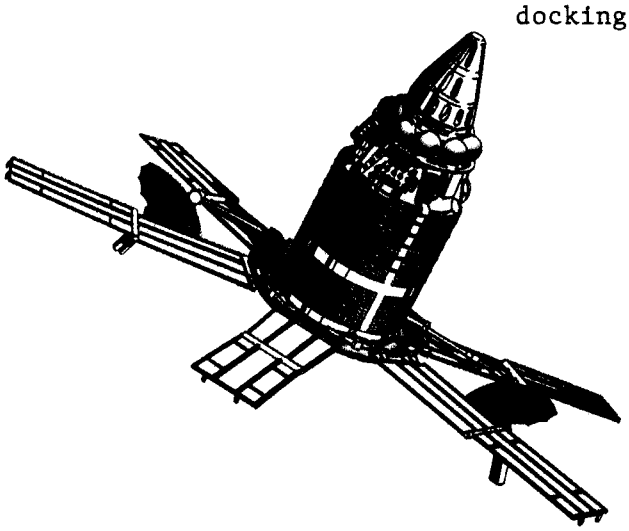
4 October 1957---USSR launches Sputnik I as the first man-made satellite in orbit

12 April 1959---Soviet cosmonaut Yuri Gagarin becomes the first human in space

20 July 1969----US astronaut Neil Armstrong is the first human to step onto the moon

15 July 1975----US Apollo and Soviet Soyus 19 spacecraft preform the first international docking of spacecraft in orbit





Payloads By Mission, 1957–94

Category	US	Russia
Platforms	**0**	**462**
Earth orbital science	**214**	**205**
Automated lunar, planetary	**55**	**85**
Moon	25	34
Mercury	1	0
Venus	8	33
Mars	9	18
Outer planets	4	0
Interplanetary space	8	0
Applications	**394**	**481**
Communications	270	270
Weather	97	74
Geodesy	20	34
Earth resources	7	94
Materials processing	0	9
Piloted activities	**135**	**222**
Earth orbital	85	84
Earth orbital (related)	13	130
Lunar	20	0
Lunar (related)	17	8
Launch vehicle tests	**11**	**22**
General engineering tests	**44**	**4**
Reconnaissance	**421**	**1,070**
Photographic	246	792
Electronic intelligence	90	127
Ocean electronic intelligence	38	79
Early warning	47	72
Minor military operations	**44**	**161**
Navigation	**79**	**195**
Theater communication	**0**	**535**
Weapons-related activities	**2**	**56**
Fractional orbital bombardment	0	18
Antisatellite targets	2	18
Antisatellite interceptors	0	20
Other military	**16**	**1**
Other civilian	**2**	**1**
Total	**1,417**	**3,500**

Spacefarers

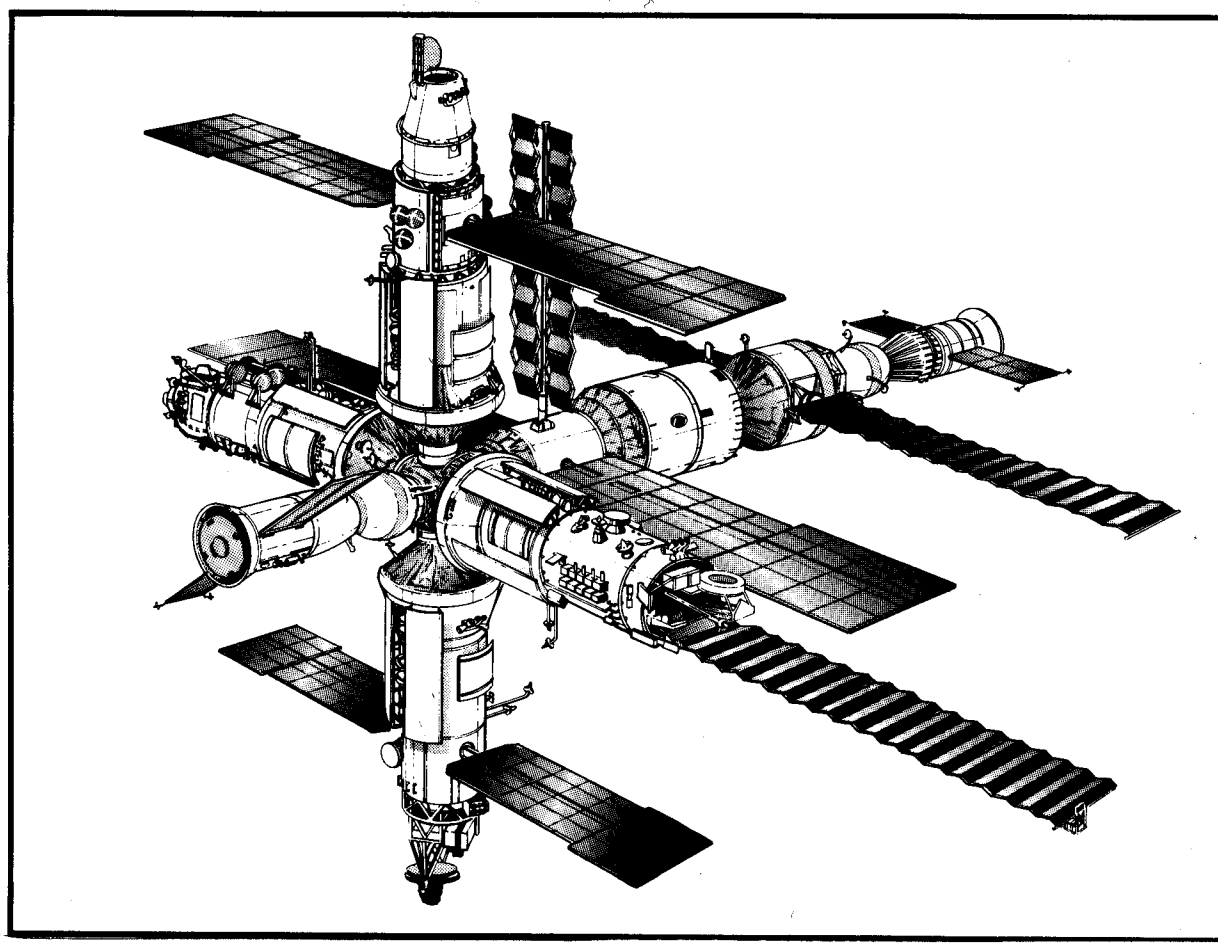
(As of end of 1994)

Nation	Persons	Nation	Persons
Afghanistan	1	Mexico	1
Austria	1	Mongolia	1
Belgium	1	Netherlands	1
Bulgaria	2	Poland	1
Canada	3	Romania	1
Cuba	1	Russia	80
Czechoslovakia	1	Saudi Arabia	1
France	5	Switzerland	1
Germany	7	Syria	1
Hungary	1	United Kingdom	2
India	1	United States	204
Italy	1	Vietnam	1
Japan	3	**Total**	**323**

Worldwide Launches by Site 1957–94

Launch Site	Nation	Launches
Plesetsk	Russia	1,409
White Sands Missile Range, N. M.	US	1,050
Tyuratam/Baikonur	Russia	971
Vandenberg AFB, Calif.	US	502
Cape Canaveral AS, Fla.	US	492
Poker Flat Research Range, Alaska	US	257
JFK Space Center, Fla.	US	85
Kapustin Yar	Russia	83
Kourou	French Guiana	69
Tanegashima	Japan	26
Shuang Cheng-tzu/Jiuquan	China	22
Uchinoura	Japan	21
Wallops Flight Facility, Va.	US	19
Xichang	China	14
Indian Ocean Platform	Kenya	9
Sriharikota	India	6
Edwards AFB, Calif.	US	5
Hammaguir	Algeria	4
Woomera	Australia	2
Taiyun	China	2
Yavne	Israel	2
Total		**5,050**

THE MIR SPACE STATION COMPLEX



A SPACE STATION IS CONSTRUCTED BY ADDING ON PIECES OVER A LONG PERIOD OF TIME. LUNCH VEHICLES CAN ONLY BRING SMALL PIECES INTO SPACE AT A TIME. ALSO, THERE IS THE PROCESS OF LEARNING HOW TO EFFECTIVELY WORK TO BUILD STRUCTURES IN THE SPACE ENVIRONMENT.