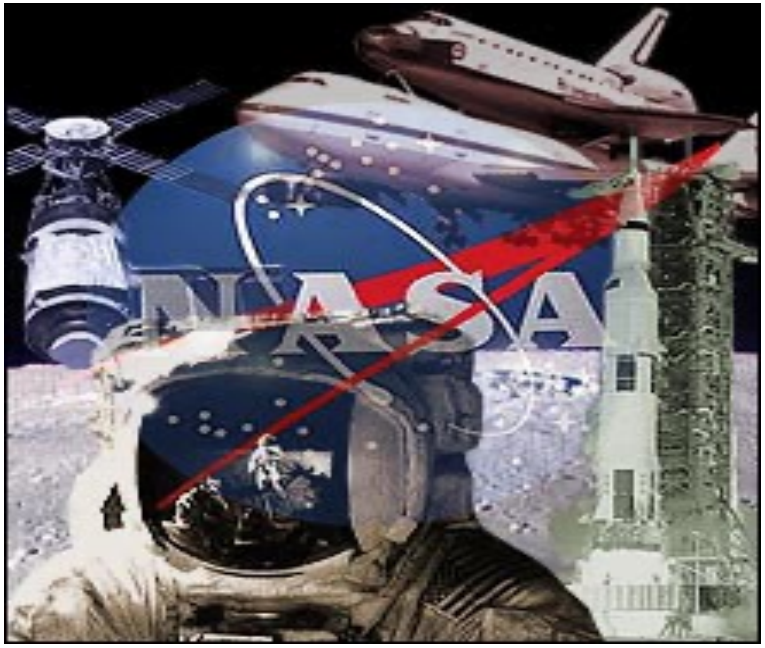


The History of Spaceflight

Dr. Ugur GUVEN

Aerospace Engineer

Nuclear Science & Technology Engineer

The Beginning of the Space Era

- Konstantin Eduardovich Tsiolkovsky was a Russian scientist largely responsible for the first equations that detail spaceflight. He was responsible for the famous Tsiolkovsky equation that details Delta V of spacecraft.
- From the Newton's equations of motion and momentum:

$$F = ma = m\frac{dv}{dt}$$

Since Thrust is defined as：

$$F = \dot{m} \cdot V_e$$

Thus by equating these two equations:

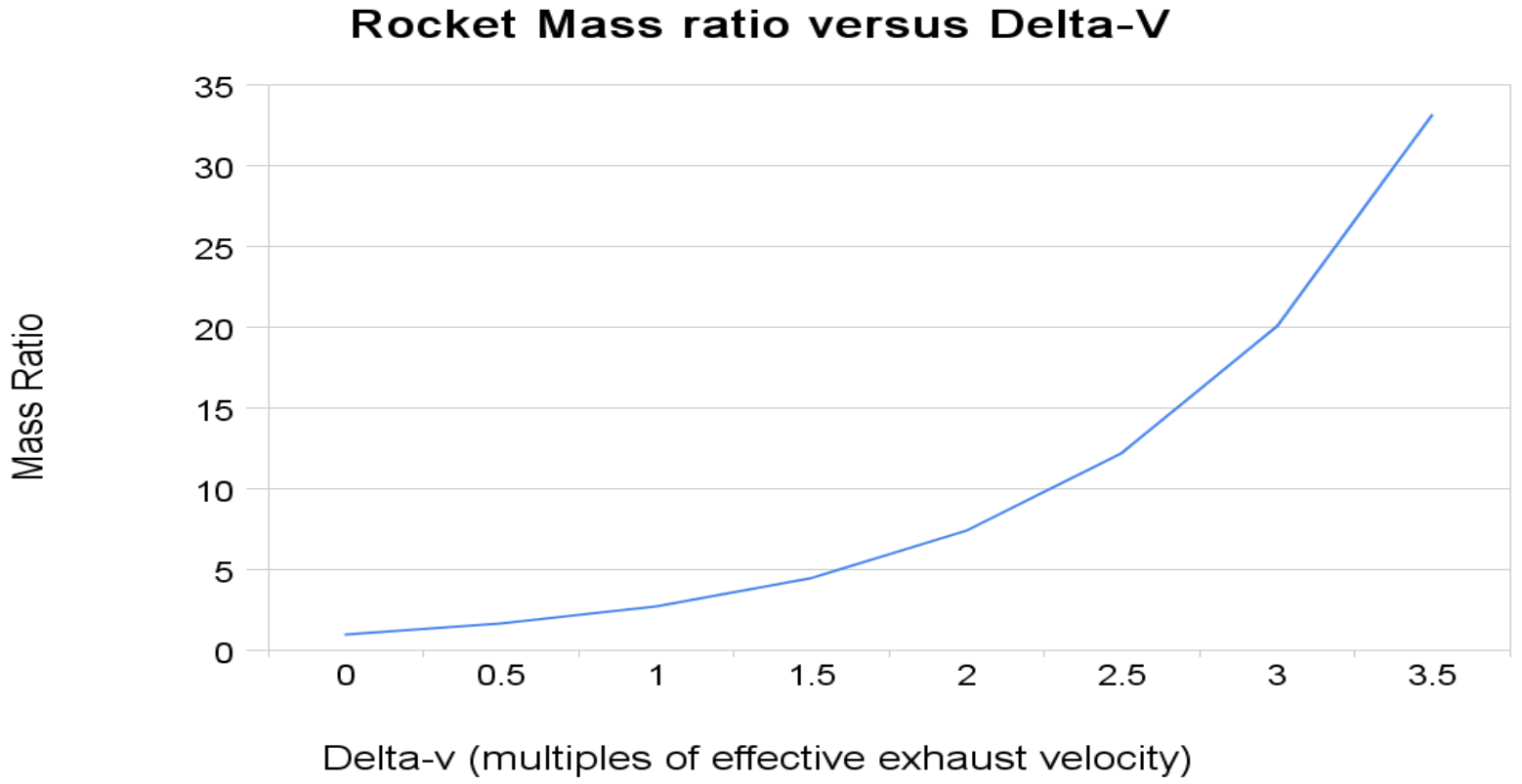
$$m\frac{dv}{dt} = -\frac{dm}{dt}V_e$$

Tsiolkovsky's Rocket Equation is born:

$$\Delta V = V_{exhaust} \ln \frac{M_{initial}}{M_{final}}$$

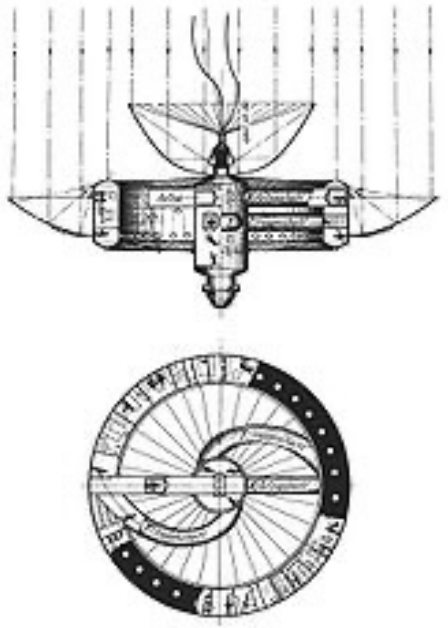
Tsiolkovsky Equation

- Tsiolkovsky Equation clearly showed that mass ratio of spacecraft is determinant of the final velocity. You can effect the exhaust velocity by changing the mass ratio.



Hermann Noordung – Inventor of the Space Station

- The concept of the first space station was realised by the Slovene rocket engineer Hermann Noordung.
- He visualized how to have a space station in geostationary orbit in 1929 and his plans paved the way to ISS in 70 years in the future.



Robert H. Goddard- The Pioneer of Rockets

- The American rocket scientist Goddard pioneered the way for test rockets to be born. He was the first scientist to calculate and test small rockets. His work led to the concept of specific impulse.
- **Specific impulse** is the measure of the performance and the travel capability of the spacecraft. As the specific impulse goes up, so does the speed and the range of the spacecraft.

$$I_{sp} = \frac{V_e}{g}$$

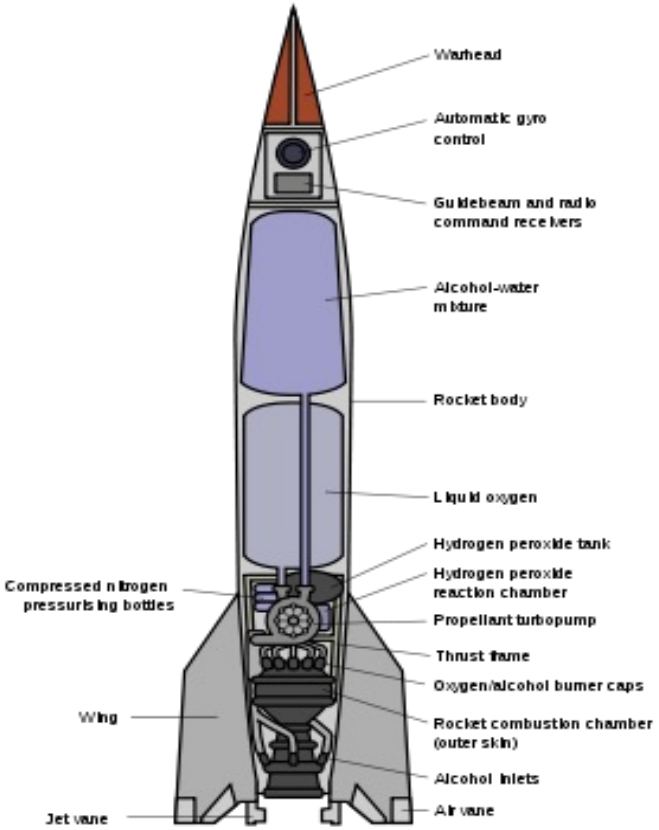
Wernher Von Braun

- Wernher von Braun was a German Engineer who pioneered the world's first rocket with the invention of the V2 during World War II.

- He later defected to the United States and started to work for the Air Force and to NASA.
- He pioneered the work in the Gemini flights and the Saturn rockets which were responsible for the flight to the moon.

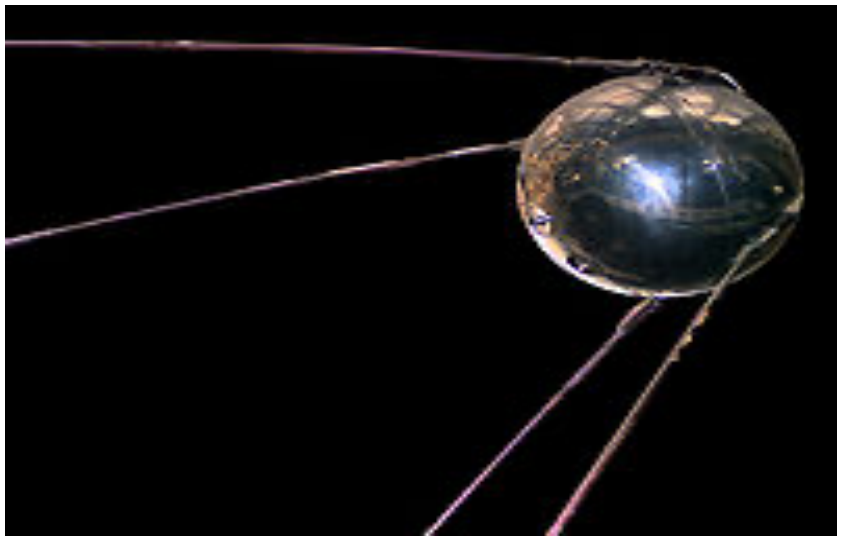
World's First Rocket V2

- The V2 was the first man made object to reach a sub orbital flight. It was the beginning of the rocket age. V2 was pioneered by Wernher Von Braun who later made the flight to Moon possible.



Sputnik – The First Satellite in Space

- Sputnik was launched by the Russians in October 4, 1957. It signaled the beginning of the Space Age.
- Sputnik travelled at 29000 km/hour and it transmitted a continious radio signal to Earth for 22 days.
- Sputnik was a 588 mm diameter sphere with protruding antennas and it was roughly 100 kg with 53 kg being the mass of the power supply.



Laika-The First Living Being in Space

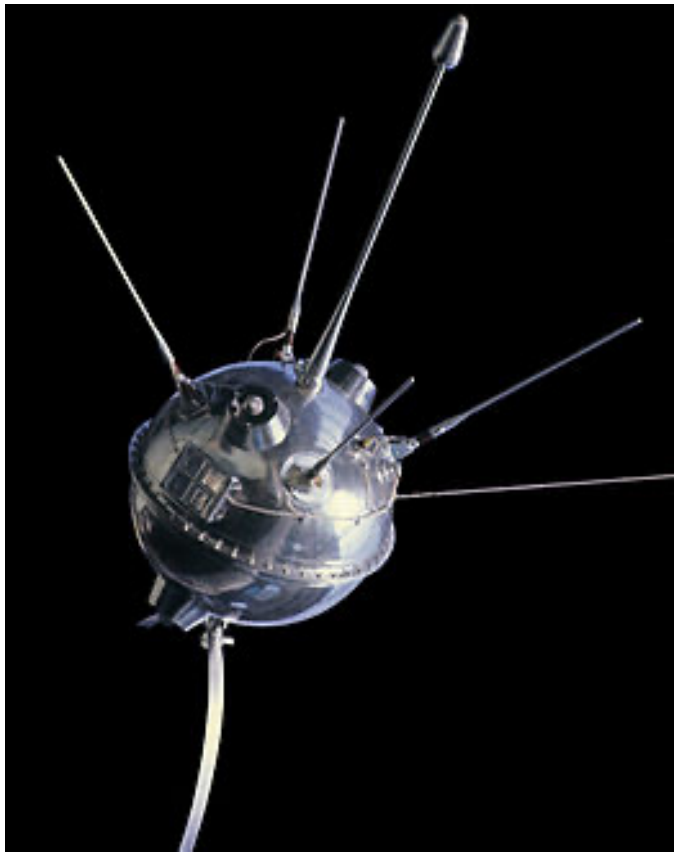
- In November 3, 1957, the first living being a dog was sent to space by the Russians.
- Laika was able to live for several hours after the launch of Sputnik 2 and she died due to thermal exposure.
- Spaceflight of Laika proved that it is possible to survive in the weightless environment of space. Although she was the first living being to go to space, she would not be the last to die in space.

Explorer – America's First Satellite

- On Jan. 31, 1958, the JPL-designed and -built Explorer 1 soared into space. The spacecraft, a quick response to the Soviet's Sputnik, lofted the United States into the Space Age.
- It was 203 centimeters long and it weighed 14 kg.

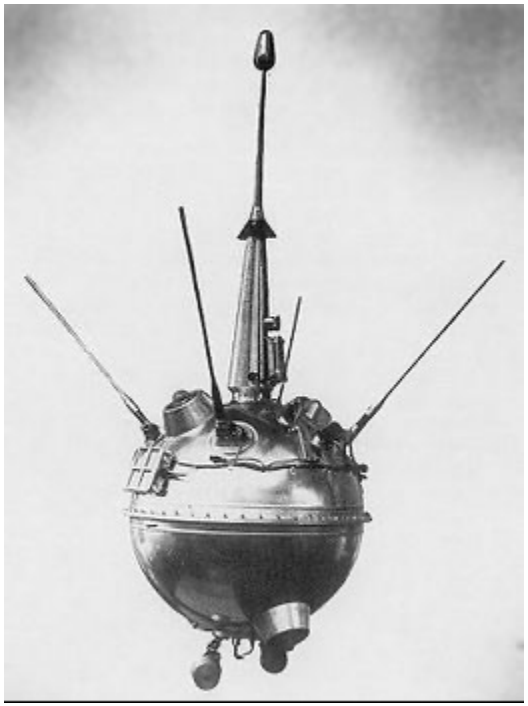
First Moon Spacecraft

- Luna 1 was the first spacecraft to reach the moon. It was send by USSR in January 1959, but due to miscalculation it missed the moon and it achieved an orbit around the Sun, located between Earth and Mars.



Luna 2

- Luna 2 was launched in September 1959 by USSR and it reached the moon and crash landed.



Yuri Gagarin – The First Human in Space

- On April 12, 1961, Yuri Gagarin (a Russian cosmanaut) became the first human in space.
- He flew in Vostok 1, and the mission flight time took 1 hour and 48 minutes reaching an apogee of 327 km and perigee of 169 km.

Alan Shepard – The First American in Space

- In May 5, 1961, Alan Shepard became the second person and the first American in space.
- Mission was launched with Freedom 3 spacecraft as part of the Mercury mission. The flight lasted 15 minutes and 22 seconds while it reached an apogee of 187.42 km.

First Crewed Mission for 24 Hours

- Vostok 2 under the command of Gherman Titov commanded the first mission which lasted slightly above 24 hours. The effects of weightlessness were observed. He is also the youngest person to go to space (26 years of age)

Valentina Tereshkova – The First Woman in Space

- Valentina Tereshkova was the first woman in space as she was launched in June 16, 1963.
- The mission with Vostok 6 almost took 3 days to complete and it reached an apogee of 166 km which is considered LEO.

Alexey Leonov – First Spacewalk

- In March 18, 1965, Alexey Leonov became the first human to do an EVA or spacewalk.
- He spacewalked for 12 minutes and 9 seconds while connected with a 5.35 m tether.
- His suit inflated so much that he had trouble getting in the airlock.

Project Mercury

- Project Mercury was the response of the Americans to the Space Race by initiating a series of suborbital flights and taking people to space.

Carpenter/Cooper/Glenn/Grissom/Schirra/Shepard/Slayton

Goals of Project Mercury

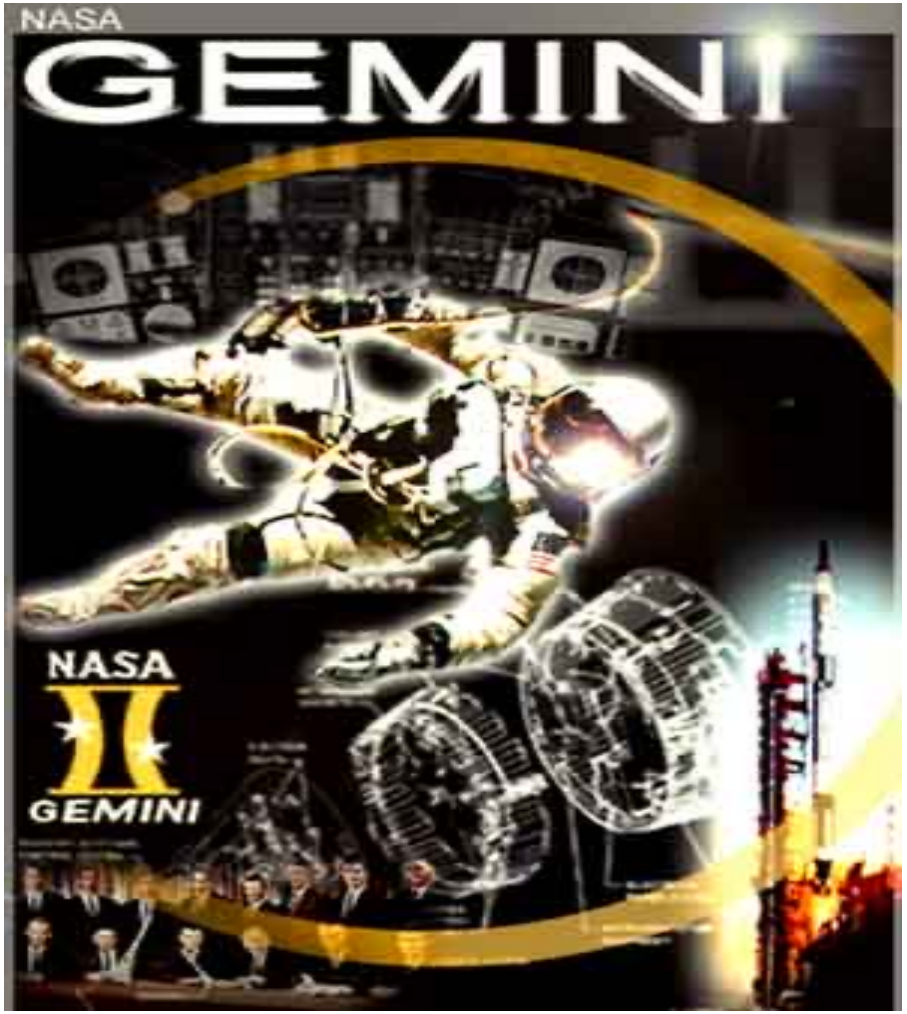
- The project lasted from 1958 to 1963. It cost around $2.8 billion dollars and its goals were:
- To orbit a manned spacecraft around Earth;

To investigate man's ability to function in space;

To recover both man and spacecraft safely.

Project Gemini – A Way to the Space

- Project Gemini was between 1965 and 1966. It made several things possible such as orbital rendezvous.

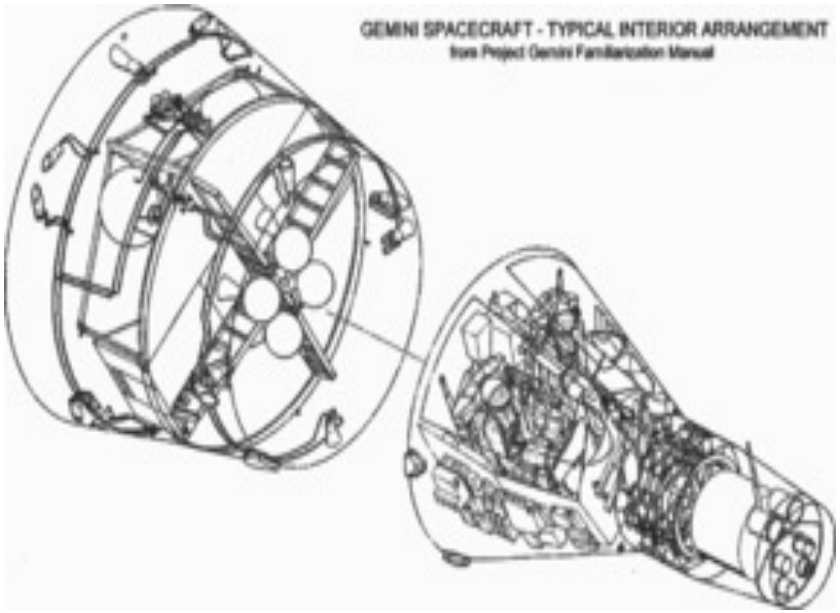


Goals of Project Gemini

- To subject man and equipment to space flight up to two weeks in duration.
- To rendezvous and dock with orbiting vehicles and to maneuver the docked combination by using the target vehicle's propulsion system;
- To perfect methods of entering the atmosphere and landing at a preselected point on land. Its goals were also met, with the exception of a land landing, which was cancelled in 1964.

Gemini Spacecraft

- Gemini spacecraft were subcontracted to McDonnell Douglas.
- It weighed 3.8 tons and it was able to reach an apogee of 402 km and have a delta v of 222 km/sec.
- It could alter its orbit.



Project Apollo – The Way to the Moon

- This was the biggest space projecy for mankind and it still remains the mankind's biggest achievement.

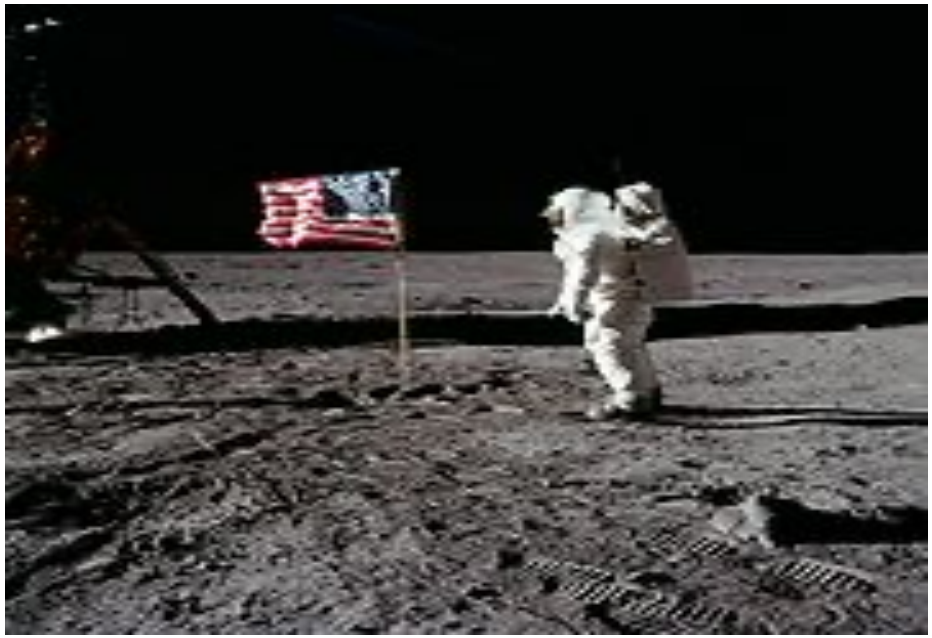
The Dream of Kennedy

- The Apollo Program which eventually took mankind to the moon began as the dream of President John F. Kennedy.

"I believe 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 Earth. No single space project in this period will be more impressive to mankind, or more important in the long-range exploration of space; and none will be so difficult or expensive to accomplish."

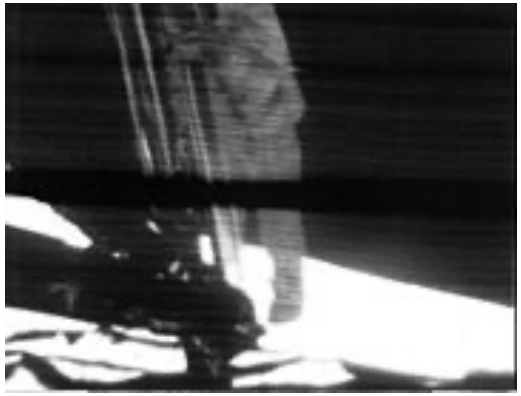
Apollo 11-The First Flight to the Moon

- The first flight to reach the moon and make a landing was Apollo 11.
- Astronaut Neil Armstrong in July 20, 1969 became the first human to ever step on the moon. He was followed by Buzz Aldrin on the same flight.
- They spent 21 hours on the lunar surface.



Flights to the Moon

- The Apollo program made 6 manned landings on the Moon with Apollo 11, 12, 14, 15, 16, 17.



Saturn Rockets

- Apollo was launched by rockets that is the most powerful ones known to men.
- Saturn V rockets were the result of the work of Wernher von Braun for NASA.
- They had 5 MN of thrust power and specific impulse of 421 sec.

Apollo Spacecraft

- Apollo Spacecraft consisted of the Command Service Module which flied from LEO to LMO.

- The Landing to the Moon was accomplished by the Lunar Module.

Soyuz Spacecraft

- Soyuz spacecraft have been in service for the Russian space program since 1967 and they continue to serve.
- It has 7.48 m height and 23 m2 volume.
- It can accommodate a 3 man crew.

Apollo Soyuz Test Project

- Apollo Soyuz was the first international manned spaceflight in July 15, 1975.
- It was designed to test the compatibility of rendezvous and docking systems for American and Soviet spacecraft, to open the way for international space rescue as well as future joint manned flights.
- The existing American Apollo and Soviet Soyuz spacecraft were used.A docking module was designed and constructed by NASA to serve as an airlock and transfer corridor between the two craft.
- The Soyuz was launched just over seven hours prior to the launch of the Apollo CSM. Apollo then maneuvered to rendezvous and docking 52 hours after the Soyuz launch. The Apollo and Soyuz crews conducted a variety of experiments
  over a two-day period. After separation, Apollo remained in space an additional 06 days. Soyuz returned to Earth approximately 43 hours after separation

Salyut Space Station

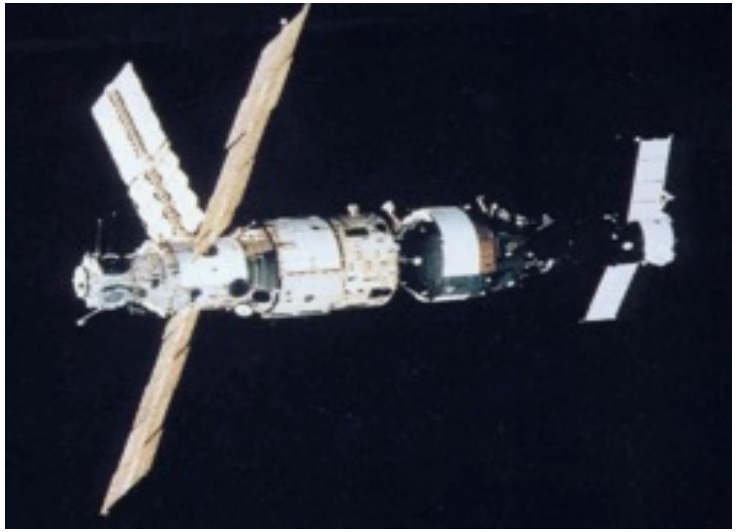
- Salyut Space Station is the first space station to be launched into space. It was a great accomplishment for the Russians.
- 9 Salyut spacestations served from 1971 to 1982.
- It paved the way for Mir and for ISS.

Mir Space Station

- Mir space station served from 1986 to 2001. Many experiments for the effects of weightlessness on humans was performed as well as biological and chemical experiments in microgravity.

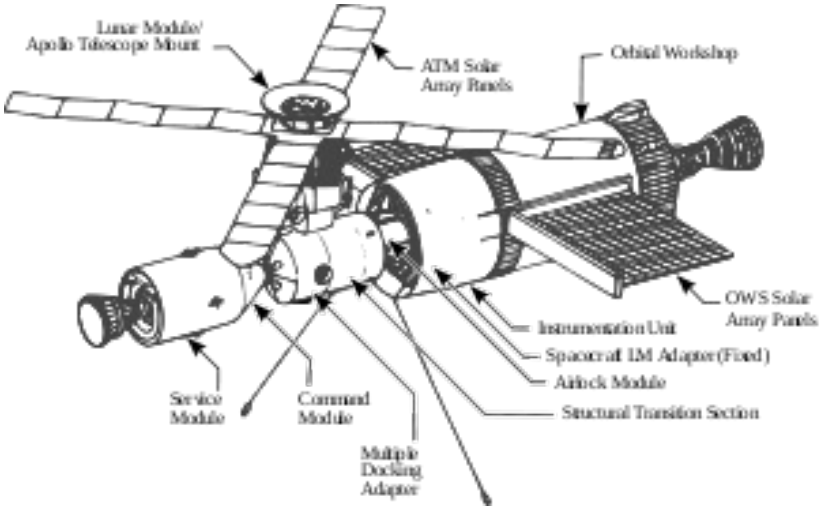
Mir Technology

- Mir brought several important spacetechnology. It consisted mainly of the Kvant module and the Krystall module. It couldbe docked by manned Soyuz craft or by automated Progress craft.
- The oxygen was provided by the Electron oxygen generator as well as by Lithium Perchloride candles.
- Mir was able to accommodate up to 6 people.



Skylab Space Station

- Skylab Space Station served as a response to Salyut Space station of Russians. It was a research suborbital platform with 441 km apogee and with 283 m^3 of volume.
- The 100 ton space station served from 1973 to 1979



The Space Shuttle

- The space shuttle was the world's first and only reusable spacecraft.
- The first space shuttle Colombia was launched in April 12, 1981 commanded by John Young.

Space Shuttle Crafts

- 6 different Space shuttles have been constructed. These are namely:

- 1) Enterprise
- 2) Colombia
- 3) Challenger
- 4) Discovery
- 5) Atlantis
- 6) Endeavour

Shuttle Tragedy

- Two major shuttle accidents have occurred resulting with the loss of the spacecraft as well as the loss of the crew.
- January 28, 1986 Challenger exploded during lauch all seven crew members died.

- February 1, 2003 Columbia disintegrated during reentry all seven crew members died.

End of the Shuttle Era

- 2010 is a big year for the Space Shuttle program since the last flight is scheduled to take place september 16, 2010 with the space shuttle Discovery as the Mission STS - 133

Buran – The Russian Space Shuttle

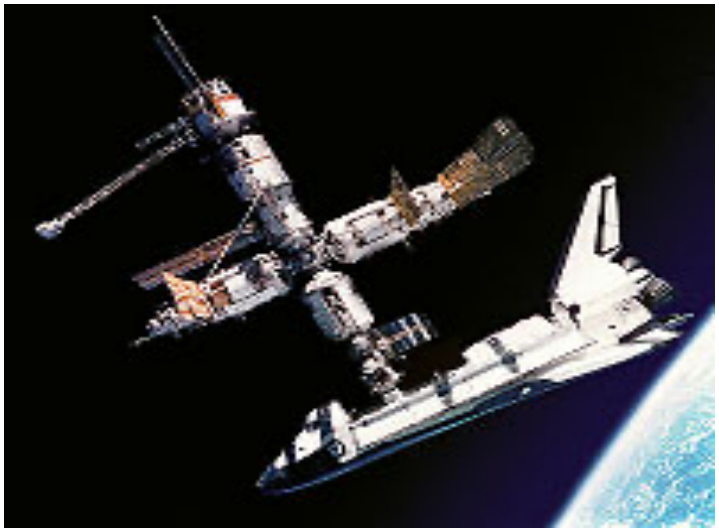
- Buran (Snowstorm) was the answer of the Russian space program to the American shuttle.
- Buran flew its only flight as unmanned in 1988. However, the project was cancelled after the flight.
- Buran was destroyed in 2002 in a hangar crash.

ISS – International Space Station

- After the Apollo program, ISS is the second biggest space project in history.
- ISS is also the biggest international project up to date.
- Construction began in 1998 and it will be completed in 2011. It will remain operational until 2016.

Project ISS

- ISS consists of 11 pressurized modules as of December 2009.
- Its main modules are comprised of Zarya module from the Russian Republic and the Unity Module from the United States.
- The ISS is serviced by the Space Shuttle and by Soyuz – Progress spacecraft.
- There is always a Soyuz spacecraft docked for an emergency evacuation.

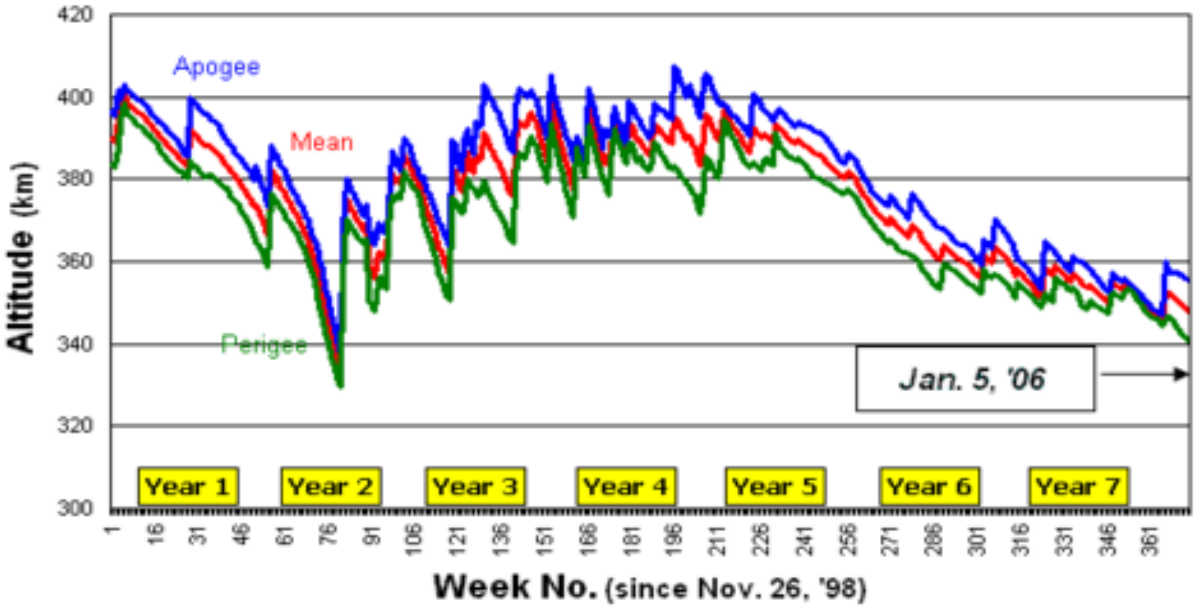


ISS – An International Project

- ISS is the most biggest and most expensive international cooperation project up to date.
- Americans (NASA), Russians (RKA), Europeans (ESA), Canadians (CSA) and the Japanese (JAXA) are the contributors to the ISS program.
- ISS contains the Columbus European Space Lab as well as the Kibo Experimental Module from the Japanese

Orbit of ISS

- ISS constantly loses altitude due to atmospheric drag. It needs to be raised to a higher altitude several times a year.
- The altitude of ISS changes from 278 to 460 km
- The altitude adjustment is usually done by the propulsion units in the Zvezda module although it can be done by a docked space vessel such as the Space Shuttle, Soyuz or Progress spacecraft.



The Age of Satellites

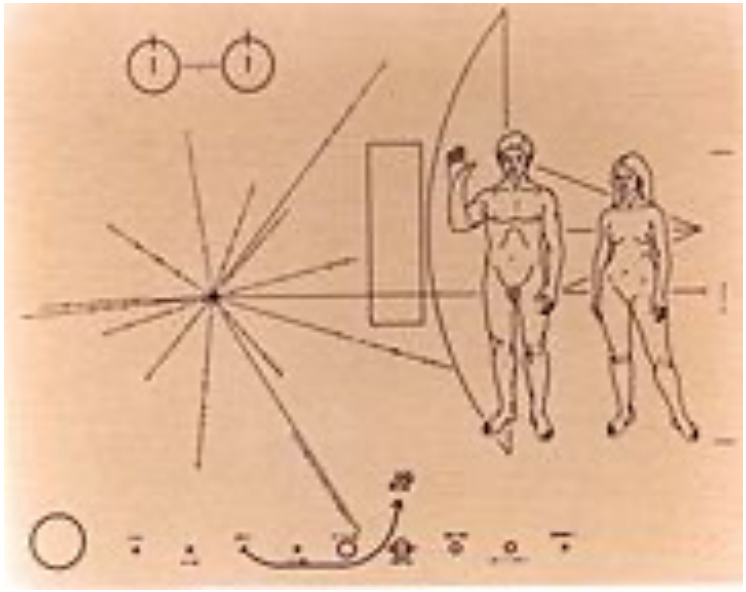
- There are hundreds of satellites orbiting our world currently. These range from communications satellites, research probes, metereological satellites, navigational satellites (GPS), remote sensing and survey satellites to military satellites.
- Currently, USA, Russia, France, UK, Japan, China, India, Israel and Iran have the capability to put a satellite into orbit.

Voyager: Exploring the Solar System and Beyond

- Voyager was launched in 1977 for researching our solar system.
- It is powered by a RTG (Radioisotope Thermoelectric Generator) of 420 Watts.
- Voyager I is now 16.59 billion kilometers from Earth.
- It is expected to exit the Heliopause (known boundary of the Solar System) in the next 5 years.
- It is now the furthest object in space made by mankind.
- It has a golden phonograph record of man's achievements.

Pioneer Probes

- Pioneer probes were launched in 1972 and 1973 to explore the Solar System, The Jovian system and Saturn.
- Pioneer contains a golden plaque that contains the drawing of a man and woman for any extraterrestrials.



Mars Probes

- NASA launched several probes to Mars:
  - Phoenix Mars Lander
  - Viking Mission to determine life on Mars
  - Mars Global Surveyor
  - Mars Pathfinder Mission to rover the surface of Mars

Major Space Agencies Today

- There are several space agencies that promote space technologies today which includes:
  - NASA
  - Russian Federal Space Agency
  - Chinese Space Agency
  - ESA (European Space Agency)
  - JAXA (Japanese Space Agency)
  - ISRO (Indian Space Agency)

Thank You

- www.aerospacelectures.com