



The Past and the Future of Spaceflight

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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:

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

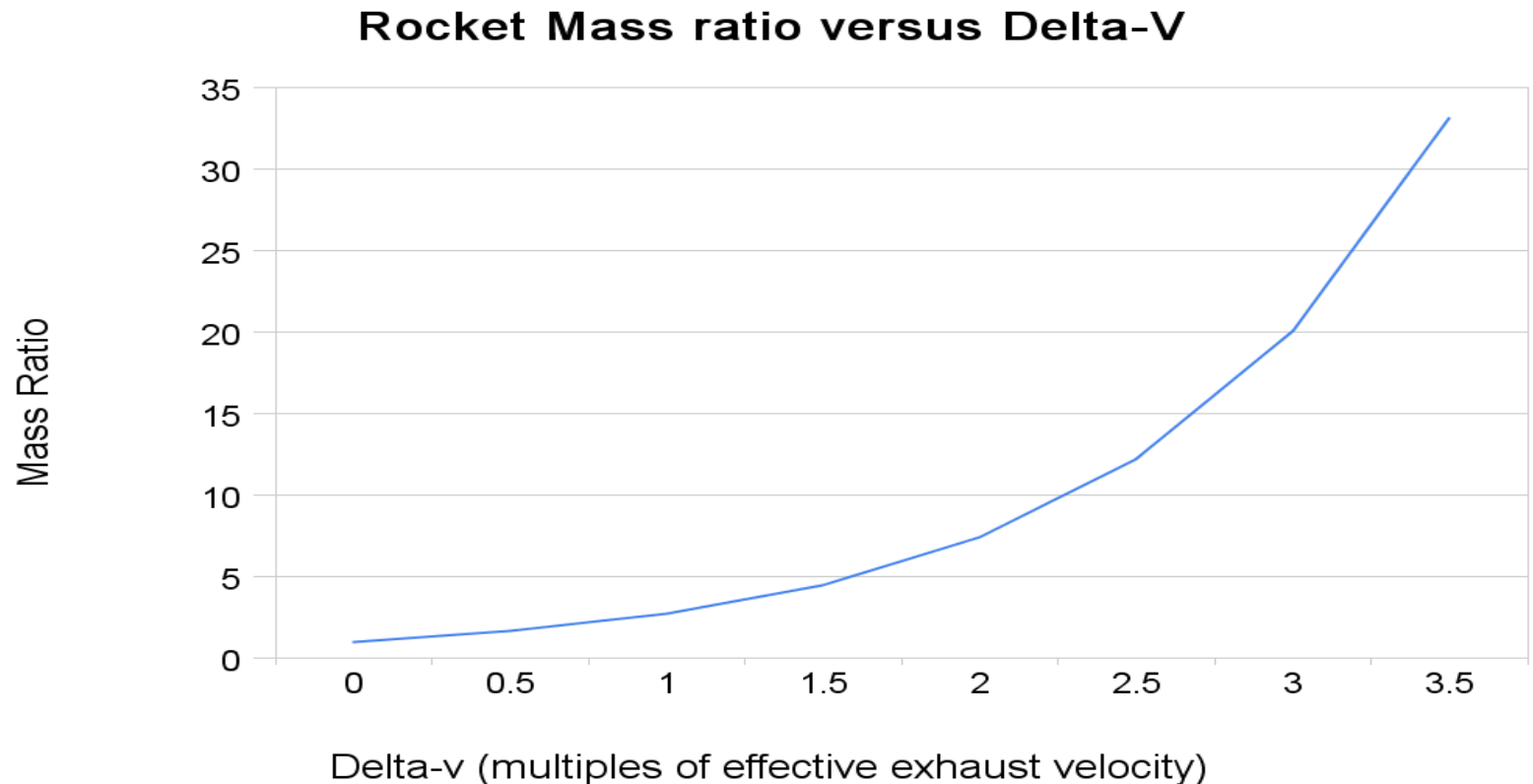
Tsiolkovsky's Rocket Equation is born:

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



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.



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

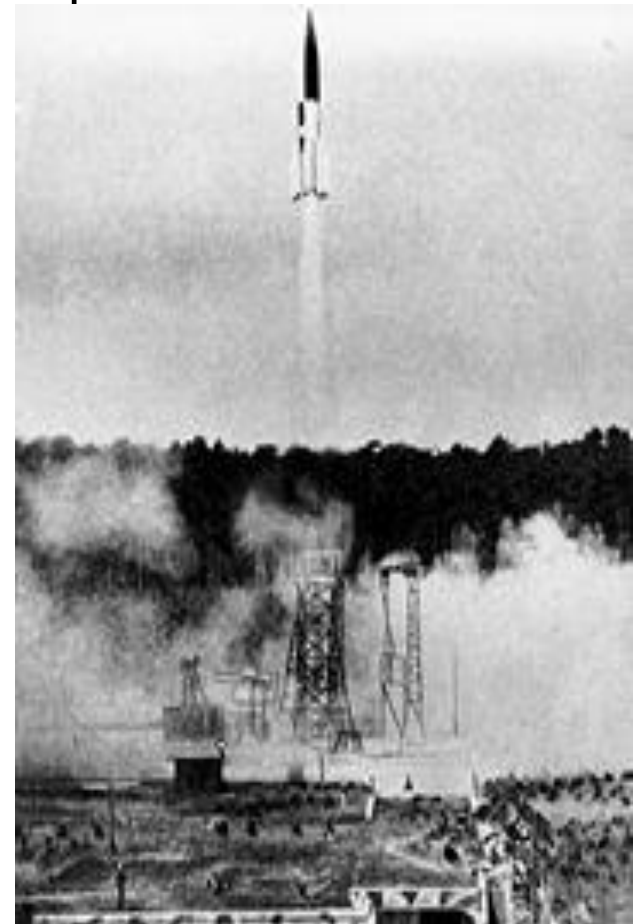
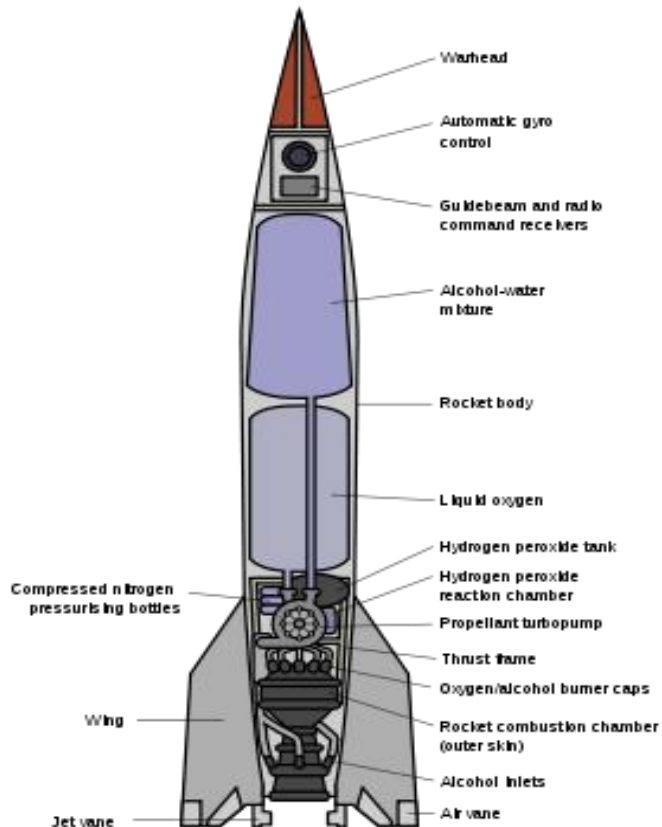
- Wernher von Braun was a German Engineer who pioneered the world's first rocket with the invention of the V2 during World War II.



- 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.

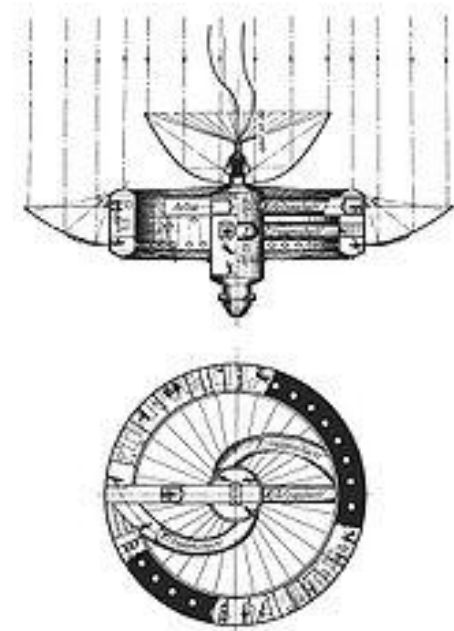
World's First Rocket V2

- 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.



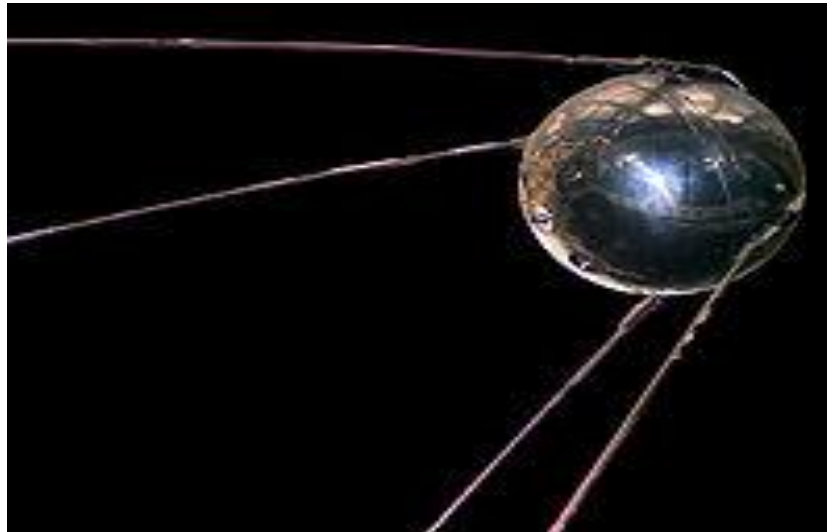
Hermann Noordung – Inventor of the Space Station

- 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.



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 continuous 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.



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.



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.



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.



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;

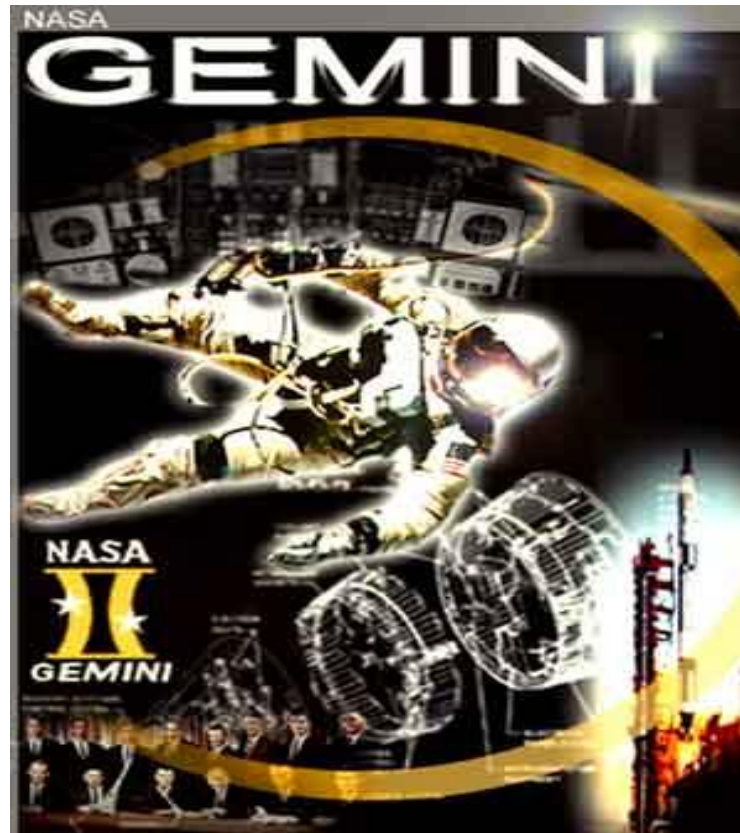
To investigate man's ability to function in space;

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.

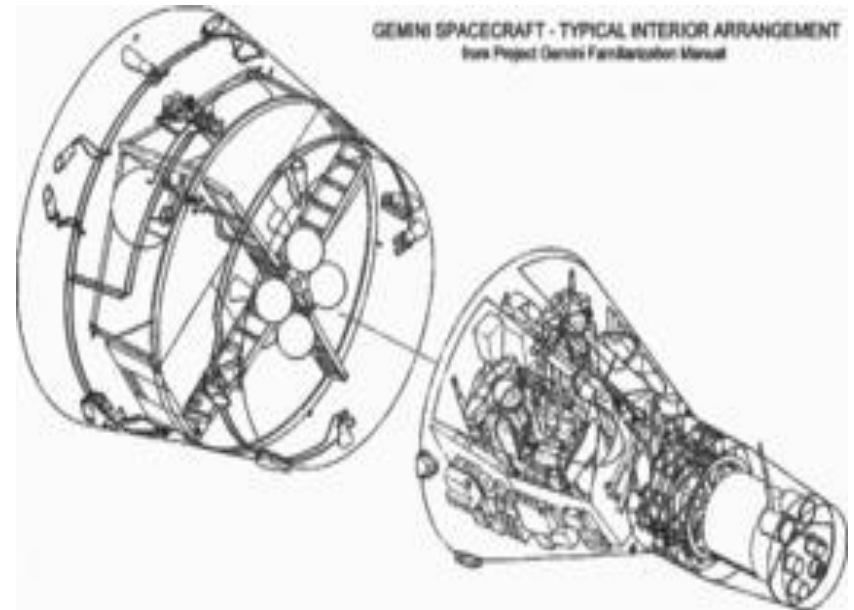


Goals of Project Gemini

- 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

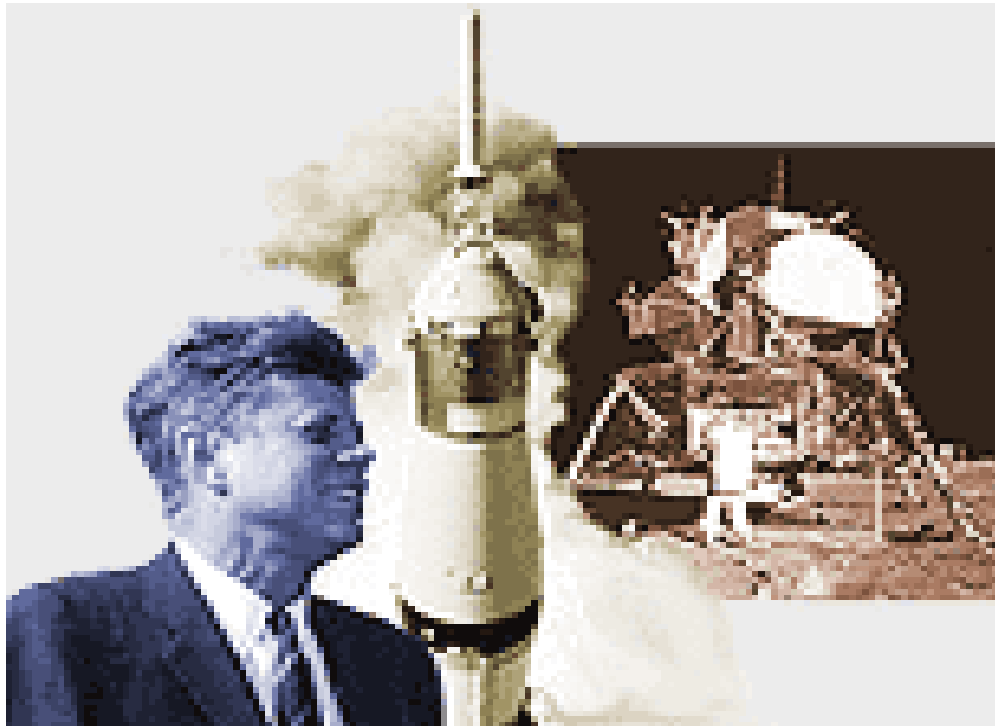
- Gemini spacecraft were subcontracted to McDonnell Douglas.
- It weighed 3.8 tons and it was able to reach an apogee of 402 km and have a delta v of 222 km/sec.
- It could alter its orbit.





Project Apollo – The Way to the Moon

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



The Dream of Kennedy

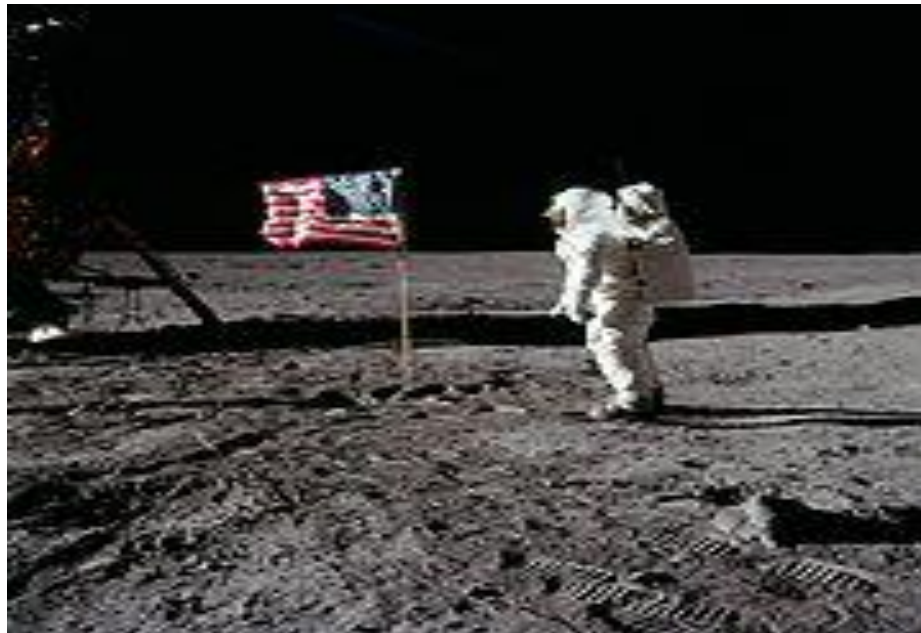
- The Apollo Program which eventually took mankind to the moon began as the dream of President John F. Kennedy.

"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."



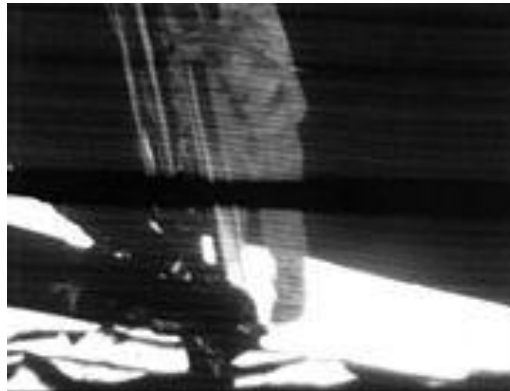
Apollo 11-The Flight to the Moon

- 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 flew 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.



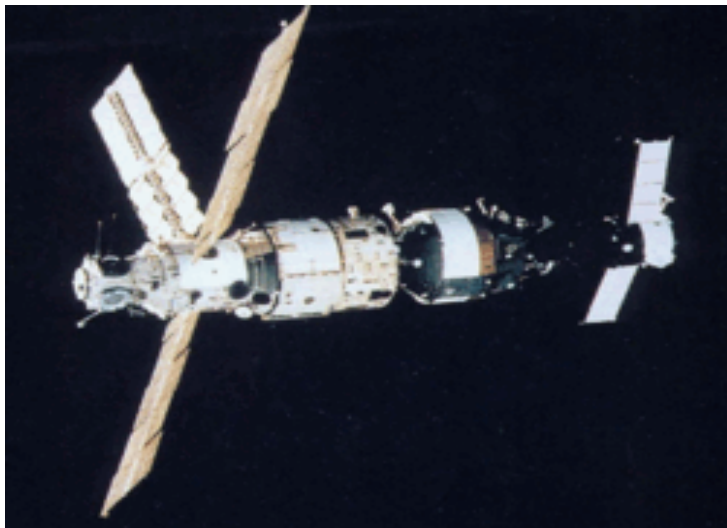
Mir Space Station

- 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

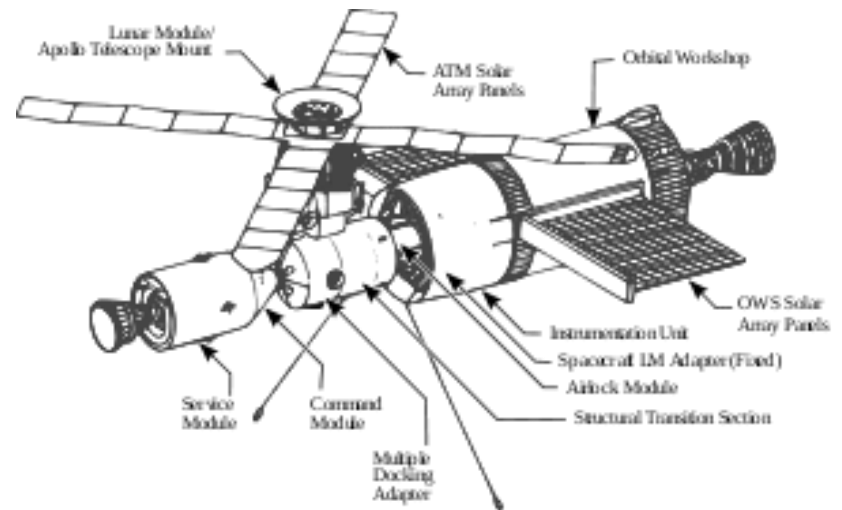
- Mir brought several important space technology. It consisted mainly of the Kvant module and the Krystall module. It could be docked by manned Soyuz craft or by automated Progress craft.
- The oxygen was provided by the Electron oxygen generator as well as by Lithium Perchlorate candles.
- Mir was able 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 m³ of volume.
- The 100 ton space station served from 1973 to 1979



The Space Shuttle

- The space shuttle is the world's first and only reusable spacecraft.
- The first space shuttle Columbia 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 launch 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.



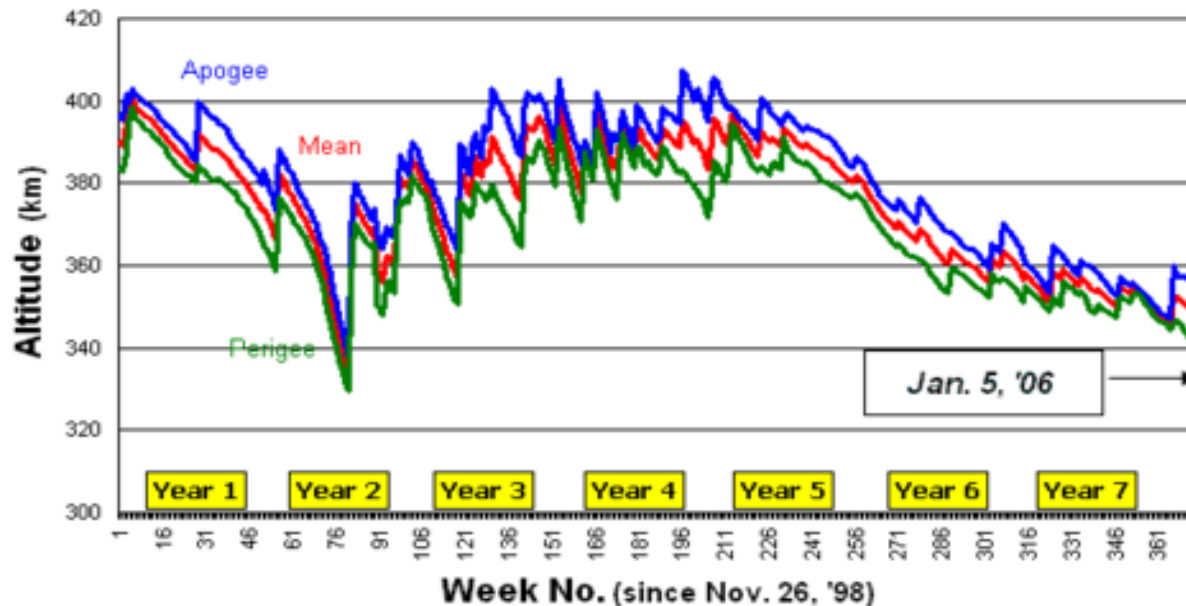
ISS – An International Project

- 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



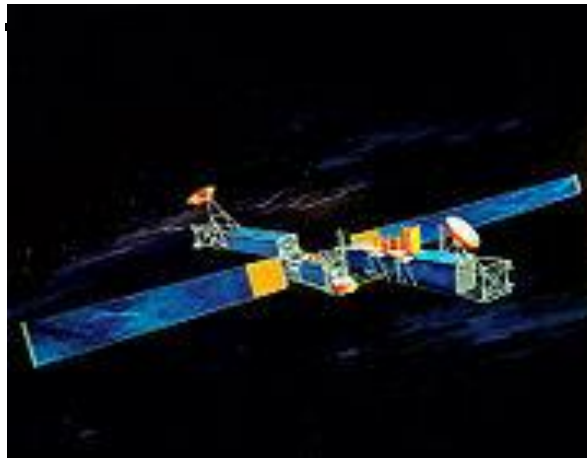
Orbit of ISS

- 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, meteorological 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.



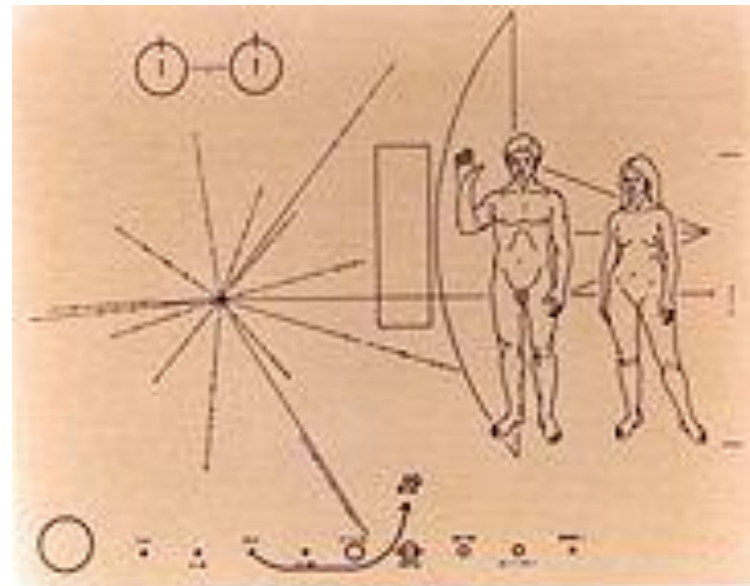
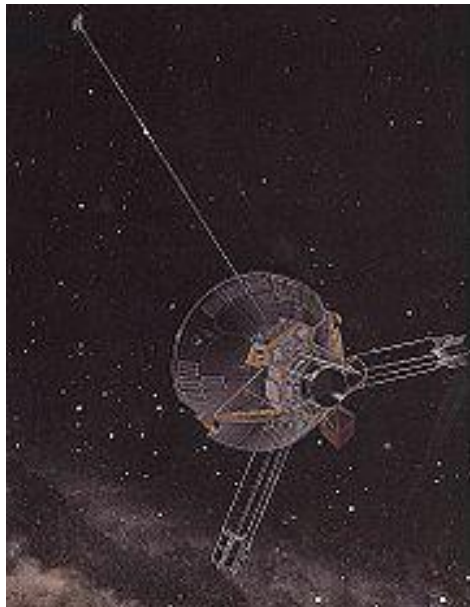
Voyager: Exploring the Solar System and Beyond

- 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



CHINA - The Third Nation for Manned Flight to Space

- October 15, 2003 was a monumental time as the third nation in the world reached manned spaceflight capability.
- At that date, China launched Shenzhou 5 with the Chinese astronaut Yang Liwei and reached an altitude of 343 km.
- China is the fifth nation to send an unmanned craft to orbit the moon.



Start of a New Era - CEV

- CEV or Crew Exploration Vehicle is the next generation of spacecraft for NASA. It is also known as the Orion spacecraft.
- It is expected to be able to travel as far as the Moon
- CEV will be ready in 5 years and it will be constructed by Lockheed Martin. It will make its first flight in 2014.



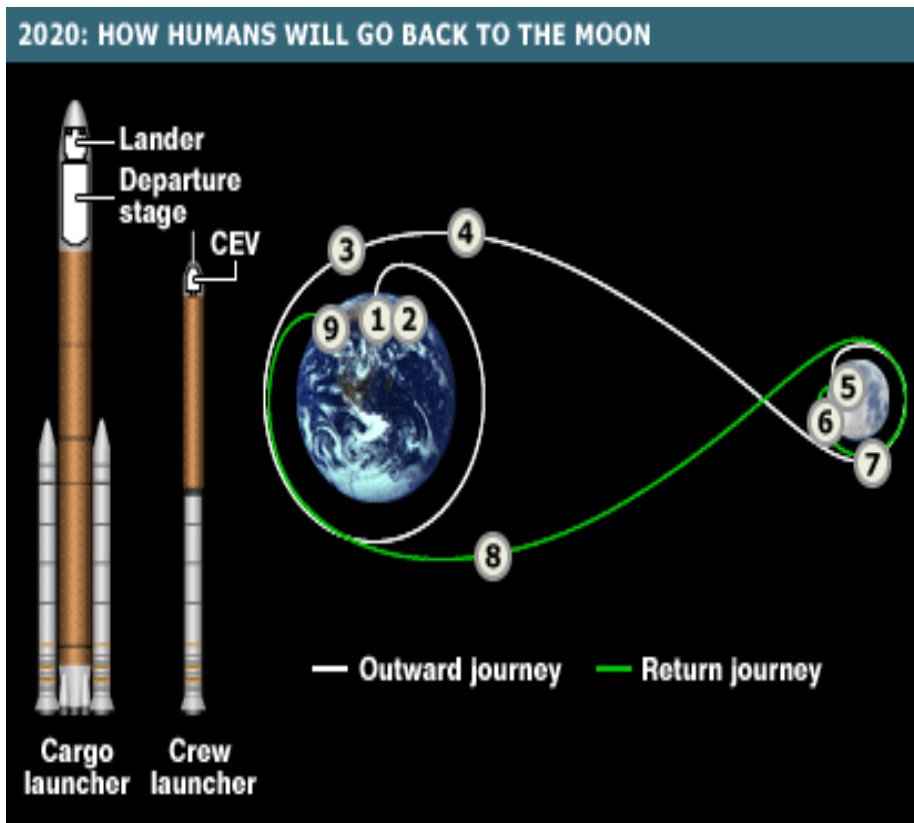
Clipper – The Russian Counterpart of CEV

- Clipper is the Russian counterpart of CEV.
- Clipper is a partially reusable spacecraft.
- It is expected to replace Soyuz spacecraft.
- Clipper is expected to fly as early as 2012.
- It is designed to be launched both from Baikonur or French Guianes.



Plans to Go Back to the Moon

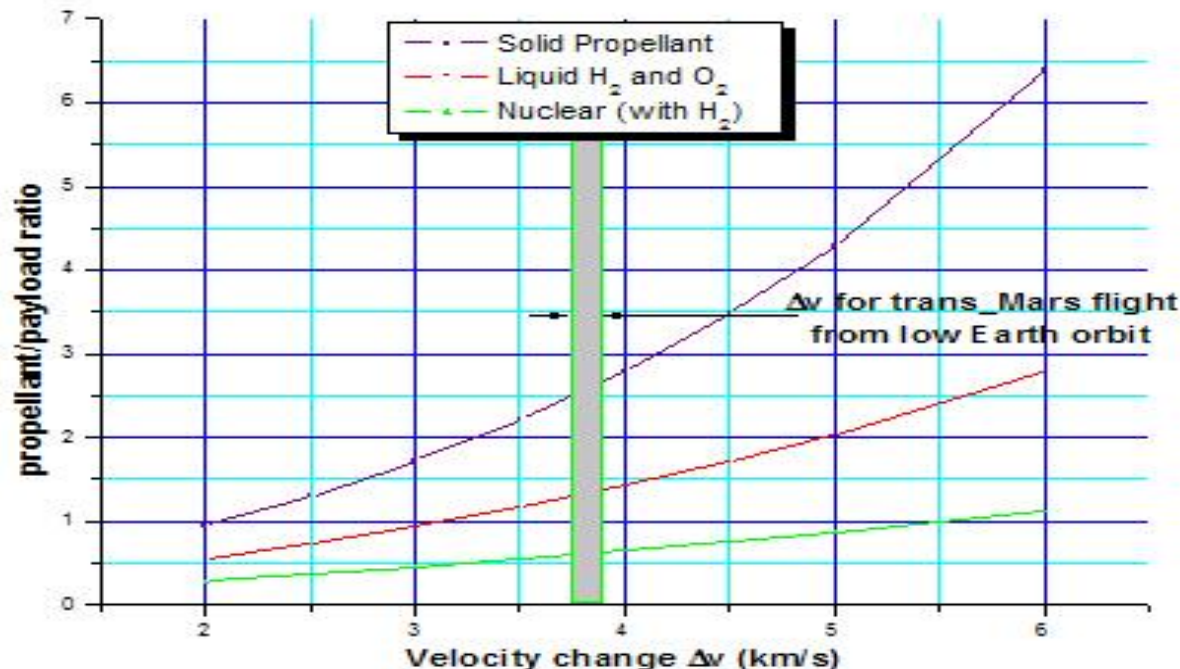
- NASA plans to go back to the Moon by 2020. NASA will use the CEV spacecraft for this purpose.



- (1) A heavy-lift rocket blasts off from Earth carrying a lunar lander and a "departure stage"
- (2) Several days later, astronauts launch on a separate rocket system with their Crew Exploration Vehicle (CEV)
- (3) The CEV docks with the lander and departure stage in Earth orbit and then heads to the Moon with the aid of nuclear propulsion.
- (4) Having done its job of boosting the CEV and lunar lander on their way, the departure stage is jettisoned
- (5) At the Moon, the astronauts leave their CEV and enter the lander for the trip to the lunar surface
- (6) After exploring the lunar landscape for seven days, the crew blasts off in a portion of the lander
- (7) In Moon orbit, they re-join the waiting robot-minded CEV and begin the journey back to Earth again using nuclear propulsion.
- (8) On the way, the service component of the CEV is jettisoned. This leaves just the crew capsule to enter the atmosphere
- (9) A heat shield protects the capsule; parachutes bring it down on dry land, probably in California.

Mission to Mars

- In 2030, Mars is planning a mission to Mars by using a Nuclear Thermal Rocket.
- The mission window is estimated to be at 500 days and it is estimated that the whole Mission to Mars project will cost around 700 billion dollars.



Colonization of the Moon

- Moon is the stepping stone of the mankind.
- The first realistic project was suggested by Tsiolkovsky in 1930.
- US Army conducted a research into the matter in 1959 with Project Horizon.
- NASA plans to have a Lunar outpost in 2024 at the pole of the Moon.
- Russians plan to send a man to the moon in 2025 and establish an outpost in 5 years.
- China wishes to send a man to the Moon by 2022.
- India and Japan have a plan to establish an outpost on the moon after 2030.
- The best place to have an outpost on the Moon is on the Poles since it offers the most sunlight and the direct line of sight of communications.



Resources of the Moon

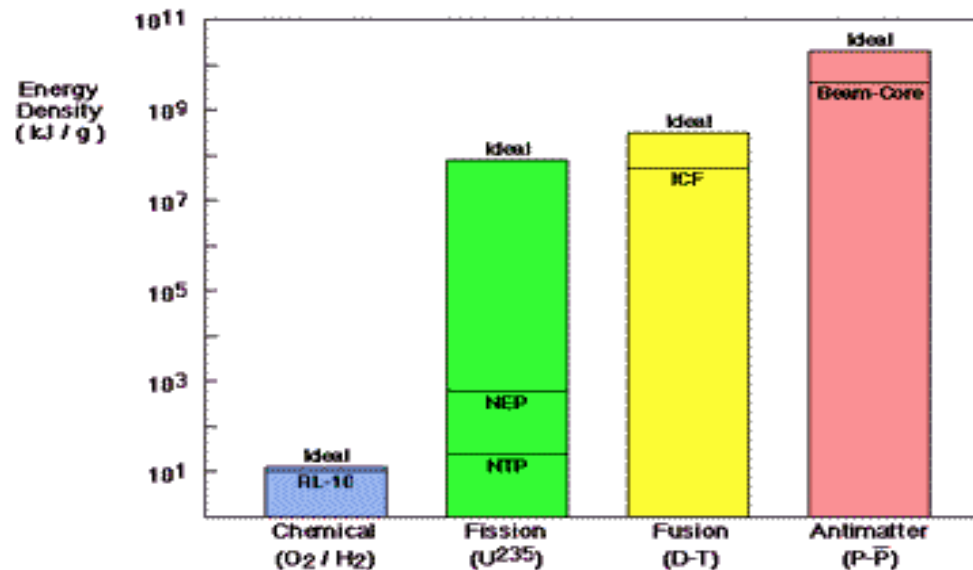
- On November 13, 2009, NASA announced that its LCROSS mission was successful and that water was found (around 100 kg at the impact site) on the Moon in ice form.
- Water can be used as Hydrogen is separated to make rocket fuel. Moreover, water can be used to supply human needs at the Moon Outpost.
- Moon is also abundant with Helium 3, which is very rare on Earth. Helium 3 is a source of fuel for fusion and it can be used to power Earth's needs.

Colonizing the Solar System

- NASA has plans on the drawing board to colonize Mars and other planets in the Solar System after the year 2050.
- Especially the Asteroid Belt promises many different ores of minerals to Earth.
- There are certain biochemical procedures contemplated by NASA for terraforming the planets.
- Especially for Mars terraforming, it is planned to release lots of Carbon Dioxide into the atmosphere to cause planet warming.

Interstellar Flight

- Interstellar Flight can only be possible with Nuclear Propulsion Techniques.
- Nuclear Propulsion Techniques use Fission, Fusion or Antimatter Technology.
- With the present technology Fission powered spacecraft is possible.



The Future is in Our Hands

- Everything from an Outpost on the Moon to Colonization of Mars is possible.
- Mankind's true destiny lies in the stars
- Every country has a responsibility to contribute to Space Technology, so that mankind can take his rightful place amongst the stars.
- All kinds of exotic space travelling techniques are being explored currently.

Thank You

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