

Science Voyages :

The Skies & Beyond Aviation & Space

By: Akashdeep Singh, AEO



Aviation: Science Behind Flying



Leonardo's Screw



Would you believe that **Leonardo Da Vinci**, the famous artist who painted **Mona Lisa** and the mural **'Last Supper'** gave the first theory behind flying? And that he is also known as a scientist, mathematician, engineer, inventor, anatomist, sculptor, architect, botanist, musician and writer?







3D model

Leonardo's Screw

- An Aerial Screw designed by Leonardo in 1400 was an early precursor to the principle of the modern day helicopter. He designed a device like a screw to compress air in order to obtain flight. He believed that this would generate enough force to lift the aerial screw in the air.
- It was 15' in diameter and made from reed, cloth and wire. It called for a 4-man team to stand on a base and employ a pumping action to spin the rotary blade in order to lift the device off the ground.
- We now know that this design would not be able to achieve flight due to weight of materials used
- In Da Vinci's time, the technology of modern day flying had not been invented, but the basic principles of lift used by this aerial screw remain relevant today as they provide the foundation for how modern helicopters fly.



Hot Air Balloon

The hot air balloon is the first successful human-carrying flight technology. The first untethered manned hot air balloon flight was performed by Jean-Francois Pilatre de Rozier and Francois Laurent d'Arlandes on November 21, 1783, in Paris, France, in a balloon created by the Montgolfier brothers .



You can see a Balloon model in Pushpa Gujral Science City



Hot Air Balloon - Working...

- A hot air balloon is lighter-than-air aircraft consisting of a bag, called an envelope, which contains heated air. A wicker basket is suspended beneath the balloon which carries passengers and a source of heat.
- Normally, the open flame is caused by burning liquid Propane.
- The heated air inside the envelope makes it buoyant since it has a lower density than the colder air outside the envelope.



There are many places where you can take a Hot Air Balloon ride in India, like Pushkar, Manali, Darjeeling, etc.

Wright Brothers

World's First Airplane.

 The Wright brothers – Orville and Wilbur were two American aviation pioneers who invented, built and flew the world's first successful motor-operated airplane. They made the first controlled, sustained flight of a powered aircraft with the Wright Flyer on December 17, 1903, 4 mi (6 km) south of Kitty Hawk, North Carolina.



Orville and Wilbur Wright in 1905



You can see the 1st Wright Brother's Airplane model at PGSC

World's First Airplane

- In 1904–05, the brothers developed their flying machine to make longerrunning and more aerodynamic flights with the Wright Flyer II, followed by the first truly practical fixed wing aircraft, the Wright Flyer III.
- The Wright brothers were also the first to invent aircraft controls that made fixed-wing powered flight possible.



Mechanism Behind Flying Of Air Plane

Lift & Drag



Lift

How the aeroplane is lifted up?

- Lift is the force that directly opposes the weight of an **airplane** and holds the **airplane** in the air.
- Lift is generated by every part of the airplane, but most of the lift on a normal airliner is generated by the wings.
- Lift is a mechanical aerodynamic force produced by the motion of the airplane through the air.



Lift

How the aeroplane is lifted up?

Explanation:

Airplane gets a lift when it runs on the runway mainly due to the shape of its wings. As shown in the picture, when a plane runs on runway, the air on the top surface of the wings get slipped due to its shape and hence the speed of air at this surface increases, whereas the speed of the air at the bottom of the wing is less in comparison. This speed difference creates a pressure difference on top and bottom of the wing (higher pressure at bottom and lesser at the top). As per the Bernoulli's principle, this gives an uplift to the plane.







Drag – what is drag? In a plane

Drag is the aerodynamic force that opposes an **aircraft's** motion through the air.

Drag (resistance produced by air) is generated by every part of **the airplane** which reduces the speed of the plane.

Therefore, to get maximum speed of the plane, we need to minimize the drag by reducing its cross-sectional area by giving it a stream lined/pointed shape.





Swati– An Indian Training Air Craft

The **Bharat Swati** is an Indian two-seat training monoplane designed by the Technical Centre of Directorate General of Civil Aviation and built by Bharat Heavy Electricals Limited.

VT-STR

Want to fly a plane?

You can sit in a real Swati Aircraft and get yourself pictured at Science City

Swati Plane Salient Features...

The Swati is a low-wing cantilever monoplane with a steel tube fuselage covered in fabric at the rear and composite material at the front. It has metal tail surfaces and wooden wings and a fixed landing gear with a steerable nose wheel. The Swati has a 116 hp (87 kW) Lycoming O-235 piston engine at the front, driving a two-bladed propeller.

General characteristics	Crew: 2
Length: 7.21 m (23 ft 8 in)	Height: 2.78 m (9 ft 1½ in)
Wingspan: 9.2 m (30 ft 3 in)	Wing area: 11.96 m ² (128.74 ft ²)
Empty weight: 530 kg (1168 lb)	Gross weight: 770 kg (lb)
Performance	
Maximum speed: 268 km/h (167 mph)	Range: 453 km (282 miles)
Cruising speed: 195 km/h (121 mph)	Endurance: 2 hours 45 min

Beyond the Skies..... Into Space



V2 Rocket Beginning Of Space Era

- The V-2 was the world's first longrange guided ballistic missile. The missile was developed during the second world war by German Army.
- The V-2 rocket also became the first artificial object to travel into space by crossing the Karman line on 20 June 1944.





Discoverer

Discoverer-1 was the first manmade object ever put into a polar orbit.

Specifications

- Discoverer-1 was a 5.73 m long and 1.52 m in diameter .
- The upper stage was capped by a conical nosecone.
- The satellite casing was made of magnesium.
- Most of the 18 kg payload, consisting of communication and telemetry equipment, was housed in the nose cone.



Discoverer...

- It was launched on a Thor- Agena, on 28 January 1959 from Vandenberg Air Force in California. It was also the first satellite launched towards the South Pole in an attempt to achieve polar orbit, but was unsuccessful.
- Thor-Agena was a series of orbital launch vehicles. The rockets used Thor first stages and Agena second stages.
- The DISCOVERER program was managed by the ARPA (Advanced Research Projects Agency) of the Department of Defence and the U.S. Air Force.



Space Missions



SPUTNIK

Sputnik was the first artificial earth satellite.

- The Soviet Union launched it into an elliptical low earth orbit on 4 October 1957.
- It orbited for three weeks before its batteries died.
- It was a 58 cm (23 inch) diameter polished metal sphere, with four external radio antennas to broadcast radio pulses. The 'beep' 'beep' sound of radio signal was easily detectable every time when it took the round of earth.





International Space Station

- The ISS Programme is a joint project between five participating space agencies: NASA (United States), ROSCOSMOS (Russia), JAXA (Japan), ESA (Europe), and CSA (Canada).
- The ISS serves as a microgravity and space environment research laboratory.
- The crew members conduct experiments in biology, human biology, physics, astronomy, meteorology, and other fields.
- The station is suited for the testing of spacecraft systems and equipment required for missions to the Moon and Mars.



The ISS maintains an orbit with an average altitude of 400 kilometres. It circles the Earth in roughly 92 minutes and completes 15.5 orbits per day.

A model of International Space Station can be seen at Science City

More about International Space Station (ISS)

- The ISS appears as a bright moving light across the night sky (like Venus). It can be seen from Earth without the use of a telescope by night sky observers.
- It flies at an average altitude of 248 miles (400 kilometers) above Earth.
- It circles the globe every 90 minutes at a speed of about 17,500 mph (28,000 km/h). In one day, it travels about the distance it would take to go from Earth to the moon and back.
- It generally holds crew of 3-6 people
- Astronauts spend most of their time on the ISS performing research experiments and maintenance of Space craft, at least two hours every day to exercise and some times perform spacewalks or conduct media/school events for outreach.
- NASA App can be used to find out its location on a particular night.



Moon Model And Apollo Missions

- A huge lunar model welcomes you when you enter in the science voyage hall. This diorama shows various lunar missions from 1963 to 1972.
- The Apollo program was designed to land humans on the Moon and bring them safely back to Earth.
- Six of the missions (Apollo 11, 12, 14, 15, 16, and 17) achieved this goal.
- Apollo 7 and 9 were Earth orbiting missions to test the Command and Lunar Modules. It did not return lunar data.
- Apollo 8 and 10 tested various components while orbiting the Moon and returned photography of the lunar surface.
- The six missions that landed on the Moon returned a wealth of scientific data and almost 400 kilograms of lunar samples.





Brief Of Apollo Missions

- The Apollo mission consisted of a Command Module (CM) and a Lunar Module (LM). The CM and LM would separate after lunar orbit insertion.
- One crew member would stay in the CM, which would orbit the Moon, while the other two astronauts would take the LM down to the lunar surface.
- After exploring the surface, setting up experiments, taking pictures, collecting rock samples, etc., the astronauts would return to the CM for the journey back to Earth.



Mission Apollo-11 July 20, 1969 : "That's one small step for a man, one giant leap for mankind."

Crew members Neil A. Armstron, Commander Michael Collins, Command module pilot Edwin E. Aldrin, Jr., Lunar module pilot





Mission Apollo-11

The Apollo 11 Lunar Module (LM) "Eagle" was the first crewed vehicle to land on the Moon. It carried two astronauts, **Commander Neil A. Armstrong and LM pilot Edwin E. "Buzz" Aldrin, Jr.**, the first men to walk on the Moon.



Launch date: 16 July 1969; UT 13:32:00 Landed on Moon: 20 July 1969; UT 20:17:40 Landing Site: Mare Tranquillitatis - Sea of Tranquility (0.67 N, 23.47 E) Returned to Earth: 24 July 1969; UT 16:50:3



MISSION APOLLO-11

The LM undocked from the Command/Service Module (CSM). After a visual inspection by Collins, a separation manoeuvre was commenced. The LM descent engine fired putting the craft into a descent orbit with a closest approach 14.5 km above the Moon's surface. The LM landed at 20:17:40 UT on **20 July 1969** in the region known as Mare Tranquilitatis (**the Sea of Tranquility**) at 0.67416 deg. N latitude, 23.47314 deg.East longitude.







Lunar Rover And Apollo Missions

A **lunar rover** is a space exploration vehicle designed to move across the surface of the moon. The Apollo Program's Lunar Roving Vehicle was driven on the Moon by members of three American crews, Apollo 15,16 and 17.





Moon Rocks

The Apollo missions collected 2,200 lunar samples weighing 382 kilograms.

Dating

- Rocks from the Moon have been measured by radiometric dating techniques. These rocks range in age from about 3.16 billion years old for the basaltic samples derived from the Lunar Maria, up to about 4.44 billion years old for rocks derived from the highlands.
- Mare basalts contain 18-21% FeO (Iron oxide) by weight, and 1-13% TiO₂ (Titanium dioxide).







Hubble's telescope

The Hubble Space Telescope is named in honour of astronomer **Edwin Hubble**.

TheHubbleSpaceTelescopeitwaslaunchedintolowearthorbitinandstillremainsinoperation.



You can see a model at Pushpa Gujral Science City



Features of Hubble's space telescope

- Hubble features a 2.4m mirror, and its four main instruments observe in the ultraviolet, visible, and near infrared regions of the electromagnetic spectrum.
- Hubble observatory is the first major optical telescope placed in the space. Above the distortion of the atmosphere, far above rain clouds and light pollution, Hubble has an unobstructed view of the universe.



Images sent by Hubble Space Telescope











Voyage To The Venus Venera program

The Venera program was the name given to a series of space probes developed by the Soviet Union between 1961 and 1984 to gather information about the planet Venus. Ten probes successfully landed on the surface of the planet while thirteen probes successfully entered the Venusian atmosphere. Due to the extreme surface conditions on Venus, the probes could only survive for a short period on the surface, with times ranging from 23 min - 2 hrs.



A model at PGSC



Venus Globe FACTS ABOUT VENUS

- Venus is the only planet that rotates clockwise.
- Venus rotates very slowly. A Venus day is approximately 243 Earth days long.
- The atmospheric pressure you would experience on the surface of Venus is about 90 times the pressure at the Earth's surface.
- Venus is the brightest natural object in the sky besides the sun and Moon. It can be as much as 15 times brighter than the brightest star (Sirus).
- Venus has a surface Temperature of 498 degree Celsius ("Visual Encyclopaedia Pentagon Press, 2002")





Voyage To The Red Planet

- The Viking program consisted of a pair of space probes sent to Mars by NASA (Viking-1 and Viking-2).
- Each spacecraft was composed of two main parts: an Orbiter designed to photograph the surface of Mars from orbit and a Lander designed to study the planet from the surface.
- The orbiters also served as communication relays for the landers once they touched down.



A model at PGSC



Mars Pathfinder/ Sojourner Rover

- Mars Pathfinder was designed to be a demonstration of the technology necessary to deliver a lander and a free-ranging robotic rover to the surface of Mars in a cost-effective and efficient manner.
- Mars Pathfinder returned 2.3 billion bits of information, including more than 16,500 images from the lander and 550 images from the rover, as well as more than 15 chemical analyses of rocks and soil and extensive data on winds and other weather factors.




Space Shuttle

- The Space Shuttle was a partially reusable low earth orbital spacecraft system that was operated from 1981 to 2011 by NASA as a part of the Space Shuttle program.
- 6 Space Shuttles were built by NASA : Challenger, Enterprise, Columbia, Discovery, Atlantis & Endeavour, which undertook several space missions.
- Kalpana Chawla, the first Indian born American woman astronaut was one of the 7 crew members who died in the Columbia disaster



Visitors at Science City can see model of space shuttle and its various parts by pressing buttons provided on the panel.

Indian Women In Space

Sunita Lyn Williams is an Indian origin American astronaut and United States Navy officer who held the records for total spacewalks by a woman (seven) and most spacewalk time for a woman (50 hours, 40 minutes). Williams was assigned to the International Space Station as a member of Expedition 14 and Expedition 15. In 2012, she served as a flight engineer on Expedition 14 and then commander of Expedition 33.

Kalpana Chawla was an American astronaut, engineer and the first woman of Indian origin to go to space. She first flew on Space Shuttle *Columbia* in 1997 as a mission specialist and primary robotic arm operator. In 2003, Chawla was one of the seven crew members who died in the Space Shuttle *Columbia* disaster when the spacecraft disintegrated during its re-entry into the Earth's atmosphere. Chawla was posthumously awarded the Congressional Space Medal of Honor.



Sunita Lyn Williams



Kalpana Chawla



Huygens Lander- Cassini Probe

- At Space gallery of science city, visitors get information about various space missions.
- The *Cassini–Huygens* space research mission was a collaborative program between NASA, European Space Agency and Italian Space Agency to send a probe to study the planet Saturn and its system, including its rings and natural satellites.
- The Flagship class robotic spacecraft comprised of both NASA's *Cassini* probe and ESA's Huygens lander, which landed on Saturn's largest moon, Titan. *Cassini* was the first to enter Saturn's orbit.



Launched on October 15, 1997

Space Missions Efforts by India



Satellite Aryabhata

Aryabhata was India's first satellite, named after the famous Indian astronomer Arybhata. It was launched on 19 April 1975 from Kapustin Yar, a Russian rocket launch using a Kosmos-3M launch vehicle. It was built by the ISRO.

Launch mass: 360 kilograms (790 lb)
Decay date: 10 February 1992
Mission duration: Planned for 6
months

Last contact: March 1981



To mark the success, a commemorative step was taken by the then Govt. of India to print a picture of Aryabhata on the Rupees two note.





POLAR SATELLITE LAUNCH VEHICLE

The Polar Satellite Launch Vehicle (PSLV) is a third-generation rocket launcher designed, manufactured and operated by the Indian Space Research Organisation (ISRO).

The PSLV was designed to be 450 m high and of 2.8 m diameter.

The vehicle is incorporated with two cylindrical aluminium tanks attached to the solid rocket boosters for storing the injected fuel.



Witness a Rocket Launch event in PGSC through a working model and feel the excitement

PSLV – Types Of Fuel Used

PSLV can launch a satellite into orbit in four stages.

- The first and third stages are incorporated with two solid propulsion systems, with the second and fourth stages powered by liquid engines.
- Fuel used at first stage Hydroxyl-terminated Poly-butadiene (HTPB)
- The second stage ignites using di-methyl hydrazine and nitrogen tetroxide oxidiser after reaching 68.5km.
- The third stage is powered by HTPB propellant.
- The fourth stage comprises a dual-engine configuration and utilises liquid propellant
- mono-methyl-hydrazine fuel and nitrogen tetroxide oxidiser.



Chandrayana-1

• Chandrayaan-1 was the first Indian lunar probe under Chandrayaan program. It was launched by the Indian Space Research Organisation in October 2008, and operated until August 2009. The mission was last contacted on Aug 20, 2009 at 20.00 UTC





Goals of

Mission Chandrayan-1

- High-resolution mineralogical and chemical imaging of the permanently shadowed north- and south-polar regions.
- Searching for surface or sub-surface lunar water-ice, especially at the lunar poles.
- Identification of chemicals in lunar highland rocks.
- Chemical stratigraphy* of the lunar crust by remote sensing of the central uplands of large lunar craters and of the South Pole Aitken Region (SPAR), an expected site of interior material.
- Mapping the height variation of features of the lunar surface.
- Observation of X-Ray spectrum greater than 10 keV and stereographic coverage of most of the Moon's surface with 5 m resolution.
- Providing new insights in understanding the Moon's origin and evolution.

*the analysis of the order and position of layers of archaeological remains.



Components and Specifications of Chandrayan-1

Mass

1,380 kg at launch and 675 kg at lunar orbit and 523 kg after releasing the impactor.

Communications

X band, 0.7 m diameter **dual gimballed parabolic antenna** for **payload** data transmission. The Telemetry, Tracking & Command (TTC) communication operates in S band frequency.

Power

The spacecraft was mainly powered by the solar energy which included one solar panel covering a total area of 2.15 × 1.8 m generating 750 W of peak power, which was stored in a 36 A-h lithium-ion battery for use during eclipses.

Propulsion

The spacecraft used a **bipropellant integrated propulsion system** to reach lunar orbit as well as orbit and altitude maintenance while orbiting the Moon. The power plant consisted of one 440 N engine and eight 22 N **thrusters**. Fuel and oxidiser were stored in two tanks of 390 litres each.

Gimballed Parabolic Antenna

- A **gimbal** can be described as a pivoted **point** that allows to rotate an object along a single axis. It helps to shoot incredible images from various angles
- A gimbal system is used in space studies for supporting and enabling the orientation of a circular satellite antenna dish in azimuth and elevation. The gimbal system includes a hoop structure, the ends of which are connected to the antenna dish. The dish is supported on the hoop for pivotal motion about its "X" axis. The hoop is mounted for rotation about the "Y" axis of the antenna dish.
- Gimbal system is now available in I- phones to help shoot stable pictures



Payload*

Scientific Payloads from India

- a) Terrain Mapping Camera (TMC)
- b) Hyper Spectral Imager (HySI)
- c) Lunar Laser Ranging Instrument (LLRI)
- d) High Energy X ray Spectrometer (HEX)
- e) Moon Impact Probe(MIP)

* For a rocket, a **payload** can be a satellite, probe, equipment or spacecraft for use in scientific studies. For a ballistic missile, the payload is one or more warheads and related systems

Thrusters

A small rocket engine on a spacecraft, used to make alterations in its flight path or altitude.

Bipropellant Integrated Propulsion System

 A liquid-propellant rocket or liquid rocket utilizes a rocket engine that uses liquid propellants. Liquids are desirable because their reasonably high density allows the volume of the propellant tanks to be relatively low and it is possible to use lightweight centrifugal turbopump to pump the propellant from the tanks into the combustion chamber

Chandrayan-2

- Chandrayaan-2 mission was a highly complex mission, representing a significant technological leap compared to the previous missions of ISRO.
- It brought together an Orbiter, Lander and Rover with the goal of exploring south pole of the Moon.
- This was a unique mission which aimed at studying not just one area of the Moon but all the areas combining the exosphere, the surface, as well as, the sub-surface of the moon in a single mission.



Contact with Vikram Lander was lost just 1.3 miles (2.1 km) above the lunar surface. Despite the apparent crash-landing, ISRO confirmed that all the instruments on board the orbiter were working well and released photos of a crater called Boguslawsky E, located near the lunar south pole.

Launcher- GSLV Mk III

Mk-III • The GSLV (Geosynchronous Satellite Launch Vehicle rocket) carried Chandrayaan 2 to its designated orbit. This threestage vehicle is India's most powerful launcher to date, and is capable of launching 4-ton class of satellites to the **Geosynchronous Transfer Orbit** (GTO).



Chandrayan-2- Orbiter

- Chandrayaan-2 Orbiter was capable of communicating with Indian Deep Space Network (IDSN) at Byalalu as well as the Vikram Lander.
- The precise launch and mission management had ensured a mission life of almost seven years instead of the planned one year.



Vikram Lander

- The Lander of Chandrayaan-2 was named after Dr Vikram A Sarabhai, the Father of the Indian Space Programme. It was designed to function for one lunar day, which is equivalent to about 14 Earth days.
- Weight 1471 kg
- Power generation capacity 650 w
- The primary objectives of the Chandrayaan-2 lander was to demonstrate the ability to softland on the lunar surface and operate a robotic rover on the surface.



ROVER- PRAGYAN

- Chandrayaan-2's Rover was a 6-wheeled robotic vehicle named as Pragyan, which translates to 'wisdom' in Sanskrit.
- Weight 27 kg
- Power generation capacity 50 w



First Indian in Space: Rakesh Sharma

- Rakesh Sharma is the first Indian citizen to reach outer space on April 2, 1984.
- He went as a part of a joint program between the Indian Space Research Organization (ISRO) and the Soviet Inter-Cosmos space program.
- □ He spent 7 days, 21 hours and 40 minutes in space.
- Interestingly, he took Indian food like, suji halwa, aloo chholey and veg pulao, developed with the help of Defense Food Research Lab, Mysore, which he shared with fellow astronauts.
- His work in space was focused on areas of biomedicine and remote sensing.
- In order to cope with space sickness, Sharma adopted 'zero gravity yoga'.

When the then PM of India, Mrs. Indira Gandhi asked Sharma how does India look from the outer space, Sharma said

"Saare Jahaan se Achcha".





Challenges Of Living In Space

Living in Space



Satisfying Your Eagerness About Living In Space

Did you ever wonder :

- Why do Astronauts wear a different suit for launch and Landing?
- What do Astronauts wear on the Space Station and the space shuttle?
- Why do the pants they wear have so many pockets and Velcro?
- Why do Astronauts wear Space Suits?
- What do they do with their dirty clothes?
- How do they breathe in Space ?
- Where do Astronauts in space get water from?
- What do the Astronauts eat and how often?
- How do they eat in Space?
- How is the Space Food Packed?
- Why and how is the food Freeze-dried?
- How is the waste disposed?

These and many more questions are answered at the Space Gallery in PGSC

Why do Astronauts wear Space Suits?

- To explore and work in space, human beings must take their environment with them because there in no atmospheric pressure and no oxygen to sustain life.
- Inside the spacecraft the atmosphere can be controlled so the special clothing isn't needed but when outside, humans need the protection of a spacesuit.



Why do Astronauts wear a different suit for launch and Landing?

During launch and entry aboard a space shuttle, crew members use the orange Launch and Entry Suits. In the event of a pressure leak in the space shuttle's flight cabin, the suits would maintain a positive air pressure around the astronaut. This provides enough air pressure for the astronaut to survive the return to earth during an emergency landing. The pressurized suit also provides thermal protection, an emergency oxygen system, parachute system and survival kit.



Why the pants they wear are covered with so many pockets and Velcro?

• The pockets and Velcro help them keep everything they are working with near them. Without gravity, anything a person lets go off will float away- to be found later on the filtering screen of the shuttle's air circulation system.

What do they do with their dirty clothes?

 Because it's expensive to take supplies into space and there's no washing machine aboard the space station in order to save water- station crew don't change clothes as often as people do on Earth. When a piece of clothing has been worn as many times as possible. It's placed in a bag for disposal resupply vehicle before it undocks from the space station. The dirty clothing and other garbage is then burnt up with the process when it re-enters the Earth's atmosphere.

How do they breathe in Space ?

• You cannot breathe in the vacuum of space because there is so air. Oxygen is the gas we need to stay alive and it forms an important part of the air we breathe. All space missions have to carry their supply of air.

Where do Astronauts in space get water?

 Since it's expensive to carry water from earth. it has to be recycled. The Recycling System reclaims waste waters from the space Station/Space Shuttle's fuel cells, from urine, from oral hygiene and hand washing, and by condensing humidity from the air. Without such careful recycling, 40,000 pounds per year of water from earth would be required to resupply for a minimum of four crew members for the life of the station.

Astronaut's Food and Nutrition Needs

One of the most important needs of mankind is the need for reliable and nutritious food. The food must provide the most favourable conditions for the astronaut's physiological and psychological well-being. Scientists have been faced with the problem of feeding men in a weightless environment.

What do the Astronauts eat?

 The food NASA's astronauts ate in space in the early stages of space flight was limited to freeze-dried foods. Today the space shuttle astronauts eat foods that are familiar to them back on Earth.



- **TYPES OF FOODS**: Food used on the space shuttle mission (1981-2007) include dehydrated, thermo stabilized, irradiated, intermediate-moisture and ready-to-eat.
- MEALS ON BOARD: On most shuttle flights, meals are prepared in a galley installed on the Obiter's mid-deck. First used in 1983, the galley has a water dispenser, an oven, condiment and meal tray stowage and a food preparation area. A full meal for a crew can be set up in about five minutes.
- FOOD CULTIVATION IN SPACE: NASA research program is studying the possibility to cultivation of sweet potato varieties in space. The leaves stem and other parts of the plants not consumed will need to be converted into food.

How often do the Astronauts eat?

• Three meals a day is scheduled for each crew member and each meal is well balanced giving them all the vitamins and nutrients needed for their daily requirements. They can choose from a variety of foods and they even able to have a snack. (Microgravity does not effect the ability to swallow).

How do they eat in Space?

 The astronauts use knives, forks and spoons and also use a serving tray which helps keep the food from floating away. Hot water is available and an oven (not like the one in your kitchen) is available for warming food.

How is the Space Food Packed?

 The Packaging used for Space Food is mainly aimed to prevent food from flying away. It is designed to be flexible, easier to use, as well as maximize space when stowing or disposing food containers.

Why is the food Freeze-dried?

- Removing water via freeze drying reduces food weight up to 99%. This helps astronauts meet weight restrictions on space missions. Freeze-drying preserves food's shape, color and texture, making it last longer.
- Microorganism the food spoiling culprits are eliminated in the freeze-drying process.
How is the waste disposed?

- As on Earth, space food packages must be disposed. Astronauts, after they are done eating, must throw their packages away in a trash compactor inside the space shuttle.
- Non-recyclable items are either put in a return vehicle, which will be totally disintegrated while re-entering the Earth's atmosphere, or in one of NASA's Shuttles, which brings it all back to Earth for disposal.

Daily Routine

Astronauts Living and working in space have the same needs as people on Earth. They take care of their physical fitness and grooming. They wash their hair, brush their teeth, shave and go to the bathroom. However, due to the microgravity environment, they use several different methods to take care of themselves.

Daily Routine...

Shampooing :- Astronauts shampoo their hair with a rinse less shampoo that was originally developed for hospital patients who were unable to take a shower. Mostly they have to take a sponge bath only.

Using the toilet

The toilet, on the space shuttle, basically works like a vacuum cleaner with fans that suck air and waste into the commode.

Thank you