



Space Programmes: History & Current Status



Historical Perspective

Chinese are acknowledged pioneers of space **technology**, through development of **fireworks**.

However, it is only at the **start** of 1900 that study of space as a **formal** discipline began, with development of **rockets** that overcame Earth's **gravity**.



Early Developments

During the decade **1948-1958**, most developments were in the context of **rocket** technology, which saw the **evolution** of German **V-2** rockets & USA's **sounding** rockets.

These were used for **detecting** X-rays and study of upper atmosphere **structure**, including aurorae, **magnetosphere**, ionosphere, Von Allen **belts** etc.



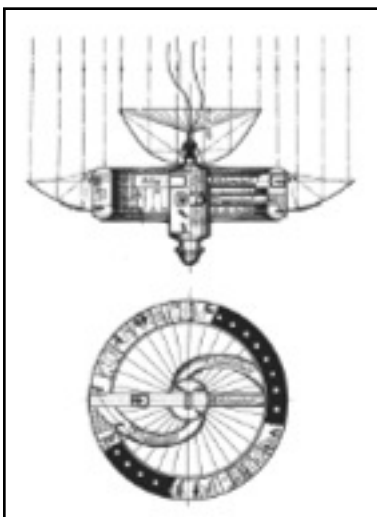
Early Developments

It should be noted that **till** this time it was believed that **only** rockets could perform such **tasks**.

However, launch of **Sputnik-1** by USSR in 1958 **established** that satellites could also be used **effectively**.



Early Space Concepts

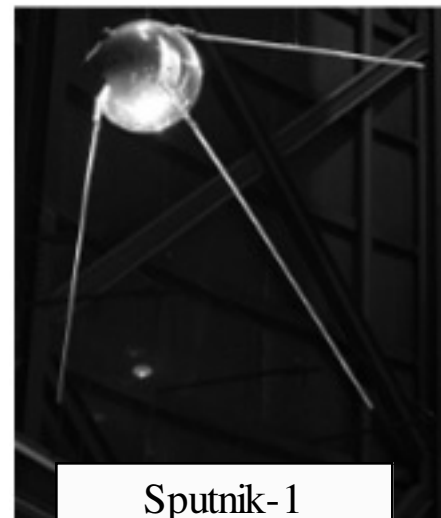


1929 space station concept



V-2 Rocket

Sounding Rocket



Sputnik- 1



Next Four Decades

Luna 3, launched in **1959**, was the first among many space **probes**, that were launched to photograph **moon**.

April 12, 1961 is an important **milestone** for space programmes, as **Yuri Gagarin** established an **orbit** around Earth for the **first** time.



Next Four Decades

This **led** to significantly scaling up of **activities**, which culminated in **USA** putting a man on the **Moon** in 1969.

USSR, followed this with the launch of **Salyut-1** in 1971, which was a kind of **space station**.

Next, **USA** followed this development with the launching of **Skylab** in 1973.



Next Four Decades

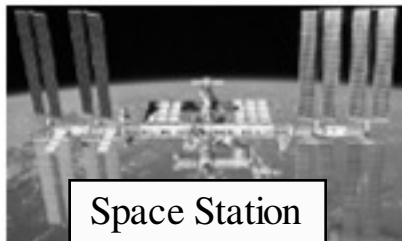
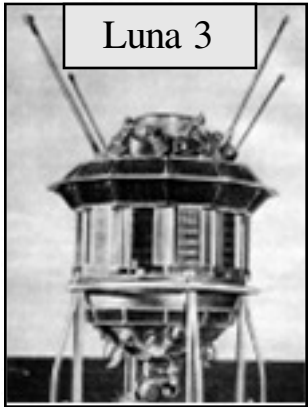
India entered the space age in **1967**, with participation in the sounding **rocket** programme and raised the **level** with establishment of **satellite** centre in 1973.

European space programmes were **initiated** in 1975 with setting up of **ESA**, an inter-governmental initiative of **22** countries, while **ArianeSpace** came up in **1980**.

The period of **1970-2000** witnessed many milestones e.g. **space station**, space shuttle, missions to Mars, **Jupiter**, Saturn, Venus, **Mercury** etc.



Missions during 1960-2000





Last Two Decades & Future

India has not only **consolidated** its position in **launcher** segment with **PSLV & GSLV**, but also has **embarked** on Moon & Mars missions, including **human** spaceflight.

Globally, **SpaceX** has emerged as a major private **player** in launch systems with heavy **launchers**, launch-to-orbit missions & fully **reusable** technology.

The **renewed** interest of many other countries in **Moon & Mars** is expected to **significantly** scale up the space **activities** in the next decade.



Last Two Decades & Future



Falcon 9 Heavy



Orion Spacecraft



Chandrayan 2



Starship Hopper



Delta IV Heavy



GSLV



Space Mission Configuration



Space Mission Configuration

Space mission is defined as an act of **transporting** a space object to its designated **spot** and then carrying out the **scientific** / technological activities.

In general, space **objects** are termed **spacecraft** which consist of **satellites**, probes, landers etc. as per the **specific** role assigned to these **objects**.

Transportation of these objects is done through **rockets** which are also termed launch **vehicles** and burn a large amount of **propellant** to impart the required **energy**.



Space Mission Classification

Further, **space** mission is broadly divided in terms of **ascent**, orbit /inter-planetary and **entry/reentry** missions.

Ascent mission is the **part** in which space **object** is imparted sufficient **energy** to form an orbit around **earth**.



Space Mission Classification

Orbital mission pertains to the **part** where the object is placed in a desired **orbit** / put on a path to other **planets**.

Lastly, **reentry** (or entry) mission is that **segment** in which the **object** is brought to the surface of **earth** (or planet) in a controlled **manner**.



Space Mission Segments



Ascent Mission Concept

Objective of ascent mission is to **provide** potential (altitude) & kinetic (velocity) **energy** to desired payload, so that it can **remain** at a specified altitude above **earth**.

This is **made** possible through burning of a **large** quantity of propellant. (Typical ascent mission).

It should be **mentioned** that ascent missions are **designed** to perform the above **task** in a safe and optimal **manner**.



Orbital Mission Concept

Objective of **orbital** segment is to perform spacecraft related **tasks** and is broadly grouped as follows.

1. **Manoeuvres** to achieve desired **earth** orbit.
2. **Manoeuvres** to achieve desired **inter-planetary** path.
3. **Manoeuvres** to achieve desired orbit around **planets**.

Typical Orbit/Interplanetary Path



Re-entry Mission Concept

Re-entry or return is the **reverse** of the ascent mission, that involves **recovery** of space objects, without **damage**.

The main **challenge** is the dissipation of large amount of **energy**, imparted during ascent & **orbital** mission phases.

Problem is further **complicated** by the requirement of precise **positioning** during the landing phase.

Typical Reentry Mission

Shuttle Reentry Mission



Space Mission Design Strategy

Space missions aim to carry **out** scientific/ technological **tasks** so that their **design** is primarily driven by the **intended** role of the spacecraft.

However, **spacecraft** needs to be **placed** at the correct **location** to enable it to carry out the **desired** task, and hence, we **need** a launch vehicle to achieve positioning.

In most **mission** design activities, we first **design** the spacecraft, and then **synthesize** a suitable launch **vehicle**.



Summary

Space missions aim to create **objects** in space for **various** scientific and technological **needs**.

The **missions** involve the development of a **spacecraft** and a space vehicle for its **transportation**.