

# Space Travel for last 50 years

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**D**reams give us the tremendous power to conceive what might be possible. The three main stalwarts who dreamt that space travel was possible were Tsiolkovsky, Robert Goddard and Von Braun. Konstantin Tsiolkovsky (1857-1935), an unassuming Russian school teacher, wrote a paper explaining mathematically that the horizontal speed required minimum orbit around the Earth of 5 miles per second can be achieved by means of multistage rocket fired by liquid oxygen and liquid hydrogen. Robert Goddard, an American Physics professor, invented the first liquid propelled rocket, and from 1930 to 1941 launched rockets of increased complexity and powerful capability. Though the foundations of space science were chalked out during the 1700s but it took 200 years before the ideas could be put into practice. Wernher Von Braun, a German engineer, worked in the design of deadly V2 rocket that spread the venom of death killing many during World War in the Western front. But it was the German V2 rocket that showed the way to others for building powerful rockets in succession. He was the pioneer who pushed rocket science to its pinnacle by developing powerful rockets with incremental capacities, starting with Redstone Atlas which had begun development in 1950s as Intercontinental Ballistic Missiles (ICBMs) and finally the Saturn rockets that put the victorious astronauts on the Moon from 1969 to 1972.

Space is a large laboratory where experiments in many novel fields that scientists and engineers carried out in the last fifty years have been enriching our daily lives. The whole period of space exploration, during this time, may be considered to consist of many successive eras starting in the 1950s, such as the Cold War era, the Apollo Moon era, the era of Space shuttle, robotics, the International Space Station, and Sky-lab, the recent era of commercial activities involving telecommunication, navigational, meteorological and Earth Resources satellites, and last but not the least, the present Constellation program, *i.e.* Heavy lift Ares I and Ares V Rockets, and the Orion Spacecraft. The plan was to land by 2020 on Moon and then Mars; however, it has been recently discontinued owing to paucity of funds.

The Cold War era was the home of space exploration; the warring superpowers during the 1950s prompted the development of powerful rockets for launching their ICBMs that pushed them to the brink of space. It was on April 12, 1961 that Yuri Gagarin of Russia in 53.6 kg Vostok 1 reached the outer limits of space. There has been no looking back since. Advances in trajectory control and astrodynamics have made it possible by continued space experimentation to put a spacecraft manned or unmanned, exploring and navigating through gravitational forces of solar system to any point on space with precision. Mankind had advanced thus far to the limits of space. Its astronauts are able to carry out extravehicular activity (walking in space).

To visit another planet like Moon beyond low earth orbit (200 miles above earth) we needed one Mother Spacecraft docked with another Lander craft. During the Apollo moon missions, astronauts could dock and undock at will while detaching the Lander and landing on the Moon; at the end of the mission, they would take off from the Moon in the jet powered Lander, dock to the Mother spacecraft, and then safely get back to Earth. Astronauts

mastered these skills with pinpoint accuracy with advances in trajectory control negotiating the gravitational forces of planets, as well as in astrodynamics (science of dynamic movement in space), utilizing rocket power and thrusters fitted on the body and wings of the spacecraft.

Rocket jet propulsion is based on the fact that if a vehicle ejects chemical exhaust at a high speed through a nozzle, in a given direction, a force acts in opposite direction. This is briefly according to Newton's third law of motion, which states that to every action there is an equal and opposite reaction. Possibility of putting vehicles into orbit around the Earth was understood by Isaac Newton in the late 1600s as an aftermath of his discovery of law of gravitation. While aeronautics is a science of flying aircraft in the atmosphere, astronautics is the science of space flight; it is the knowledge of navigating the wilderness of space, with the spacecraft negotiating different gravitational forces of the solar system.

A reliable rocket is the first requirement for a successful launch into space when it transforms the inherent chemical energy of the fuel into kinetic energy. Rockets operate by firing a liquid or solid propellant which gives its forward thrust to propel it to outer space. Outside Earth's atmosphere, in space the rocket engine carries not only its fuel but also an oxidizer, unlike any air breathing engine or commercial aircraft that takes oxygen from the Earth's atmosphere. As the velocity which can be obtained by using chemical reactions is limited, chemical rockets require very large quantities of propellant when used for missions requiring large velocity requirements. Greater and heavier spacecraft payloads require large velocities, and hence, larger rockets, sometimes multistage rockets – which means one rocket firing after another is used to provide extra thrust in stages. Huge quantity of propellant is needed to reach and go beyond the low earth orbit (around 250 miles from earth), getting into the Moon's or Mars' arena.

Apollo Moon era was the most technological advancement-rich era in space history. During this time, astronaut piloting skills, as well as essential processes like docking and undocking the Lander to the Mother Spacecraft, were executed with military precision. Kennedy's famous speech on May 25, 1961 was the key impetus for space victory, when he declared that he will land Man on the Moon and bring him back to mother earth. It was a challenging promise because then astronauts had to leave low earth orbit for the Moon's gravitational field quarter million miles away.

The whole process was planned in three stages. First, a man was sent in a metal capsule, Mercury craft, to test his ability to remain there. Secondly, astronauts went into another improved craft, Gemini, which could maneuver around its three axes, and allowed space walks and docking with another spacecraft. The third and final victory spacecraft Apollo was designed and attached with another spacecraft, the Lander, which could dock and undock at will to land on the Moon and take off.

Man landed on the Moon on April 11, 1969. Since then, a total of 12 men have walked on the Moon; there was Lunar excursion module built and used later and all men spent about 300 hours on lunar surface. A fitting conclusion to the Apollo Moon era was a Sky Lab orbiting station during 1973-74 which brought the competition to full circle. In 1975 the USA and Soviet Union achieved the first joint Apollo Soyuz project, a true picture of space co-operation.

The Space Shuttle era started in 1981 by the test flight of Columbia Shuttle. However, the concept had spread out for over many years starting out much before the Apollo Moon era. It started when a German engineer Sanger foresaw such a possibility where a spacecraft would need to be flown as a rocket assisted spacecraft to begin with, and as an aircraft landing on a horizontal runway at end of the mission, unlike the metal capsules launched in space earlier. The airplane having been invented by the Wright Brothers in 1903, the concept of an aircraft flying at higher and higher speeds was being tried out successfully. Some of the jet powered fighter-plane pilots managed to reach the speed of sound (760 miles per hour at sea level). Since then humankind knew that airplanes could be pushed to fly at hypersonic speeds.

X (experimental) planes were designed to be flown with rocket engines; NASA started a new project of designing and flying X-15. One of the dreams of flying spacecrafts came true from the lessons learnt from the X-15 program between 1959 to 1968. X-15 brought to light the structural and aerodynamic problems at hypersonic speeds. It was indeed a space plane forerunner and prompted NASA to design flight-capable vehicles – like a Space Shuttle – that could be utilized as space workhorses replacing the old metal capsules. As a prerequisite, a fleet of airplanes reaching low earth orbit needed to be flown and experimented upon by the end of 1970. Finally a Space Shuttle was born from many alternatives as the most viable solution to the issue of designing a partially reusable spacecraft.

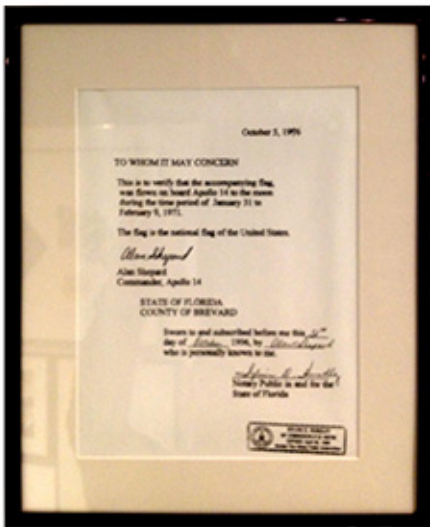
Space Shuttle is essentially a rocket launched from earth's surface which is able to enter a low earth orbit and then re-enter Earth and land as an aircraft. The only other parallel to Space shuttle is the Russian Buran powered by Energia rocket with a payload of 30 tonnes which flew an orbital test flight in November 1988. A Space Shuttle, on the other hand, can put a payload of slightly more than 24 tones in low earth orbit. It consists of a large orange colored external tank (ET), two solid rocket boosters (SRBs) and an Orbiter vehicle similar in shape to a Boeing aircraft where crew and payload is carried.



Space shuttle Atlantis, with orange colored ET, two SRBs and the orbiter; documentation of mission STS-45 (Courtesy: US Naval Academy, Annapolis, MD)

The Shuttle launches vertically like a rocket, lifting off on SRBs and then by the power of its three main engines which are fuelled by liquid hydrogen and liquid oxygen from the external tank. Upon reaching the speed of 17,500 miles per hour (7.8 km/s) necessary to

enter a low earth orbit, the main engines are shut down, the external tank (that can be reused) jettisoned, and the Orbital Maneuvering System (OMS) engines started to adjust the orbit. Orbiter carries a crew of five to seven; its payload capacity is 50,000 lbs (about 24 tonnes). Upon completion of its mission, the Orbiter fires OMS thrusters to drop out of orbit and reach the lower atmosphere to glide down and land back on a horizontal runway. The Space Shuttle is the world's most complex huge machine and a technological marvel of computer, electronics and high speed super-charged engines. It is also a marvel of material science, with about 3600 ceramic tiles covering its body to absorb the extreme heat on reentry. Recently, there has been a lot of advancements in the mirror-like cockpit display (such as in modern aircrafts) and many engine-heat and vibrational sensors that warn the pilot against disasters of the kind that have occurred in the past. The International Space Station formed in co-operation with ten nations is still in the low earth orbit, and needs occasional servicing by the Space Shuttle. However, the Space Shuttle has been phased out, with its last flight on July 21, 2011. It was planned to be replaced by the Constellation program, which has since been shut down. In September 2011, NASA announced working on a future platform to launch spacecrafts from.



*Flag of the US carried on board Apollo 14 during its moon mission under the command of Astronaut Alan Shepard (Courtesy: US Naval Academy, Annapolis, MD)*

Tremendous commercial activities have taken place since we started venturing into space. Telecommunications satellites have brought people of the world closer to each other by improving telephone communications and TV broadcasts. Navigational satellites can be of dual use, civil and military. Meteorological satellites observe Earth from space, keeping an eye on changing weather conditions over the world. The Earth Source satellites operate in a relatively low earth orbit, altitude of 500-1000 km; their field of application is geology, hydrology, oceanography and agriculture. These satellites are used to study crops and vegetations, among other things. Beyond commercial activities, there are scientific satellites doing fundamental physics research, astronomical missions, engineering and materials research, and finally observing the Earth from a distance.

Space probes for over last 30 years have reached all the planets of our solar system; some are still probing. Scientific probes of planets have yielded a great deal of information; very thin discs of dust have been discovered around Jupiter and Uranus; the surfaces of Venus and Mercury have been studied in detail. Unmanned Voyager spacecraft has visited all the planets outside the orbit of Mars. Unmanned Space probes, landing on Moon and Mars, have provided useful scientific information required for future explorations.

In conclusion, we as human beings have achieved a lot in Space-related pursuits – from the staggering first flights, putting the first astronaut in orbit; landing on the Moon; and sending over a hundred space shuttles in many flights. We have conquered the science and technical know-how of sending a man to Space and allowing the performance of a “walk in space”; we have mastered the technique of docking one spacecraft to another; we have learnt how to take advantage of the gravitational forces of different planetary bodies and steer a spacecraft to any point in space. However, with the present technology we still cannot immediately colonize Moon and Mars. If we keep going in this manner, we may land in future on the Moon again, and perhaps on Mars and beyond.

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**Editors’ Note:** Our readers in the United States may soon be able to witness first-hand some of the fascinating devices and equipments mentioned in the article. Following the conclusion of the Space Shuttle program, NASA announced its intention to transfer space-worthy Orbiters to educational institutions or museums. As of now, the decision is to display **Atlantis** at the Kennedy Space Center, Florida, **Discovery** at the Udvar-Hazy Center of the Smithsonian Institution’s National Air and Space Museum near Washington DC, **Endeavour** at the California Science Center in Los Angeles, and **Enterprise** (atmospheric test orbiter) at the Intrepid Sea-Air-Space Museum in New York City. NASA also made **Space Shuttle thermal protection system tiles** available to schools and universities. In addition, **flight and mid-deck training hardware** was destined for the National Air and Space Museum and the National Museum of the US Air Force. The **full fuselage** mockup, which includes the payload bay and aft section but no wings, was to go to the Museum of Flight in Seattle; **Mission Simulation and Training Facility’s fixed simulator**, to the Adler Planetarium in Chicago; the **motion simulator**, to the Aerospace Engineering Department of the Texas A&M University; and other **simulators used in shuttle astronaut training**, to the Wings of Dreams Aviation Museum in Starke, Florida and the Virginia Air and Space Center. (via Wikipedia). Unfortunately, however, NASA’s good intentions are currently embroiled in political and bureaucratic hurdles. But once it is cleared up, you may be able to see these glorious pieces of history up close.