International Journal of Research Studies on Environment, Earth, and Allied Sciences (IJRSEAS)
| *Volume-3 Issue-1* | *February-2026* | *ISSN: 3066-0637* | *Website:* https://eesrd.us

Manuscript ID:
IJRSEAS-2026-030132

OPEN ACCESS

Quick Response Code:

Website: https://eesrd.us

DOI: 10.5281/zenodo.21734809

DOI Link:
https://doi.org/10.5281/zenodo.21734809

Volume: 3

Issue: 1

Pp. 151-153

Month: February

Year: 2026

E-ISSN: 3066-0637

Submitted: 17 Jan. 2026

Revised: 29 Jan. 2026

Accepted: 15 Feb. 2026

Published: 28 Feb. 2026

Address for correspondence:
Dinesh Bhausaheb Balsaraf
Assistant Professor, Dept. of Geography, Arts, Science & Commerce College, Kolhar, Tal–Rahata, Dist–Ahilyanagar
Email:
dinesh.balsaraf10@gmail.com

How to cite this article:
Balsaraf, D. B. (2026). Foundations of the Space Age. International Journal of Research Studies on Environment, Earth, and Allied Sciences, 3(1), 151–153.
https://doi.org/10.5281/zenodo.21734809

Foundations of the Space Age

Dinesh Bhausaheb Balsaraf
Assistant Professor, Dept. of Geography, Arts, Science & Commerce College,
Kolhar, Tal–Rahata, Dist–Ahilyanagar

Abstract

The mathematical and technical foundations of spaceflight emerged through the visionary work of early 20th-century scientists who drew inspiration from the imaginative novels of Jules Verne. Konstantin Tsiolkovsky introduced the rocket equation together with his concept of liquid-fueled multistage rockets while Hermann Oberth and Robert Goddard developed their own versions of these concepts (Goddard's first liquid-fueled rocket flew in 1926). The space age began with Sputnik I launch in 1957 and reached new heights when Yuri Gagarin and Alan Shepard completed their historic human flights in 1961. The first Moon landing occurred during Apollo 11 mission in 1969 and US–USSR Apollo–Soyuz mission occurred in 1975 together with the launch of the reusable Space Shuttle program which started in 1981. The paper examines the achievements through different historical periods together with their supporting technologies which include rocket propulsion systems that use different fuel types and staging methods and launch operations that involve countdowns and staging and astronaut selection procedures and training and microgravity operations. The study analyzes present advancements through satellites and ISS experiments while outlining plans for upcoming Mars missions which will take place during the 2030s.

Keywords: *Space Age Rocket Propulsion Astronaut Training Space Exploration*

Introduction

Science fiction author Jules Verne (1828–1905) created detailed lunar flight descriptions before scientists developed rocket technology. His 1865 novel From the Earth to the Moon and others sowed the seeds of fascination with space travel. Russian engineer Konstantin Tsiolkovsky (1857–1935) in the early 1900s acknowledged that Verne's works served as his main inspiration. Tsiolkovsky created the rocket equation and he presented a multistage rocket design which used liquid oxygen and hydrogen propellants in 1903. Hermann Oberth and Robert Goddard both researched these concepts at the same period. At 14 years old, Oberth created his first model rocket which he developed through his own research of multistage rockets. Goddard launched the first liquid-fueled rocket on 16 March 1926 after he methodically introduced the concept of high-energy liquid propellants which he developed as a follower of Verne and Newtonian physics. Goddard's critics faced defeat after his successful launch proved his lunar flight methods which had faced derision from the press in his 1920 article. The three scientists Tsiolkovsky, Oberth and Goddard developed essential scientific principles which included high-energy liquid propellant usage and staging methods.

These pioneers "laid the foundation for the space age" by proving that Newtonian rocketry could in principle reach space. Verne's "unrealistic" vision of the future became real through the theoretical research which enabled both artificial satellite creation and human space travel during the mid-20th century.

Objectives

- Trace the historical progression from Verne's novels to actual spaceflight developments.
- The study examines all astronaut requirements together with their training methods
- The study examines aspects of space environment which are microgravity conditions and life support systems.

Data Collection and Methodology

The research paper derives its content from an extensive examination of historical and technical literature. The researchers obtained primary data through historical archives and NASA mission summaries and technical documents, which included NASA press kits and mission reports, and they used authorized secondary sources, which included science journalism and encyclopedias. We cross-referenced mission dates and technical specifications with cited sources to ensure accuracy. The researchers established qualitative descriptions of spacecraft and missions and astronaut training through documented facts, which they derived from sources that contained vital information.

Results and Discussion

Rocket theory became established as the fundamental element which enabled spaceflight to progress through its various milestones. The Soviet Union successfully launched Sputnik I on 4 October 1957 as the first artificial satellite to orbit Earth. Sputnik I launched at a weight of approximately 84 kilograms and a size that matched a beach-ball into an Earth orbit which completed one revolution every 98 minutes to establish the start of the space age. Sputnik II launched aboard a spacecraft in November 1957 to establish biological space research when it delivered Laika the dog into orbit. The successful missions created a competition between nations for space exploration. The Luna-1 probe launched toward the Moon in January 1959 and reached a distance of 5995 kilometers after 34 hours of flight to become the first spacecraft which achieved solar orbit. Luna-2 became the first human-made object to reach the Moon when it landed on the Moon in September 1959. The instruments stopped working after the spacecraft hit the surface. The missions proved that both navigation and instrumentation systems could successfully operate during lunar flight testing.

Human spaceflights began during the early 1960s. Soviet cosmonaut Yuri Gagarin reached space on 12 April 1961 as he orbited Earth from Vostok 1 for 108 minutes. Gagarin's return to Earth after his space mission showed that humans could successfully complete space travel missions. The U.S. astronaut Alan Shepard launched to space three weeks later on 5 May 1961 when he entered Freedom 7 (Mercury-Redstone 3) for a suborbital flight which lasted about 15 minutes. The initial flights between these two countries started a fierce competition between them. The two superpowers increased their military operations during the next ten years because they viewed each other as threats.

NASA launched its Space Shuttle Columbia on STS-1 which took place on April 12 1981 to establish the reusable Shuttle era. Columbia's solid rocket boosters produced approximately 80 percent of their total thrust power during their initial two minutes of flight. Every solid rocket booster held approximately 1.1 million pounds of solid propellant which consisted of 16 percent aluminum fuel and 70 percent ammonium perchlorate oxidizer. The solid rocket boosters completed their propellant burn after 2 minutes and 45 seconds of flight during which they reached an altitude of 46 kilometers. Their descent to the ocean occurred through parachute systems and they underwent refurbishment for subsequent missions. The shuttle main engines brought Columbia to orbital speed which equals 7.8 kilometers per second within a duration of 8.5 minutes. The mission control team initiated Main Engine Cutoff after the spacecraft reached an altitude of 113 kilometers when they detached the external tank which subsequently reentered the atmosphere and disintegrated unlike the reusable solid rocket boosters. Rocket propulsion systems function through the expulsion of reaction mass according to Newton's third law which states that greater exhaust velocity produces greater thrust. Rocket propellant consists of two components which are fuel and oxidizer because atmospheric oxygen is not present. Propellants exist in three forms which include solid, liquid and hybrid forms. Liquid propellants provide higher specific impulse through their combination of liquid hydrogen and oxygen while solid propellants offer simpler storage solutions through their combination of aluminum and ammonium perchlorate. Many launch vehicles use both types. The PSLV launcher from India which successfully launched Chandrayaan-1 utilized a solid first stage which carried 138 tons of HTPB-based fuel and a liquid second stage which used UDMH fuel combined with N_2O_4 oxidizer. The first US liquid rocket used gasoline and liquid oxygen fuel in 1926 while later spacecraft, including the Shuttle main engines, operated on liquid hydrogen and liquid oxygen fuel.

Satellites and orbits:

Today Earth has hundreds of satellites that operate for communications and navigation and Earth observation and scientific purposes. Low-Earth-orbit satellites require about 90 minutes to complete a full satellite pass which allows them to create one orbital path every hour. (Thus Jules Verne's Around the World in Eighty Days would be "Around the Earth in eighty minutes" by modern satnav standards.) Higher orbiting craft complete their orbits exactly every 24 hours. Spacecraft can enter orbit by sufficient horizontal velocity; the shuttle reached approximately 400 kilometers after its ascent.

Astronaut selection and training: Early astronauts were all military test pilots. NASA required its first Mercury astronauts in 1959 to have jet fighter experience and a height less than 5 feet 11 inches which corresponds to 180 centimeters because the capsule only accommodated that height. The selection process expanded to include new candidates at a later time. Modern astronaut candidates must have advanced STEM degrees and at least 2 years of relevant experience or 1,000 hours jet flight time. The candidates must complete a comprehensive medical examination that requires them to achieve 20/20 vision either through natural vision or corrective lenses and maintain blood pressure 140/90. NASA currently requires astronauts to meet height specifications that range from 157 centimeters to 190 centimeters. The candidates undergo academic training and flight practice for two years while they complete their training program. This program involves training on spacecraft systems and spacewalking (EVA) procedures and robotics and comprehensive Earth survival training. Astronauts learn to experience microgravity by using parabolic "zero-G" flights which people called the "Vomit Comet" because this aircraft replicates short periods of weightlessness that occur during aerial flight. (The U.S. Air Force began flying parabolas in 1957; NASA took over this program in 1973.)

Life in space (microgravity):

Astronauts floating in space experience weightlessness because both they and their spacecraft enter free-fall under Earth's gravitational pull. The gravity at 300 to 400 kilometers reaches approximately 90 percent of Earth surface gravity yet all objects there experience simultaneous descent. The spacecraft interior lacks any directional indication of "down" because its design renders all surfaces as random space elements. Astronauts and floating objects in the spacecraft experience weightlessness. The body fluids inside human beings move upward because Earth gravity pulls blood downwards which causes the initial space adaptation syndrome symptoms of headache and nausea and dizziness to last for two days. Because astronauts stop using their muscles and bones, their muscles and bones start to lose strength through calcium disappearance. Astronauts need to perform intense workouts for approximately two hours each day, which includes using treadmills and stationary bikes and resistive devices, to maintain their physical health. Astronaut Sunita Williams ran the complete 42 kilometer distance of the "Boston Marathon" on an in-flight treadmill which proved that humans can maintain their endurance while in space. The absence of a downward direction makes simple tasks more difficult because tools and crew members float in space, which requires them to use either tethers or hand grips to maintain control.

Spacecraft life support and suits: Spacecraft transport limited amounts of air and water together with food supplies from their origin on Earth. The system produces oxygen through chemical generators or water electrolyzing processes while chemical absorbers remove carbon dioxide from the environment. The system recycles water through a process that purifies both urine and environmental humidity. The astronauts consume their food which comes as pre-packaged dehydrated meals through a process that requires them to avoid creating floating crumbs. Astronauts use multi-layer extravehicular mobility suits which function as spacesuits during their spacewalk activities. The suits function as personal spaceships because they provide astronauts with air and temperature control systems together with power sources and communication tools and waste management capabilities. The modern suits use 15 to 17 different materials which include Teflon and Mylar and fiberglass to provide protection against extremely high temperature changes and micrometeoroid collisions.

Conclusion

Humanity has developed space travel from its earliest science fiction beginnings into operational space exploration. The combination of Verne's 19th-century ideas and Tsiolkovsky Goddard and Oberth's early 20th-century theories made spaceflight look possible. The period between the late 1950s and 1960s brought real-world applications of those concepts through the development of satellites and lunar probes and human space missions. The Shuttle program introduced reusable spacecraft which allowed astronauts to practice international docking operations. Mature technologies today enable astronauts to access low Earth orbit through satellite systems and the International Space Station while using ion engines for propulsion. The most ambitious goals of the project still exist as upcoming research targets.

Acknowledgment

The author expresses sincere gratitude to the management and colleagues of Arts, Science & Commerce College, Kolhar, Tal–Rahata, Dist.–Ahilyanagar, for their encouragement and academic support during the preparation of this research work. Special thanks are extended to the scientists, researchers, and organizations whose historical records, technical reports, and publications on space science and exploration provided valuable information for this study.

Financial support and sponsorship

Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Konstantin E. Tsiolkovsky – *Wikipedia* (history of astronautics, liquid propellants).
2. Smithsonian National Air and Space Museum, *“Rockets and the Dream of Spaceflight”* (history article).
3. NASA Glenn Research Center, *“Robert H. Goddard (1882–1945)”* (historical profile).
4. Hermann Oberth – *Wikipedia* (rocketry concepts, Jules Verne inspiration).
5. NASA History Office, *“Sputnik 50th Anniversary”* (world’s first satellite).
6. EarthSky News, *“Luna 1: Russia’s First Mission Toward the Moon”*.
7. NASA Science/Cosmology, *“Luna-2: First Moon Impact (1959)”*.
8. Vostok 1 – *Wikipedia* (Yuri Gagarin, 1961).
9. NASA, *“Mercury-Redstone 3 (Freedom 7)”* (Alan Shepard 1961).
10. Luna 9 – *Wikipedia* (first soft Moon landing, 1966).
11. NASA History Office, *“Apollo 11 Mission Overview”* (first Moon landing, 1969).
12. NASA History, *“Apollo–Soyuz Test Project”* (US–USSR docking, 1975).
13. NASA “The First Space Shuttle” (STS-1 launch, 1981); NASA Technical Brief on Shuttle SRBs.
14. PSLV launch vehicle – *Wikipedia* (Chandrayaan-1; stage propellants).
15. NASA Jet Propulsion Lab, *“Deep Space 1 Images”* (ion engine images, 1998).
16. NASA Apollo 11 Press Kit (1969) – countdown schedule.
17. *Times of India*, “Countdown to moon mission begins” (Chandrayaan-1, 2008).
18. NASA, *“Astronaut Requirements”* (education, flight experience).
19. Space Foundation, *“Astronaut Degree Requirements”* (experience and health).
20. Space.com, *“Vomit Comet: Training Flights for Astronauts”* (zero-G training).
21. Space.com, *“NASA wants to send humans to Mars in the 2030s”* (Mars mission plans).
22. U.S. Dept. of Energy, *“New Horizons: Radioisotope Power System”* (Pu-238 mass in RTG).
23. Loksatta newspaper articles NASA Science, *“Radioisotope Power Systems FAQ”* (Voyager power sources).