CSIT 100

Technology In NASA

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# Introduction

The National Aeronautics and Space Administration (NASA) has been the foreground of space technological innovation since 1958. From launching the first man into space to Mars rovers and more, NASA’s greatest achievements have been thanks to the creation of next level technology and the effort to push scientific advancements. The things we thought were impossible are slowly becoming a reality through the development of robotics, satellite communications, and artificial intelligence (AI). Even after 67 years, NASA continues to look toward the future, with each new development testing boundaries and redefining the limitations of exploration. Allowing people to enter the doors of discovery and inspire future generation to expand the possibilities of the life that lies beyond our planet.

NASA is so much more beyond space exploration, NASA technologies have contributed to real-world innovations including communication systems, medical advancements, and environmental monitoring on earth and space. Their work pushes the boundaries of space travel but also helps to solve global obstacles through research, experimentation, innovation, and partnership. As technology evolves, so does NASA as they revolutionize tech with the testament of human curiosity in desire to reach new frontiers in space innovation. As we continue to look ahead, NASA remains a symbolic of what can be achieved when science, technology, and imagination can do when they all work together.

## Overview of NASA Technological Evolution

NASA’s journey into technological development began during the Cold War. NASA was created in response to the Soviet Union’s early space accomplishments such as the launch of the first artificial satellite, Sputnik, marking the start of an intense space exploration race between the United States and Soviet Union. NASA was quick to bring things to the next level with the creation of programs like Project Mercury, which aimed to put a astronauts in Earth’s orbit and return them safely. After three failed attempts, NASA successfully made Alan Shepard the first America in space on a suborbital flight in 1961 and John Glenn the first American to orbit earth a year later.

Toward the late sixties, former president John F. Kennedy proposed the idea of putting a man on the moon, soon following the creation of the Apollo program. The creation of Apollo enabled the development of the Saturn V rocket, one of the most powerful rockets to be built by the United States with it begin 363 feet tall and weighing approximately 6.2 million pounds with it being launched in 1967. “It was one of three types of Saturn rockets NASA built. Two smaller rockets, the Saturn I (1) and IB (1b), were used to launch humans into Earth orbit” (NASA). The rocket launched a total of thirteen times between 1967-1973, with twelve successful Apollo mission launches and one partial failure. The Saturn V rocket was used to launch the first American space station in Earth’s orbit. In 1969, Apollo 11 marked the success of the first astronauts to land on the moon.

After the end of the Apollo program in 1972, NASA’s focus shifted to long term space missions marking the creation of The Space Shuttle Program. The Space Shuttle marked a major technological advancement for NASA, creating the world’s first reusable spacecraft that could carry satellites in and out of orbit. The creation of the shuttle revolutionized the way spacecrafts were built, “Since 1992 alone, NASA has made engine and system improvements that are estimated to have tripled the safety of flying the Space Shuttle, and the number of problems experienced while a Space Shuttle is in flight has decreased by 70 percent,” (NASA). These enhancements not only made space travel safer but also helped NASA to develop a platform to carry out a variety of logistical missions.

# Key Technologies Developed

Overtime NASA has been responsible for the development of a wide array of advanced space technology that have transformed space exploration. Rockets like the Saturn V and the Space Launch System, played a role in allowing heavy equipment to be carried into deep space, especially when they are needed on missions for example, the Mars Perseverance rover. The rover weighs over 2,260 pounds and is currently on mission for ancient signs of life on Mars and collect rock samples.

Communication is another vital area of development with the creation of the Deep Space Network. “The Deep Space Network—or DSN—is NASA’s international array of giant radio antennas that supports interplanetary spacecraft missions, plus a few that orbit Earth,” (NASA). Essentially DSN makes up a large system of antennas around the world which enables communication from distant spacecrafts allowing scientists to receive data from millions of miles away from space. DSN was established in 1958 which contributed to the launch of the first U.S. satellite. Due to the DSN antennas it allowed the first man on the moon Neil Armstrong to communicate his famous quote, *“That’s one small step for man, one giant leap for making.”*

In addition, artificial intelligence (AI), has made large technological changes in space craft navigations as they are used for navigation systems, data processing, and solo operation on spacecrafts. AI has made it possible for things like probes and rovers to make decisions on their own based on environmental factors, for example a Mars rover deciding whether a rock sample is valuable or not. Through these innovations, NASA has developed technology that is more efficient and has built up the groundwork for the next generation of space exploration. Ai capabilities will be vital to future missions when it comes to exploring distant planets and what else might be beyond, ensuring NASA’s continuation to push the boundaries of exploration.

## Current & Future Technologies

As NASA pushes the boundaries of space exploration, new technologies are being researched and created to support missions beyond Earth’s orbit. With one of their most recent projects being the Artemis program, which is directed to returning humans back to the Moon by 2025. By using new technology, NASA will be better able to study the moon to prepare humans for missions to Mars. NASA will be using a new rocket known as the Space Launch System (SLS) for the Artemis missions. “SLS will carry the Orion spacecraft with up to four astronauts riding aboard to lunar orbit. Then, astronauts will dock Orion at a small spaceship called the Gateway. This is where astronauts will prepare for missions to the Moon and beyond,” (NASA). As of today, Artemis has three scheduled launches, Artemis 1 carried out a test flight of the SLS rock along with the Orion spacecraft in 2022. Artemis 2 will fly SLS and Orion before going past the moon and circling back to earth, with a crew being on board. Lastly, Artemis 3 will have a crew on board and will have the next man land on the Moon. The SLS rocket is special as it has far more complexities and capabilities than past NASA rockets, “Offering more payload mass, volume, and departure energy than any other single rocket, SLS can support a range of mission objectives, while reducing mission complexity,” (NASA).

Another recent tech development would be the project CRS-27, a collaboration with company SpaceX. NASA has done various collaborative projects with SpaceX since 2012, having worked on things like the SpaceX Falcon 9 and SpaceX Dragon. The CRS-27 was a commercial resupply service mission to the International Space Station (ISS), which launched on March 15, 2023. It deliver over 6,200 pounds of cargo including scientific experiments, food, and equipment for the crew on board. A key experiment was Cardinal Heart 2.0, which studies the effect on heart muscle tissue in space and treatments to instill during spaceflights. Another key study was Engineered Heart Tissue-2, which focused on the creation of 3D human heart tissue to understand the cardiac function in microgravity and space-based pharmaceutical testing. In addition, experiments for cell immunity, plant biology, and fiber optic production in space were also a part of the supply drop. This is just the beginning of revolutionary tech when it comes to space exploration, and it looks like NASA is just getting started. The development of complex rockets, computing all come back to the same question that NASA scientist are trying to answer, “Are we alone?”

## Challenges & Ethical Concerns

Despite NASA’s achievements, the development of such tech comes with several obstacles and ethical considerations. One of the biggest constraints being budget, believe it or not space exploration is extremely expensive, and NASA must choose carefully what to prioritize due to its limited funding. NASA’s annual budget is $24.875 billion with 2% cut, while that might seem like a dream to have that much money an average NASA project or mission cost between $2-$8 billion with each landing costing between $3-6.2 billion. It is clear to see how their limited budget makes it obvious why projects or missions span over years. What helps to weigh out the costs is collaboration between companies like SpaceX, Blue Origin, Rocket Lab etc. In addition to financial challenges, there are also concerns on the environmental impact of space missions, specifically the accumulation of space debris. Space debris is a wide variety of objects such as decommissioned satellites, disused rocket parts, debris from satellite collisions, or any other small particles from non0functional human made objects. The debris floats in a lot of Earth orbit meaning within 2,000 km of the Earth’s surface so relatively close. Organizations including NASA track the space debris and study them to reduce the risk of collision. Another issue is the carbon footprint left behind due to rocket launches, rockets today run on fossil fuels which cause an increase in temperature and raise the levels of the atmosphere. Satellites often produce a chemical compound known as aluminum oxides which is often used in ceramics, the production of aluminum oxide alters the thermal balance. “Both types of emissions also have the potential to destroy ozone, the protective gas that keeps dangerous ultraviolet (UV) radiation from reaching Earth's surface,” (Pultarova).

## Conclusion

NASA technology has played a pivotal role in expanding the boundaries of space exploration and deepening our understanding of what lies out there in the universe. Since 1958, NASA has evolved from launching the first Americans into space to creating rovers to explore Mars and potential space colonization. Through each mission, like the Apollo and Artemis program, demonstrates NASA’s relentlessness to pursuit innovation. With technologies like the Deep Space Network, AI, and collaborative missions like CRS-27 go to show how close we’ve come in making what once seemed like science fiction into reality.

As NASA prepares for future missions and beyond, it continues to rely on partnerships and cutting-edge tech. However as cool as it may seem, unfortunately technological advancements do come with its challenges both practical and ethical. Whether it’s budget cuts, environmental concerns like space debris and carbon emissions, it is important to protect the environment as best as we can. NASA plays a crucial role in understanding climate change and have made active efforts to further understand and prevent it. Through this, NASA can challenge and inspire new ways of problem-solving, reinforcing the need for innovation.

Ultimately, it is clear to say that NASA is just more than just a space agency, it is a symbol of curiosity, progression, and the unending deep dive to explore the unknown. Through its dedication to science and technology, NASA continues to advance exploration while also encouraging the next generation of future astronauts or scientists to think better and to reach for the stars. If we continue to ask the questions “Are we alone?” and “What lies beyond earth?”, NASA will continue to be the forefront of space exploration. With every launch and mission and every discovery made, we are taking one step closer to understanding the vast and complex universe that surrounds us, our place in a chaotic world full of planets, black holes, gas giants, and stars. We are just a little spec in the universe.

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