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The importance of the Apollo 11 mission to the present day

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At 9:32 am on July 16, 1969, at Cape Kennedy, Florida, the first stage engine's flames of the Saturn V rocket fired, and their joint lights became a giant ball of fire like a rising sun [1]. That is how it begun the most important voyage made by any human being since the great navigations time.

The objective of the Apollo 11 mission was to land the first humans on the surface of the Moon and bring them safely back to Earth [2], but the feats of astronauts Neil Armstrong, Edwin Aldrin, and Michael Collins would cause an impact greater than anyone could ever imagine.

The three passengers carried with them the hopes and prayers of thousands of people from different countries who hoped that science and technology could finally bring peace to the world in a time when the Cold War and the arms race were haunting people's thoughts [3]. It was the first time humankind felt that it could accomplish unimaginable things if insignificant differences were abandoned and everyone worked together for a greater cause.

Even today there are people who question the costs of space exploration given the number of problems to be solved on Earth [4], but both the greatest challenges of humanity and the greatest advances require long-term investments, continuous research, and hard work; for this reason, the results only materialize many years after its beginning. The seeds of the Apollo program were planted in the late '50s when President Dwight Eisenhower created the National Defense Education Act for increasing investments in the US education

system as a response to the success of the USSR Sputnik program [5]. Many scientists who worked on the Apollo program benefited from this law. It is estimated that the cost of the Apollo program was approximately \$ 288.1 billion (adjusted value) [6], but its contribution to the development of science, technology, and even culture is much more difficult to estimate considering the program's results to the present day.

In 1970, a Zambian nun wrote a letter to NASA inquiring how to justify the billions spent on the Apollo program when the children of her country starved to

death [4]. This letter reached the table of Ernst Stühlinger, one of the engineers who worked with Wernher von Braun, the Saturn V rocket's development leader. Respectfully, Stühlinger answered the letter by saying that orbital evaluation research (using artificial satellites) helped to increase food production, that the advances made in the precision

engineering field and reliability, in the new materials development, and in the improvement of manufacturing processes resulted in the creation of better agricultural equipment, ships, airplanes, and radios; such advances paid off several times what has been spent with the Apollo program [4].

Perhaps the Apollo program's greatest legacy has been the inspiration for children, youths, and adults. In the Apollo program years, there has been an increase in the number of Ph.D. graduates in science, technology, engineering, and mathematics as never before [5]. For astrophysicist Carl Sagan, the Apollo program "conveyed a confidence, energy and breadth of vision that did capture the imagination of the world, it inspired optimism about technology, and enthusiasm for the future", after all, "If we could go to the Moon, what else was now possible?"[7].

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However, after the Apollo 17 mission, the US Congress canceled the Apollo program, NASA's budget was drastically reduced, and their efforts were turned to less expensive programs like Skylab, the space shuttle and later the International Space Station [8]. Currently, the space shuttle program has been shut down, projects such as the James Webb Space Telescope and the Space Launch System are behind schedule and over budget [9] [10], and the space agency studies "to open" the International Space Station for new business opportunities [11]. It seems that without proper motivation (such as the Cold War), NASA's future is to survive on ever-shrinking budgets, despite successful programs such as those that used robots to explore planet Mars.

Recently, free enterprise space exploration has been gaining momentum. Jeff Bezos, president and CEO of Amazon, with an estimated US\$ 157 billion net worth, [12] founded with its own resources the aerospace company Blue Origin. Elon Musk, CEO of Tesla Motors, with an estimated US\$ 20 billion net worth [12], similarly founded the aerospace company SpaceX. In their way, these entrepreneurs also inspire the new generations of scientists and engineers with their philosophy of doing more with fewer resources, but some facts deserve reflexion.

In the late '70s, scientists led by Carl Sagan spent weeks choosing sounds and images that would be placed on Voyager 1 and 2 spacecraft to represent humanity in case of being found by other intelligent life forms [13]. In 2018, SpaceX, on the Falcon Heavy rocket test flight, launched an astronaut mannequin inside a commercial car into the orbit of Mars [14]. Despite the irreverence, it should be noticed that space exploration has entered the era of private aerospace companies that will do whatever they want to make a profit. Some say that the space exploration future is following its natural course, by becoming auto-sustainable due to free competition and private initiatives.

Nevertheless, in 2018, the US Senate passed the "American Space Commerce Free Enterprise Act" that aimed "to ensure that the US remains the world leader in space commercial activities, because, according to the text, "outer space shall not be considered a global commons" [15]. This law's text contradicts a UN document 1967, valid until today, was signed by 90 countries, the "Treaty on Principles Governing the

Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies" [16]. The treaty's text said that space exploration would be "carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind". What happened to the altruistic ideals that inspired the 1967's treaty? It is like they have been put aside since 2018.

After the end of the Cold War, NASA ended up without a political purpose, so Carl Sagan suggested that the space agency reinvents itself, by associating the space exploration with environment protection, international collaboration, and world peace maintenance [17]. The perspective is that space exploration will continue to exist with more initiatives created by the private sector, but the private sector is not so keen to inspire optimism and enthusiasm for the future unless it is to sell its products and services. Hence, the reinforcement that NASA, in the future, perhaps should have a more important role to show that through international cooperation humanity can make a bigger step than one given by Neil Armstrong on the surface of the Moon 50 years ago.



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