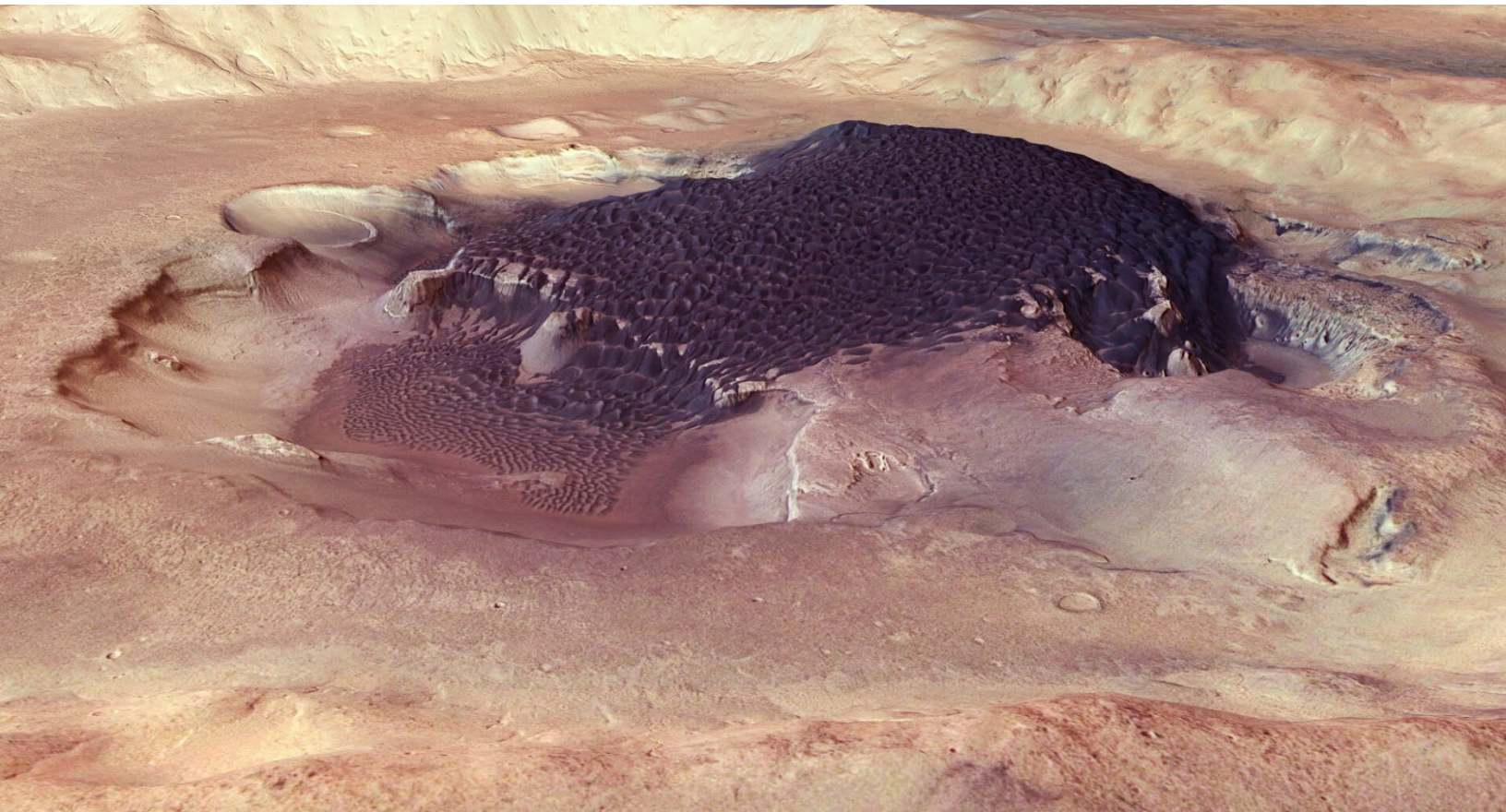


Different Perspectives on Mars



Introduction

Named by the ancient Romans after their god of war because of its color resembling blood, the red planet has fascinated humanity since the beginning of time. Its surface leads to an intriguing story, the one of a small planet with liquid water, which billions of years ago could have been mistaken with our current Earth.

Now, however, we hope that under the dusty, cold and barren martian desert lies a trace of life, be it current or past. We've studied extensively the seemingly waterless surface of the planet, sending orbiters and rovers to examine this unknown world. Is it all worth it? Are we doing enough? Most importantly, the never-ending human pursuit of more - should we send humans on Mars?

A plethora of questions arise. We'll try to answer a few.

What is the space industry doing at the moment regarding Mars

After a period in which space research has seen a general decline, today it is in turmoil.

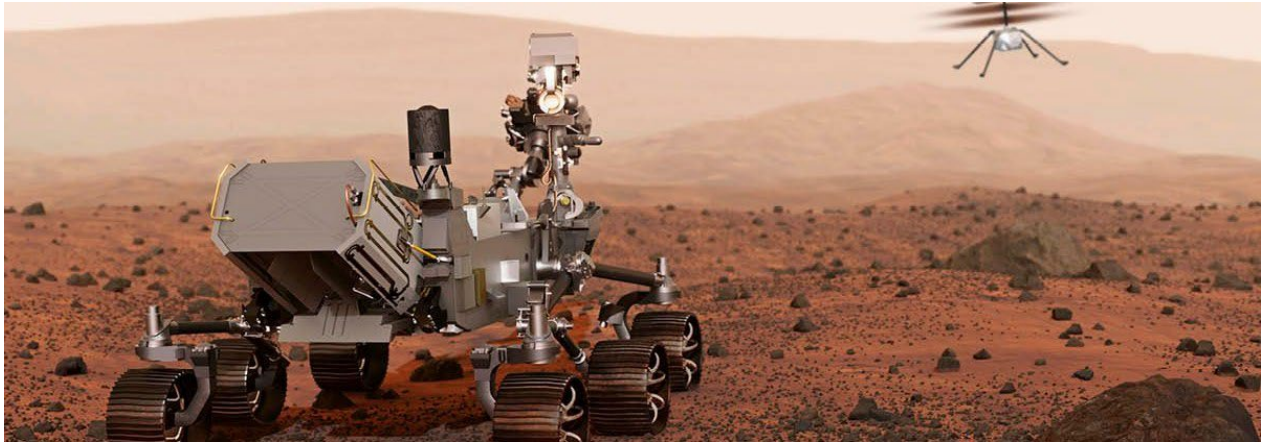
Focusing on the red planet, the space industry is very active in exploring it, especially in recent years, with several ongoing missions or programs that have already been funded and are meant to start in the next few years. There are also numerous plans about new missions that haven't been properly thought through, but are more of a good indicator of the overall spirit regarding the exploration of Mars.

What makes this newfound interest and research focus on the planet so fascinating and so current is that there are many players in the arena trying to reach the planet, both private companies and government agencies.

The main role, as it has almost always been, is being played by NASA. The Mars Exploration Program, a long term exploration whose aim is to explore Mars and to provide a continuous flow of scientific information and discovery through several missions. The program costs billions of dollars and includes a series of robotic orbiters, landers and mobile laboratories shipped to Mars for collecting information about the planet's history, geology, climate, and potential for habitability.

The most important and famous mission of the program is the Mars 2020 Mission. It includes the development and the launch of the Perseverance rover, which landed on Mars in February

2021. The rover, the fifth robotic one sent to Mars, is designed to search for signs of ancient microbial life on the planet, collect data on its geology and climate, and pave the way for future human exploration of Mars.



The rover has a robotic arm that is equipped with a number of tools that can also collect samples which are supposed to be returned to Earth to be properly studied. In addition to its scientific instruments, Perseverance is also equipped with a small helicopter called Ingenuity, designed to test the feasibility of powered flight on Mars. The mission is expected to last at least one Mars year, which is about 687 Earth days.

Regarding manned missions, the focus of this report, NASA has announced its plans to send humans to the red planet in the 2030s, with the aim of establishing a sustainable human presence on its dusty surface. The agency's plans include several key stages, including the development of a spacecraft capable of transporting humans to and from Mars, the establishment of a long-term habitat on the Martian surface, and the provision of resources and supplies necessary to sustain human life for an extended period of time.

On the other hand, the main private company that is working on reaching Mars is the famous SpaceX. With his company, Elon Musk aspires to make humanity a "multiplanetary species" by enabling the colonization of other planets in the solar system, with Mars as the primary destination, as boldly stated:



Elon Musk 
@elonmusk

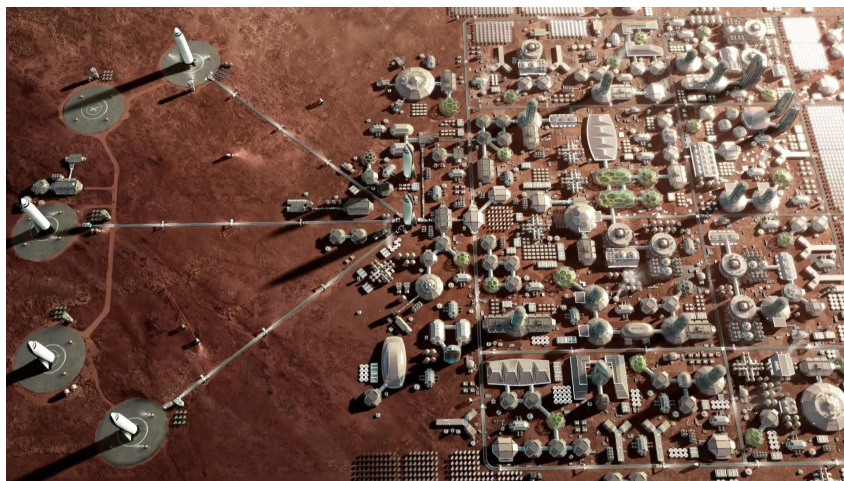
Humanity will reach Mars in your lifetime

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The biggest efforts of the company are focused on improving the Starship spacecrafts, designed to be fully reusable, with the goal of reducing the cost of space travel and making Mars colonization more affordable. Moreover, Elon Musk announced in 2021 that SpaceX is developing a fuel production system that can produce propellant on Mars using local resources. This hasn't been officially confirmed yet; however, it goes to highlight the concepts and ingenuity Mars sparks in the space industry.

Many other bold statements have been made about the aim of colonizing Mars. Musk has often talked about his goal for the planet: terraforming the planet, making it more Earth-like, in order to make it more habitable for humans. There is no evidence of any present studies going in such a direction. For sure SpaceX wants to bring humanity to Mars as soon as possible and it's the closest one to reach this target being the most advanced researcher in the spacecraft industries. Musk's target is to send crewed missions to Mars as early as the mid-2020s, to establish a human settlement on the planet by the end of the decade. Even more ambitious, the company strives to send one million people to Mars over the next century. Musk is famous for his "aspirational" timelines, so the above target dates are far from set in stone and will depend upon regulation, testing and other matters.



Furthermore, the European Space Agency (ESA) has conducted several Mars missions over the years, with the goal of exploring the planet's surface, atmosphere, and geological history. The main program currently active is the ExoMars program, a joint mission between ESA and Russia's Roscosmos space agency, with the goal of searching for signs of past or present life on Mars. The mission consists of two parts: an orbiter called the Trace Gas Orbiter (TGO), which was launched in 2016, and a rover called Rosalind Franklin, which was set to launch in 2022. The program has suffered the consequences of the tensions following the invasion of Ukraine; hence, the collaboration between the two organizations has been interrupted, and in May 2022, it was announced that the launch of the rover should not take place before 2028 due to the need for a new non-Russian landing platform.

The ESA is also planning the Mars Sample, which is a joint project between ESA and NASA, with the goal of collecting samples of Martian rock and soil and returning them to Earth for analysis. The mission is expected to launch in 2027 and return to Earth in 2033.

China also has been developing its space program during the recent years. On July 23, 2020, the national space agency successfully launched its first mission to Mars, the Tianwen-1, which consists of an orbiter, a lander, and a rover. The main aims of the mission are to study Mars' surface, atmosphere, and geology, searching for signs of water, and to study the planet's climate and environment. The mission also aims to explore potential landing sites for future manned missions to Mars.

China has ambitious plans for Mars exploration in the future that also include manned missions. In fact, China has announced plans to build a Mars simulation base in Qinghai province, which will provide a simulated environment for scientific research and astronaut training.

Finally, the United Arab Emirates (UAE) have shown interest in Mars in recent years. They launched their first Mars mission, called the Emirates Mars Mission or Hope Probe, in July 2020. The Hope Probe is an unmanned spacecraft that is designed to study the Martian atmosphere and climate. The mission is also part of a larger effort by the UAE to establish the country as a leader in the space sector.

Pros of Missions to Mars

As humans, our stubbornness has often been the driver of many successes reached in history, but also of many more failures. The question in this case regards Mars, is our stubbornness of reaching the planet with a human exploration worth it, or is it just another obstacle which will remain a limit for humanity?

The feasibility of the mission relies on a series of challenges to overcome. A few key points which still need to be fully achieved for future missions on Mars are:

- Developing proper life support systems for the astronauts against both the duration of the transportation and the hostile environment
- Tracing the proper travel plan, at the right time of the year, to diminish the travel time to Mars which varies between 6 to 9 months depending on the position of the Planet
- Minimizing the risk of exposure to the high level of radiation once reached Mars

Overall, it is an ambitious and challenging endeavor, but it is within the realm of possibility with continued investment and research and adequate considerations of the potential risks.

One of the most significant advantages which human exploration of the red planet would provide, regards the fact that humans have the capability to collect a wider range of data and samples, and analyze them in ways robots already present on the planet cannot. On-ground research would also be more accurate and require considerably less time to be accomplished in respect to the time a rover needs.

Furthermore, having direct contact with the planet could also lead to potential new discoveries on its history and acknowledge the reasons behind its shift in the type of habitat and climate. So far, what has been studied regarding the climate can be considered positive, since repeatable weather patterns have been mapped by the spacecraft. Some dust storms have been witnessed in the same location around the same period year after year. This confirmed that Mars experiences four seasons during the 687 days which make up a year on the Planet, just like Earth. The seasons are recognizable, but because of its eccentric orbit Spring and Summer last more than Autumn and Winter and no season lasts on average the same number of days.

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Another important consequence of a human expedition to Mars, would be that of inspiring future generations and increasing public interest in science and exploration. It would in fact represent a milestone in human history, almost comparable to the first moon landing. It would demonstrate our ability to push beyond boundaries and possibly motivate people around the world to pursue careers in science, technology, engineering, and mathematics (STEM). This, in turn, would foster a new generation of innovators who could tackle further important challenges.

These potential benefits favored the emergence of theories on future human settlements on Mars. Two of the most prominent ones are:

- **Mars Base Camp:** This project would represent a first step of settlement on the Planet. It would serve as a staging area for human missions to the surface and it would in fact orbit around Mars and not lay on its ground. According to Lockheed Martin's concepts, the major components of the four-part base area would be launched separately, and then assembled to some other parts already in orbit. The base project would include among its main components: living space and habitat, command and control deck for the entire space-craft, solar arrays, radiators, robotic arms along the base, an observatory module for Mars analysis and a lab from which astronauts could pilot drones and rovers.

- **Mars Underground City:** This concept goes beyond the creation of a platform and proposes building a city beneath the Martian surface to protect future inhabitants from radiation. This would be accomplished, according to a study by the Delft University of Technology, through swarming robots and 3D printed cement-based habitats.

Cons of missions to Mars

Human missions to Mars have been the subject of scientific and public fascination for decades, but there are significant drawbacks and risks associated with such endeavors:

The **health risks** associated with human missions to Mars are a significant concern. Long-duration spaceflight exposes astronauts to space radiation, microgravity, and isolation, which can have significant impacts on human health. Space radiation, in particular, can damage DNA, leading to increased cancer risks. Microgravity can cause cardiovascular problems, muscle and bone loss, and other physiological changes. Psychological stress is another challenge that can occur due to confinement, isolation, and exposure to extreme environments.

Moreover, the lack of a robust medical infrastructure on Mars could exacerbate these issues, making it difficult to provide adequate care for sick or injured crew members. The development of medical technologies and strategies to address these issues is a key challenge for future human missions to Mars (Lewis, 2022).

Establishing a **sustainable human presence** on Mars is a significant challenge. The technology needed to transport, house, and support a crew on Mars is still in its infancy, and significant advances would need to be made before such a mission could be successful. The mission would require a complex and extensive infrastructure, including life support systems, habitats, transportation, and communication networks. The challenges of Mars missions also include landing and takeoff, as well as dealing with dust storms, which can damage equipment and pose risks to human health.

Furthermore, the **cost** of such a mission would likely be exorbitant, requiring significant funding and political support from multiple nations. The total cost of a Mars mission is estimated to be in the range of hundreds of billions of dollars. This raises questions about the prioritization of resources, particularly in light of pressing issues on Earth such as climate change, poverty, and inequality.

Finally, there are questions about the long-term sustainability of a human presence on Mars. While establishing a human settlement on the planet has been proposed as a way to ensure the survival of the human species in the event of a catastrophic event on Earth, it is unclear how sustainable such a settlement would be in the long run. Factors such as resource depletion, environmental degradation, and social isolation would need to be carefully considered and managed to ensure the success and longevity of a Mars settlement (Ehlmann, 2005).

Colonization of Mars also raises **ethical concerns** that must be addressed. One significant issue is the potential violation of planetary protection principles, which aim to prevent the contamination of other worlds with Earth's microbes and protect any potential native life. There is a risk that human missions to Mars could introduce new microbial species and contaminate the planet's environment.

Similarly, colonizing Mars could involve the irreversible transformation of a pristine planetary environment, potentially harming any existing microbial life and setting a precedent for future human exploitation of other worlds. Additionally, questions of social justice and indigenous rights arise regarding the potential exploitation of any native martian resources and the possibility of displacing any existing life.

One of the other major ethical considerations in human missions to Mars is the issue of ownership. Currently, private companies have been granted the right to own and sell resources extracted from celestial bodies like Mars. This raises concerns about the potential for exploitation of resources on Mars and its impact on the future of space exploration and resource management. The question of who has the right to own and benefit from extraterrestrial resources is a complex legal and ethical issue that requires careful consideration and regulation. The international community must come together to create a framework for responsible and sustainable resource management on Mars and beyond (Dirks, 2021).

Finally, human missions to Mars have significant cons that must be considered before any mission is undertaken. The health risks to astronauts, the cost and feasibility of such a mission, and the ethical implications of colonization all suggest that human missions to Mars should not be undertaken lightly. Instead, alternatives such as robotic exploration may be more appropriate in the near term. If and when humans do go to Mars, they will face significant challenges that must be addressed to ensure their health, safety, and ethical responsibility.

Conclusion

Though there is much debate on the subject of human missions to Mars, one thing remains clear. The planet has a harsh, hostile environment, unfit for human life, even the one enhanced by technology. We still have numerous questions unanswered, challenges to face that we can't even predict at the moment. Mars is simply unobtainable in the near future.

But when has that ever stopped us? We already send rovers, orbiters and landers to explore what we cannot, we gather information at a breathtaking pace, we use these discoveries to make life better on Earth and beyond. We've come so far in such a small amount of time.

So, while right now it seems almost impossible, humanity will keep trying to find ways to do it. We'll invest in research - there's already competition between private companies and public agencies driving constant innovation, already so many ideas of how to make human missions work. Eventually, we'll achieve this seemingly unachievable task, and move on to a more complex one.

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