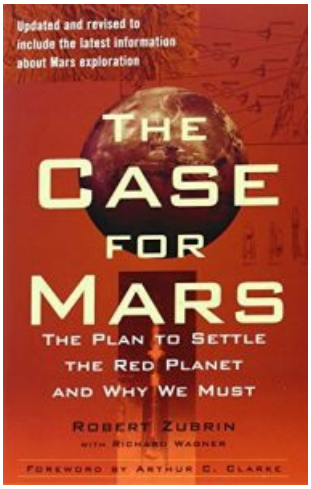

Book The Case for Mars

The Plan to Settle the Red Planet and Why We Must

Robert Zubrin and Richard Wagner
Free Press, 2011
First Edition:1996

Recommendation

Robert Zubrin combines genuine enthusiasm for space exploration with the levelheaded pragmatism you want in an engineer (which he is). That second quality is essential, as skeptical readers may find themselves shaking their heads at the matter-of-fact way in which Zubrin dispels objections to going to Mars. He makes the journey sound not only easy but logical and inspiring. The book has just two minor weaknesses: First, Zubrin can seem partisan – arguing not just for Mars but against alternative projects, like lunar exploration. Second, occasionally he goes into more detail than really necessary. For instance, plans to name Martian months seem premature, albeit interesting. *BooksInShort* recommends his fascinating book to skeptics who don't see why society should bother with space, to those old enough to remember the glory days of the *Apollo* missions, and to anyone interested in bold scientific exploration. This is a trip you can take.

Take-Aways

- The American space program needs a new goal to give it direction. Mars is it.
- Existing technology makes it possible to send humans to Mars successfully.
- The "Mars Direct" plan would let people explore Mars relatively economically.
- Mars's conditions and resources offer the best choice in Earth's solar system for human exploration and colonization.
- The arguments against Martian exploration (wasted money, radiation and contamination risks, zero gravity, going to the moon first) are often either exaggerated or incorrect.
- Once on Mars, reliable transportation will be pivotal to successful exploration.
- After manned exploration, people should build colonies on Mars and, eventually, "terraform" the planet – that is, reconstruct its surface to make it livable.
- Exploring Mars would bring tremendous scientific breakthroughs. Colonizing Mars would eventually earn hefty financial payoffs.
- Mars would provide a good base for trade, including harvesting precious elements from the asteroid belt.
- Going to Mars is important for science, politics and the human spirit.

Summary

Why Mars?

To understand the nature of life, to provide a second home for humanity and to reach for the stars, humankind must go to Mars. America's space program is stalled and aimless. Its last great achievement was the *Apollo* moon landings, now decades in the past. The space program needs a goal to renew its purpose. Fine, you might say, get a goal...but why Mars?

> "The time has come for America to set itself a bold new goal in space."

Start with water. While temperatures on Mars's surface average below freezing, the fourth planet from the sun hasn't always been so cold. Photos show "dry riverbeds," evidence that Mars once had essential water. Settlers will be able to find water below ground. Mars also has carbon, nitrogen, hydrogen, and oxygen, so people will be able to grow food and make rocket fuel. Because no oceans cover its surface, Mars actually has as much land as all of Earth's continents combined. A

Martian day is about the same length (24 hours and 39.6 minutes) as an Earth day. This will make it easy for settlers to adjust, as will the 24° axial tilt, which gives Mars seasons that vary like Earth's. Using existing methods of propulsion, a trip to Mars would take about six months during the orbital period when Mars is closest to Earth. That's a long time, but no longer than it took European settlers to sail to Australia. Water, food, fuel, space, seasons, workable days and a reasonable trip: Let's go to Mars!

> "The purpose of the first several human missions to Mars will be to explore, to survey, and to answer above all the question of whether or not the Red Planet ever harbored life."

Mars also offers great beauty, with "mountains three times as tall as Mount Everest," and canyons longer and deeper than the Grand Canyon. Of all the solar system's other planets and satellites, Mars has the best resources to support exploration and colonization. Its atmosphere will allow easy landings and protection from radiation. Mars has iron (hence its red color), silicon (used in solar cells and computer chips) and water (frozen in large amounts at the poles and underground). Mars has all people need to survive, set up a base and, eventually, host industrial activity.

> "The richness of Mars...makes the Red Planet not only desirable but attainable."

Humankind can go to Mars relatively cheaply using existing technology, without waiting for any major technological breakthroughs. What's more, scientists and engineers have been developing exploratory mission plans for more than 20 years. These missions would cost money, of course, but not that much in the scale of things. Developing the initial material investment to mount the mission would cost $30 billion; each follow-up mission, once the program is underway, would cost $3 billion. That seems expensive, but, in context, it is "about 7% of the existing combined (US) military and civilian space budgets." Planners have even blocked out workable stages for the "Mars Direct" plan. If work began in 2011, expect these milestones:

- **August 2020** – An unmanned "multistage rocket" blasts off, headed for Mars.
- **February 2021** – The unmanned ship arrives on Mars using an "aeroshell" and then a parachute to slow its speed enough to land. Once down, it deploys a small automated processing plant to synthesize fuel for the flight home.
- **September 2021** – The ship on Mars is fully fueled.
- **October 2022** – A ship carrying a human crew takes off for Mars. It carries four broadly trained people with science and engineering backgrounds. Mutually, they have the skills of a flight engineer, a pilot, a geologist, a biogeologist and a medic.
- **April 2023** – After a six-month journey, the crew arrives on Mars.
- **September 2024** – After spending 18 months on Mars, the crew goes home.

The Way to Go: The "Mars Direct" Plan

Some proponents of space exploration argue that explorers should go to Mars, but not yet. They want to wait for more sophisticated technology, especially better methods of driving spacecraft. Instead, missions should use advanced propulsion methods as they become available: Nuclear drives, solar drives, and the like will all be welcome. However, such advancements are not necessary. Mars Direct argues for manned exploration using existing technology for primary systems. The contention that humanity should wait for more technology is dangerous: Columbus did not wait for steam or diesel engines. He sailed across the ocean repeatedly in wooden ships.

> "Images of Mars taken from orbit show dry riverbeds, indicating that Mars once had flowing liquid water on its surface – in other words, that it was once a place potentially friendly to life."

The idea that going to Mars would require an extended technological development has been circulating for some time. In 1989, when President George H.W. Bush called for a manned mission to Mars, NASA reported that it would take decades and $450 billion to develop a program. The crew would spend 18 months traveling to Mars, a month in orbit and two weeks on the surface. In response, the plan that became Mars Direct simplifies the mission, using dependable technology and avoiding building spacecraft in orbit. The mission has to be as inexpensive as possible and yet have "high effectiveness," maximizing time and "mobility" on Mars's surface to extend exploration and experimentation. The mission requires producing a lot of power, both for surface explorations and to fuel the flight home. Mars Direct will not wait for nuclear propulsion. It plans to use Saturn V rockets and other mature technology. By sending and refueling the return ship in advance, this plan provides relative safety for the crew and gives them 18 months to search for life and resources, establishing a foundation for future missions.

Facing the Dangers

Some early maps of Earth contained margin warnings about dangerous "dragons" that lived in the unknown areas or "sirens" who lured explorers off course. Similarly, five widely feared dragons threaten humans as they head for Mars, and one siren sings a song that might lead them astray:

1. **Radiation** – The first dragon is radiation, and fear of it is based on reality: If you're exposed to too much radiation too quickly, you'll get sick or even die. But that doesn't apply in this case. While the Mars Direct mission would expose explorers to minimal radiation, it carries limited risk, raising the threat of a fatal cancer by only 1%.
2. **Zero gravity** – After extended periods in zero gravity, your bones will demineralize and your muscles will atrophy, though you would recover. To address this dragon, astronauts can exercise, wear special suits or spin the ship to generate artificial gravity.
3. **Human factors** – Some people fear the crew would go stir-crazy from being cooped up, bored, crowded and cut off from their loved ones. Historically, people have lived in much smaller spaces and in much worse conditions.
4. **Dust** – Observers have seen signs of "powerful dust storms on Mars" for more than 100 years. These storms are real: They blocked *Mariner 9*'s view of Mars's surface for months. The eccentric Martian orbit drives these storms by causing strong shifts in atmospheric heat and pressure, but people on the surface could deal with this weather pretty easily. Martian winds don't pack much of a punch in Mars's thin atmosphere, and explorers could sweep off any dust that accumulates and blocks their solar panels.
5. **"Back contamination"** – Some people worry that a return voyage might bring Martian germs back to Earth, germs that would be especially devastating because people lack the immunity developed through exposure. This fear "is not only illusory, but hallucinatory." Almost certainly, nothing is alive on Mars's surface. And if any life form exists, it is extremely unlikely to be able to infect people. If it could, it already has: Many meteorites carrying Martian materials have

hit Earth, so people already have been exposed.

6. **"Diana, the Lunar Siren"** – One seductive siren that may lead explorers astray is the argument of going to the moon first because lunar bases would offer materials and experience for a stepping-stone to Mars. Wrong. The moon is too different from Mars for that experience to shape Martian exploration. And Mars offers better resources.

Exploring Mars

The argument for a mission to Mars dates back at least to 1600, when Giordano Bruno was burned at the stake (in part) for stating that the stars were suns and had planets. German astronomer Johannes Kepler's observations that century showed humanity that Mars is a planet and so is Earth. Since 1636, people have watched Mars through telescopes. These observations took a striking turn in 1895 when American Percival Lowell thought he saw canals on Mars and sparked public imagination with speculation about a dying race of Martians struggling to keep their civilization alive. His false vision "inspired the pioneers of rocketry," such as Robert Goddard and Herman Oberth. Unmanned *Mariner* spacecraft began visiting Mars in 1965, first doing flybys. Mankind has been sending probes to Mars's surface since the 1976 *Viking 1* landed. This scientifically fruitful mission produced countless images and increased human knowledge of Mars, but it did not find life. To do that, people will need to go and look for themselves.

> "If we are to find out the truth about the nature of life, human explorers will have to go to Mars."

The mission to Mars needs complex human judgment, and far more flexibility and improvisation than robotics can handle. The length of time it takes radio signals to go back and forth to Mars would create dangerous delays for robots. Since Mars has so much land surface, explorers must be able to travel extensively over the planet. To make missions economically viable, astronauts must be able to produce propellant on site. *Apollo* used a "battery-powered Lunar rover," but it had only a 20 km range limit (10 km out, 10 km back), so it simply won't do. Various combustion engines could enable new "Mars cars," and possible rocket-powered flying vehicles could allow people to "hop" quickly from place to place.

Living on Mars

While the plans for exploring Mars call for extended focused visits, not colonization, at one point explorers will prolong their stay. Their missions will become colonization programs. The base on Mars will start small, with rudimentary shelters made of native materials, like bricks made from soil. Later, crews can erect pressurized domes for living and for greenhouses. Nuclear power is essential, but explorers eventually can build solar panels or windmills and generate geothermal power at geologically active sites.

> "The creation of a new frontier thus presents itself as America's and humanity's greatest social need."

While people live in domed colonies, another stage of Martian colonization will be underway: "terraforming." Reshaping Mars to support human life sounds far-fetched...until you realize that humanity has been doing that to Earth for millennia. Mars is "cold, dry and possibly lifeless," but the poles hold tons of frozen carbon dioxide (dry ice). Melting that ice would release ample carbon dioxide into the atmosphere, a greenhouse gas that would heat up the planet. Raising the polar temperatures just 5º Kelvin (273º Kelvin equals 0º centigrade, water's freezing point) would be enough to generate "a runaway greenhouse effect." People could engineer global warming by using orbital mirrors to focus sunlight, artificially producing greenhouse gases, or finding or bioengineering methane-producing bacteria – or, most likely, combining all three.

The Meaning and Implication of Mars

Space program critics complain about the cost, as if that money would be wasted. This is false, since most of the money spent on a Mars mission would cover hiring welders and engineers on Earth. This argument also dismisses the massive economic, political, scientific and spiritual benefits of a space program. The economic benefits range from direct effects (paying workers) to general impact (NASA's years of high investment helped drive a growing US economy) to more speculative possibilities. Mars's considerable resources include elements that are comparatively rare on Earth, such as deuterium, which is used in heavy-water nuclear reactors and currently sells for 12 times as much as silver. On Mars, wages will be high because labor will be scarce – and there's an entire planet's worth of real estate to sell. From Mars, going to the metal-rich asteroid belt would cost relatively little. Scientist John Lewis of the University of Arizona estimates that one asteroid (1 km diameter in size) could contain "$150 billion in platinum alone." Imagine a "triangle trade" in which Earth sends high-tech materials to Mars, which sends low-tech goods and supplies to the asteroids, which send raw materials to Earth.

> "Ultimately, it is your understanding that's going to get us to Mars."

Politically, space programs offer opportunities for international collaboration, but they also offer a chance to rally the US around a unifying vision many people already hold. An array of surveys say most Americans support space research, and around half already support manned missions to Mars. But these benefits, though real, are relatively pedestrian compared to Mars's true promise. America once was the place where people could go to start over, to take risks carving out a new destiny in the New World. Humans tested their spirit on the US frontier, to see just how much was possible. Mars, a literal new world, would offer such opportunity many times over. Earth will grow more crowded, regulated and culturally uniform. To give the human spirit a chance for true diversity, people must go to Mars, a stepping-stone to exploration of the entire universe.

About the Authors

Astronautical engineer **Robert Zubrin** heads Pioneer Astronautics and founded the Mars Society. **Richard Wagner** is the former editor of *Ad Astra*, an astronautical journal.