A Manned Mission to Mars is Unrealistic in the Near Future

Abstract
Space has been called the final frontier. Mars will be man's first leap into this frontier. This paper addresses the question: should we or should we not send manned space missions to Mars? By examining journal articles, this paper looks at the problems and benefits of a mission to Mars. The risks, such as radiation, that will be associated with a long duration flight are discussed and weighed against the benefits of a manned mission. These benefits range from technological advancements, which could be achieved if a mission to Mars were given approval, to the resources possibly found on and in the Martian environment. The paper addresses the problem associated with cost that could be met by a mission to Mars and how the problem can be addressed. The paper concludes by explaining why a mission to Mars is impractical for our near future.

Stephen Smith

1. Introduction

For the past sixty years, the world has been interested in what it calls the “final frontier”, space. After the United States landed a man on the moon in 1969 (Smith, 2010), the next goal for space exploration became Mars. In the past, the United States and NASA has only sent robots to Mars, such as Viking I and Pathfinder (Wikipedia Contributors b, 2010), but has never attempted a manned mission. For sometime, the reason for why not was obviously the lack of technology. As technology has improved, the reasons have become more difficult to understand. In this paper, the reasons for why a mission has not occurred yet are discussed by examining journal articles on the subject of missions to Mars. Some of the reasons are that the risk of losing human life has been too high, the funding for research and a mission has not been approved, and the technology is still not entirely adequate. The paper also discusses the benefits of a manned mission, which include technological progress and an examination of the Martian environment. The last part of the research is on the problems associated with cost. Cost has been the problem for why missions are not approved and why a mission to Mars will not be given appropriate funding. In conclusion, the paper argues that a manned mission to Mars will not occur in the near future, at least until the

1 Version 1.03, December 2010; Stephen Smith, Peoria, IL, 61614; email: ssmith@uvm.edu; Thank you to my parents for supporting my weird hours of research, thanks to Dr. F Knight for the assistance in the preparation of this paper.
problems addressed in this paper are solved. Until the problems are fixed, the United States public will not see video or pictures of a man walking on Mars.

The paper is organized as follows. The next section deals with the risks of a manned mission to Mars. The third section describes the benefits possibly found in the Martian environment. The forth section addresses possible flight plan options. The fifth section describes the technological advancements that could occur if a mission to Mars were approved. The sixth section describes the problem associated with the cost of a manned mission to Mars and how it can be addressed. The final section explains the conclusion.

2. Risks of a manned mission to Mars

The leading risk facing astronauts is radiation. Astronauts are faced with the problem of radiation every time they leave Earth’s atmosphere. Fortunately, short trips prevent any serious damage from occurring. NASA does not know exactly how a long duration mission, such as a mission to Mars, will affect the human body. NASA researchers believe that a thousand-day mission to Mars could cause a one to nineteen percent increase in the chance of dying from cancer for a forty year old healthy male (Netting, 2010). The risk for a female astronaut is close to double that due to the breast and ovaries (Netting, 2010). A mission to Mars is possible if the added risk is low. If the added risk is as high a percentage as nineteen percent, then the mission’s outcome may not outweigh the possible costs, human life. Galactic cosmic rays, GCRs, are what scientists fear most from space radiation due to their effect on human DNA. The most dangerous GCR is a heavy isotope of iron, Fe$^{+26}$ (Netting, 2010). These Galactic cosmic rays break through the shell of the spaceship and human skin with relative ease and cause damage to the genome.

![Figure 1](image.png)

**Figure 1:** An artist's concept of DNA battered by galactic cosmic rays.\(^2\)

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\(^2\) For more information on effect that GCRs have on DNA, see Netting (2010)
Figure 1 demonstrates the effect the GCRs have on the human DNA. Current missions are brief enough and close enough to Earth to limit the effect that galactic cosmic rays have on astronauts. The Earth’s magnetic field bounces some of the rays back into space while other rays are absorbed (Netting, 2010). The impact of Earth’s magnetic field causes a large reduction in the amount of galactic cosmic rays that astronauts have to face. A trip to Mars would be different. Astronauts would be away from the protective field of Earth for a long period of time. Currently, scientists do not know how the GCRs will effect to the human body during a mission to Mars for the extended period of time.

De-conditioning will be another risk that faces astronauts. One of the major problems for astronauts is keeping themselves in physical shape while in space. Time in space causes a person’s bone density and muscle strength to lower. Exercise has proven to help reduce de-conditioning (Hawley, 2010). Even with exercise during a long duration flight, astronauts still have trouble adjusting back to the gravity on Earth. A flight to Mars would be longer than the longest duration spent in space by a human. The astronaut that set the record experienced serious side effects once back on Earth. The de-conditioning will not only affect the astronauts’ physical strength, but also their mental strength because they will have to exercise every day for the duration of the flight to Mars. Two and a half years of daily exercise and living in a small quarters could get dull (Hawley, 2010) causing a mental breakdown rather than physical.

3. Martian Environment

Earth and Mars may seem similar because they have similar features, but at ground level, it is a different story. On Mars the average high temperature, at ground level, is near negative twenty degrees Celsius and the average low temperature is near negative seventy degrees Celsius. At these temperatures, plant life and vegetation is difficult to produce, but not out of the question. The bigger concern would be dealing with the difference between the Martian atmosphere and Earth’s atmosphere. Table 1 and figure 2, below, represent the contrasting atmospheres of Earth.
and Mars. Table 1 shows how Mars has a much thinner atmosphere, made up of mostly carbon dioxide, while Earth is comprised of mostly nitrogen.³

<table>
<thead>
<tr>
<th></th>
<th>Earth</th>
<th>Mars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>0.039</td>
<td>95.32</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>78.084</td>
<td>2.7</td>
</tr>
<tr>
<td>Argon</td>
<td>0.934</td>
<td>1.6</td>
</tr>
<tr>
<td>Oxygen</td>
<td>20.946</td>
<td>0.13</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>0.00001</td>
<td>0.07</td>
</tr>
<tr>
<td>Water</td>
<td>0.4</td>
<td>0.03</td>
</tr>
<tr>
<td>Nitric oxide</td>
<td>0.00003</td>
<td>0.013</td>
</tr>
</tbody>
</table>

Notes: * Percentage of the atmosphere that each of the element or compound makes up.

Source: Author’s calculation used with Mars’ data, see Dunbar (2007), and Earth’s data, see Wikipedia contributors (2010).

The most alarming feature of this data is the difference in the amount of oxygen in the atmosphere. Oxygen makes up over one-fifth of Earth’s atmosphere, while oxygen in the Martian atmosphere is scarce. Because of limited amount of oxygen, the spacecraft going to Mars would

³ For more information on Mars’ atmosphere, see (Dunbar, 2007). For more information on Earth’s atmosphere, see (Wikipedia contributors, 2010).
have to carry enough oxygen for the flight there, while on the planet, and for the return flight. The same would be said for food for the astronauts. Mars is a barren land currently, but that does not mean it will remain barren. With the help of the astronauts, the Martian soil has the potential for life. The Phoenix Lander brought back data of the Martian soil that showed it has having traits of alkaline metals and contained elements such as magnesium, sodium, potassium and chloride. These nutrients are found in gardens, and are necessary for the growth of plants (Thompson, 2008). Mars also potentially has water. Temperature and pressure on the surface prevent water from existing there, but the polar ice caps are promising. Due to core temperature, there is a possibility of water underneath the ice in the polar caps. Another promising sign for the environment of Mars is the presence of the mineral jarosite, which was discovered by NASA’s Mars Exploration Rover Opportunity in 2004. Jarosite can only be created when acidic water is near (Viotti, 2007). More evidence of water or a theory of water came when the mars Global Surveyor probe showed deep channels that seemed to have previously been habited by water flow (Zorpette, 2000).

Mars also has a twenty-four hour day night cycle (Rapp, 2006), approximately with a Martian slip of 38 minutes. This cycle is critical for possible growth of vegetation in the future. The soil, possible water, and the twenty-four hour day night cycle are crucial assets for humans in the Martian environment.

### 4. Flight Plan

The first possible flight plan will use the Hohmann Transfer orbit. The Hohmann Transfer Orbit, shown in Figure 3, is an orbital maneuver of a spacecraft that uses two bursts of thrust, ΔV, for the engine to move from one orbit to another orbit when the orbits are coplanar. Mars is gravitationally tethered to the sun in an elliptical orbit like all other planets, except Pluto. Mars and Earth follow the same orbiting path. This path allows for the two planets to have a nearest distance and a furthest distance from each other. These distances occur every twenty-six months (Windows to the Universe team, 2008). For a mission

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4 For more information on the Hohmann Transfer Orbit, see (Wikipedia Contributor, 2010c).
to Mars to be least expensive, NASA will have to plan on launching the mission when the
distance of the trip is smallest. This distance would reduce the cost, fuel, and time. The only
downside to waiting for the shortest distance is that once the astronauts reach Mars they will have
to wait a year and a half before they can return home to allow for Mars and Earth to get back to a
closer point. This will mean that the mission to Mars will take around three years to complete
(Wilson, 2010).

Hohmann Transfer maybe cost efficient, but it is very time consuming. If money rather
than time is the problem, there is a faster way. The time can be cut in half if the spacecraft leaves
the orbit at twice the speed. This change in speed will need ten times more fuel to achieve the
initial speed at the start. The spacecraft will also need ten times more fuel to reverse the speed
when approaching Mars (Wilson, 2010). This additional fuel is needed because of the increased
speed at the beginning of the mission. In order to enter the Martian orbit, the spacecraft will have
to reduce its current speed and equal the speed needed to orbit the Mars. The spacecraft achieves
this by firing its reverse thrusters, which in turn slows down the spacecraft. This faster flight
option to Mars with the use of a Hohmann Transfer Orbit for the way back to Earth would cut the
time travel from three years to only a year and a half (Wilson, 2010). This flight plan would only
be useful if cost were more of a concern than exposure to radiation.

5. Technological Progress

NASA has achieved many technical breakthroughs throughout its history. Landing on the moon
and Lunar Orbit Rendezvous (LOR) are some of its main achievements, but NASA’s goals
become possible through technological development that allowed Lunar Orbit Rendezvous and
the Moon landing to occur. Similar progress could presumably be made were NASA given
approval to begin a manned mission to Mars.

It may be argued that space exploration is a public good, but there are also private good “spin-
offs” that derive from technical progress. NASA used lighting technology, for example, to
improve plant growth in space and now that same technology is used in treatment for cancer
patients. NASA’s spending is not one-dimensional. It can help other related areas (NASA, 2010).

5 The Windows to the Universe site has an instructive video on the orbits of Mars and Earth.
NASA’s future efforts to find alternative fuel sources to reduce the cost of a mission to Mars, for example, may help save the environment if the alternative fuel source is found to be useful in the production of automobiles. Nuclear energy is one possible alternative fuel sources that could help shaped the Earth as well as space. If NASA research finds a way to make nuclear energy safe, perhaps by showing how nuclear wastes could be fully recycled, it could change fundamentally the energy profile of Earth. The world’s dependence on fossil fuels would go down and, in turn, less CO₂ would be emitted into the atmosphere. A mission to Mars could also spark interest in the field of science and mathematics from the American youth, which occurred during and after the space race of the twentieth century when the government put more money into the funding education in both math and science (“The Space Race”⁶, 2010).

Advancements in engine technology could become a key on whether or not a mission to Mars is feasible. One option recently considered is an air-breathing engine. “Air-breathing engines have several advantages over rockets. Because the former use oxygen from the atmosphere while they are still in it, they require less propellant—fuel, but no oxidizer—resulting in lighter, smaller and cheaper launch vehicles (Beardsley, 2010).” Air-breathing engines require much less propellant by weight than rockets and are safer due to the fact that they would rely, in part, on aerodynamics instead of rocket thrust. This difference would make it easier for missions to be aborted (Beardsley, 2010). For air-breathing engines to become a reality for spacecrafts, the technology needs more maturation.

6. Cost

The largest concern with a mission to Mars is the cost. According to the official NASA website, “the average cost to launch a Space Shuttle into outer space costs about $450 million per mission,” (Ryba, 2008). That is just the variable cost to get a shuttle into space. Potential profitability is a driving force in whether the United States Government gives funding or tries to get funding for NASA (McLane, 2010). If a mission to Mars is not potentially profitable in some

⁶ Author was not found when citing this source.
form, the government may be reluctant to fund the project. This is a reflection of market based thinking in public policy.

If the program or mission achieves other goals, the public may find it necessary (McLane, 2010). When the country entered the space race the United States was not looking ahead to a time in which a commercial launch industry would be profitable, but rather was trying to beat the Russians in the Cold War. Currently, the country does not have a military/political reason for space exploration similar to that of the fifties and sixties (i.e., to win the space race). Profitability is the only current driving force as market theories suggest it should be. This problem has caused NASA to suffer budget cuts in the past and may well produce more cuts in the future. Alternatives to chemical rockets may be needed for the Mars mission but currently NASA is not even working on any alternatives to chemical propulsion for its future missions (Rapp, 2006).

It is impractical to think that a mission to Mars can or will be launched directly from Earth. The majority of the fuel used to launch a spacecraft into space is used to escape Earth’s gravity well. This can be avoided if a mission to Mars is launched from LEO by launching parts of the spacecraft into space from Earth and assembling the spacecraft in space. This solution will reduce the cost and the amount of fuel needed to go to Mars because it will no longer need the fuel to escape Earth’s gravity well.

7. Conclusion

The main conclusion is a manned mission to Mars should not take place until unnecessary risks are solved and until NASA can receive more funding. Currently, NASA’s main objective is safety. Until NASA solves the issue dealing with radiation, a mission to Mars may be too risky for humans. NASA will not allow a person to go into interplanetary space without understanding the consequences associated with Galactic Cosmic Rays and long duration flight. A mission to Mars is also impractical due to the time it takes. Until an astronaut last as long or longer in space than the expected time of a manned mission to Mars, it would be irresponsible for NASA to risk the outcome of such a long stay in space. NASA is not going to receive funding for the total cost of the Mars mission until these issues are solved.
The results of the paper show benefits of a manned mission to Mars if the issues discussed above and in the paper are solved in future. To achieve a manned mission to Mars, the investment into technological improvements will be needed and these improvements will spill over into fields outside of space flight. These achievements have occurred before and have caused technological advancements outside of NASA. A manned mission to Mars could also cause major discoveries of what lies inside the Martian environment. Since Mars has a similar day-night cycle, it would be interesting to find out why Earth’s neighboring planet is so different from itself. These discoveries could explain Earth’s past or help its future. These discoveries could only occur with extensive manned research on the planet.

In conclusion, Steven Hawley⁷ (2010) says it best, “I have no doubt that there would be an abundance of volunteers. I would not be one. However, humanity’s future is beyond low-Earth orbit and to be one of the individuals to take humanity’s first steps on another planet as part of a well-considered program of exploration is worth accepting an amount of risk appropriate to the historical nature of the quest.” There are necessary risks and impractical ones. The current condition and research leads to the conclusion that, without finding solutions for the unnecessary risks, a manned mission to Mars is impractical.

References


⁷ Steven Hawley is a retired NASA astronaut.


