Human Space Flight

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For centuries, human beings have dreamed of traveling to the stars. The development of rockets in the 1940s intensified the interest in space travel, which had been popularized in the nineteenth century by science-fiction writers such as Jules Verne. The commercial movie industry began capitalizing on the concept of space travel in the early 20th century; the launch of Sputnik in 1957 and Yuri Gagarin's flight shortly after in 1961 further boosted the world's fascination with space flight. Today, outer space-related science-fiction movies and books continue to be money-making ventures.

Like most people, I grew up enjoying fictional space travel entertainment that portrayed space journeys as something achievable, full of adventure, and fun. Many children view fictional space heroes as role models, and they may even have wished to become space adventurers themselves when they grow up. Indeed, some of these children have grown up to fulfill their dreams by becoming astronauts. Most of us merely fantasize about space and hope that human flight to other planets, as well as other solar systems, will become easily achievable sooner rather than later. Unfortunately, this common conviction is far from reality. Long-distance space travel is neither easy nor fun. Because of this reality, there is a school of thought that robotic exploration of the solar system and beyond is preferable to crewed missions, at least for the next few decades. Robotic exploration advocates argue that more science can be gained for the same cost if machines are used for space exploration instead of people.

Although I work in the space industry, I have no special expertise with human spaceflight. I do know that the technology is mature for robots to explore the far reaches of the solar system. We have visited every planet in our solar system at least once; and in some cases, such as Mars, our spacecraft have visited many times using orbiting, landing, or flyby missions. We have landed a probe on Titan, the distant moon of Saturn. In 2015, a New Horizons spacecraft will visit Pluto, once considered to be our ninth planet. (Astronomers no longer consider Pluto a planet; after the discovery of similar worlds deeper in the distant Kuiper Belt, they reclassified Pluto as a dwarf planet.). Voyagers 1 and 2, launched in 1977, are now in the "heliosheath"—the outermost layer of the heliosphere where the solar wind is slowed by the pressure of interstellar gas. Both spacecraft are still sending scientific information to Earth about their surroundings. Clearly, we have plenty of evidence that machine-based exploration of the solar system and beyond is feasible with the technology and funding currently available.

Crewed space travel is different. At great expense, we have been to the Moon. Also we have built and maintained a space station. But after decades of space presence, no human has escaped the gravity of the Earth. Granted, we have successfully demonstrated zero-gravity existence for periods of several months—note that both the Moon and the international space station are bound to Earth by its gravity. Still, we do not yet even have a plan to land people on a nearby planet like Mars.

A few years ago, I attended a talk by a NASA astronaut who had been to the international space station. I do not remember exactly how long his trip lasted, but it must have been on the order of weeks, or possibly months. He discussed the trip to the station and commented on what it would take for a person to travel to Mars. His remarks were eye opening, at least for me.

Before I share the highlights of his talk with you, I would like to point out the main obstacles to a safe human voyage to Mars. Unless propulsion technology changes dramatically, a round-trip journey to Mars takes more than two years. To save fuel, only certain windows of time can be used for traveling to and retuning from Mars; these windows are determined by the relative positions of Earth and Mars. Outside the Earth's atmosphere and its magnetic field, a spaceship is subject to brutal radiation, mostly generated by the Sun and by cosmic rays. The radiation is lethal, and the charged particles can leak through the ship's protective skin. Although the intensity of harmful radiation is significantly reduced inside the spaceship, long-term exposure is hazardous and could cause permanent health problems for an astronaut going to Mars. A less likely but still real danger is the presence of meteors and other small-sized space objects moving at very high velocities. A spaceship hit by such a fast-moving object could be damaged or permanently disabled.

Perhaps one of the biggest obstacles for long-term spaceflight is the lack of gravity, which causes drastic bone and muscle loss for the human traveler. Going back to the NASA astronaut's talk, we learn that in spite of rigorous daily exercises, an astronaut returning from a space station visit of only a month or so is unable to stand up for a while—the returning astronaut needs a few days before resuming normal life activities. Even for trips that last only a week or two, it takes a while for the astronaut to get back his or her correct sense of balance. Therefore, after a long trip, a returning astronaut may not be able to exit the capsule without assistance from the staff on the ground. The speaker then posed the question: "Who will aid an astronaut landing on Mars?" Apparently, after a seven- or eight-month space trip to Mars, the arriving astronaut will be too weak to exit the space capsule! One may argue that artificial gravity could remove this obstacle. Although this is in principle true, the technology is not readily available. Others postulate that robots may be able to help the newly arriving astronauts on Mars. Again, a solution is yet to be demonstrated.

Another impediment to long space travel is the psychological impact. Can a human being's mind and soul handle more than two years of mostly confined space away from Mother Earth? There is a real chance that even if the astronauts return home alive, their biological and psychological health would have suffered permanent harm. Normal telephone calls to Earth are not practical in a trip to Mars because of the round-trip delay; the one-way delay to Mars varies between 3 minutes and 22 minutes, depending on the relative positions of Earth and Mars. Without real-time contact with Earth, the feeling of detachment from home will be amplified. Finally, what will happen if a member of the space-faring crew contracts a disease? Or if someone is injured due to an accident?

I personally have no doubt that humankind will eventually safely land on Mars and possibly even colonize it in some form or other. However, such a journey is neither easy nor imminent. Many technological, financial, and political issues will need to be addressed before space travel to Mars becomes reality.

In the closing, I would like to share my thoughts on a crewed voyage beyond Mars. The dream of touring the far outer planets of our solar system and their moons, as well as journeying to other solar systems, is, presently, so farfetched that I leave it to Hollywood to address as a subject of entertainment, at least for decades to come.

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