

Preface

Human missions to Mars represent the pinnacle of solar system exploration for the next half-century. In addition to providing a means of exploring Mars, such missions would represent an inspiring engineering achievement and create a new era of expansion of humanity into space. Because such missions would require a major technological effort as well as very large expenditures, they remain for the moment as futuristic concepts embodied in paper studies by visionaries, advocates, and enthusiasts.

As we point out in Chap. 3, David Portree reported that since the 1950s, “more than 1,000 piloted Mars mission studies were conducted inside and outside NASA” and he provided descriptions of 50 of the most developed studies. While a great deal of effort has been addressed on paper to conceptual human missions to Mars, many of these have relied upon technologies such as nuclear thermal propulsion, space nuclear reactor power, large-scale aero-assisted entry descent and landing, and long-life, high-efficiency recycling, and although some work has been done on these technologies, none of them have matured to a point of readiness.

As the decades have passed, NASA does not seem to have closed the gap between paper studies and a realistic human mission to Mars. One of the problems is that Mars is more than 100 times further from Earth than the Moon, necessitating much longer traverse times. In addition, once arriving at Mars, most mission scenarios require remaining on the surface for about a year and a half until Mars and the Earth are oriented propitiously for a return trip to Earth. The entire round trip to Mars and back is then about two and a half years, and there are essentially no abort options. This requires extreme reliability in all systems. A great amount of materiel must be launched and assembled in space. Preparing for a human mission to Mars will require at least two decades of technology development and validation in space and at Mars. The cost of the end-to-end sequence of preparation and implementation will likely exceed \$100 billion.

Despite the many technical hurdles in implementing a human mission to Mars, the greatest impediment seems to be cost. The NASA budget carries with it a number of commitments that preclude adequate funding to mount a human mission

to Mars. The NASA budget allocates only \sim \$3.2B out of \sim \$18B to “exploration systems.” Another \sim \$4B is allocated to the space station, which does not seem to provide much benefit. The NASA science budget of about \$5B is mostly dedicated to the search for extraterrestrial life.

In the world of science and engineering, there is room for both visionaries and skeptics. Visionaries play an important role in imagining what might be and stubbornly pursue a dream that may be difficult to realize, but which in the end, may be achievable. Skeptics identify the barriers, difficulties, pitfalls, and unknowns that impede the path, and point out the technical developments needed to enable fulfillment of the dream.

In the realm of human missions to Mars, there exist a number of studies by visionaries, advocates, and enthusiasts, but there seems to be a total absence of skepticism in this arena. This book represents the first skeptical analysis of human missions to Mars, and it is offered as a counterbalance to the optimism so widely promulgated by NASA, the *Mars Society*, and others.

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