

Exploration of Mars (08)
Mars Sample Return and Human Exploration (2)

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HUMAN MISSION TO MARS: PRE-DEPLOY VERSUS ALL-UP

Abstract

Many different options can be chosen for a human mission to Mars. The pre-deploy versus all-up option is one of them. Historically, the all-up option was first. Von Braun, for instance, proposed a scenario in which 2 giant spaceships are assembled in LEO and then sent to Mars. The major inconvenient of his proposal was the initial mass that had to be sent to LEO (IMLEO). In order to minimize IMLEO, Mars Direct and Mars semi-direct scenarios have been proposed with the idea of pre-deploying a chemical unit (ISRU) on the surface of Mars to produce propellant for the return [1], [2]. The crew is sent to Mars 2 years later while the Mars ascent vehicle is waiting on the surface and is ready for the launch. The idea of sending the astronauts to the surface of Mars with a dry Mars ascent vehicle was indeed considered risky. However, it seems that there has been a change in the perception of the risks. In the last reference architecture from NASA, the pre-deploy option is preferred but the primary justification for that choice is the presence of the Mars ascent vehicle of the next mission. In the all-up scenario, which has also been studied by NASA, that vehicle is indeed not available. In addition, when assessing the risks of the scenario, NASA pointed the risk of using a rather old Mars ascent vehicle in the context of the pre-deploy option. Noticeably, in a recent work, the all-up option has been revisited with a full duplication of the mission to reduce the risks of ISRU failure [3]. We propose in this paper to reopen the debate between pre-deploy and all-up. The impact on other parameters of the mission is examined. The problem is complex and the way we perceive interactions between humans and systems is concerned. The pre-deploy option can be viewed as a bet on pure technology, while the all-up one may be considered a bet on the quality of the synergy between humans and systems.

[1] B.G. Drake ed., Mars Architecture Steering Group, Human Exploration of Mars, Design Reference Architecture 5.0, NASA Johnson Space Center, 2009. [2] R. Zubrin and R. Wagner, The Case for Mars, The Plan to Settle the Red Planet and Why We Must, Free Press, Touchstone Ed 1996. [3] J.M. Salotti, Simplified scenario for manned Mars missions, Acta Astronautica, vol. 69, p. 266–279, 2011.