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Colonization of Mars

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Abstract: - Mars has long been the ultimate goal for human space exploration. This paper will compile research objectives relevant to a Martian presence in an attempt to create a coherent justification for human expeditions to Mars. It will organize these objectives in a balanced human spaceflight architecture driven by a platform of research objectives inclusive of engineering research, pathfinding for commercial operations, and scientific research domains. It will then propose a Martian campaign that allocates sufficient manpower, surface stay time, and equipment to accomplish these objectives. Finally, it will demonstrate how such a campaign is not an Apollo-reminiscent "flag, footprints, and forget about it" venture but is instead a preparation for a relevant, long-term human endeavor on Mars, including linkage of initial Mars exploration to continued exploration of the planet and additional human exploration further into the solar system.

Key Words: — ***Mars, exploration, science, research, life, NSBE Visions for Human Space Flight Working Group.***

I. INTRODUCTION

The human exploration of Mars will be a complex undertaking It is an enterprise that will confirm the potential for humans to leave our home planet and make our way outward into the cosmos Though just a small step on a cosmic scale it will be a significant one for humans because it will require leaving Earth with very limited return capability The commitment to launch is a commitment to several years away from Earth and there is a very narrow window within which return is possible This is the most radical difference between Mars exploration and previous lunar explorations Personnel representing several NASA field centers have formulated a Reference Mission addressing human exploration of Mars This report summarizes their work and describes a plan for the first human missions to Mars using approaches that are technically feasible have reasonable risks and have relatively low costs The architecture for the Mars Reference Mission builds on previous work principally on the work of the Synthesis Group 1991 and Zubrin's 1991 concepts for the use of propellants derived from the martian atmosphere In defining the Reference Mission choices have In this report the rationale for each documented however technology advances or political might change the choices in the future.

II. TARGETED AREAS OF MARS RESEARCH

It is not sufficiently descriptive to list "Mars" as a destination. The NSBE Visions for Human Space Flight Working Group has identified a single location on the planetary surface, an aerostationary orbit, and both of its moons as key destinations, all of which are visited during every human expedition to Mars.

This represents a significant deviation is implied from many other Mars studies, which often take an "either/or" approach. Some have suggested a phased approach where an initial mission is merely a flyby. A subsequent mission may visit a moon, and eventually there are missions to the surface. Advocates of such architectures promote them as a way to reduce overhead. However, it is actually only a delay of overhead. If a surface mission exists in any part of the architecture, then that overhead is by definition part of the architecture. And in actuality it must also by definition either increase total overhead (if all objectives are retained then the total number of surface days cannot be changed, thus adding additional transit flights to the architecture for those missions that do not land on the surface) or it must reduce mission objectives (if total number of launches are held constant then the number of missions including surface landings are accordingly reduced).

The common spacecraft architecture and modified program management, systems engineering, and risk management processes recommended by the NSBE Visions for Human Space Flight Working Group are intended to reduce the overhead of human Mars exploration to where planetary landings can be achieved on all Mars-bound flights. It is worth noting that the same Mars Transfer Vehicle and the same Mars Surface Outpost are reused by all four Mars expedition crews.

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A. Recommended surface outpost site

The recommended surface outpost site for the Mars outpost is Ophir Chasma. A chasma is a deep, elongated, steep-sided depression. Ophir is located near the northern center of Valles Marineris. Named after the Mariner 9 Mars orbiter, Valles Marineris is the largest canyon system on Mars. Located on the Martian equator, it is nearly as wide as the United States, stretching a fifth of the circumference of Mars as shown in figure 1. [18] Ophir Chasma is on the image of Mars in figure 1.

Fig.1. Surface outpost site

B. Martian Moons

Phobos: Phobos has a surface area of roughly 1548 square kilometers [26], making it roughly half the size of Rhode Island. [37] Due to the small size of Phobos it will not be necessary to restrict exploration to any particular location on the moon.

Deimos: Deimos is smaller than Phobos, with a surface area of approximately 483 square kilometers [25], approximately the size of Albuquerque, New Mexico. [36] Like Phobos, the entire surface of Deimos can be surveyed during an expedition if desired.

The recommended Mars orbit is an aerostationary orbit above the Ophir Charisma. This will focus most orbital sensing data on one hemisphere of the planet, but planet wide data can be obtained during inbound and outbound spirals.

III. Engineering Research

A key objective of engineering research is to develop the operational techniques that will be needed to grow the human presence on Mars from small, prefabricated outposts to larger, indigenous complexes capable of accelerating the expansion of human exploration of the solar system.

A. Demonstrate Cost-Effective Systems Engineering Capabilities

It is not possible to send humans to Mars under the dual constraints of the current federal fiscal climate and modern acquisition strategies. [24] We are rapidly becoming a nation that cannot do anything because everything is too expensive. Even the military, which is often viewed as having a luxurious budget, is finding itself unable to meet its goals. The Navy and Marine Corps anticipate having to cut 25 aircraft from FY14 acquisitions, the Air Force plans to eliminate four to five F-35 acquisitions and cut up to 25,000 airmen and up to 550 aircraft, and the Army plans to reduce 45-50 Stryker vehicle acquisitions with additional impediments to other procurement plans. [4] The systems engineering challenge of executing a Mars exploration strategy in the context of parallel lunar and NEA exploration strategies [29] requires radical, innovative changes in NASA acquisition strategies on the order of the radical and transformative engineering development required for the Apollo program of the 1960s.

Executing this architecture will force the development of new systems engineering models [29] and overall increased discipline with respect to both engineering and management processes that will permit the United States to explore complex undertakings in countless domains on Earth and beyond that are presently unaffordable.

B. Surface Infrastructure Development

Structural Shelters: There are four possible paths to building human shelters on Mars: deploy habitats fabricated off planet (Earth), build with component materials transferred off planet, use planetary materials to build shelters, or a combination of the above. Bringing material from earth has the advantage of Earth-based testing, but has the disadvantage of the mass and volume required to transport these materials. Using Martian materials reduces the transportation cost to that required for the fabrication and construction equipment, but does require the development of Mars-based testing capabilities to verify that such shelters are safe for human occupation.

Martian habitats will need to provide radiation protection, thermal control, and structural rigidity, and also maintain breathable atmospheres at appropriate pressure. This may be achieved through the sealing of existing Martian caverns or caves, or may involve fabrication of structures from regolith, iron, or other materials. Research will involve exploration of existing natural features on Phobos, Deimos, and the Martian surface for use as shelters, including the installation of pressure bladders into existing structures as well as methods of sealing natural structures to hold pressure. Additional research involves shelter fabrication on the Martian surface from in-situ resources.

Grading and Landscaping: In addition to building shelters, the surrounding terrain must be properly shaped to provide access to and between shelters, as well as to protect them from weather. Research will include development of techniques for cutting and filling, as well as methods for transport of excess waste, regolith, and rocks. This will enable the development of walkways, bridges, roads, blast deflectors, and dust barriers.

C. Renewable Energy

The initial power for a Mars outpost comes from the Power and Thermal Unit (PTU) [28] deployed with the outpost. (It is beyond the scope of this paper to define whether the PTU uses solar, nuclear or other sources of energy, and is only referenced here to state that to provide power for the outpost.) However, an expanded, long term human presence on Mars will require in-situ power generation capability.

D. Mining and Manufacturing Industries

As previously noted, iron, oxygen, and sulfides are present in the Ophir Chasma region and volatiles are suspected to be present on Phobos and Deimos. Research will involve demonstration and refinement of ISRU equipment to mine and process these resources.

Iron: Iron ISRU research will initially focus on mere extraction of iron, including separation from the various iron oxides. Additional research will include forming this iron into various shapes, including structural members, aerodynamic surfaces, and pressure vessels.

Oxygen: Oxygen ISRU research will pursue oxygen extraction from both iron oxides and the Martian atmosphere. Research activity will also include developing the processes and hardware to incorporate this oxygen into spacecraft propellant and ECLSS oxygen and water supplies.

Sulfides: Sulfide ISRU research will primarily focus on techniques for the extraction of jarosite. Once extracted, the jarosite will be used in the previously mentioned renewable energy research. Consequently, research will also involve exploration of different ways to package the jarosite for use in pyroelectric energy systems.

Volatiles: Phobos and Deimos have long been suspected of harboring volatiles (water, oxygen, hydrogen, etc.) there is no direct evidence to confirm or deny their presence. Thus, initial research on the Martina moons will focus on the search for volatiles. If volatiles are found on Phobos or Deimos, research in subsequent missions will refine techniques for their extraction and storage.

IV. Mission and Systems

Previous studies of human have tended to focus on rather than on what the crew the surface The Reference Mission point of view that surface key to the mission both for science evaluation of the potential for a consequence the Reference allows for a robust surface with significant performance Crews will explore in the outpost out to a few hundred be able to study materials in situ laboratory and will be allowed and modify the exploration advantage of their discoveries In addition key technologies will and demonstrated to test issues potentially imposing workload on the Mars To improve the effectiveness of supporting systems must be reliable highly autonomous and responsive to the needs of the needs may not be anticipated preparation and training which will significantly challenge the management operations systems to support the crew in new situations.

V. Conclusion

The main objective of this research paper is to make the mars habitable with the use of extensive amounts of technologies and make the travel cost as least as possible and also to encourage people to study about mars and make groundbreaking technologies in order to provide help in that.

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