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The Mars imperative: Species survival and inspiring a globalized culture

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ABSTRACT

Humanity has crossed a unique technological threshold enabling self-guided survival, a first in the history of life on Earth. From a human perspective the Earth may be considered as a single interconnected ecosystem, and given our tenuous understanding and control over the environment as well as our own behaviors, ever-looming specters of social collapse or even extinction dictate enacting immediate off-world diversification and self-preservation efforts. Herein, Mars is touted as the most tenable and sustainable location in which to initiate such permanent diversification. Scientific curiosity alone cannot initiate nor drive such off-world settlement and concerted impetus and public support for such an endeavor is shown to be constrained by human attention span. Lastly, the initial act of settlement uniquely serves as humanities greatest globally inspiring self-initiated endeavor, a tangible benefit capable of inspiring generations, connecting cultures and motivating college enrollments and career path choices in science, technology, engineering and math (STEM) in a manner similar to the dawn of human space exploration.

1. Introduction

We begin simply with a fundamental assumption before considering several wider associations, that humans are intrinsically important and somehow worth preserving. This work further presumes that the universe is governed by the laws of probability, which in turn reflect the timing of events and outcomes, both natural and human initiated. Therefore, actions taken for the sake of preservation must be considered in relation to all physical and philosophical constraints. As individuals we perceive reality through a series of unique filters, experiences and emotions, and all too often are moved to action only when directly forced, threatened or provoked. Our long term survival is repeatedly hindered by the difficulties associated with proactively initiating complex endeavors intended to protect from natural or social threats. Whether such actions, designed to insure our survival, are also capable of making the world a better place or not remains to be determined.

Throughout human history, few if any societies or cultures have had such advanced awareness of the multitude of dangers that threaten their existence while at the same time have developed the knowledge and technology sufficient to take the necessary measures to ensure survival. Most of human existence has been mired in mysticism, misunderstanding and hubris regarding the genuine fragility of our biosphere, societies and cultures, no matter what the scale. Our ultimate survival depends on a growing understanding and acceptance of this fragile and tenuous fabric. Over time, how much knowledge has been lost due to human negligence, ego, apathy, strife, social decay or lack of funding (e.g., the loss of the Library of Alexandria and Hattusa or the 221 B.C. purging of scholars and books by Emperor Qin)? How many times in human history must the proverbial wheel be reinvented as a result of our passively expecting others to take steps to ensure our survival? Our species short history is

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exemplified by an inability to learn from its recklessness, lack of forethought, inaction and hubris, wherefore current and future generations repeat history ad nauseam – "those who cannot remember the past are condemned to repeat it" [1].

In addition to human threats to survival (e.g., war, social and economic failure and global climate change), nature itself can impart disasters and catastrophes that affect the survival of our species to an equal or even greater extent – ranging from massive death tolls due to earthquakes, tidal waves and volcanic eruptions, to complete extinction by large impacts. The Earth and life itself may continue to survive, as it has done for billions of years, but it is unclear whether we will remain a part of its tapestry. Probability is not on our side. One of the best ways to protect against such threats is to create a refuge – at a location far removed from the birthplace of humanity. As the author Robert Heinlein once said, "The Earth is just too small and fragile a basket for the human race to keep all its eggs in."

Our species has reached a unique evolutionary and technological confluence which potentially could insure the survival of our species. The settlement of Mars is probably the most viable endeavor that would create a backup for life on Earth, in effect a global-meitosis. Such an endeavor can further provide positive inspiration to individuals on a global scale for decades or more. There are numerous reasons for going to and settling Mars and advocates extend back to before the dawn of human space flight [2–4]; yet, our fascination with this little red-planet runs much deeper, shaped by figures such as Schiaparelli, Lowell, Burroughs, Bradbury and Sagan. Currently, and for the foreseeable future, Mars is the only destination whose environment and accessible natural resources efficiently enable permanent and sustainable human habitation off Earth.

Our current understanding of Mars provides evidence of its preeminence as a second home, and it is only the availability of sufficient quantities of water that makes this possible. Mars evolved out of the primordial solar nebula much as Earth did and therefore has similar composition and features. As a result of its smaller size (~53% of Earth's diameter), lower gravity field (~38% the gravity on Earth) and early rapid loss of internal heat energy, the planet's surface became the cold and dry world we see today. Yet, early in its history and for a short period, Mars is believed to have had a much denser atmosphere, rivers and potentially ancient oceans [5–9]. Over the eons, all surface water was redistributed to various cold traps (e.g., subsurface ice and polar caps) or been lost to space [10]. The Mars Odyssey spacecraft's Gamma Ray Spectrometer used to measure neutrons emitted from below the surface [11,12] and observations from the Phoenix landing site [13] today suggest that near surface ice deposits are ubiquitous across the planets northern lowlands. The ultimate key to success is sustainability and the settling of any other world requires the extraction and use of indigenous resources. It is this remaining ice, among other resources and environmental characteristics that makes Mars the second most habitable and sustainable location in our solar system. Today, prospecting is still required to identify optimal landing sites with sufficiently producible quantities of ice and therefore water. Additionally, ready access to ice allows architects to simplify designs by using the most efficient non-closed-loop technologies available today (i.e., oxygen from ice supplements simpler leaky or non-regenerative life-support systems). Otherwise, exploration and settlement must await the development of complex and expensive closed-loop technologies. Another important aspect, in both getting to and staying on Mars, is having a comprehensive understanding of the dangers and challenges associated with such an endeavor. Many challenges face any Mars endeavor, but the most likely hurdles to implementing permanent Mars habitation include radiation dosage and physiological responses to reduced gravity (occurring primarily during interplanetary transit), surface dust contamination, and large vehicle entry, descent and landing (EDL) operations [14–21]. Years of mission designs and architectures exist in the literature, and many work under assumptions of excessive optimization and risk avoidance [22,23], while others advocate more straightforward approaches [4] in light of limited government support and funding. Ultimately, all hindrances to initiate the settling of Mars are believed manageable and may be overcome in a timely manner given creative, judicious, synergistic designs and architectures [24].

Presupposing Mars as our obvious destination, the only further obstacle to acquiring this unique survival insurance, is ourselves. Critics of space exploration base their argument on the perceived need to solve humanities problems here on Earth first. The probability of a positive global paradigm shift in human behavior or nature is fleetingly small and furthermore, our species has been attempting to solve its ongoing social problems ever since we became a uniquely differentiated and highly social species, more than a 100 thousand years ago [25]. Surely, no one can argue this history. And yet what has become of it; are we, the entire species, truly any better off today than any other point in history? Delaying the migration of our species off Earth only serves to heighten the probability of catastrophe and extinction.

Indecision, obstinacy, ego and shortsightedness generate unending obstacles, which are further hampered by a current unwillingness to accept the risk or to implement and finance programs to completion. Unfortunately, history is replete with examples of exorbitant government spending and waste on projects that were terminated prior to completion.

Contentious and ongoing debate across various levels of government, industry and within the human space flight community further obscures the path that should be taken to get to Mars. For example, is the Moon or another intermediate destination a necessary stepping-stone? Arguments stress that significantly more scientific, technological, and operational advancements and preparation are needed before attempting a Mars mission. Practice landing on and launching from a large celestial body is one such argument; yet, is that not exactly what we do from Earth itself? It has been said that this "logical" path for developing and demonstrating such capabilities is needed in advance of the more distant and risky venture of going to Mars. This author and others resists these assertions, believing rather, that our bureaucratically over-burdened space flight leadership is entrenched in overly conservative beliefs and fearful of risk. Yet, all