



Mars Science and Exploration Working Group Report

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Mars Science and Exploration Working Group

Part of the Next Generation Exploration Conference

Declaration

In Mars, the spirit of exploring an exciting and rewarding new frontier is alive. Mars not only offers a unique destination for exploration, but it is also a critical destination for the advancement of human society and preservation of humanity. The exploration of Mars will provide significant social and technological benefits to enhance life on Earth as well. International cooperation will not only be essential to the success of a human presence on Mars, but development of such interactions will jumpstart collaboration on global issues. The eventual commercialization of space holds tremendous opportunities for economic growth. Finally, there is an undeniable basic human need to explore and define our place in the universe. The overarching theme that ties together all of these reasons for exploration is to inspire and unite the global community to pursue a common cause that is much larger than disagreements over ethnic differences or national borders. Continuous inspiration of the public, the scientific community, and the community of Earth are required in order to explore Mars.

1.0 Introduction

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- 2.2 Scientific benefit of Exploring Mars
- 2.3 Technological development benefits in Exploring Mars
- 2.4 Exploration as need for humanity
- 2.5 Economic benefits of Exploring Mars
- 2.6 The cross-cutting theme: inspiration and unity

3.0 Objectives:

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- 3.2 Society
- 3.3 Exploration
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- 5.3 Raise Public Awareness and Support
- 5.4 Raise Visibility through use of "virtual world" technology

1.0 Introduction

The following two questions were considered during the Mars Science and Exploration working group:

- (1) What are the compelling reasons for exploring Mars?
- (2) What activities are needed to enable a safe and productive Mars campaign?

Properly articulating the “why” of Mars science and exploration at a high level is an important starting point for this activity. The working group established five major themes (science, society, exploration, technology development, economics) and one overarching concept (inspiring and uniting humanity). Each of these themes are discussed in detail below. Recommendations are kept at a high level so that they might remain relevant throughout the lifetime of the program. For example, specific scientific objectives were outlined since it was determined that those details are adequately being assessed by various other science working groups.

In order to achieve science and exploration goals on Mars, there are a number of activities that must be accomplished. There was a strong feeling among participants that great care must be taken to ensure that these activities are well-defined in advance and it is clear when objectives are met in order to move forward. The team felt that a well-defined and publicized plan would help space agencies and the public track progress and remain focused on the road to Mars and beyond. A clear plan will ensure that activities on the Earth and Moon enable ongoing scientific discovery and exploration outside of the Earth-Moon system.

2.0 Themes

Perhaps the foremost question regarding the exploration of the red planet is the justification behind the exploration itself. Much work has been done regarding what science can be achieved on the surface, as well as the necessary engineering challenges to overcome in order to allow humanity to extend its presence in the solar system. However, the more profound questions regarding why the Earth’s energy and financial resources should be spent on such an undertaking has, in the minds of the working group’s participants, not been addressed in a significant way.

The Mars Science and Exploration group at the Next Generation Exploration Conference has attempted to address this question. As a result, the motivations have been divided into five different categories, or themes, that will benefit humanity. These five themes—society, science, technology development, exploration, and economics—are linked with a fundamental cross-cutting, more philosophical theme: inspiring and uniting human society.

2.1 Societal Benefit of Exploring Mars

Earth is currently challenged environmentally, socioeconomically, and by the potential threat of a large asteroid impact; each of these challenges could threaten the survivability of humanity. Human habitation of Mars would decrease the probability of extinction of our species, and promote and encourage the further spreading of humanity’s seed beyond its cradle.

As described previously, the exploration of the red planet would benefit not only the space-faring countries, but all of humanity, in the inspiration it would provide to youth, the international collaboration it would necessitate, and the economic returns in might provide to less-developed countries. As such, the space-faring nations have the societal responsibility to undertake the exploration of Mars for the benefit of all nations, including those that may not currently have the political, technological, or financial capabilities to do so.

2.2 Scientific Benefit of Exploring Mars

Perhaps one of the most fundamental questions that humanity has been addressing since the dawn of consciousness is whether or not we are alone in the universe. In this early stage of the 3rd millennium, it is finally financially and scientifically feasible to seek out the answers to this ageless question. The search for a second genesis of life is within reach. Specifically, the astrobiological clues already discovered on Mars, such as past evidence of liquid water on its surface and potential methane in the atmosphere, make Mars the best laboratory outside Earth to potentially answer this question.

Because Mars is a planet that is less geologically active and has simpler atmospheric dynamics, it would serve as an ideal environment in which to perfect the tools needed to understand the much more complex dynamics of Earth. As such, characterizing the planetary systems of Mars (geology, hydrology, climate, glaciology, etc.) would enable the testing of terrestrial models on Mars to improve their outputs, and hence, predictions.

Whether or not humans can exist beyond the cradle of Earth is still unknown. The physiological response of human activity in different gravitational environments is not well understood. An outpost on Mars (and the Moon, as a precursor) would provide important data in understanding whether or not humanity is capable of sustained living off Earth.

2.3 Technological Development Benefits in Exploring Mars

The engineering challenges necessary to accomplish human exploration of Mars will stimulate the global industrial machine and the human mind to think innovatively and continue to operate on the edge of technological possibility. Numerous technological spin-offs will undoubtedly be generated during such a project, and it will require the reduction or elimination of boundaries to collaboration among the scientific community. It will also foster the incredible ingenuity necessary to develop technologies required to accomplish something so vast in scope and complexity. The benefits from this endeavor are by nature unknown at this time, but evidence of the benefits from space ventures undertaken thus far point to drastic improvement to daily life and potential benefits to humanity as whole.

One example could come from the development of water recycling technologies designed to sustain a closed-loop life support system of several people for months, or even years, at a time, (necessary if a human mission to Mars is attempted). This technology could then be applied to drought sufferers across the world or remote settlements that exist far from the safety net of mainstream society.

2.4 Exploration as Need for Humanity

Human beings are natural explorers. After having mapped the continents, it is only normal that our species looks beyond our sphere into the cosmos. Mars is particularly interesting as a new venture because of its first-order similarities with Earth.

2.5 Economic Benefits of Exploring Mars

The effort to sustain a habitat on an environment inherently lethal to humans will require careful use of local resources. Such responsible use might spur new protocols in energy extraction/usage that could benefit terrestrial exploitation and thus improve the management of and prolong the existence of resources on Earth.

In the long term, commerce with Mars would create new enterprises between the planets, thereby increasing the economic sphere of Earth. Possibilities in tourism, advertising, the transport of raw materials, and improved energy methods are just a few of the many examples that will arise as the economy boosts on Earth.

2.6 The Cross-Cutting Theme: Inspiration and Unity

The misunderstanding and miscommunication among people from different cultures and racial backgrounds are fundamental roadblocks that global society is dealing with in both yesterday's and today's socio-political situations. A global strategy, involving as many people on Earth as possible, must be put on the table to challenge humanity as a whole, which would require the world to collaborate for the successful realization of that event. A major point arising out of the working group's discussions is that international collaboration is not only vital to sending a human mission to Mars, ***but it should be one of the most important reasons for going in the first place.*** The exploration of Mars is undertaken with the idea of eventual settlement for preservation and expansion of the human presence into the solar system. In order to realize such a settlement, it is of extreme importance to think in terms of a "paradigm shift" in the current viewpoints of how the current global society is structured. The next generation of explorers, who will be responsible for the monumental undertaking of exploring the planet Mars, requires that the goal of uniting countries of the globe toward Mars exploration be considered with extremely high priority; it will be critical to involve all of humanity to achieve objectives that claim to be undertaken in the name of all of humanity.

Putting humans on the red planet will be an awe-inspiring event. The collaboration will be technological, educational, philosophical, cultural, and artistic. The international effort of putting humans on Mars will inspire future generations, and perhaps reprioritize global challenges resulting in a greater understanding and respect of our society

3.0 Objectives:

3.1 Science

The NGEC Science theme has five main objectives: 1) Search for past and present life including alternative life forms, 2) Characterize the planetary system of Mars by gaining knowledge of another planetary body in terms of geology, hydrology, climate, and other planetary properties, 3) Understand the history and evolution of our solar system through comparative planetology, 4) Determine human biological limits in particular the

physiological effects of long-term 1/3 G, and 5) Determine the Psychological and Sociology effects of long-term isolation and 1/3 G.

3.2 Society

A human mission to Mars has the unique ability to establish and create many changes to society. NGEC suggests a human mission to Mars to be designed around the philosophy “of the good for all mankind.” The NGEC anticipates five main societal benefits from a human exploration of our Solar System, and in particular Mars: 1) Unite the international community under one common goal, 2) Understand humanity’s place in the Universe, 3) Human preservation and survivability, 4) Fulfill societies responsibility to explore, and 5) Foster a society promoting international cooperation on Mars.

3.3 Exploration

Four main themes comprise the Exploration theme of the NGEC: 1) Inspire current and future generations to look beyond ourselves, our national borders, and our planet, 2) Establish human survivability, sustainable habitation, and long-term presence, 3) Satisfy the natural human desire to explore, and 4) Create a new perspective on humanity and Earth.

3.4 Technology Development

Under Technology Development, the NGEC has two main objectives: 1) Enable sustained human habitation and long-term presence in space, and 2) Utilize spin-offs for Earth preservation and to identify alternative and new energy sources and infrastructures.

3.5 Economics

The NGEC objectives under the Economics theme are: 1) Research new energy developments and resources, 2) Increase resource base and expand the economic sphere, 3) Create new employment opportunities, and 4) Foster commercialization opportunities.

4.0 Issues and Enablers

4.1 Issues:

Sustained Funding: In the past, exploration efforts have faded due to a lack of public interest. The cyclical nature of scientific and technology development funding is detrimental to sustaining a workforce, interest, and infrastructure.

Restrictions to International Cooperation: There currently exists a restrictive set of export controls that limit international cooperation in space science and engineering.

Public Interest: The public often overestimates the amount spent on space exploration and feels that it does not impact their own lives.

Planetary Protection: The difficulty of and regulations associated with planetary protection inhibit many scientific and exploratory goals. The additional resources required to adequately address many of the planetary protection regulations make some types of missions economically infeasible.

4.2 Enablers:

International Traffic in Arms Regulations (ITAR): To engage the global community, it will be necessary to rework or dissolve the ITAR regulations.

Media: More education and communication with taxpayers could convince the public of the utility of space science and exploration.

Committee on Space Research (COSPAR): Review planetary protection protocols to focus on enabling exploration while protecting the pristine martian environment and potential subsurface ecology.

Milestones: Setting clear objectives and exit strategies for exploration will allow continued forward progress without being mired in the status quo. A globally recognized agenda will ensure interagency cooperation.

Commercial: A clear transition plan to commercial interests will allow the private sector to engage from the outset.

5.0 Action Items:

In order to have a successful Moon-to-Mars mission, action must be taken now to gain the support of the global community. Things that can be done now to facilitate this are:

5.1 Political Action

Write or speak to local politicians / representatives to gain their contemporaries' support of the Moon-to-Mars mission.

5.2 Inspiring Our Youth

Inspire the younger generation's interest in the Moon-to-Mars initiative through speaking at conferences, giving presentations to elementary through post-secondary institutions and youth organizations, and organizing programs to educate and excite students.

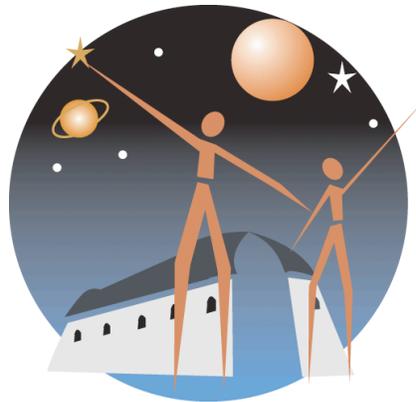
5.3 Raise Public Awareness and Support

Publicize the goal through writing papers to be included in newspapers, magazines, and online publications.

5.4 Raise Visibility Through Use of "Virtual World" Technology

Utilize contemporary media sources, such as YouTube, MySpace, and Podcasts, to raise visibility for the Moon-to-Mars initiative.

Mars Science and Exploration Working Group



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Emerging global space leaders designing
the future of space exploration.

August 16 - 18, 2006

NASA Ames Research Center • Building 3

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Mars Science and Exploration Introduction



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- **Why Mars?**

- Crosscutting Theme: Inspiring and Uniting
- Science
- Societal Benefits
- Exploration
- Technology Development
- Economic Benefits

- **Pre-Mars**

- Clear, distinct Moon-to-Mars plan
 - Long-term lunar base
- Inform and involve general public
- Enhance and foster international cooperation

Crosscutting Theme

INSPIRING AND UNITING THE GLOBAL COMMUNITY

SCIENCE

SOCIETY

EXPLORATION

TECHNOLOGY AND DEVELOPMENT

ECONOMICS



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Mars Science and Exploration Themes



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- **SCIENCE**
 - Search for past/present life (second genesis)
 - Characterize planetary system (geology, hydrology, climate, etc.)
 - Understanding history and evolution of solar system through comparative planetology
 - Human biological limits
 - Physiology: 1/3g, radiation
 - Sociology
 - Psychology

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Mars Science and Exploration Themes



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- **SOCIETAL BENEFITS**
 - Unite the international community under one common goal
 - Doing something bigger than ourselves
 - The “wow” factor
 - Catalyst for further international cooperation on Earth
 - Understanding humanity’s place in the Universe
 - Human preservation
 - Societal responsibility to explore – any nation/humanity
 - Opportunity to create a society promoting international cooperation on Mars

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Mars Science and Exploration Themes



• EXPLORATION

- Inspire generations to look beyond:
 - Ourselves
 - Our national borders
 - Our planet
- Establishing human survivability/ habitation / long-term presence
- Human exploration
- New perspective on humanity and Earth

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Mars Science and Exploration Themes



• TECHNOLOGY DEVELOPMENT

- Sustaining human habitation and long-term presence
- Spinoffs
 - Earth preservation (tech developments)
 - Identification of alternative and new energy sources and infrastructure

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Mars Science and Exploration Themes



- **ECONOMICS**
 - Researching new energy resources
 - Increase resource base / economic sphere
 - Creation of new jobs
 - Commercialization
 - Human habitation/Tourism

Pre-Mars Responsibilities



- Establish a clear Mars plan without abstract goals, such as: ‘sometime in the future we will go’.
- Define exact goals and objectives on the Moon.
- Advertise this plan to the general public with clear milestones of achievement.
- Enhance involvement of the general public in the Moon-to-Mars initiative.
- Ease restrictions to international cooperation
- Increase coordination between space agencies

Pre-Mars Responsibilities



- Establish long term lunar base with mission similar in duration to Mars base.
- Plan for transition to private lunar base logistical support to allow for better use of global space resources.
 - Private contractors managing operation under government oversight.
 - Allows for both scientific and commercial use.
 - e.g. Antarctica

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Conclusion

INSPIRING AND UNITING THE GLOBAL COMMUNITY

SCIENCE

SOCIETY

EXPLORATION

TECHNOLOGY AND DEVELOPMENT

ECONOMICS



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