



# Mars Settlement and Society Working Group Report

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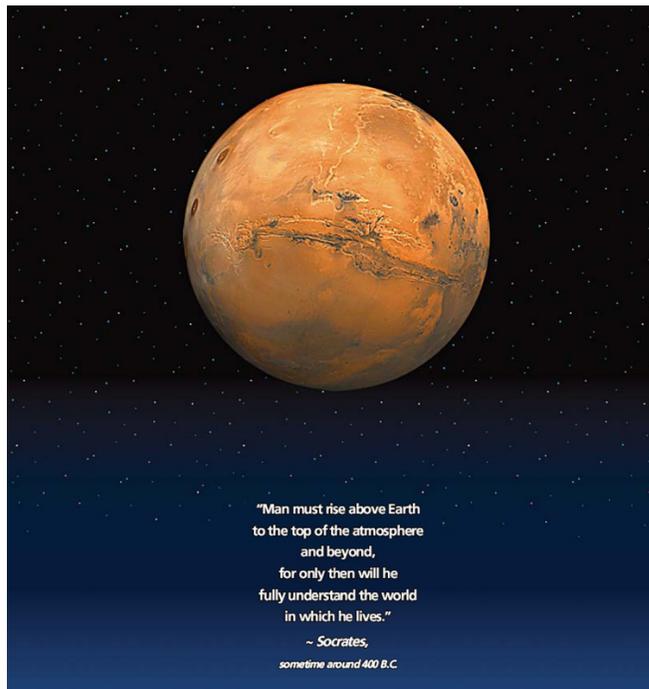


## Mars Settlement and Society Working Group

Part of the Next Generation Exploration Conference

### Declaration

*The long-term implications of space exploration must be considered early in the process. With this in mind, the Mars Settlement and Society Group focused on five key areas: Philosophical Framework, Community Infrastructure and Government, Creating Stakeholders, Human Subsystems, and Habitat Design. The team proposes long and short term goals to support getting to and then staying long-term on Mars. All objectives shared the theme that they should engage, inspire, and educate the public with the intent of fostering stakeholders in the exploration of Mars. The objectives of long-term settlement on Mars should not neglect group dynamics, issues of reproduction, and a strong philosophical framework for the establishment of a society.*



#### 1.0 Introduction:

#### 2.0 Themes:

- 2.1 Philosophical Framework
- 2.2 Community Infrastructure / Government
- 2.3 Create Stakeholders
- 2.4 Human Subsystem
- 2.5 Habitat Design

#### 3.0 Objectives:

- 3.1 Philosophical Framework
- 3.2 Community Infrastructure / Government
- 3.3 Create Stakeholders
- 3.4 Human Subsystem
- 3.5 Habitat Design

#### 4.0 Issues and Enablers:

#### 5.0 Action Items:

## 1.0 Introduction

*“Man must rise above the Earth to the top of the atmosphere and beyond, for only then will he fully understand the world in which he lives.” --Socrates*

Socrates uttered these words over two thousand years ago and they continue to resound in the call to space exploration being rallied by space faring nations around the globe. The expansion of humanity beyond the confines of Earth will enable us to learn more about our fragile planet and to expand on our knowledge of life. While years of technology challenges may stand before us, the long term vision for space exploration looks ever outward to the Moon, on to Mars, and then beyond. Humanity dares to envision a future where not only small groups of scientists explore but where societies flourish throughout the Solar System.

With this in mind the Mars Settlement and Society group choose to look beyond the issues of getting to Mars and instead focused on the ultimate goal of sustainable societies consisting of humans living full lives on Mars. By “settlement” and “society” we envisioned communities living, working, playing, and raising families on the Martian surface. Perhaps creating generations of people to whom Earth is not home – children being born and living their whole lives on Mars. In this future vision, Mars will have its own culture and all of the cultural trappings that make up a society.

This long-view of exploration may seem to stretch into the science fiction realm for some – especially considering the immediate technological hurdles that must be crossed to even get to Mars. However, many aspects of Mars settlement bring to light key technology and science issues that need to be addressed now. For example, if the ultimate goal of space exploration is long-term settlement, issues of reproduction and child development in reduced gravity need to be addressed. Even though the realization of this may be many decades in the future we can begin now with science to explore these issues. Another example is what is commonly called crew selection. In short sortie missions or short-duration stays off-world, selecting the most physically and psychologically fit astronauts is achievable. When we look at families of “colonists” relocating to Mars it becomes more difficult to control these factors. Thinking of this long-term problem now allows us to begin research into psychology, long-term health, and other factors in reduced-gravity.

Some key questions that this team addressed;

- Is there extant, or recoverable, life on Mars that represents a second genesis?
- Can humans survive on Mars for long durations?
- Can long-term human settlements be made self sufficient?
- Can Mars be restored to habitability (Martian ecosystem)?
- Can a breathable, oxygen-rich atmosphere be generated on Mars (Earth-like ecosystem)?
- What are our responsibilities in exploration?

## 2.0 Themes

### 2.1 Philosophical Framework

*ACTION: Develop guiding principles for exploration that will enable humans to ethically explore the solar system and beyond, to understand, protect, expand and preserve all life in the Universe,*

*and to move from scientific-driven exploration to societies, not as citizens of nations but as citizens of Earth.*

As an overreaching goal, a philosophical framework needs to be developed that will enable Mars exploration to move from scientific-driven exploration and outposts to self-sustaining, autonomous societies.

One of our basic assumptions is that humans will go to Mars not as citizens of a Nation State but as peoples of the Earth. Relations between the communities of Humanity (Lunar, Earth, Mars, and Beyond) should be conducted as citizens of a common species and not based on nationalism derived from any specific community.

### *2.2 Community Infrastructure / Government*

*ACTION: Develop and implement the governing structure and community infrastructure that allows for both short and long term Martian exploration and settlement.*

A Master Plan for infrastructure and government will include a wide range of activities including, law, security, settlement layout, utilities and communications, education, and establishing a chain of authority.

### *2.3 Create Stakeholders*

*ACTION: Create and sustain stakeholders through active public interest and ownership in the activities, milestones, and people within the space program.*

The base of stakeholders in space exploration is broad including business, politicians, international partners, media, young people, and the general citizenry. Engagement of these groups should go beyond simply educating them to the technology being utilized to realize spaceflight. Creating a public that is invested and excited about the space program is crucial to success.

### *2.4 Human Subsystem*

*ACTION: Develop and maintain subsystems that enhance the quality of human life in long-duration spaceflight and habitation on Mars.*

The human factor in spaceflight is well documented. With longer missions a long-term settlement these factors become magnified. Areas of concern include human physiology and psychology, nutrition, safety, hygiene, and fitness. In addition, settlements will require expanded social considerations such as a need for privacy, entertainment and cultural activities, and spiritual and/or religious needs.

### *2.5 Habitat Design*

*ACTION: Provide the tools and facilities necessary to enable a sustained human presence on Mars.*

The design of living environments will both support and shape the other factors listed above and many of the objectives are the same (i.e. hygiene, communication, transportation infrastructure, etc.). This theme focuses on the design of the physical resources necessary for sustained settlement on Mars.

### 3.0 Objectives:

#### 3.1 *Philosophical Framework*

**Martian Life – Objective:** Create a philosophical framework for interaction with extant or recoverable life on Mars. **Value:** It is widely accepted that preservation of life is good in all its forms and worthy of respect. This may include plans for the treatment of earth-like as well as second genesis life forms. Mars inherently belongs to its extant population.

**Terraforming and ecosynthesis – Objective:** Create a philosophical framework for the ethical use of terraforming and ecosynthesis. **Value:** The decision to alter existing ecological conditions should be effected by what we find on Mars and not made prior to exploration. Mars does not belong to Earthlings.

**Environment and Preservation – Objective:** Create a philosophical framework the ethical use of the Martian environment. **Value:** An X% of Mars must be preserved intact until our knowledge of it assures that the Martian intrinsic properties are well established and understood. The remaining Y% can be used for human settlement and modified accordingly.

**Military – Objective:** Create a philosophical framework for military and defense activities at a Martian settlement. **Value:** Human presence on Mars will be military free. This shall not prevent the use of military personnel or equipment for scientific research or for any other peaceful purpose.

**Martian/ Earth Relations – Objective:** Create a philosophical framework for the extension of humanity to Mars that seeks to learn from past human experience with parent-nation/ colony relations. **Value:** The frontier occupants of the Mars will not exist as a colony or colonies of the nation states of earth, but as an autonomously governed community(s) of the people of Earth and will serve the highest good of all humanity. When earthlings settle on Mars, Earth will be the mother planet and Mars will be the child. Mars will be Earth-dependent (politically, economically, etc.) until Mars reaches adulthood as determined by the citizens of Mars. Mars will belong to its Martian citizens.

**Human Rights – Objective:** Create a philosophical framework for assuring basic human rights and civil rights across the solar system. **Value:** Human rights and civil rights should not be infringed upon simply based on status as a Martian occupant (Universal Human Rights Declaration).

**Culture – Objective:** Create a philosophical framework for ensuring minimum interference in the development of Martian culture. **Value:** It is the right of the citizens of Mars to develop their own culture independent of outside influence. Martian communities share an organic relationship, functioning together for a common purpose.

#### 3.2 *Community Infrastructure / Government*

**Government – Objective:** Establish a Multi-National Governing Document/ Body (with an established hierarchy). **Value:** The document should be a charter/ constitution that will establish rights, powers, and the governing structure of the community. The organization will be made of multiple nations that will be led by a principal nation.

Standardization – Objective: Establish standard measurements and units. Value: Establish a common calendar, time measurement, unit system, language and finally develop and implement an international Martian reference coordinate system.

Environment – Objective: Adopt an environmental standard. Value: This would control waste management, promote ways to re-use waste, and minimize negative impacts to the environment.

Law – Objective: Create a Community Order of Authority. Value: Derived from the Constitution and the multi-national council a citizen council at Mars will be established. The laws will come from natural and common law.

Security – Objective: Determine regulations on Armaments for security. Value: Derived from the Constitution and the Multi-National council a

Master Plan – Objective: Establish a ‘Settlement Master Plan’. Value: Develop infrastructure layouts, settlement, locations, and overarching plans for short and long term Martian settlement.

Infrastructure and Utilities – Objective: Develop infrastructure and utilities systems on Mars to aid Martian operations. Value: Utilities can include power generation. Infrastructure can include paved “roads” or transportation systems. These are capabilities required by virtually all activities that will be conducted on the lunar surface.

Communication – Objective: Establish communication abilities. Value: Establish a Ka-band from Martian ground to communication satellite via earth for video and audio capabilities. Create communication network on Martian land. Usage will be both technical and personal use: Personal use will be determined by the people/Martian council.

Education – Objective: Develop and establish education programs. Value: Establish orientation program, lessons learned database, develop infrastructure for graduate studies and research

Emergency Services – Objective: Emergency Evacuation. Value: Safety officer on earth/Mars will establish regulations and procedures.

### *3.3 Create Stakeholders*

#### *Economic Stakeholders:*

Businesses / Private Sector – Objective: Open up opportunities for innovative advertising and revenue-generation activities. Value: Reaches to broader audience and creates opportunities for income generation. Also engages political figures based on economic activity potential for constituents.

Commercialization / Privatization of Space Operations – Objective: Define early the plan for privatization. Encourage non-traditional company participation. Reduce red tape and restrictions on leasing or buying government-created infrastructure and operations. Create benefits to space operations and a timeline. Value: Increases private industry involvement

and interest. Reduces NASA overhead to allow for focus on new products & programs. Increases political support of space programs.

International Partners – Objective: Create a mentorship program to include other nations in the development of mission components/operations. Value: Increases the participation in space operations across nations.

Alternative data users – Objective: Open NASA resources/architecture. real-time access to information gathered by spacecraft for use by private companies (Non-governmental orgs) or people for alternate purposes (Google Earth). Value: Creates a new category of stakeholders that are actively interacting with the data streams and gaining economic value from space activities with little upfront cost for the mission operator.

### Public Stakeholders

Media – Objective: Ongoing, Scheduled, Interactive, First person participation. Engage the public with the regular activities of NASA. Value: Keep space activities fresh in the minds of the public. Keep the people updated on missions.

Mission Planning – Objective: Coordinate and publicize mission planning (features), make it interactive with the public. Value: Provide a continuous public view of what is happening and a sustained public awareness of mission events. Make them have an invested interest

NASA / Public Affairs – Objective: Reduce/remove the barriers of self-promotion at NASA. Value: Give NASA an accessible and personal persona as opposed to an “Elite and Distant” organization

Earth-based Citizen Participation – Objective: Plan for and openly prepare for private citizen participation in space activities and research. Value: Creates opportunity for stakeholder participation in science

Fine Arts Community – Objective: Promote and expand the interaction between the artists and engineers to include more art and music in the space program including artist astronauts. Value: Gives a broader spectrum of people access to spaceflight opportunities and engages the public with nontraditional interactions.

Young People – Objective: Elementary and middle-school students that are early-adopters of technology but have limited resources for funding and limited physical mobility round the globe. Value: Next-generation constituents are introduced to space program for workforce sustainability.

Humans in Space – Objective: Broaden spectrum of people “qualified” for space, commercial/private, cultural/artistic, charismatic, medical/scientific. Eliminate the “test pilot” astronaut stereotype. Value: Increases the “culture” factor of missions and enables public to relate to astronauts, can see themselves there,

### 3.4 Human Subsystem

Physiological Effects – Objective: Understand the affects of the integrated Mars environment, in particular partial gravity, radiation and dust on human performance and

human factors. Value: Keeping humans healthy and at peak performance during extended stays on Mars will require an understanding of how features of the Martian environment affects human health, starting from fundamental biological and physical processes. This knowledge will provide data toward understanding the risk present in the system, aiding the design of mitigation strategies. Studies can provide data points for understanding the effects of gravity levels at 1/3g, the effects of the mixed-type radiation spectrum, and the consequences of exposure to unhydrated Martian dust, none of which can be simulated on Earth, enabling the design and development of countermeasures.

Human Development & Adaptation – Objective: Understand the impact of Martian environments on aging, reproduction, and the capability of returning to earth on multiple generations of terrestrial lifeforms. Value: The proliferation of Martian settlements, colonies, and society will depend on our understanding of long term effects of exposure to the Martian environment, specifically aging, reproductions, and returning to Earth. Long term health concerns such as respiration ailments must also be taken into consideration.

Long Term Health Care – Objective: Determine the affects of the Martian environment on surgical procedures, medication potency and production, and other health care issues. Value: The creation of pharmacies and other long term health care facilities must be preceded by research on the effects of 1/3g on medical treatments and procedures. The effects of radiation and microgravity on medicine during transit to Mars must also be researched.

Psychological Effects – Objective: The affects of long-term isolation, Earth withdrawal, and time-delay on the psychological well-being of a Mars exploration crew must be researched in conjunction with the establishment of “Martian psychology”. An extended mission on the far side of the Moon (away from the view of the Earth and with limited communication) could serve as an analog to the Mars missions. Value: Ensure the short term psychological fitness of early Martian crew members and the long-term well-being of inhabitants on Mars surface.

Diet & Food Variety – Objective: Determine the optimum diet for Mars missions with respect to health, variety, and ease of preparation in a closed environment. In the future establish agricultural infrastructure for continued food production. Value: A healthy diet filled with variety is critical for the physiological and psychological fitness of crews on short term missions. Developing means to continue the production of food with a habitat and colony is critical to settlement growth and effectiveness.

Safety – Objective: Develop and implement effective systems and procedures for fire, chemical, and lab safety. Value: Safety systems are not only important for the physical well-being of crews, but for their psychological benefit as well.

Microbial Life forms – Objective: Understand the impact of Martian environments on multiple generations of terrestrial life forms that impact human health. Value: Increases our knowledge of risks to human health and concomitantly increases our capability to manage, mitigate, or eliminate microbial risks to human health. Improved understanding of accelerated microbe mutation and virulence may help in the development of anti-microbial therapies for evolving terrestrial microbes.

**Time Delay – Objective:** Determine the effects of time delay on mission operations, communication, and crew psychological health. **Value:** Procedures that work under normal conditions may be ineffective with the time delay experienced on Mars. New methods must be explored.

**Pharmacological Labs – Objective:** The effect of 1/3g on earth-made medicine must be understood in order to establish pharmacological labs on Mars. **Value:** The setting up of a pharmacological lab for production of medicines will be needed long-term for a successful and healthy settlement on Mars.

**Biologically Based Life Support – Objective:** Develop biologically based life support system components to support long duration human exploration missions. **Value:** Successful closure of the life support system with ecologically balanced plant and microbial communities will reduce resupply logistics for extended lunar stays and Mars missions and facilitate significant terrestrial benefits, particularly in waste management. Additionally, the presence of plants on board may add to the psychological well-being of astronauts during extended missions.

**Hygiene – Objective:** Methods for maintaining effective waste disposal and personal hygiene in a conservation minded manner. Waste management services include the storage, processing, and (if necessary) disposal of human and manufactured waste. **Value:** The maintenance of personal hygiene is critical for crew morale. Waste management and recycling is necessary for the health of the crew and habitat.

**Privacy – Objective:** Ensure that crew members on near term Mars missions receive a fair amount of privacy despite heavy publicity and mission control monitoring. **Value:** The need for privacy is inherent to human nature and must be maintained in order to preserve crew morale.

**EVA Equipment – Objective:** The development of lighter and more maneuverable EVA suits that can be used effectively in Martian gravity. Recreational EVA suits should also be developed. **Value:** The ability to perform effective and comfortable EVAs for both scientific missions and recreation.

**Implement a Communication Infrastructure – Objective:** A communication infrastructure is a necessity of a Martian settlement in order to enable the use of telemedicine, GPS, telecommunication, and the internet. **Value:** It is important to develop a communication infrastructure for long-term settlement of Mars that enables inter- and intra-planetary communications. During early exploration efforts, a short term installation of satellites around Mars would enable settler access for intra-colony communication.

**Environmental Monitoring – Objective:** Environmental monitoring allows for the local prediction of weather, radiation, solar events, and dust storms. **Value:** Prior knowledge of local environmental conditions may influence the location of habitat establishment.

**Maintaining Personal Links – Objective:** Telecommunication will become a method for Martian citizens to maintain personal links with their earthling relatives, as well as

engaging Earth's public by keeping them involved in Martian activities. Value: Maintaining personal links is beneficial for the psychological well-being of the crew and new settlers. Public engagement ensures Earth's support of current and future missions.

Crew Composition – Objective: Utilize a moon analog of crew selection in order to determine ideal crew composition with regard to both profession and psychological frame of mind. Value: Moon analogs used for experimental crew compositions can lead to improved group dynamics and increased productivity.

Exploration Astronaut Corps – Objective: Initial crew composition should include humans who have both a vested scientific interest en-route (scientific experiments) as well as highly-developed maintenance skills. Value: To ensure mission success while maintaining high crew morale during transit to Mars, the initial exploration crews will need to have a vested scientific interest and knowledge to keep the vehicle operating smoothly.

Commercial Astronaut Corps – Objective: A commercial astronaut corp may consist of private individuals selected and specially-trained to perform duties on the Martian surface and eventually form new civilizations in Mars. Value: Transferring astronaut selection and training to the commercial sector may increase the number of astronauts able to travel to Mars by decreasing government involvement in the process.

Sports for fitness and health – Objective: Astronaut crews will need to minimize the effects of long-duration space flight through strength training and sports. Value: Techniques can be developed to reduce the amount of muscle atrophy that may occur at micro gravity. A greater amount of data can be generated and sent back to Earth from 6-month travel to Mars.

Sports for entertainment – Objective: New Martian societies can create new organized sports at 1/3 g. Value: Fun recreational sports, such as gymnastics, quidditch, human powered flight, and other Martian sports can be envisioned because of its lower gravity. Initially, these activities may simply be stimulating recreational activities for crews. Over time, these activities may grow into full-scale tourist destinations that offer a unique experience for paying customers.

Entertainment and Cultural Activities – Objective: Provide arts, entertainment, and recreation (art, literature, gardening, etc) and other leisure activities for those living on Mars. Value: Arts, entertainment, and recreation maintain the psychological well-being of people working in high-stress environments and over a long period of time will be of great value. Recreation and entertainment can be an added attraction for Martian settlers and tourists.

Spiritual and Religious Activities – Objective: Spiritual activities for mental well-being and relaxation must be accommodated. Value: Meditation, prayer, and other spiritual activities for crew mental health.

### *3.5 Habitat Design*

Science Support – Objective: Systems and facilities will need to be set up and maintained for scientific research studies. Value: Scientific studies will be the grounds for initial efforts

performed on Mars and will serve as test beds for future communities and industries.

**Maintenance – Objective:** Provide tools and parts for the repair and preservation of facilities. **Value:** Providing tools and resources necessary to maintain facilities is critical to a self-sustaining community.

**Industry – Objective:** Lay an infrastructure such that, when industry nucleates and expands, systems will be in place to support industrial operations. **Value:** Industry will be a result of initial scientific efforts and has the potential to sprout economic infrastructure in the infant Mars community. It will be important to lay the groundwork where industry can take root and spread.

**Power – Objective:** Provide power generation capabilities, storage, and redundant power sources. Alternative power sources (solar, fuel cells, nuclear) may be necessary. **Value:** Power will be a basic necessity for virtually all activities on Mars.

**Communication – Objective:** Create an infrastructure which provides communication within the outpost, and between outposts, orbital assets, and other bodies. **Value:** Communication systems and information relays will be vital to sustaining scientific research, long term survival, and the physiological well being of Mars inhabitants.

**Computer Systems – Objective:** Create a technology and computer infrastructure/network which controls the previously listed systems. **Value:** Computer infrastructure and networks will be a basic necessity for many activities on Mars.

**Surface Transportation – Objective:** Develop vehicles, such as rovers, to enable humans to transverse the surface of Mars. **Value:** This capability will be important for activities such as mining, exploring, scientific experimentation, and other mobile activities.

**Launch/Escape – Objective:** Provide inhabitants transportation to access to orbit or journey to Earth and other bodies. **Value:** Launch capabilities will be necessary to facilitate crew rotation, maintenance, emergency evacuations, etc.

**Medical – Objective:** Provide materials and equipment for human health monitoring and care required for health, survival and work efficiency. **Value:** Medical care is a basic human necessity.

**Fire detection and suppression system – Objective:** Provide a system able to detect fire through flame, smoke, etc. and initiate suppression techniques. **Value:** Will minimize risk for crew and equipment.

**Thermal control system – Objective:** Provide a system to monitor and control temperature levels of internal environment and equipment. **Value:** Necessary for crew survival and work efficiency.

**Hygiene materials and equipment – Objective:** Supply materials and equipment for human hygiene. **Value:** Necessary for crew health and work efficiency.

Initial Food & Water Sources – Objective: Provide initial delivery of food and water. Provide resources and supplies to create renewable sources of food and water. Value: Initial food and water supplies will need to be carried from Earth. Provisions will need to be made to create renewable and regenerative supplies for a self-sustaining community.

Renewable and regenerative food sources – Objective: Provisions will have to be in place to support renewable and regenerative sources of plant and animal matter for consumption. Value: Food is a basic human necessity. Proper nutrition is essential for ongoing sustainability.

Renewable/regenerative sources of water – Objective: Use of a similar system like what is currently available can be adapted for the Mars “ecosystem”. Value: Water is a basic necessity for all life in the habitat.

Waste management facilities and processing – Objective: Use of a similar system like what is currently available can be adapted for the Mars “ecosystem”. Value: Recycling of waste products will evolve into part of the water regeneration aspect of a sustainable “ecosystem” and is also “ethically” important.

Primary and redundant oxygen supplies – Objective: Use of a similar system like what is currently available can be adapted for the Mars “ecosystem”. Value: Oxygen is a basic necessity for all life in the habitat.

Primary and redundant “make-up” gases supplies – Objective: Use of a similar system like what is currently available can be adapted for the Mars “ecosystem”. Value: “Make-up gases” are a basic necessity for all life in the habitat.

Environmental monitoring system – Objective: For survival, the environment should be analyzed for potential emergency conditions. Value: For both research and survival, the environment – water, atmosphere, radiation, weather, temperature – will need to be observed.

Mission Design/Planning – Objective: Develop an overall “master” plan for the habitat and supporting systems to include current and future goals. Determine proper use of materials, techniques, and practices for constructability and maintainability. Value: Master Planning will be essential to laying out and constructing the most resource efficient habitat possible.

Location – Objective: Determine a location with convenience, practicality, constructability, and environmental considerations. Value: A proper location will be essential for a resource efficient habitat.

Safe Haven – Objective: Develop and implement a structure to provide a temporary refuge for personnel and required resources. Value: Protection from predetermined excessive danger.

Storage – Objective: Both pressurized and non-pressurized protective facilities for resource storage. i.e: warehousing of fuels, materials, equipment and other necessities. Value: Offsite storage facilities, often with separate environment controls, will be required for resources

with special storage requirements or resources that pose potential health risks and should not be stored in primary habitats.

Modular/ Expendable – Objective: Develop facilities and system with the capability for future expansion and technological growth. Concepts to include inflatable facilities or pre-fabricated facilities (ship and shoot). Value: The most economical and growth efficient habitats will be easily expandable, both in accessible room and in systems.

## 4.0 Issues and Enablers

*“When the unknown becomes known, it catalyzes change, stimulating human thought, creativity and imagination.” National Aeronautic and Space Administration Vision for Space Exploration February, 2004*

Through our discussion several issues and enablers became apparent for successful Mars Exploration.

### 4.1 World Community

It was unanimous that exploration of the Solar System will require a paradigm shift in the current climate of international collaboration. Currently, space-faring nations create separate but complementary missions – cooperating and yet maintaining the separateness of their country of origin. We believe that the farther humanity reaches into the cosmos the more necessary it will be to explore as a whole rather than as distinct parts of humanity. Additionally, space exploration is a task that affects all of mankind and therefore must engage traditionally non-space-faring countries. This concept moves beyond “multi-nationalism” and into a realm of pan-nationalism or Earth-nationalism. There are currently laws in place that make this type of paradigm shift difficult (i.e. ITAR).

### 4.2 Public Interest

This topic was also a common theme in our discussions. The “space race” of the 1960’s had a built in motivation that spoke to the public – a race to the Moon. This race was between both the United States and the Soviet Union and with ourselves – to push the outer envelope of human capabilities. This invigorated the public. Today our task is different. We have already proven the capability to put a human on the Moon and we no longer desire for international competition to be the motivating factor. This changes the means with which we must engage the public. Current public relations seem to focus on two areas: telling the public about spin-off technology and inspiring the next generation of explorers. We feel that this should be expanded to include an overarching vision for human exploration into the next frontier and a concerted effort to teach the wonder of science even for those who will not be the “next generation” of explorers. A public with a passion for the space program will not necessarily need to understand the intricate technology involved in getting us there – it will be enough to have them excited about the human achievement of expanding beyond our planet.

### 4.3 Sustainable Funding

An increased public interest will be one way to ensure sustainable funding; however, it is also necessary to shield exploration from the changing tides of politics. Exploration is such a monumental, multi-generational project that constant shifts in direction will ensure failure.

## 5.0 Action Items:

There are many actionable items mentioned in the Objectives sections of this chapter. The major action needed in regards to Mars Settlement and Society is that there needs to be more focus on the issues presented. Planning only for the short-term goals of returning to the Moon will not prepare us adequately for the next step. By creating an international dialogue now about the long-term implications and philosophy of exploration we will help shape necessary today's science and mission goals. This will improve both the return to Moon and the outbound missions.

1. **Continue to engage the next generation.**
2. **Engage a wider variety of viewpoints.** Leaders in ethics, religion, art and cultural leaders, as well as the scientific community will enrich the strategy for exploration. Exploration might be heavily a scientific task but it is a *human endeavor* and input from various areas of society is necessary.
3. **Use diverse communication tools.** The use of new media outlets that appeal to a variety of generations will increase public exposure to exploration. There is an often unspoken expectation that an organization that can put a man on the Moon should be using the latest cutting edge communications channels.
4. **Work with educators** to design curriculum that not only grooms tomorrow's scientists and engineers but also provides an appreciation for human achievement through exploration.
5. **Create and communicate *why*.** Why are we going back to the Moon? Why are we going to Mars? Focusing only on the how and not the why disenfranchises the public.

# Mars Settlement and Society Working Group



## Next Generation Exploration CONFERENCE

Emerging global space leaders designing  
the future of space exploration.

**August 16 - 18, 2006**

NASA Ames Research Center • Building 3

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## Introduction



- *Is there extant, or recoverable, life on Mars that represents a second genesis?*
- *Can humans survive on Mars for long durations?*
- *Can long term human settlements be made self sufficient?*
- *Can Mars be restored to habitability? Likely to be a CO2 atmosphere. Enables ecosystems on Mars.*
- *Can a breathable O2 rich atmosphere be generated on Mars? Enables earthlike conditions.*

## Settlement Themes



- **Human Subsystem**
  - To develop and maintain subsystems that enhance the quality of human life in long-duration spaceflight and habitation on Mars.
- **Habitat Design**
  - To provide the tools and facilities necessary to enable a sustained human presence on Mars.
- **Community Infrastructure/Government**
  - Develop and implement the governing structure and community infrastructure that allows for both short and long term Martian exploration and settlement.
- **Create Stakeholders**
  - Create and sustain stakeholders through active public interest and ownership in the activities, milestones, and people within the space program
- **Philosophical Framework**
  - Develop guiding principles for exploration that will enable humans to ethically explore the solar system and beyond, to understand, protect, expand and preserve all life in the Universe, and to move from scientific-driven exploration to societies, not as citizens of nations but as citizens of Earth

## Human Subsystems Objectives



- **Human Health and Safety**
  - **Getting there:** Moon analog of isolation
  - **Staying there:** Human development; long-term “Martian” healthcare
- **Life Support and Living Space**
  - **Getting there:** Creating varied menus; lighter, dexterous EVA equipment
  - **Staying there:** Biologically-based life support; private space
- **Communication**
  - **Getting there:** Environmental monitoring for habitat location; communication infrastructure
  - **Staying there:** Internet; weather forecasting for safe operations
- **Crew Selection and Composition**
  - **Getting there:** Vested scientific interest AND “maintenance” skills
  - **Staying there:** Commercial astronaut corps?
- **Recreation and Personal Factors**
  - **Getting there:** Sports/strength training for fitness
  - **Staying there:** Culture, entertainment & new sports



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## Habitat Design



**Theme:** To provide the tools and facilities necessary to enable a sustained human presence on Mars.

**Description:** Develop the capabilities and infrastructure required for shelter, life support, transportation and support systems.

**Shelter** – mission design/planning, location, safe haven, storage, modular/expandable habitat system

**Life Support** – food, water, waste, oxygen, makeup gas, environmental monitoring, medical, fire detection and suppression, thermal, hygiene, move to regenerative systems

**Transportation** – surface, escape, umbilical, launch system

**Support** – science, maintenance, industry, comms, power, computer systems

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## Community Infrastructure/Government



- **Establish a Multi-National Governing Document/Body (With an established hierarchy)**
- **Establish standard measurements and units.**
- **Adopt an environmental standard.**
- **Community Order of Authority.**
- **Determine regulations on Armaments for security.**
- **Establish a Settlement Master Plan.**
- **Develop infrastructure and utilities systems on Mars to aid Martian operations.**
- **Establish communication capabilities.**
- **Develop and establish education programs.**
- **Emergency Evacuation.**

## Public Stakeholders



- **Media**
  - Ongoing, Scheduled, Interactive, First person participation. Engage the public with the regular activities of NASA.
- **Mission Planning**
  - Coordinate and publicize mission planning (features) to make it interactive with the public.
- **NASA / Public Affairs**
  - Reduce/remove the barriers of self-promotion at NASA.
- **Earth-based Citizen Participation**
  - Plan for and openly prepare for private citizen participation in space activities and research.
- **Fine Arts Community**
  - Promote and expand the interaction between the artists and engineers to include more art and music in the space program including artist astronauts.
- **Young People**
  - Elementary and middle-school students are early-adopters of technology but have limited funding and limited physical mobility round the globe.
- **Humans in Space**
  - Broaden spectrum of people "qualified" for space, commercial/private, cultural/artistic, charismatic, medical/scientific. Eliminate the "test pilot" astronaut stereotype.

## Economic Stakeholders



- **Businesses / Private Sector**
  - Open up opportunities for innovative advertising and revenue-generation activities.
- **Commercialization / Privatization of Space Operations**
  - Define early the plan for privatization and encourage non-traditional companies participation.
  - Reduce red tape and restrictions on leasing or buying government-created infrastructure and operations. Create benefits to space operations and a timeline for handing over operations.
- **International Partners**
  - Create a mentorship program to include other nations in the development of mission components/operations.
- **Alternative data users**
  - Open NASA resources/architecture. real-time access to information gathered by spacecraft for use by private companies (Non-governmental orgs) or people for alternate purposes (Google Earth).

## Philosophical Framework for Exploration



- The primary goal of space exploration is to understand, protect, expand and preserve all life in the Universe.
- Space Exploration will expand our knowledge to levels which are impossible to achieve if we remain on Earth.
- As an overarching goal, a philosophical framework needs to be developed that will enable Mars exploration to move from scientific-driven exploration and outposts to self-sustaining, autonomous societies.
- One of our basic assumptions is that humans will go to Mars not as citizens of a Nation State but as peoples of the Earth. Relations between the communities of Humanity (Lunar, Earth, Mars, and Beyond) should be conducted as citizens of a common species and not based on nationalism derived from any specific community.



# *Philosophical Framework for Exploration*



The Framework will include philosophy on:

- Interaction with extant or recoverable life on Mars
- The ethical use of terraforming and ecosynthesis
- The ethical use of the Martian environment
- Military and defense activities at a Martian settlement
- The extension of humanity to Mars that seeks to learn from past human experience with parent-nation/colony relations
- Assuring basic human rights and civil rights across the Universe
- Ensuring minimum interference in the development of Martian culture

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## *Conclusions*



**We choose to explore other worlds, establish civilizations, and develop resources in order to ensure the protection and prosperity of all life.**

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