Earth 3.0
Working Group Report

Lead Editors:
Michael Kuss
Erik Lann

Co-Moderators:
Erik Laan
Ting Wang

Rapporteur:
Michael Kuss

Working Group:

Deborah Bazar
Stacey Boland
Pei Chen
Jeeshan Chowdhury
Keith Cowing
Matthew Daniels
Thomas Fesich
Talmon Firestone
Stephanie Gliege
Loretta Hidalgo
Tiffany Hines
Maraia Hoffman
Andrew Hoppin
Nancy Kiang
Matthew Lacey
Karen Lau
Kennda Lynch
Suparna Mukherjee
Barbara Nguyen-Vu
Jon Rask
Christy Ray-Hagenau
Matthew Reyes
Bijal Thakore
Randy Wasserman

Earth 3.0 Working Group
Terrestrial Motivation for Continued Exploration of Space

Part of the Next Generation Exploration Conference

Declaration

We affirm the principle that a viable human space exploration program must be conducted hand-in-hand with a comprehensive scientific research program that incorporates both the physical and life sciences and that continues to protect and extend understanding of our home planet. Without advances in life science, we will be incapable of devising self-sustaining extraterrestrial habitats, and we will struggle to survive on the only living planet we know. Without advances in the physical sciences, we limit our ability to imagine new technologies for space travel and to understand the nature of the universe we explore. Scientific advances expand the boundaries of humanity's dreams.

1.0 Introduction

If not for basic scientific curiosity about the unknown, the Moon would still be known as a supernatural phenomenon rather than a destination. Scientific curiosity drives the continued improvement of living conditions, starting with the industrial revolution that

began after the Renaissance. However, humans of the 21st century are unique in that we are conscious of our capability to change, expand, and sustain our environment, which includes our attitudes, laws, technology, and global community. Consequently, the actual and perceived space in which we roam has expanded.

The following document defines Earth 3.0, outlines the motivation for increased scientific inquiry, describes specific objectives, identifies issues and enablers for reaping benefits, and highlights what is currently being done, or may be done in the immediate future to further the concept of "Earth 3.0." The following document is meant to be a summary of specific topics the authors felt most strongly pertained to the proposed definition of "Earth 3.0" – however, the reader must be cautioned that Earth 3.0 is a largely interpretive concept. As put by a member of the team, "We are challenged, if not crippled, by our lack of communication that relays meaning, rather than vocabulary."

1.1 Definition of Earth 3.0

Earth 3.0 represents the state of planetary affairs in the coming possible futures. Exploration and its associated scientific, economic, and ethical issues will have a major impact on society; therefore, there is a need to understand what could happen, what is likely, and what is desired. Technologies, economies, and ideas of Earth 3.0 are those that are considered desirable. In that regard, Earth 3.0 represents the end, for which space is a means.

1.2 Definition of "Sustainable"

Sustainable, as used in this documents, is defined as those systems (technological, biological, et al.) whose consumables are replenished at the same rate of consumption, or utilize otherwise wasted resources, such as wind and solar. Sustainable systems may be operated indefinitely; sustainable economies and societies are those which may persist indefinitely.

1.3 Current Applications of Earth 3.0 Concepts

There already exist many examples of Earth 3.0 concepts. Whether by coincidence or design, such concepts are already part of the US space program, including but not limited to the regular use of fuel cells and solar power for space vehicles, and regulated land utilization along the Canaveral National Seashore. Another interesting application of Earth 3.0 is "future studies". Future studies are a means for describing what possible futures lie ahead, based upon careful study of past and current trends. Future studies are useful guides to determining the best course of action based on potential outcomes. Further detailed discussion of Earth 3.0 applications can be found in the objectives section.

2.0 Themes: The Space Exploration Initiative and Earth 3.0

2.1 To Explore is Innately Human

Simply put, many existing themes regarding space exploration are justifications rather than reasons to send humans to the Moon and Mars. Often times, excess focus is spent pushing benefits from "spin-offs" and technological benefits. The psychological and societal benefits of knowing humanity is capable of going to, and sustaining a society in the cosmos is just as important, if not more important, than the technological benefits of space travel.

2.2 Pursuing Scientific Activities to Address Fundamental Questions About the Solar System, the Universe, and Our Place in Them

Study of the Moon and current lunar environment and structure will help us learn more about the evolution of our solar system. Understanding long-term effects of the lunar environment on terrestrial life and equipment is a necessary step before embarking on longer, more complex mission to Mars. The moon is also an ideal platform for performing scientific investigation of the Earth and celestial phenomena.

2.3 Foster Creation of Human Communities on the Moon

A lunar community must be created in order to develop the knowledge, capabilities, and infrastructure required to live and work at extraterrestrial locations. The goal of a lunar community would be to develop sustainable growth of:

- the number of individuals the community can support
- duration which humans can stay
- commercialization of lunar resources
- self-sufficiency of lunar operations
- non-governmental activity

The need for lunar self-sufficiency is analogous to the terrestrial need for self-sufficiency. Commercial incentive to develop such technologies already exist, and would be increased from extraterrestrial exploration needs.

2.4 Expanding the Earth's Sphere of Influence Sustainably

Long-term, cis-lunar activity will create new markets that will return economic, technological, and quality-of-life benefits to humankind.

2.5 Engage, Inspire, and Educate the Public

Use an existing vibrant exploration program to excite the public about space, encourage students to pursue careers in high-technology fields, and ensure that individuals enter the workforce with enthusiasm and the requisite scientific and technical knowledge necessary to sustain exploration. The latter should be backed by career opportunities in industry and academia that can also provide short-term and tangible successes and results for the workforce. The average new workers of today are interested in seeing near term results (i.e. within years, versus decades).

3.0 Objectives: What must be done to create Earth 3.0?

3.1 Basic Life Science Research

Summary: While the long-term space exploration objectives are technologically feasible, current understanding of human and biological factors is insufficient to carry out a manned Mars mission. Further research is needed in the following areas:

- self-sufficient engineered ecosystems
- bone and muscle loss
- immune system effects
- genetics and radiation countermeasures
- psychological effects on groups/individuals

Failed attempts to engineer self-sufficient, closed biologic systems that mimic the Earth's ecosystem should serve as a warning that we do not fully understand how our planet's ecosystem works. A funded effort to engineer a truly self-sufficient, closed ecosystem should be a top priority.

Value: The advance of self-sufficient, micro-scale environments represents a more comprehensive understanding of life itself. Such an advance would result in a more robust management of currently uncontrollable biological factors, improving capabilities in disciplines ranging from agriculture to medicine.

3.2 Basic Physical Science Research

Summary: Physical science describes the most fundamental properties of matter that makes up the universe around us. Physical science research expands fundamental capabilities in all scientific disciplines; however, basic science is unprofitable for private stakeholders due to a lack of short-term investment return. However, due to the omniscient benefits to society, responsibility lies in the government to allocate adequate funding for research into basic science.

Value: Research into basic science yields greater knowledge and, subsequently, greater technology. For example, research into nuclear physics may eventually produce a more efficient reactor. A greater understanding of chemistry will provide for advances in biology and medicine. A more in-depth comprehension of the basic sciences will increase our insight in all areas.

3.3 Earth and Space as a Continuum

Summary: Popular belief has always held that Earth and space are separate entities. In reality, both are part of a continuum. One important point of the Earth 3.0 concept is the fact that we can look back and examine ourselves as a species; this unique capability must be utilized.

Value: The conception of a separate Earth and space is detrimental because it confines our presence in space to the status of "visitor". The "Spaceship Earth" idea is a useful visualization because it brings to light the fragility of our environment, and our need to protect it for the future of our children, and the perpetuation of the human species.

3.4 Promote Inter-Agency Collaboration

Summary: NASA's human space exploration program should follow the recommendations of the National Research Council and National Academy of Sciences, and expand space sciences to other research bodies, such as the National Institutes of Health, the Department of Agriculture, and the National Science Foundation.

Value: Complexity of the challenges that must be overcome to execute a successful exploration program makes space, by nature, an attractor for thinkers of all disciplines.

3.5 Freedom of International Cooperation

Summary: While the global political climate invariably changes, the challenges of space do not. Just as space has been shown to be an attractor for the greatest minds from a spectrum of disciplines, it should be inclusive of great minds from all backgrounds.

Value: The global community benefits from space exploration, therefore the effort should be made to maximize the capabilities of the space program by permitting the most competent individuals to contribute.

3.6 How to Include Private Industry to Make Earth 3.0 Economically Profitable

Summary: In order for the space industry to truly progress, the private sector must become more involved. So long as this industry remains dominated by government agencies, it will be crippled by bureaucracy, paperwork, and lack of funding. Activity in the private sector will encourage competition and the progression of better, less expensive technology.

Value: Commercial activity in space will provide more general access to space for all.

3.7 New Ways to Bring Science and Space to the Public

Summary: One of NASA's missions is to communicate scientific knowledge. Since the space program is driven by the public's interest, a more effective way of reaching a constantly-changing audience is needed. Television shows that colorfully explain technical subjects have already been found to be highly successful – why not contract similar private entertainment corporations to produce shows on the work that NASA is already doing?

Value: There is a distressing lack of scientific literacy among a broad demographic of Americans. It is in the nation's best interest to promote and develop scientific and technological leadership. By reaching a larger audience through more relevant programming, NASA can promote this change.

3.8 Preservation of the Space Environment

Summary: One problem of particular interest was the problem of space debris, commonly referred to as space junk. Unchecked, the possibility exists that the collision between two orbiting objects could start a chain reaction, rendering access to space impossible. Because there is currently no practical way to eliminate space debris, it is an absolute necessity that no more debris is created.

Value: The preservation of space is something that all professionals in the space industry must take ownership. The multitude of benefits we reap from space must be protected.

4.0 Issues and Enablers: Are there devices of society that either impede or promote Earth 3.0?

The goal of space exploration is a large one that must be supported by society as a whole. While the benefits of space exploration are widely recognized, there are many other issues that society must deal with on a daily basis. Keeping these things in mind, the following list identifies particular challenges which impede the implementation of Earth 3.0:

- Economic conditions may force governments to cut civilian R&D funding
- Economic conditions may slow the growth of the private space industry
- Lack of understanding may cause uninformed opposition to scientific inquisition meant to improve the lives of everyone
- The perception that Earth and space are separate entities
- Shutdown of Low Earth Orbit access to space due to space debris
- Current lack of understanding how to sustain self-contained ecosystems
- Inertia to change from traditional, non-sustainable energy systems
- Unsustainable urban sprawl and deforestation
- Unsustainable population growth
- Apathy of individuals to take ownership of the Earth they will pass on to their

children
- A more effective means of communication that stresses meaning, rather than vocabulary, is needed
- Under-representation of non-technical communities, such as the arts and humanities, may reduce NASA's ability to communicate with the public

While all of these things represent potential roadblocks, nearly all of the above items can be solved with effective outreach programs that excite and educate the public.

Similarly, certain trends in society are conducive to developing Earth 3.0 in support of space exploration. These include:
- A very strong technically competent domestic work force
- Existing acknowledgement of the so-called energy crunch
- Generally high support of domestic space exploration programs
- A large number of willing and capable international partners
- A huge quantity of currently underutilized, renewable global resources
- The human desire to improve quality of life

If NASA can continue to inspire all generations to learn about science and technology, then the vision of space exploration and Earth 3.0 may be realized.

5.0 Action Items: What can be realized now and what are the first steps in implementing Earth 3.0 on a larger scale?

The potential of Earth 3.0 technologies has yet to be realized. Without a significant change on every individual's part, engineers, scientists, and public officials can create a world in which the quality of life continues to improve *in perpetuum*, motivated by the space program. To do so, a few objectives may be worked on immediately.

5.1 Contract Private Companies to Make Popular Educational Programming

When the Mars rovers landed, NASA's website was on the list of top 10 most visited websites on the internet that week – the public has already shown NASA that they are interested – "Give the people what they want." Times have changed; America is no longer a "starch-and-tie" society. Outreach programs should reflect the times in order to capture the attention of as many citizens as possible.
- Potential exists to capitalize on the popularity of "reality" TV shows – a miniseries about life on the ISS would likely be a big hit
- The idea is to feed minds with scientific knowledge: prime-time programming is the prime opportunity to reach and educate a large fraction of the population
- Invite artists, writers, storytellers, and other non-technical individuals to NASA conferences and events to gain outside perspectives and promote NASA projects
- Sell independent entertainment companies on the idea of making television shows about the inspiring and interesting work that NASA does on a daily basis

5.2 Offer Large-Scale Centennial Challenges

In the past, NASA's Centennial Challenges have been smaller-scale projects, but are continually increasing in size and complexity. One idea is to allocate a portion of NASA's budget for large-scale Centennial Challenges. Innovative concepts, such as "A Dollar to the Moon," could be devised, where companies would compete to design and build a rocket

capable of carrying a crew to the moon on $300M dollars, equivalent to about one dollar for every citizen (reference what Scaled Composites built to win the comparatively small $10M X-Prize). If this project were integrated with a prime-time television series, public interest in science and technology would surely rise, giving NASA the opportunity to educate millions of viewers.

In the end, the goal of the space program is to inspire the next generation to continue expanding scientific understanding and development, which in turn will improve the quality of life for every person on the planet: Earth 3.0.

Earth 3.0 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

Introduction

Earth 3.0 is the next step in the evolution of humanity.

For the first time in history, humans can see our capability to effect change and expand and sustain our environment, including our attitudes, laws, technology, and sense of community.

Consequently, the actual & perceived space in which humans roam has expanded.

Team Members

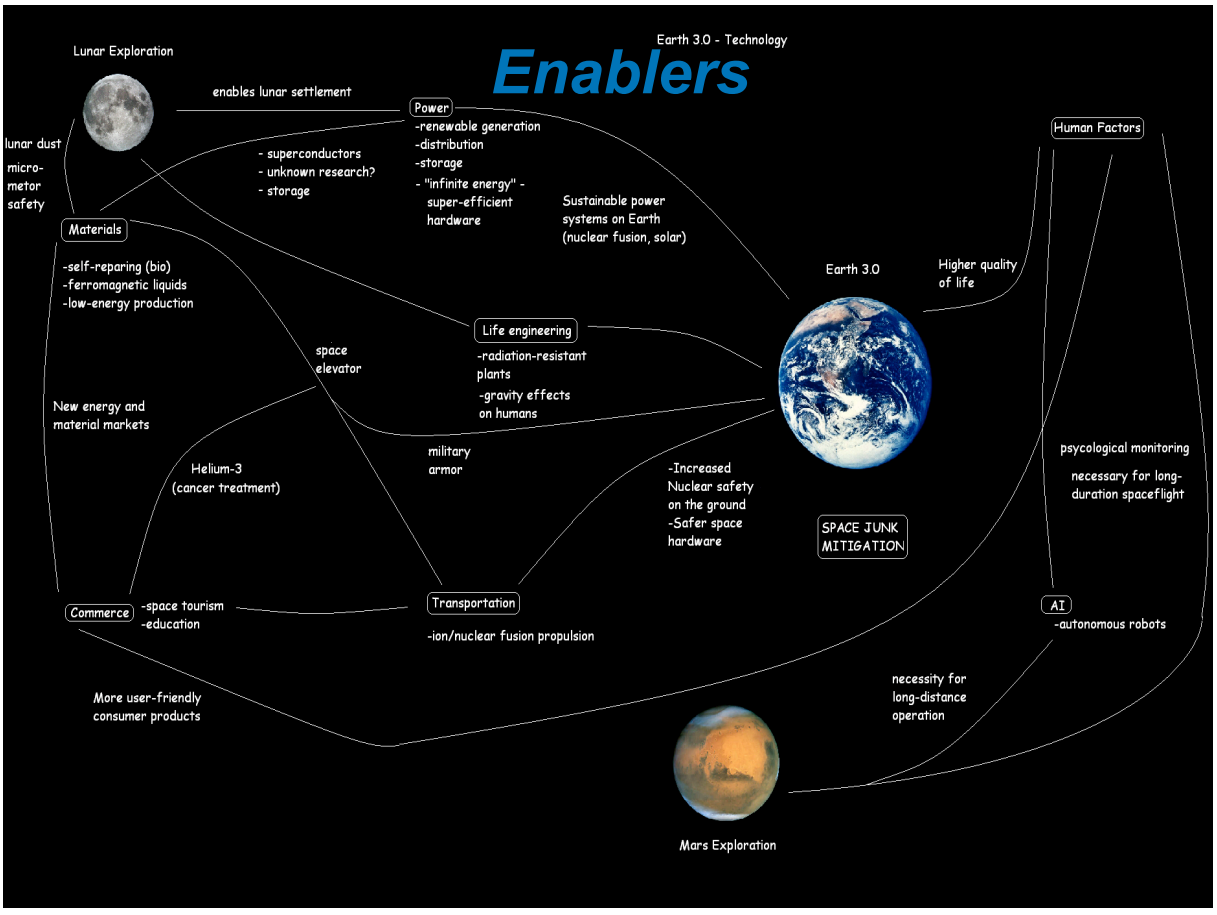
Deborah Bazar
Stacey Boland
Pei Chen
Jeeshan Chowdhury
Keith Cowing
Mathew Daniels
Thomas Fesich
Talmon Firestone
Stephanie Gliege
Loretta Hidalgo,
Tiffany Hines
Maraia Hoffman
Andrew Hoppin
Nancy Kiang
Michael Kuss
Erik Laan
Matthew Lacey
Karen Lau,
Kennda Lynch,
Suparna Mukherjee,
T.D. Barbara Nguyen-Vu
Jon Rask
Christy Ray-Hagenau
Matthew Reyes
Bijal Thakore
Ting Wang
Randy Wasserman

Findings & Recommendations on Global Exploration Strategy

- **NASA needs to carry out the recommendations made by NRC, Next Generation of Space Explorers, and similar advisory bodies**
- **Require key NASA decision-makers to participate in our discussions of vision and future policy**
- **Maintain a standing advisory board to report to top NASA administration on a quarterly basis**
- **Make sustainability of human-nature interaction a fundamental principle of space exploration**
- **Engage other federal agencies to leverage research and development for critical Earth-space technology**
- **Contract public outreach to independent entertainment companies to engage a more general audience**

Cis-lunar Themes

- **Core Theme #0 (currently missing): To explore is innately human.** ***Why? Existing themes are*** *justifications,* ***not*** *reasons* ***for going to the Moon & Mars.***
- **Core Theme #1: Use the Moon as a testbed for Mars** *only* **where applicable.** ***Why? Gives the false impression that we can't go to Mars without going to the Moon.***
- **Core Theme #3: Extend human civilization to other planetary bodies with the Moon as the first step.** ***Why? We don't want settlements; we want civilization.***
  - Drop last bullet; redundant
- **Cross-cutting Theme #2 (description): Unite nations in collaborative pursuit of common objectives by providing a challenging, shared and peaceful global activity.** ***Why? "global security" is vague and can be misinterpreted.***



Issues

- Throughout the conference, it became apparent that we are challenged, if not crippled, by insufficient means of communication
- Abstract ideas and bold visions of the future are all-to-easily discounted as sci-fi storylines or buzzwords - triggering automatic reactions that dismiss even the most profound ideas
- Development of a means to formulate a grand and bold vision, in a forum without immediate judgment or dismissal based on poor phraseology, is critical to nurture future NASA leaders, and encourage them to consider all possible futures
- Non-science and engineering disciplines (arts and humanities) should be represented among lunar astronaut community

Next Generation Exploration CONFERENCE 2006

• Earth 3.0 • 7

Action Items

The next generation of explorers have a vested interest in ensuring the boldest vision of our future as a space-faring society, we propose to meet twice yearly to:

- ***Evaluate potential outcomes associated with NASA's current direction in the context of a broad and long-term vision***
- ***Envision other desirable future outcomes***
- ***Propose specific near-term actions to enable desirable future outcomes***
- ***Actively engage NASA decision makers***

One of our recommendations is to add the focus on Earth back into our vision statements

Next Generation Exploration CONFERENCE 2006

• Earth 3.0 • 8

Earth 3.0 Declaration

We are creating an environment that fosters daring thinking and bold action that is consistent with the limitless spirit of exploration.

Space is inclusive of Earth

Nothing should stop us from dreaming forward

Conclusions

- **For the first time in history, humans can see our capability to effect change and expand and sustain our environment, including our attitudes, laws, technology, and sense of community.**
- **The Next Generation of Space Exploration – Earth 3.0 working group has found a lack of representation from science and humanities – the consensus is that these groups are needed in the discussion future of space exploration.**
- **NASA needs to actively work to change the perception that humans are separate from nature, and Earth is separate from space – they are one and the same**
- **Sustainability is key to human survival on Earth and in Space**